

5th World Conference ON ECOLOGICAL RESTORATION

REFLECTIONS ON THE PAST, DIRECTIONS FOR THE FUTURE



*Book of
Abstracts*

Wild Columbine

AQUILEGIA CANADENSIS

OCTOBER 6-11, 2013 • MADISON, WISCONSIN, USA



CELEBRATING 25 YEARS OF LEADERSHIP IN
THE FIELD OF ECOLOGICAL RESTORATION

5th World Conference ON ECOLOGICAL RESTORATION

REFLECTIONS ON THE PAST, DIRECTIONS FOR THE FUTURE

TABLE OF CONTENTS

Conference Sponsors	3
Conference Organizing Committees	4
SER Board of Directors 2011-2013	6
Board Representatives	6
SER Staff	6
Oral Abstracts	7
Poster Abstracts	198
Author Index	254



5th World Conference ON ECOLOGICAL RESTORATION

REFLECTIONS ON THE PAST, DIRECTIONS FOR THE FUTURE

CONFERENCE SPONSORS

Silver



Landscapes
of Place LLC



Office of Sustainability
UNIVERSITY OF WISCONSIN-MADISON



WORLD
RESOURCES
INSTITUTE



Arboretum
UNIVERSITY OF WISCONSIN-MADISON

Bronze



WILEY

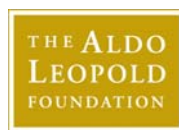
Dolomite

Great
Ecology

The Johnson
Foundation

Wisconsin Coastal
Management Program

Partners



ARBORETUM
University of Wisconsin-Madison



NELSON
INSTITUTE FOR
Environmental Studies
UNIVERSITY OF WISCONSIN-MADISON



5th World Conference ON ECOLOGICAL RESTORATION

REFLECTIONS ON THE PAST, DIRECTIONS FOR THE FUTURE

CONFERENCE ORGANIZING COMMITTEES

SER2013 CONFERENCE ORGANIZING COMMITTEE

Alan Unwin

Niagara College Canada
Conference Chair

Steven Bosak

Society for Ecological Restoration
Conference Vice-Chair

Nancy Aten

Landscapes of Place, LLC
Local Organizing Committee Vice-Chair

Stephen Murphy

University of Waterloo
Scientific Program Committee Co-Chair

Steve Glass

The Restoration Ecology Lab
Local Organizing Committee Chair

Levi Wickwire

Society for Ecological Restoration
Secretary

Steven Apfelbaum

Applied Ecological Services, Inc.
Scientific Program Committee Co-Chair

SER2013 LOCAL ORGANIZING COMMITTEE

Peter Allen

Savanna Gardens, LLC

Signe Holtz

Wisconsin Endangered Resources Bureau
Director, Retired

Donna Paulnock

University of Wisconsin-Madison

Troy Anderson

NES Ecological Services

Evelyn Howell

University of Wisconsin Madison

Autumn Sabo

University of Wisconsin-Madison

Todd Aschenbach

Grand Valley State University

Mrill Ingram

Farley Center for Peace, Justice and
Sustainability

Rocky Smiley

USDA Agricultural Research Service

Nancy Aten (Vice-Chair)

Landscapes of Place, LLC

Joanne Kline

Conservation Strategies Group

Hannah Spaul

The Nature Conservancy

Hilary Carroll

Wisconsin League of Conservation Voters
Institute, Board Member

John Kraniak

Natural Resources Foundation of Wisconsin

Joy Zedler

University of Wisconsin-Madison

Dan Collins

Landscapes of Place, LLC

Craig Maier

Wisconsin Department of Natural
Resources

Sally Gallagher

Wisconsin Department of Natural
Resources

Thomas Meyer

Wisconsin Department of Natural
Resources

Steve Glass (Chair)

The Restoration Ecology Lab



SER2013 SCIENTIFIC PROGRAM COMMITTEE

Sasha Alexander

University of Western Australia

Stuart Allison

Knox College

Steven Apfelbaum (Co-Chair)

Applied Ecological Services, Inc.

James Aronson

Centre d'Ecologie Fonctionnelle et
Evolutive/Missouri Botanical Garden

José Ignacio Barrera Cataño

Pontificia Universidad Javeriana

Elise Buisson

Institut Universitaire de Technologie
d'Avignon

Robin Chazdon

University of Connecticut

Bruce Clarkson

University of Waikato

Beverley Clarkson

Landcare Research NZ Ltd

Jordi Cortina Segarra

Universidad de Alicante

Kingsley Dixon

Kings Park and Botanic Garden

Giselda Durigan

Floresta Estadual de Assis – Instituto
Florestal

Cristian Echeverría

Universidad de Concepción

Steven Emmett-Mattox

Restore Americas Estuaries

Kevin Erwin

Kevin Erwin Consulting Ecologist, Inc.

Kern Ewing

University of Washington

Kris DeCleer

Research Institute for Nature and Forest,
Brussels

Dolf de Groot

University of Wageningen

Thierry Dutoit

l'Université d'Avignon

Bill Halvorson

Sustainable Solutions

Eric Higgs

University of Victoria

Kwi-Gon Kim

Seoul National University

Lars Laestadius

World Resources Institute

Peter Leigh

National Oceanic and Atmospheric
Administration

Robin Lewis

Lewis Environmental Services, Inc.

Junguo Liu

Beijing Forestry University

Stephen Murphy (Co-Chair)

University of Waterloo

Reed Noss

University of Central Florida

Margaret Palmer

University of Maryland

Bruce Pavlik

Royal Botanic Gardens, Kew

Karel Prach

Masaryk University

Dhananjay Regmi

Tribhuvan University

Ricardo Rodrigues

Universidade de São Paulo

Tracy Skrabal

North Carolina Coastal Federation

Jingle Wu

Arizona State University

Joy Zedler

University of Wisconsin-Madison



5th World Conference ON ECOLOGICAL RESTORATION

REFLECTIONS ON THE PAST, DIRECTIONS FOR THE FUTURE

SER BOARD OF DIRECTORS 2011-2013

Steve Whisenant (Chair)
Texas A&M University
College Station, Texas, USA

Cara Nelson (Vice-Chair)
College of Forestry and Conservation, University of Montana
Missoula, Montana, USA

Mary Travaglini (Treasurer)
Department of Environmental Protection, Montgomery County Maryland
Washington D.C., USA

Alan Unwin (Secretary)
Niagara College Canada
Niagara-on-the-Lake, Ontario, Canada

BOARD REPRESENTATIVES

REPRESENTATIVE AT LARGE

James Aronson
Centre d'Ecologie Fonctionnelle et Evolutive/
Missouri Botanical Garden
Montpellier, France

REPRESENTATIVE AT LARGE

Karen Keenleyside
Parcs Canada/Parks Canada
Québec, Canada

REPRESENTATIVE AT LARGE

Kingsley Dixon
Kings Park and Botanic Garden
Perth, Western Australia

REPRESENTATIVE AT LARGE

Robert Daoust
ARCADIS U.S., Inc.
Florida, USA

REPRESENTATIVE AT LARGE

Cheryl Ulrich
Weston Solutions, Inc.
Florida, USA

STUDENT REPRESENTATIVE AT LARGE

Thorunn Petursdottir
Institute of Environment and Sustainability,
European Joint Research Centre
Italy/Iceland

REGIONAL REPRESENTATIVE, MIDWEST NORTH AMERICA

Stuart Allison
Knox College
Galesburg, Illinois, USA

REGIONAL REPRESENTATIVE, ASIA

Samira Omar Asem
Kuwait Institute for Scientific Research
Kuwait City, Kuwait

REGIONAL REPRESENTATIVE, LATIN AMERICA/CARIBBEAN

José Ignacio Barrera Cataño
Pontificia Universidad Javeriana
Bogotá, Colombia

REGIONAL REPRESENTATIVE, ROCKY MOUNTAINS/GREAT PLAINS NORTH AMERICA

Carolyn Jane Einig
Mountain Rivers Institute
Colorado, USA

REGIONAL REPRESENTATIVE, EUROPE

Kris Decler
Research Institute for Nature and Forest,
Brussels, Belgium

REGIONAL REPRESENTATIVE, AFRICA

Clement Ebin
African Ecological Restoration Foundation
Abuja, Nigeria

REGIONAL REPRESENTATIVE, PACIFIC NORTHWEST NORTH AMERICA

James Hallett
Eastern Washington University
Cheney, Washington, USA

REGIONAL REPRESENTATIVE, SOUTHEAST US

Judy Haner
The Nature Conservancy – Alabama Chapter
Mobile, Alabama, USA

REGIONAL REPRESENTATIVE, NORTHEAST NORTH AMERICA

Michael Leff
Davey Institute/ USDA Forest Service
Philadelphia, Pennsylvania, USA

REGIONAL REPRESENTATIVE, WESTERN US

John T. Stanley
WWW Restoration
California, USA

STAFF

Steven Bosak
Executive Director

Leah Bregman
Membership & Communications
Manager

Levi Wickwire
Program Manager

Erynn Hall
Office Manager

Sabina Armstrong-Loscalzo
Conference & Communications Intern

SER Headquarters
1017 O Street, NW
Washington, D.C. 20001
United States of America
(202) 299-9518



5th World Conference ON ECOLOGICAL RESTORATION

REFLECTIONS ON THE PAST, DIRECTIONS FOR THE FUTURE

ORAL ABSTRACTS

Restoration and Management for Damaged Ecosystems in Umm Nigaa in the State of Kuwait

Abdullah, Meshal; Steven Whisenant, Layla Musawi, Rusty Feagin
Texas A&M University

The world's largest hydrocarbon spill, and one of the worst environmental disasters in history, occurred as a result of Iraq's invasion and occupation of Kuwait in 1991. Multiple ecosystems in Kuwait were impacted and contaminated by these spills and associated military activities. As compensation, Kuwait was awarded over \$460 million USD to restore its damaged terrestrial ecosystems and four locations were approved as future protected areas, yet each is currently damaged and restoration needs to be planned. The central objective of our study is to assess and design a restoration plan for Umm Nigaa location. We sought to assess the ecosystem damage using soil samples, topographic maps, and field reconnaissance. We also sought to assess the impact of land cover change in the protected areas using remote sensing products to determine the vegetation change for both the restored and reference areas. To design a restoration framework plan and strategies for the long-term protection of the site, we are integrating social and ecological aspects of this system, and using IUCN categories for planning purposes. As a portion of the overall restoration effort, the re-vegetation of damaged ecosystems will be critical in stabilizing desert surface, possible enhancement of the distribution of rainfall, ensuring the continued viability of multiple endangered species, providing sustenance for endemic wildlife, and alleviating some of the problems resulting from desertification and land degradation affecting livelihood of people and their well-being. Ultimately, the study could also be applicable to the restoration of other damaged similar ecosystems in the future.

Longleaf (*Pinus palustris*) restoration in the southeastern USA: The big picture from The Longleaf Alliance

Abernethy, Robert
The Longleaf Alliance

The longleaf pine (*Pinus palustris*) ecosystem once covered over 90 million acres of the southeastern USA. By the end of the 20th Century, this magnificent forest had been reduced to just 3.4 million acres. Exploited for turpentine and timber; when the forest regrew, fire was excluded and loblolly pine (*Pinus taeda*) dominated the landscape. Longleaf was difficult to plant and grew more slowly than loblolly. Consequently during the last half of the 20th Century most of the remaining longleaf stands were cut and converted to loblolly and slash pine (*Pinus elliottii*). As a result we lost this diverse, open savannah-like grassland habitat containing over 900 endemic species. Twenty-nine species are listed as federally endangered or threatened. In 1995, a small group of professors and researchers organized The Longleaf Alliance to, "ensure a sustainable future for the longleaf pine ecosystem through partnerships, landowner assistance and science-based education and outreach. By 2005, this small group had expanded and included other non-profit conservation organizations as well as state and federal land management agencies. This group initiated, "America's Longleaf - A Restoration Initiative for the Southern Longleaf Pine Forest." This collaboration produced a plan and process to more than double longleaf forest to 8 million acres by 2024. By 2012, we had stabilized the loss of acreage and started to realize an increase. We currently stand at a little over 4 million acres. With all partners working together; we can achieve this goal.

Effects of plant derived smoke solutions on seed germination of ten forage species

Abu, Yusuf; Jim T. Romo, Yuguang Bai
University of Saskatchewan

Exposing seeds to smoke may improve germination. Germination of grass and legume seeds was tested at 10/0°C and 25/15°C under 12h light/12h dark and 24h dark after priming in aqueous smoke solutions (1/1000 v/v, 1/100 v/v, 1/10 v/v, 1/1v/v, 0/1v/v, unprimed control) produced from wheat straw or prairie hay. Germination varied among dilutions, light, temperature, and their interactions, but not between smoke sources ($P < 0.05$). *Astragalus cicer*, *Trifolium ambiguum*, *Stipa comata*, *Stipa viridula*, and *Agropyron smithii* germination did not improve after priming seeds ($P > 0.05$). Priming *Elymus angustus* seeds in 0/1 or 1/100v/v dilutions increased germination 54 to 69% in 24h dark; priming in 1/1000v/v increased germination 40% in 12h light/12h dark. *Elymus junceus* seeds primed in 0/1 to 1/1000v/v had 27% greater germination than unprimed seeds at 25/15°C, but not at 10/0°C. Priming *Dactylis glomerata* seeds in 1/10v/v improved germination about 34% at 10/0°C and 32% in 24h dark; priming in 0/1 to 1/1000v/v increased germination 16% at 25/15°C and 13% in 12h light/12h dark. Priming *Agropyron dasystachyum* seeds did not benefit germination in 24h dark and 10/0°C; priming increased germination 13% in 12h light/12h dark, and 0/1 or 1/1000v/v improved germination 18% at 25/15°C. *Festuca hallii* seeds primed in 0/1 and 1/100v/v had 30% greater germination in 24h dark at 25/15°C; priming in 1/1000v/v increased germination 71% at 25/15°C in 12h light/12h dark. Priming *Elymus angustus*, *Elymus junceus*, *Dactylis glomerata*, *Agropyron dasystachyum*, and *Festuca hallii* seeds in aqueous smoke solutions may improve germination during restoration.

ORAL ABSTRACTS (CONT'D)

Education for sustainable development with a focus on land restoration - what is its impact?

Aegisdottir, Hafdis Hanna; Berglind Orradottir

United Nations University Land Restoration Training Programme

Following the Rio Earth Summit in 1992, focus on education for sustainable development has been highlighted in the international community to give people of all ages, cultures and social classes the knowledge, skills and tools needed to create a sustainable future. In 2005, the UN Decade of Education for Sustainable Development commenced, emphasising the need for the issue. The UNU-Land Restoration Training Programme (UNU-LRT) is an institutional capacity building programme, which offers six-month fellowships to specialists from developing countries faced with severe land degradation. Sustainability is central to all work at UNU-LRT and the training advocates that land degradation should be combated with sustainable and ecologically sound solutions. Moreover, we trust that education for sustainability is a powerful tool to break the vicious cycle of land degradation, food insecurity and poverty. Training has been held annually from 2007 and specialists working at local institutions in countries in Africa and Central Asia have participated. To ensure that the UNU-LRT training meets the needs of its participants and its partner institutions, a survey was sent out to all former participants about the impact of the training. The answers indicated a great impact of the training on former participants' personal and professional skills, and showed increased work responsibilities after participants finished the training. We believe that monitoring and evaluating the quality and influence of the UNU-LRT six-month training programme will ensure that the goals of the training are achieved.

Response of *Haloxylon salicornicum* and its rhizosphere microflora to soils contaminated with petroleum hydrocarbons in Kuwait

AlAteeqi, Sarah; Kevin Murphy, Layla AlMusawi

University of Glasgow

Haloxylon salicornicum has been identified as a potential native plant phytoremediator in Kuwaiti soils polluted by petroleum hydrocarbons. The need for a large scale approach to such remediation emerged after the Gulf War in 1990-1991, where oil pollution seriously contaminated vast areas of desert ecosystem soils. In this experiment a random block experimental design was used to examine the response of the target phytoremediator species to oil-polluted desert soils; with 4 blocks, each with 5 treatments (100%, 75%, 50%, 25% oil-polluted soil, plus clean soil as a control), using 3 replicate one-year old *Haloxylon* plants in each treatment unit. The results indicated the ability of this species to grow successfully in oil-polluted soils. In addition, the rhizosphere microflora associated with *Haloxylon* plants from oil-polluted and clean soil areas of Kuwait was extracted and identified. Various types of fungi (e.g. *Penicillium*) and bacteria (e.g. *Streptomyces*) were present, which have been previously shown to be associated with PAH (Polycyclic Aromatic Hydrocarbon) degradation.

Rangelands beyond agricultural production: a rancher's perspective

Alexander, Ted

Alexander Ranch

The rangeland manager of today has a multi-faceted task different at least in one aspect from the rangeland managers of yesterday. The rangeland manager of today must consider the needs for the ecology, economics, and people, as well as the needs and desires of society. The Alexander Ranch is one of several ranching businesses throughout the nation that makes every effort to balance these ranch and public needs and desires through the application of a comprehensive business plan to balance the ecologic, economic, and people needs of the business. Alexander Ranch strives to create the highest possible ecological state across the entire ranch through the application of an annual grazing plan and a drought management plan. Management decisions concerning stocking rates and degree of use are always based on a desire to achieve a higher biological state on the ranch's ecological sites. The proper application of the M-IG system has created a healthy, highly diverse and productive biota responsible for providing quality habitat for almost every species of amphibian and reptile within the region in addition to high quality livestock forage. Ranch managers of the future will be required to be better stewards of all the natural resources available to the ranch. Tomorrow's ranch managers will need to be more concerned with healthy, highly productive ecological sites, improved soil health, and water quality and quantity than at any time in the past. Change is constant! Ranch managers have to consider the effects of the ranch ecology and economics.

Reinforcement and reintroduction of beetle populations after ecological restoration of a Mediterranean steppe (La Crau, southeastern France)

Alignan, Jean-François; Capucine Fournier, Jean-François Debras, Thierry Dutoit

Institut Méditerranéen de Biodiversité et d'Ecologie (IMBE) - Université d'Avignon

In the last century, human activities contributed to the loss of 80% of the steppe of La Crau. Among these one, the industrial orchard of Cossure was set up in the centre of the plain in 1987 and was abandoned in 2006. In 2009, an ecological rehabilitation project was undertaken and four ecological restoration treatments were used to restore soils, vegetation and their associated entomofauna (Coleoptera and Orthoptera). Soil inoculation, nurse species seeding, hay transfer and topsoil removal were tested. In 2011, beetle communities identified on restored and rehabilitated areas were totally different with the non degraded steppe used as a reference ecosystem except for some typical beetle steppe species which some rare individuals were identified on the former orchard now rehabilitated. Then, it appears that the natural resilience of the typical steppe beetle communities will be extremely slow. In 2013, the aim of our present study was to set up reinforcement and reintroduction of some typical steppe beetle populations (*Asida sericea*, Tenebrionidae and *Poecilus sericeus*, Carabidae). Living individuals of the target species have been caught with pitfall traps and have been double

ORAL ABSTRACTS (CONT'D)

marked. Then, they have been transplanted on different study areas which have been restored (by soil transfer), rehabilitated or on the reference steppe. Beetles have been recaptured to evaluate survival and capture rates on the short term. The first results show that after just some weeks of recapture, the survival rate of *Asida sericea* seems higher than the one of *Poecilus sericeus* whatever the restoration treatments used.

Merging of the Minds: a new breed of ecologist and landscape architect approach ecological restoration

Alleger, Sue Ann

MLA - Temple University

Conflicts between practitioners due to inherent differences in approach and training are inevitable and further complicated by the ecological restoration projects which can fall anywhere along a spectrum of work ranging from natural/wild projects to built/developed projects. A new professional with ecological and landscape design sensibilities is well suited to develop solutions which are ecologically sound and well-designed in this age of increasing environmental degradation and increasing population pressure. The presentation will explore the convergent and divergent approaches of each field using examples gleaned from the ecology and design curriculum at the Temple University graduate landscape architecture program and will provide an example of the new professional to an ecological restoration team.

Above and belowground limitations to grassland restoration in California

Allen, Edith B.; Sara Jo M. Dickens

University of California, Riverside

Major challenges to restoration of California grasslands include the dense seedbank of exotic annual grasses, high rates of reinvasion following exotic plant control, high levels of nitrogen deposition, and the lack of historic reference areas. Often exotic annuals have dominated for so long there is no record of the original vegetation, and the native seedbank has been depleted. Soil nitrogen dynamics have been altered by high levels of anthropogenic nitrogen (N) that increase exotic grass productivity preferentially over native species. Carbon addition to immobilize N and promote native species is only a temporary solution. Legislative controls on N deposition are needed to reduce exotic plant productivity and promote native recovery. Other techniques for control of exotic annuals include spring fires before seed drop, solarization, mowing, grazing, and herbicides, all with short-term success because reinvasion occurs within a few years. Exotic annual grasses also alter soil microbial and chemical characteristics, but these recovered relatively rapidly following restoration, in comparison with other disturbed grasslands that may have more persistent shifts in soil characteristics. The reason for this may be that our invaded southern California soils were not depleted in total C and N, and thus may be resilient to invasion from the standpoint of biogeochemistry. However, restored grasslands are not resistant to continued reinvasion by exotic annuals. In the absence of uninvaded reference sites, the new "normal" for California grasslands is invaded exotic grassland that includes a proportion of native forbs and grasses under continuous management to control exotic seedbanks.

Concluding remarks: The history of ecological restoration: Where has the field been and where might it go?

Allison, Stuart K.

Knox College

As the Society for Ecological Restoration celebrates its 25th anniversary, it is time to pause and reflect on the history of the field. Although we often talk about the academic side of ecological restoration beginning at the University of Wisconsin Arboretum in the 1930s, the history of the field is considerably older and more complicated than that story indicates. During this symposium we examined the long history of activities that constitute ecological restoration. What actions taken in the past would we consider ecological restoration today? How were those endeavors described when originally conducted and why did people engage in them? What kinds of challenges did early restorationists face? How did they meet those challenges? And how can an examination of our history help us meet the challenges restorationists face today and will face in the future? Knowing our history helps us to understand how we got to be where we are today. But it is vital that we use that knowledge, of how we got here, of what worked and what did not work, to help us address the current practice of ecological restoration and prepare for restoration in the years to come. I will summarize the remarks of previous speakers and draw conclusions based on their observations.

ARC: Creating a new systematic approach to wildlife-highway crossings in North America

Ament, Rob

Western Transportation Institute - Montana State University

ARC is an interdisciplinary partnership of government agencies, non-governmental organizations, academics, and private interests working together to facilitate new thinking, new methods, new materials and new solutions for wildlife crossings on our busy roads. North America has over 7.9 million kilometers of paved and unpaved roads. Much of this infrastructure was designed and built in the 19th Century without the consideration of ecological connectivity and wildlife. ARC derives its mandate from the understanding that today's transportation challenges are exacerbated by three critical factors in North America: 1) an increasing population and expanding suburban and exurban development; 2) an aging, deficient and outmoded infrastructure; and 3) a changing climate. ARC seeks to reconnect landscapes and wildlife habitats that have been split apart by our road systems; reacquaint people and wildlife, helping drivers to be aware of the habitats our roads interrupt and the animals that use these places; and reaffirm the need for humans and animals to coexist. Situated at the intersection of science and design, ARC is a forum for creative collaborations and surprising synergies. Presented will be the results by the five finalist teams and winner of the first international competition for wildlife crossing infrastructure design and other findings subsequently generated by ARC.

ORAL ABSTRACTS (CONT'D)

Coating seeds with arbuscular mycorrhizal fungi spores for use in ecological restoration of mined areas by hydroseeding

Amir, Hamid; Nathanaëlle Leclerc, Danielle Saintpierre
Université de la Nouvelle-Calédonie (New Caledonia)

Ecological restoration of degraded nickel mining areas in New Caledonia still necessitate important research efforts. Different revegetation techniques are used; among them, the revegetation by hydroseeding is frequently preferred in sloping areas. As fresh topsoil is generally lacking in these conditions, the associated mycorrhizal fungi are not present. The aim of this study was to find the appropriate technical conditions to coat the seeds with a component containing arbuscular mycorrhizal fungi (AMF) spores. Germination of the seeds of the most used plant species and the AMF spores occurs nearly simultaneously after 3 to 5 weeks. In some cases, a pre-germination treatment of the seeds is necessary. Four plant species, producing seeds of different sizes were tested: *Alphitonia neocaledonica*, *Gymnostoma deplancheanum*, *Dodonea viscosa* and *Costularia comosa*. Alginate, at the concentration of 15 g L⁻¹, was the best coating compound. In these conditions, seed germination was slightly delayed, but without differences in total germination percentage with the non-coated control. The germination of AMF spores was not significantly reduced when compared to spore germination on Millipore membranes. Water pH influenced the quality of the coating and the spore germination percentage. The levels of mycorrhizal colonization obtained with coated seeds are similar to those observed with plants inoculated by spore suspension laid down on their root system. When alginate coat was air dried, seed and spore germination was not significantly reduced.

Land use history and native seed limitation influence the abundance of invasive plant species in an intermountain bunchgrass prairie

Andersen, Kelly M.; Bryan Endress
San Diego Zoo Global

Understanding the factors influencing patterns of non-native plant species abundance is critical to developing and implementing strategies for invasive plant management. Previous land use history can enhance non-native plant species dominance by providing a pathway for introduction of non-native species through propagules, creating optimal habitat through disturbance, and suppressing native plant cover. We examined native and non-native plant cover and soil seed bank communities in relation to land use history in a Zumwalt prairie, an intermountain bunchgrass ecosystem in northeast Oregon. Our vegetation surveys registered 125 native species and 44 non-native species, whereas 26 native and 21 non-native species were recovered from the soil seed bank. Plant community composition in areas with no disturbance history and canyon land use categories were distinct compared to areas that had historical land use disturbance regimes. Native species richness of the soil seed bank and established plant communities were positively correlated, regardless of land use history. Non-native species richness of the soil seed bank was consistent across all levels of species richness of the native and non-native established plant communities and all land use histories. Thus, the native plant community appears to be limited by propagule availability whereas non-native plant community may be limited by other processes, such as biotic resistance. These results suggest that native seed addition may be an effective management strategy to restore areas of more intense land use to the natural bunchgrass community of the Zumwalt prairie.

Organic Matter Accumulation in Reclaimed Soils Beneath Different Vegetation Types in the Athabasca Oil Sands.

Anderson, Jeff K.; Cindy Prescott, Sue Grayston
University of British Columbia

As of 2008, 60,234 ha of boreal forest have been disturbed by strip mining in the Athabasca Oil Sands in northern Alberta. Reclamation of this area is proceeding concurrently with mine operations, and 6,687 ha are considered to be reclaimed by industry (RSC, 2010). Our study has focussed on understanding how vegetation planting prescriptions affect soil organic matter (SOM) accumulation in the mineral section of these soils, and the mechanisms that drive this accumulation, as well as the effects SOM has on the quality of the reclaimed soils. Four research questions were developed: (1) What is the relationship between SOM and cation exchange capacity, pH and nutrients in these soils? (2) Is SOM accumulating quickest in soils under replanted deciduous (*Populus tremuloides/balsamifera*), spruce (*Picea glauca*) or grasses? (3) What are the mechanisms of this SOM accumulation? (4) Does the SOM content of mineral soil differ between reclamation and natural soils? Twenty sites were studied, 5 each of the reclaimed deciduous, spruce and grassland, as well as 5 natural forest analogues. SOM appears to be accumulating fastest under the deciduous trees and slowest at the spruce sites. The SOM content of all reclaimed soils is significantly higher than the natural analogues. The mechanisms by which SOM accumulates differ for each vegetation treatment. RSC (Royal Society of Canada). 2010. Environmental and Health Impacts of Canada's Oil Sands Industry. Ottawa, Ontario: The Royal Society of Canada.

Maintaining diversity in tallgrass prairie: Forb response to white-tailed deer (*Odocoileus virginianus* Zimmermann) browsing.

Anderson, Roger C.; M. Rebecca Anderson, Erica A. Corbett
Illinois State University

We examined changes in forb species abundance, floristic quality, and diversity (H' Shannon) in response to white-tailed deer browsing (1992-2001). Our study site was a species rich remnant prairie in Goose Lake Prairie State Park, 70 km southwest of Chicago, Illinois. Deer densities varied from 32-50 deer km⁻² between 1992 and 1997 and declined to 7-9 km⁻² after hunting was initiated in 1997. We divided the study area into four 24m x 16.5m quadrants (quarter) and used thirty-six 25cm x 25cm quadrats to sample browsed and non-browsed forb stems in each quadrant. After initial

ORAL ABSTRACTS (CONT'D)

1992 sampling, two quadrants were enclosed with a deer proof fence and two were left unprotected. Stem count data for forbs species in protected and unprotected plots each year were analyzed using Detrended Correspondence Analysis (DCA). Axis one ordered samples along a deer browsing intensity/duration gradient. Species stem counts were regressed against sample DCA scores. Five species had significant positive responses to browsing and ten species responded negatively. Forb diversity was highest at intermediate levels of browsing intensity. On a weighted floristic quality index [Coefficients of Conservatism (CC) x Stem Counts], floristic quality decreased with increasing browsing, because browse tolerant and non-browsed species generally have lower CC's than browse sensitive species. Land managers concerned with maintaining tallgrass prairies of high diversity should consider balancing floristic quality with diversity. Moderate to low deer browsing pressure may enhance diversity by maintaining species with low floristic quality that nonetheless are part of the tallgrass prairie flora.

Conservation, degradation and restorability – Ecosystem services, management and land use changes in the south Brazilian grasslands

Andrade, Bianca; Christiane Koch, Ilsi Boldrini, Julia-Maria Hermann, Gerhard Overbeck
Universidade Federal do Rio Grande do Sul

Paradigms and strategies of nature conservation and restoration in Brazil focus principally on forest systems, while grassland or other open vegetation types have been largely neglected. Grasslands in Rio Grande do Sul state, the largest continuous region of grassland ecosystems in Brazil, are increasingly threatened by fragmentation, by unsuitable management and by the invasion of exotic species with consequences both for their biodiversity and for their potential to provide ecosystem services. The goal of this study is to initiate a debate on degradation causes and consequences in South Brazilian grasslands, with the overall objective to get a better understanding of the problems that grassland restoration faces. We verified that the main causes of grassland degradation in southern Brazil are conversion for agriculture and forestry. Total conversion rate of natural vegetation in RS state is 54%. The few studies available regarding effects of forest plantations and crop production on biotic and abiotic variables showed that grasslands do not return to original conditions without assistance and that exotic species may present a problem in restoration. Livestock production can be a tool for grassland conservation as well as the cause of its degradation. High or low grazing pressure can affect biotic and abiotic features, and promote the loss of ecosystem services, however, such areas can be recovered. Studies on effects of grassland management point to possibilities of conciliation between grassland conservation and use for livestock production. Research needs were pointed out to satisfy the needs for a well-founded grassland conservation strategy.

Dispersal, legacy effects, and deer directly and indirectly affect restoration outcomes after clearing and burning

Andruk, Christina M.; Norma, L. Fowler
University of Texas at Austin

The reintroduction of fire to restore encroached savannas and promote hardwood regeneration in woodlands often fails due to exotic species, over-abundant white-tailed deer, and, in central Texas, re-colonization of *Juniperus ashei* after fire. We examined the effects of mechanical removal of *J. ashei*, high intensity burns of the cut material, and deer herbivory on (a) grass, forb, and hardwood cover, (b) individual native and exotic species, (c) number and size of woody plants, and (d) plant community composition pre-treatment and for 2 years post-treatment. These treatments replicated common management practices in the region, and achieved the management goal of retaining the 70% canopy cover required by the endangered golden-cheeked warbler. Ordination found that the burning, cutting, and control treatments produced different assemblages of plant species. Unexpectedly, hardwood cover was lower inside the deer enclosure than outside. An exotic forb, *Lactuca serriola*, dominated the treated fenced plots, suppressing hardwood regeneration. This is problematic as overabundant deer suppress hardwood regeneration. All plants and seeds in the heavily-burned areas were killed; wind dispersed forbs were common after treatment. Legacy effects were important in cut-only areas: the pre-treatment woodland contained small patches of remnant grasses that quickly increased in cover after cutting. However, the dominant invasive grass did not significantly increase post-treatment. In the short term, clearing and burning of *J. ashei* woodland produced small patches of diverse, native-dominated savanna vegetation. These treatments also stimulated hardwood regeneration, which will eventually improve habitat quality for the endangered warbler.

Kissimmee River restoration: Evolution or intelligent design?

Appelbaum, Stuart
ARCADIS

The Kissimmee River once meandered for 103 miles (165 km) through central Florida. Its two-mile (3 km) floodplain of wetlands was inundated for long periods. As part of a flood control project, the U.S. Army Corps of Engineers converted the Kissimmee River into a deep, wide canal, which resulted in significant loss of wetlands and habitat. In 1992, following completion of a feasibility study by the Corps of Engineers, Congress authorized the Kissimmee River Restoration Project, the first large-scale ecosystem restoration project in the United States. The restoration project, expected to be completed in 2015, will restore 40 miles (64 km) of the Kissimmee River and 29,000 acres (11,700 hectares) of wetlands. The author's involvement in the project as a member of the Corps of Engineers began in 1988 – the same year that SER was founded. This presentation will offer a perspective on the evolution of the Kissimmee River restoration project over the past 25 years to the present. It has been a long road, with many growing pains and lessons learned. These include: overcoming policy and authorization challenges, evolving goals and objectives, implementing a Federal-State partnership, and developing an adaptive management program. Kissimmee River restoration is the foundation upon which the Everglades restoration program was built, and Everglades restoration is the foundation for many other ecosystem restoration efforts throughout the world. The maturing of ecosystem restoration, as embodied by the Kissimmee River project, parallels the growth and maturation of SER over the last 25 years.

ORAL ABSTRACTS (CONT'D)

Does a non-native legume used in reclamation of eroded land facilitate or inhibit native species?

Aradottir, Asa L.; Inga Vala Gísladóttir

Agricultural University of Iceland

The use of introduced nitrogen fixers may be an attractive option for the reclamation of nutrient-poor soils in eroded areas. But effective and fast-growing nitrogen fixers can also be strong competitors that alter ecosystem structure and function, and their use may therefore lead to undesirable results. The objective of our study was to assess whether Nootka lupine (*Lupinus nootkatensis*)—an introduced legume that has been extensively used for revegetation of eroded or degraded areas in Iceland—facilitates or inhibits the colonization and growth of native birch (*Betula pubescens*). The study was carried out in four areas of Iceland where lupine was expanding over eroded or sparsely vegetated land. In 1995, birch was seeded or planted in experimental plots that were established inside mature lupine stands, at their edges and on sparsely vegetated soil outside the lupine stands. Survival and growth of birch, lupine abundance and vegetation composition in the plots was monitored from 1995 to 1998 and again in 2011. In some cases the relationship between birch survival (in 1998 and 2011) and lupine abundance (in 1997) was quadratic, i.e. birch survival increased with lupine cover up to about 40-50%, but above that birch survival decreased radically as lupine cover increased. In other cases there was a negative linear relationship between birch survival and lupine abundance. The effects of lupine abundance on birch survival and vegetation composition will be discussed with respect to facilitation and inhibition in succession and their implications for ecological restoration.

Using the forestry reclamation approach to reclaim coal mined to establish *Nothofagus* forest in Chilean Patagonia

Arellano, Eduardo; Patricio Valenzuela, James Burger

Pontificia Universidad Católica de Chile

Surface coal mining in Chilean Patagonian region results in forest and grassland disturbance, altering the landscape and affecting sensitive vegetation naturally adapted to grow in extreme site conditions. Previous reclamation experiences have been focuses on restoring grassland using exotic herbaceous species. There are no local experiences on restoring native *Nothofagus* forest due to poor reforestation practices, soil handling, and species selection. This work includes soil and vegetation assessment developed as a baseline for a coal reclamation project located in Isla Riesco, in the Magallanes and Antarctica Region in Chile. Base on the forestry reclamation approach model, the objectives were to identify (1) microsite conditions that promote tree development, and (2) select surface soil materials in the mining area that have the potential to restore soil productivity and use for vegetation. Despite the high landscape variability, natural forest regeneration occurs on microsite condition where shrubs and native grasses protect the seedling on a initial stage. Soil profile had a surface loam and sandy loam layer with an average depth of 1.5 m. deposited over a clayey glacial till with signs of poor drainage and low pH. Trees and shrubs roots development is naturally limited by the presence of this layer. Surface soil removal to a depth of 1.5 m. followed by the use of a mix of herbaceous, shrubs and native trees using specific microsite conditions increase the potential of reclamation success.

Ecological Mangrove Restoration, a community based project for mangrove restoration in Bay of Jiquilisco, El Salvador

Argueta Pineda, Jose Maria

Mangrove Association

Mangrove degradation in Bay of Jiquilisco El Salvador has different reasons. Mostly aquaculture and wood usage are the facts of destroying mangrove ecosystems. The present study is aimed to start an ecological mangrove restoration project in “El Turco”, a little deforested area of three hectares in Bay of Jiquilisco. As part of the ecological understanding of the site, the participation of local fishermen and shellfish collector will contribute to survey species density, population growth, species richness, hydrology, and the relationship of human activities in surrounding areas of El Turco. Four different plots will be selected to study vegetation and surrounding human pressures. Each plot will be five meter radius and will include species such as *Rhizophora mangle*, *Rhizophora racemosa*, *Avicennia bicolor*, *Avicennia germinans*, *Conocarpus erectus*, *Laguncularia racemosa*. GPS and clinometer will be used to collect information of elevations and slopes as well as measured poles and tapes for measuring trees. Spreadsheet and GIS software will be a tool to analyze species density by using the Kernell method and the other data collected will help to analyze the hydrology of the area. As result, we will plan a restoration plan to be executed by the stake holders.

Near shore and Deep Sea Ocean Restoration: What's what and A Way Forward

Aronson, James; Linwood Pendleton

Centre d'Ecologie Fonctionnelle et Evolutive

An era of expanding ocean industrialization is before us, with policy makers establishing governance frameworks for sustainable management of coastal, near-shore and deep-sea resources while scientists learn more about the ecological structure and functioning of the largest biome on the planet. Missing from most discussions of the oceans, and marine protected areas, is ecological restoration. Multidisciplinary approaches are needed to identify ecologically and economically cost effective ocean, including deep sea, restoration options. At the interdisciplinary Sete Workshop on Deep Sea Restoration, held in October 2012, a set of socio-economic, ecological, and technological decision parameters were developed that might (or might not) favor their restoration. We also adapted the SER Primer's list of attributes of a restored ecosystem to a series of the major ecosystems of the Deep Sea, and elaborated a set of restoration principles for the oceans, including the deep sea. Finally, we enunciated the first call for a scientific research agenda that 1) characterizes the impacts of the growing range of exploitation activities, 2) develops restoration techniques, 3) assesses the costs, benefits

ORAL ABSTRACTS (CONT'D)

and obligations for restoration, and 4) determines where and when restoration of the oceans, including the deep sea, is in the present and future best interests of society.

Workshop: Orchestrating Holistic Restoration: Why and How

Aronson, James; Jackie Brookner, Mrill Ingram
Centre d'Ecologie Fonctionnelle et Evolutive

Many restoration projects are conceived and carried out using only science and engineering. Others focus on economics or aesthetics, and have no particular stake in science or engineering. Yet in order for ecological restorations to be successful and sustainable in the long term, they must draw from a range of fields including the arts and humanities, and the social and political sciences, as well as science and engineering. In most cases, ecological restoration also needs to be sourced from place, embedding and embracing the unique qualities of that place, the heritage of its community and the will of its people. Summing up, ER needs to be holistic. In this workshop we will explore these concepts and how they can be integrated into daily practice. A multidisciplinary panel including professional restoration practitioners, an ecological artist, a restoration ecologist, social scientists, a Lakota Restoration practitioner, book authors, and a journalist long engaged with restoration, will discuss attempts at putting holistic restoration into practice. We will then break into groups to engage in a scenario planning game focusing on restoration projects of varying scales and complexities around the world. Areas of exploration may include how to effectively engage community members in restoration processes; recognizing pertinent ethical issues, and differing meanings and goals given socioeconomic and cultural differences; how to reveal unconscious assumptions and values that are informing goals; etc.

Coordinated by James Aronson (restoration ecologist, France), Jackie Brookner (ecological artist, USA), and Mrill Ingram (social scientist, USA), in collaboration with Keith Bowers (professional practitioner, USA), Linda Different Cloud-Jones (ethnobotanist and restoration practitioner of the Lakota Nation), Pedro Brancalion (restoration ecologist, Brazil), Gary Nabhan (writer, ethnobotanist) & Paddy Woodworth (writer/journalist, Ireland).

The historical reference system: critical appraisal of a cornerstone concept in restoration ecology

Aronson, James; Luis Balaguer, Adrián Escudero, José F. Martin-Duque, Ignacio Mola
Centre d'Ecologie Fonctionnelle et Evolutive; Missouri Botanical Garden - St. Louis

The relevance and viability of restoration ecology as a scientific discipline, and of ecological restoration as a practice, are questioned by those who claim current restoration and conservation goals are somewhat or entirely obsolete in a rapidly changing world. Human-mediated perturbations, and transformation on a grand scale, are widespread, (though often ancient), ongoing and accelerating. Nonetheless, a locally-relevant reference system, which includes cultural elements where necessary, is an invaluable cornerstone concept, a vital tool to sharpen focus and achieve consensus among stakeholders. It provides the key to distinguish ecological restoration -- and the related activity of ecological rehabilitation, which focuses on recovering the ecological functionality of a damaged ecosystem -- from reallocation of a damaged site. Reallocation, via landscaping and creation of 'designer' ecosystems, or the simple acceptance of emerging novel conditions, also has its place in conservation strategy, but it should not be confused with restoration, nor does it replace it. When a created ecosystem is intended to mimic a natural ecosystem, the use of an historically-informed reference model is useful as well. We discuss these concepts, and present case studies from Spain and France to illustrate our approach which includes the conceptual tool of multiple sequential references and the emerging technology of geomorphological modeling. If the appropriate cultural, historical elements are factored in, then a reference can be constructed in a way that makes restoration and rehabilitation more viable and relevant than ever.

Results of variable grass seeding rates on community development in a sand prairie restoration experiment in the Manistee National Forest, Michigan

Aschenbach, Todd; Robb Roos
Grand Valley State University

Sand prairie was a primary component of Michigan's historic oak-pine barrens ecosystem. However, sand prairie has been all but eliminated in the state. Our restoration experiment, established in 2009 in the Manistee National Forest, examines the influence of variable seeding rates of warm season grasses on plant community development. Initial results show that high grass seeding rates (10,000 seeds/m²) have had a positive impact on plant community development by increasing native species cover, richness, and diversity while also decreasing non-native species cover, richness, and diversity. Data from July 2013 will also be evaluated to determine if the positive impacts of this methodology are sustained. Results from this study can be used to elucidate ecologically successful and economically efficient seeding approaches in plant community restoration.

Restoration of degraded drylands in Kuwait

Asem, Samira; Waleed Roy
Kuwait Institute for Scientific Research

Over the past decades, the problem of land degradation in dryland regions have accelerate throughout the world leading to loss of vegetation cover and fertile top soil, increased dust storms and speed up of desertification. Kuwait is no exception to the environmental problems facing dryland ecosystems. One way of responding to increased development pressures in drylands is by setting aside the most sensitive natural or semi natural areas, by establishing protected areas such as national parks, wilderness areas and nature reserves. Protected areas offer opportunities to maintain or restore natural vegetation patterns and to conserve the habitats of wildlife species that are endangered. Protected areas also offer more immediate benefits to human societies, by maintaining a range of critical ecosystem services for example help to protect and maintain: water supply, food security, disaster reduction, carbon

ORAL ABSTRACTS (CONT'D)

storage, drought resistance and cultural survival. In Kuwait five new protected areas are proposed to restore lands damaged by military activities under the of the United Nations Compensation Commission. The total protected area is 1,679.5 Km². A revegetation plan has been developed to restore each area considering soil type and vegetation map units. The revegetation sites were selected by using hydrological modeling.

Management challenges in Western rangelands under a changing climate

Atkinson, Michael R.

US Forest Service

As a public land manager, the District Ranger for the Kiowa and Rita Blanca National Grasslands, I have the challenge of dealing with restoration and resource management decisions on grassland ecosystems related to climate change, including balancing public perception and expectations with agency policies, legislation, and best available science. Another challenge is dealing with the global subject of climate change on a local level. The land I administer lies within the shortgrass steppe of the southern Great Plains on the Kiowa and Rita Blanca National Grasslands. These grasslands encompass approximately 230,000 acres in six counties within New Mexico, Texas, and Oklahoma. These administrative units are not solid blocks of Government owned land; rather they consist of numerous small Government parcels, intermingled with privately owned tracts. The District focuses on managing a widely varied program of work including grazing management, a wildlife program, and a large range of pinyon- juniper management programs, which includes prescribed burning and mechanical treatments. A guiding principle of the US Forest Service Mission is to manage administered lands in an ecological approach. In dealing with issues from multiple uses on public lands an ecological approach becomes more imperative when considering the predicted climate change impacts of increased aridity, seasonal shifts in precipitation and more extreme precipitation events on Western ecosystems.

Bringing back the water: A decade of restoration in the Borderlands

Austin, Valer; David Hodges

Cuenca Los Ojos Foundation

CLO is working cross border in Arizona, and Sonora, Mexico. This area is semi-arid and receives monsoon rains in July and August. It's possible to receive 45% of the annual rainfall in one event. Harvesting water therefore becomes an important objective. Many streams are seasonal and, depending upon the watershed, can go from dry to flooding within an hour. Historically, a large cienega (wetland) complex was found in the region (Rio San Bernardino watershed) and was a major stopping place for migrating birds and animals. By the early 1900's these cienegas had mostly dried up, due to poor land management practices that resulted in the down-cutting of streams. CLO restoration activities are focused on both riparian and upland areas, using techniques such as trincheras, gabions, and pole-planting in riparian areas. Removal of livestock and the use of a Lawson renovator, combined with native grass seeding, is utilized in grassland restoration. When CLO began working at this site, the wetlands complex was 3% of its historic size. This project has increased the primary cienega by 85%, while additional wetlands have reestablished along the riparian areas. Five miles of surface water has been created, along with almost 2000 acres of vegetation and 8000 acres of grasslands. These results have been achieved during a decade long drought. The work CLO is doing on a regional level is a model that can be done on a global scale for climate adaptation.

Restoration of landscapes invaded by Lantana (*Lantana camara* L.) in Corbett Tiger Reserve: Response of the avifaunal community over a five-year period

Babu, Suresh

Ambedkar University, Delhi

One of the biggest challenges in recent times for protected areas in India is to manage Lantana (*Lantana camara* L.), one of the world's most invasive weeds that has altered the structure and composition of the forest understory across the country. Large-scale invasion of forest areas by Lantana has adversely impacted the protected areas besides causing resource conflicts in the multi-use buffer areas of national parks. This study is about the changes in avifaunal composition following a successful restoration experiment that has converted two large Lantana infested patches into grasslands in Corbett Tiger Reserve, India. It has been suggested that removal of Lantana without appropriate restoration of the habitat would result in decrease of conservation values of these areas for avifauna. An assessment of the avifaunal composition has been carried out to understand the impact of vegetation change following restoration on the avifaunal community to directly address this concern. The avifauna was studied across four seasons and at three stages— before undertaking restoration, after 3 years and after 5 years of restoration. The results indicate significant shifts in relative species abundances and species composition of avifauna with restoration that is marked by a gradual shift from a mixed-frugivorous guild to a mixed-granivorous guild. The response of the bird community is synchronous with the increase in the abundance of grasses coupled with a sharp decline in Lantana. Since the frugivores persist in low densities in later years, results imply that unless the entire landscape is free from Lantana re-invasion could occur.

Ecosystem functioning in restored tallgrass prairie affected by fertilizer addition

Bach, Elizabeth M.; Kirsten S. Hofmockel

Iowa State University

Wide-scale conversion of tallgrass prairie to row-crop agriculture in central North America has dramatically altered ecosystem functioning, increasing loss of nutrients and carbon (C) from soil. Ecosystem restoration is increasingly viewed as a tool to increase terrestrial retention of C and nitrogen (N), mitigating greenhouse gas emissions and controlling nutrient run-off that leads to eutrophication of waterways. Because C and N cycling are linked, limitations in N can affect the balance of soil C respiration and storage in restored ecosystems. We examined soil C and N pools and extracellular enzyme activity in replicated restored tallgrass prairies (4yr old) receiving no nutrient additions and receiving N fertilization (84 Kg ha⁻¹ yr⁻¹).

ORAL ABSTRACTS (CONT'D)

Unfertilized prairie systems had twice as many root inputs as fertilized prairie systems ($P < 0.01$). Pools of total soil, extractable, and microbial biomass C and N were similar between unfertilized and fertilized prairies. However, microbial activity within these systems differed. Acid phosphatase and N-acetyl-glucosaminidase activity was significantly greater in unfertilized prairie than fertilized prairie ($P < 0.04$). This trend was also observed for C-cycling enzymes beta-xylosidase and cellobiohydrolase. Seasonal fluxes in potential enzyme activity for phosphatase and glucosaminidase also depended on prairie system, reaching maximum activity in August in unfertilized prairies, and sustaining maximum activity in August and October in fertilized prairies ($P < 0.03$). In addition to restored prairies limited belowground rates of organic matter decomposition without changes in labile and microbial biomass pools, which may increase storage of C and N in soils over the long-term.

Cloud forest restoration for erosion control in a Kichwa community of the Ecuadorian central Andes Mountains

Backus, Laura L.; William B. Mahoney, Ignacio Sacatoro

Institute for Arctic and Alpine Research, University of Colorado

The Denver Professional Chapter of Engineers Without Borders (EWB) has begun conducting erosion control projects in the Kichwa communities of Malingua Pamba in the Andes Mountains south of Quito, Ecuador. In many areas, erosion of volcanic soils is severe and associated with infrastructure, including roads and water supply systems, and with loss of native cloud forests for land conversion to agriculture. Following a 2011 preliminary investigation of over 75 erosion sites, the multidisciplinary Erosion Control team traveled to Malingua Pamba in October 2012. With the communities, we installed woody cloud forest species, grass hedges, erosion matting, and structures (toe walls, plunge pools, check dams) to slow and direct water flows at five sites. In keeping with the EWB goal of project sustainability, we used primarily locally available resources. High school students of the community grew 5000 native trees and some naturalized shrubs in a nursery started by the school principal, hand weavers supplied jute netting for erosion mats, rocks were brought in from a nearby quarry, and tools and miscellaneous supplies were purchased at an in-country hardware store. Based on follow up reports and photographs from EWB members, plants are growing well and erosion control structures have remained in place throughout the November to April rainy season. The community has continued plantings at several additional erosion sites. We plan an October 2013 project to focus on training the community how to site and build erosion control structures. Following the training, the community will teach these skills to adjacent villages.

BambuChar: A novel project of a restoration based economy

Bacre González, Ramón Agustín; José Raúl Díaz Martínez, Juan José Melgarejo Murrieta, Diego Miguel Saavedra Olea

Instituto de Geología, UNAM

The Project BambuChar arises from efforts to produce a novel ceramic material, made up from clay and bamboo stabilized biomass, with high recalcitrant organic carbon content. The resulting material can be used as a basis for the production of Mexican handicrafts and green building materials which contains or sequester atmospheric carbon on their matrices. The relevance of the project is the creation of a high value commercial chain to manufacture eco-friendly Mexican artistic pieces, which reflect part of the traditional culture of the states of Puebla / Veracruz and at the same time sequester CO₂ from the atmosphere. Socioeconomic improvements of local communities, in addition to the positive effects on the environment are considered very important in the project, and can be used as an example of a restoration based economy, in which you can achieve economic growth while providing a service with high environmental value, such as atmospheric carbon sequestration. The technology used on the project is a low temperature pyrolysis system to produce bamboo biochar, then the biochar is mixed with clay and some other materials protected with intellectual property laws. The main objective is to build the first commercial production line in the world of Mexican crafts and contemporary abstract art that capture atmospheric CO₂. The project stills at an early stage and expects to obtain/provide data of atmospheric carbon capture capabilities, and socioeconomic improvements in the months to come.

Discerning the presence and ecological consequence of ecotypic variation: A dilemma for restoration

Baer, Sara G.; Brian R. Maricle, Keri L. Caudle, Nora M. Bello, Keri L. Caudle, Matthew Galliard, David J. Gibson, Miranda Gray, Rachel K. Goad, Evan McCrea, Meredith L. Mendola, Jacob T. Olsen, Sofia Sebates, Hannah Tetreault, Loretta C. Johnson

Southern Illinois University

Common garden experiments can be used to discern whether phenotypic variation is under genetic or environmental control and distinguish the presence of genetically-based ecotypes. However, knowledge of ecotypic variation in species used to restore plant communities is generally limited. We established two forms of reciprocal common gardens across a longitudinal gradient to quantify ecotypic variation in a dominant and widely restored prairie grass, *Andropogon gerardii*. Seeds of *A. gerardii* were collected from four geographically separated populations in each of three regional sources or putative ecotypes: central Kansas (CKS), eastern Kansas (EKS), and southern Illinois (SIL). Morphological, physiological, reproductive, phenological, and growth-related traits were measured in common gardens consisting of evenly-spaced individual plants from each population of *A. gerardii* (without competition) and plots restored using seeds of all populations of *A. gerardii* collected from each region plus other species (with competition). To date, this study has revealed: (1) distinct morphological [trichome density], physiological [photosynthesis and leaf N], reproductive [seed production], and phenological [days to anthesis] traits in the CKS source maintained across all sites; (2) 'home site advantages' in growth-related traits of the SIL source [productivity] as well as establishment [growth] and reproductive [seed production] traits in the CKS source; and (3) inconsistent effects of *A. gerardii* source on traits with and without competitors. In Illinois, there was a tradeoff between species diversity and cover of locally-sourced dominant grasses. Results from this ongoing multi-site study demonstrate that the presence and hierarchical consequences of ecotypic variation are trait-, site-, time-, and competition-dependent.

ORAL ABSTRACTS (CONT'D)

History offers direction for restoration: A tallgrass prairie perspective

Baer, Sara

Southern Illinois University - Carbondale

The historically-based reference has been a cornerstone concept in tallgrass prairie restoration with respect to setting restoration goals, assessing restoration trajectory, forecasting recovery, and securing the human and economic capacity for success. The utility of the historically-based reference concept to prairie restoration may be an artifact of few well-documented thresholds that prevent attaining a more biologically desirable and functional condition from restoration of the most ubiquitous degraded state, i.e., cultivation. Empirical knowledge of tallgrass prairie compositional and ecosystem response to global changes is increasing, whereas this knowledge in restored prairie is premature, and in novel systems (non-historic assemblages) it is virtually absent. By this logic, the well-studied extant and historically-based restored systems possess the greatest potential to inform restoration targets. Species that establish in restorations reveal ecological filters and community assembly processes; those that persist and reproduce over spatially or temporally variable conditions indicate the amount of adaptive variation in restored populations. A restoration observation network is critically needed to project species establishment and persistence under varied environmental conditions with the greatest scientific certainty. Until such a database exists in systems that have not crossed ecological thresholds for cost effective or sustainable restoration, the historically-based reference offers the most empirically-based direction to improve a degraded system's state and potential for human connection needed to acquire the social capacity to conduct ecological restoration.

An overview of principals of natural channel design and a case study of the Dead River Recovery project in Michigan's Upper Peninsula

Baker, S. Paige

Collins Baker Engineering, PA

For much of the twentieth century in the United States, channel improvements focused on flood reduction. This work typically required grading a large cross section, laying stream banks back to a stable angle, and lining banks with engineered revetments. Negative ecologic adjustments often resulted. Channel design philosophy has shifted in recent decades and now many channel improvements use natural channel design techniques. Channel improvement projects, once characterized by full bank rip rap or channel hardening, vegetation removal, and channel cross-section enlargement, are increasingly minimizing or eliminating rip rap, preserving or replanting vegetation, reclaiming abandoned floodplains, and restoring stable dimension, pattern, and profile. Even more recently channel design philosophy has shifted again, and focuses on recovering stream functions or "the physical, chemical, and biological processes that occur in ecosystems". The Dead River is located in Michigan's Upper Peninsula. Historic flooding occurred on the river in May 2003 when a fuse plug flood control dike on Silver Lake was activated following a rain-on-snow event. Impacts included channel realignments, soil and vegetation loss, habitat loss, and sediment/debris deposition. The Dead River Recovery project used a natural channel design methodology developed by Dave Rosgen that later became the basis for Chapter 11, "Rosgen Geomorphic Channel Design," of the US Department of Agriculture's National Engineering Handbook published in 2007. The project included assessment, design, implementation, and monitoring tasks. Five miles of geomorphic stream functions and a variety of aquatic and terrestrial habitats were recovered.

Species-specific responses to site preparation and spatiotemporal variation during grassland restoration

Bakker, Jonathan D.; Eric Delvin, Peter W. Dunwiddie

University of Washington

Although many grasslands are endangered, these ecosystems provides critical ecosystem services and habitat. Restoring grasslands requires controlling undesired species while promoting desired species. We conducted a field experiment to evaluate the importance of site preparation and quantify spatiotemporal variation in plant establishment. The experiment was conducted in four abandoned agricultural fields in two regions of western Washington and in four seeding years (2009-2012). Site preparation involved killing the extant vegetation (non-native grasses and agricultural weeds) using prescribed fire, solarization, or repeated herbicide. Plots were then broadcast seeded with a diverse seed mix (mean: 24 species; ~680 seeds m^{-2}). Seedling density was measured during the first growing season after seeding on 1032 quadrats within 149 plots. Establishment, the percentage of sown seeds present as seedlings, was calculated for each species individually and for all sown species together. Few sown species were detected in unseeded quadrats, indicating that all species were seed limited. Each site preparation treatment favored some species, though overall establishment was greatest following the herbicide site preparation treatment and lowest following solarization. Variation in establishment was generally greatest among quadrats and seeding years, but patterns differed strongly among species. For example, seeding year accounted for 1-75% of variation depending on the species. Because of these interspecific differences, differences in overall establishment rates were muted. Variation at small spatial scales and among seeding years can limit our ability to predict the outcome of restoration actions but enables the assembly of diverse and heterogeneous communities.

Staged-scale restoration: A systematic approach for improving restoration effectiveness

Bakker, Jonathan D.; Peter W. Dunwiddie, Eric Delvin

University of Washington

Adaptive management has been widely discussed and recommended, but it is rarely implemented effectively to inform large scale restoration efforts in a scientific, experimental manner. Instead, practitioners often decide upon restoration strategies based on anecdote, educated guesses, and personal experience. This approach can result in costly and time-consuming failures. To overcome these problems, we developed a "staged-scale restoration" (SSR) strategy that explores multiple solutions to restoration challenges in an adaptive management framework that is both scientifically rigorous and

ORAL ABSTRACTS (CONT'D)

site-specific. SSR begins by identifying several promising restoration approaches, selecting those that can be applied at large scales, and testing them in small, replicated experimental plots directly on the restoration site. Plots are monitored, and the most successful treatments are applied in scaled-up plots (e.g., 10x area) while incorporating refinements suggested during the small-scale experiments. Restoration of the site proceeds in progressive steps by implementing the most successful approaches at increasingly larger scales that build on accumulated experience. We illustrate the SSR approach using four years of data from a prairie restoration in Washington, in which we established assemblages of prairie species in abandoned agricultural fields. Significant challenges included controlling invasive weeds and developing effective methods for establishing diverse suites of native plants. Our results demonstrate how SSR allows implementation of adaptive management principles in ways that minimize risks, improve scientific rigor, and provide a feasible, more effective, and potentially less costly approach to restoration.

Long-term development and ecosystem functions of restored wetlands

Ballantine, Kate A.; Peter M. Groffman, Johannes Lehmann, Rebecca L. Schneider
Mount Holyoke College

Field-scale manipulations were used to investigate the impact that soils amended with organic materials of differing lability have on soil and vegetative development and on desirable and undesirable biogeochemical functions in restored wetlands. Experimental plots were established in four newly restored depressional freshwater wetlands in central New York. Amendments ranged along a continuum of decreasing carbon lability (straw, topsoil, straw/biochar mix, and biochar). Three years after restoration, the addition of soil amendments to wetland plots stimulated the development of a suite of key structural and chemical properties (e.g., soil carbon, soil nitrogen, cation exchange capacity, bulk density) and biological properties (e.g., microbial biomass and activity, nitrogen cycling) indicative of wetland functions. Straw and Biochar had minimal influence on key wetland functions, whereas most properties associated with desirable functions were highest in topsoil-amended plots. Potential methane emissions were primarily driven by differences in hydrology among sites, and were significantly higher in amended plots than control plots. Despite improvements, soil properties did not reach levels of comparable natural wetlands within three years of restoration. In contrast, plant biomass recovered quickly, and had reached levels of comparable natural wetlands within two years. Results of this research reveal that addition of organic amendments to soil during wetland restoration can improve key properties indicative of wetland functioning and highlight the importance of site selection in restoration design. More research is required, however, to determine what level of amendment application will be sufficient for meeting functional goals within an acceptable time frame.

Meadow restoration on former agriculture land in southwestern Ontario, Canada

Balsdon, Jennifer Lau; Stephen Murphy, Dawn Bazely
University of Waterloo and CH2M Hill Canada

Best practices for Restoration Ecology have been largely derived from case studies. Social-ecological resilience is an approach that can provide restoration research both structure and a road map for ecological recovery. Ontario Parks will be ceasing the lease of farmland within the Parks system. I chose the method photo-elicitation and semi-structured interviews to understand the different landscape preferences of major stakeholders. After a fall planting, I examined the species richness and percent cover for all species across three fields with different planting treatments. For initial ground cover for first year after planting, I looked at the survivorship and growth of five species. My recommendations include implementing the restoration efforts at a smaller scale to start. In terms of survivorship and growth, plant plugs for *Elymus trachycaulus* and a combination of plant plugs and seeds for *Monarda fistulosa* and *Penstemon hirsutus* were the best choices. Open communication should continue between all stakeholders with information on each of the species that are to be planted. Soil preparation before planting by tilling was beneficial only on abandoned land that was not an active farmland before (e.g. old homestead). Tilling on hay or annual crop fields depends on the plant composition present. If meadow species are present, a no-till planting method may be a better option. Future studies need to increase the biodiversity of this study. Much longer-termed research is necessary to understand community dynamics and potential recovery of system.

Can considering phylogenetic diversity improve restoration outcomes in tallgrass prairie?

Barak, Rebecca S.; Andrew L. Hipp, Marlin Bowles, William Sluis, Rebecca K. Tonietto, Daniel J. Larkin
Chicago Botanic Garden/Northwestern University

Restored communities are, by their nature, established quickly, while remnant native communities have been shaped by long-term processes. As a result, restored communities are often less species-rich and contain fewer target species, traditional metrics of quality. Though rarely explicitly considered in a restoration context, phylogenetic diversity (PD) can provide a complement to traditional metrics that deepens our understanding of plant communities, and can potentially influence restoration and management decisions. Phylogenetic structure has been used to make inferences about community processes, and increased PD has been linked to greater community stability and ecosystem functioning. We studied community phylogenetic patterns in remnant and restored tallgrass prairies throughout northeastern Illinois to test these hypotheses: (1) remnant prairies have higher PD than restored prairies, and (2) regular burning maintains PD. The 41 remnant prairies in our analysis were sampled in 1976 and 2001, with a subset revisited in 2013. Fourteen restored prairies were initiated between 1963 and 2003. Our findings to date show that remnant prairies were phylogenetically clustered at large spatial scales (across sites) but showed variability at finer scales (within sites), comprising clustered, random and overdispersed structures. Fire frequency was positively correlated with PD. Several outstanding questions remain: Should restoration efforts mimic PD of reference sites, or be phylogenetically diverse by design? To what extent is PD associated with targets like biodiversity support, productivity, and resilience? Collaborations are needed between restoration researchers and practitioners to answer these questions. PD has the potential to become an important tool for designing and assessing restorations.

ORAL ABSTRACTS (CONT'D)

Turning Brownfields into green space: Part 1. A framework to evaluate the net ecosystem services associated with natural re-development.

Barber, Timothy R.; Jennifer L. Lyndall, Thomas S. Leigh
ENVIRON International Corporation

Brownfields are industrial or commercial properties that have been abandoned, idled, or underused and where expansion or re-development is hindered by real or perceived environmental impacts. Brownfields can be relatively large tracts of land in disjointed and often disadvantaged communities. These areas are well-suited for conversion to green space which could provide numerous improvements to ecosystem service flows, including: recreational opportunities, aesthetics, stormwater control, noise abatement, and ecological systems. Unfortunately, city leaders and members of the public have not always embraced this approach due to concerns about maintenance costs, loss of tax revenue, and reduced industrial/commercial capacity. A net ecosystem services analysis can be used to evaluate the advantages and disadvantages associated with these types of projects. This framework includes identification of the types of services that may be impacted and estimation of the spatial and temporal extent of service gains or losses. Based on a conceptual re-development plan, pre- and post-development service flows are estimated in discounted-service-acre-years (a common ecological currency) or monetized using benefits transfer. Other factors should be considered, including: remaining industrial/commercial capacity, increase in property values (and taxes) associated with being near a green space and due to the reduced supply of available land for development, and reduced level of city services required for undeveloped land. This approach provides a quantitative framework that can be used to communicate the benefits of converting Brownfields into green space to city leaders and the public in a transparent and scientifically sound manner.

Turning Brownfields into green space: Part 2. Applying the net ecosystem services framework to a case study in northeast Ohio.

Barber, Timothy R.; Thomas S. Leigh, Jennifer L. Lyndall
ENVIRON International Corporation

The City of Ashtabula, Ohio, is a former shipping, commercial, and industrial center located on the shore of eastern Lake Erie. The remnants of this historical activity consist of a patchwork of blighted and underutilized Brownfields interspersed with small areas of fragmented and underutilized green space. To provide a more attractive historic business district and enhance community activity in city-wide green space, a conceptual re-development plan is presented to address numerous Brownfields and expand and enhance the function of green space in the city. This green corridor will stabilize property values, encourage a sense of well-being, expand tourism-supported businesses, and contribute to the revitalization and economic growth of the city. We identified existing Brownfields and underutilized green spaces within the city and harbor area, evaluated the feasibility of consolidating the identified parcels into a contiguous corridor, and analyzed the net ecosystem services associated with implementing the conceptual re-development plan. Services affected by the project were identified and service gains and losses were quantified on a spatial and temporal scale using the proposed net ecosystem services framework. To facilitate comparison to other economic re-vitalization plans, these service gains and losses were monetized using values from the ecosystem services valuation literature. In addition to the valuation of ecosystem services, other direct economic benefits were estimated. The results from this analysis can be used to shape future policy and land-use decisions and be used to communicate the economic benefits of converting Brownfields into green space to city leaders and the public.

Resilience to Sea Level Change through Subsurface Accumulation of Refractory Roots in Mangroves and Bio-restoration of Intertidal Habitat

Barik, Jyotiskona
Jadavpur University

The long-term stability of coastal ecosystems such as mangroves and salt marshes depends upon the maintenance of soil elevations within the intertidal habitat as sea level changes. This paper examines the rates and processes of biotic control on soil elevation by mangroves of Sundarbans in the northeast coast of India to better understand biological controls on habitat stability in climate vulnerable coasts. Biological processes controlling mangrove peat formation were estimated in *Rhizophora mangle* (red mangrove) along habitats with varying nutrients (nitrogen or phosphorus) and the effects on the dynamics of soil elevation were determined over a 2-year period using Rod Surface Elevation Tables (RSET) and marker horizons. The presence of adequate nutrients to mangroves caused significant changes in rates of mangrove root accumulation, which influenced both the rate and direction of change in soil elevation. Areas with low root input lost elevation and those with high rates gained elevation. Perusal of results show that mangroves common to the northeast coast regions of India have adjusted to changing sea level mainly through subsurface accumulation of refractory mangrove roots. Without root and other organic inputs, submergence of these tidal forests is inevitable due to peat decomposition, physical compaction and eustatic sea-level rise. These findings have relevance for predicting the effects of sea-level rise and biophysical processes on tropical mangrove ecosystems.

Integrated Management of Common Reed (*Phragmites australis*) in Panne Ecosystems

Barker, Steve
Cardno JFNew

Marquette Park, located at the southern tip of Lake Michigan, is the headwaters of the Grand Calumet River, and today serves as the easternmost terminus of the Grand Calumet River Area of Concern. It is also positioned directly adjacent to the Indiana Dunes National Lakeshore, the greater

ORAL ABSTRACTS (CONT'D)

Chicago area's only national park. Pannes are distinct calcareous, sand-based, intradunal wetlands found in close proximity to the shoreline. Pannes are also globally rare and are known to have high quality native plant assemblages, many of which are listed as endangered, threatened, or rare. There are 6 wetland pannes located at Marquette Park. There are only 15 known pannes within the Indiana Dunes National Lakeshore, so restoration and management of this resource is even more crucial. Unfortunately, the Marquette Park pannes have been severely impacted by common reed (*Phragmites australis*) and other invasive species. The restoration work plan utilized an integrated management approach to control target species such as common reed. While controlled burning is often utilized in conjunction with herbicide treatment practices, there was limited data and/or experience with this approach in panne ecosystems. The presentation will provide background information on the restoration work plan and highlight the management techniques, monitoring strategy and vegetation response of the panne community. Cardno JFNew worked in partnership with Indiana University's Northwest Indiana Restoration Monitoring Inventory to evaluate the vegetation trajectory of the management activities.

Optimizing seed mixtures and seeding rates for restoration of surface disturbances on Colorado shortgrass steppe

Barr, Stephanie A.; Jayne Jonas, Mark Paschke
Colorado State University

The discovery of oil and gas resources over the last decade has led to unprecedented localized and dispersed surface disturbances on shortgrass steppe ecosystems in the western US. Reclaiming and restoring these surface disturbances to native ecosystems through revegetation seedings has proven challenging. Seed mixes and rates currently used are generally similar across private and public sectors (3-10 species at rates ranging from 400-600 pure live seeds (PLS) per meter squared). The objective of this study was to determine an optimal seed mix diversity level and corresponding seeding rate for restoration of surface disturbances in shortgrass steppe. We examined five seed mix diversity levels, 5-50 species, and five seeding rates, 400-1600 PLS per meter squared using a response surface regression experimental design. This study was implemented at twelve sites across three different locations in north central Colorado. Treatments and overall restoration success were evaluated based on resulting biomass and diversity of seeded, volunteer native, noxious, and non-native species, and the density of seeded species. Our results show greatest restoration success occurring at a seed mix diversity level of 44 species and a seeding rate of 1155 PLS per meter squared. These results suggest that higher seed mix diversity levels and higher seeding rates could lead to greater restoration success on surface disturbances in shortgrass steppe.

How do we determine which invasive plant will invade regenerating wetlands? The importance of land-use legacies and abiotic conditions

Bart, David; Tara Davenport, Austin Yantes
University of Wisconsin-Madison

Assessments of site invasibility are crucial for creating resistant restoration sites. Land-use legacies impact pre-restoration biotic and abiotic conditions, and therefore have the potential to impact invasion resistance. Here we present results of a study analyzing the invasibility by two groups of invasives (competitive/ruderal species (*Phalaris arundinacea*, *Urtica dioica*, *Ambrosia trifida*, *Stellaria media*, and *Populus tremuloides* and stress-tolerant/seral (*Rhamnus frangula*, *Rhamnus cathartica*, *Cornus stolonifera*, *Cornus racemosa*, *Salix discolor*)) based on interactions among hydrology, nutrient availability, and plowing history in Wisconsin calcareous fens. Root-zone volumetric water content data (moisture), available-N and-P, and plowing history data were collected from 11 WI fens. We used PLS regression to determine the best predictors for percent cover of each group as well as each species. The best predictors of competitive/ruderal species cover were a combination of being plowed at least once, low volumetric water content, and high nutrient availability. The best predictors of stress-tolerant/seral-species cover were a combination of plowing, stable saturated root zones, and low nutrient availability. Legacies from plowing proved to be the most important determinant of invasions. Moreover, the species that invaded were determined by interactions between plowing and moisture or nutrient availability. These results may be explained by: 1) loss of competitive native graminoids from seedbanks in plowed areas; 2) variations in resource and non-resource stress and 3) competition among invaders. These results suggest that understanding how legacies interact with abiotic conditions is crucial for predicting a restoration site's resistance to plant invasions.

Incorporating uncertainty into forest reconstructions: Implications for developing historical reference conditions

Barth, Molly A. F.; Andrew J. Larson, James A. Lutz
University of Montana

Forest reconstruction studies to quantify pre-settlement conditions are an important source of information about how forest structure has changed during the post-settlement period and can guide forest restoration prescriptions. Results from reconstructions may be inaccurate, however—and therefore inappropriate for guiding restoration—if uncertainty about the estimates is not appropriately considered. The purpose of this study is to identify and quantify the uncertainties involved in forest reconstructions and develop a new reconstruction methodology. A review of studies from across the western US demonstrates that assumptions about wood decay, snag fragmentation, and tree growth rates introduce significant uncertainty into estimates of historical forest structure. The literature provides limited decay rate data for several tree species; a challenge often overcome by substituting decay rates of different species from different forest types. In addition, evidence of historical small diameter trees often disappears prior to contemporary sampling, especially where decomposition rates are high. When these assumptions are not incorporated into reconstruction modeling, biased estimates of historical conditions are potentially obtained, with implications for ecological inferences and the application thereof to management. This study reveals a lack of understanding of snag and log decay rates and of techniques to accurately translate field assessments of dead trees into tree

ORAL ABSTRACTS (CONT'D)

death dates. We demonstrate a new simulation-based reconstruction approach which incorporates known uncertainties into the model to estimate a range of potential historical conditions, providing a more defensible source of reference information for guiding contemporary forest management and restoration.

Estuarine, coastal and marine ecosystem restoration: The importance of refugia.

Battershill, Chris

Environmental Research Institute, University of Waikato

The coastal marine estate is largely un-inventoried. The 2010 Census of Marine Life recorded approximately 250,000 species, hypothesising that over 1 million are likely, hence there are new species waiting to be discovered and their ecological role yet to be fully understood. It is therefore difficult to contemplate marine ecosystem restoration when often there is little quantitative information about how that coastal habitat was constructed; how its' components may interact over time; or how it engages with neighbouring systems. We know a reasonable amount in a general sense about various marine habitats' functionality, but the dilemma of localised marine ecosystem restoration is that often we have little idea of the detail at species level. What do we aim at? Is close enough, good enough in restoring habitat character? By examining environmental responses to a range of large scale, deleterious human induced coastal events, including the collapse of over 100km of hill ranges into the coastal margin and review of New Zealand's worst maritime pollution event, it is possible to examine the benefits of refugia in marine protected areas. How marine ecosystems may be further encouraged to recover through environmental engineering is explored with examples from New Zealand's largest Port. The importance of a network of reservoirs of relevant biodiversity is critical in providing 'seed stock' for re-establishment of habitat characterising communities. The presence of reference ecosystems to provide a blue print by which to measure a return to 'normality' is paramount to the coastal marine restoration process.

Plant-soil feedbacks influence productivity and succession in tallgrass prairie

Bauer, Jonathan T.; James D. Bever, Heather L. Reynolds

Indiana University

There have been notable successes in ecological restoration, but restorations are often limited by gaps in our understanding of the mechanisms structuring plant communities. Recent studies indicate that plant-soil feedbacks influence plant community productivity and diversity, but further research is needed to determine the generality of these results and to develop applications in ecological restoration. In two experiments, we measured plant-soil feedbacks for prairie plant species in soils from remnant and restored prairies. First, we measured feedbacks on individual seedlings of eight plant species. All plant species experienced similar feedbacks in remnant and restored prairies, but we found a positive correlation between the strength of plant-soil feedback a plant experiences and the successional stage of that species. This indicates that early successional plant species alter soil microbial communities in ways that encourage their replacement by later successional species. We also found that soils associated with some species consistently promoted the productivity of other species, but other soils reduced productivity. In the second experiment, we tested the effects of plant-soil feedbacks in diverse prairie mesocosms. Results in these mesocosms support the results of our first experiment, with significant effects of plant-soil feedback on plant community structure. Further, we found considerable differences in plant productivity in mesocosms containing soil associated with different plant species. Overall, our results support an important role of plant-soil feedbacks in determining plant community structure and suggest potential applications that could increase the overall productivity of restored grasslands and encourage the re-establishment of late-successional plant species.

Indigenous Arts and Sciences Earth Partnership: Sustaining community partnerships through cultural connections and ecological restoration education

Bauer-Armstrong, Cheryl; Curt Meine, Fawn Youngbear-Tibbetts, Cynthia Soto, Spring Rosales, Rick Hall, Maria Moreno

University of Wisconsin-Madison Arboretum

Earth Partnership for Schools (EPS) uses ecological restoration as a context for learning across discipline, age, learning style, culture and place. EPS is collaborating with Indigenous communities to integrate culturally accurate and authentic resources for relationship building, inquiry and citizen science process skills and ecological restoration across the curriculum in multiple learning environments. Indian Nations monitor and protect their natural resources, underscoring the need for Native scientists, yet Native Americans are the most underrepresented group in STEM fields. Native American children and all young people can benefit from understanding the contributions of Indigenous Arts and Sciences (IAS), integrating them with western STEM concepts while participating in restoring native ecosystems. We will present different viewpoints that are integral aspects of this holistic model, based on the values of Relationship, Reciprocity, Respect, and Responsibility. The following key points will be explored: Land ethics: Aldo Leopold and Indigenous perspectives; The dialogues continue: Indigenous Arts and Sciences Earth Partnerships; Urban Native populations and restoration; Native youth finding strength in their cultural heritage to become inspired to explore science careers; Rural partnerships: Forest Service and Tribal relationships; and Learning to read the cultural landscape: An example of Service Learning.

Will local or commercial native plants succeed where exotic invaders fail? Cheatgrass die-offs as an opportunity for restoration in the Great Basin, USA.

Baughman, Owen W.; Elizabeth A. Leger, Susan E. Meyer

University of Nevada, Reno

The exotic annual cheatgrass (*Bromus tectorum*) commonly occurs in dense near-monocultures in the Great Basin, USA after diverse native plant communities have been mostly extirpated. Efforts to reestablish extirpated native species via direct seeding are often unsuccessful. Restoration often

ORAL ABSTRACTS (CONT'D)

utilizes commercially produced, non-local seeds which may lack important adaptive traits. Also, strong cheatgrass competition likely impedes native establishment in highly invaded communities. The phenomenon of complete cheatgrass stand failure, or 'die-off', can leave areas within cheatgrass near-monocultures devoid of growth for one or more years. Such areas may represent restoration opportunities if native seeds can establish within them. This ongoing study addresses two questions within one cheatgrass die-off in northern Nevada: (1) Will native grasses establish from seed within cheatgrass die-offs, with or without modest ameliorations? (2) Do adaptations to local conditions give local genotypes higher fitness than commercial cultivars? In October 2012, local and commercial accessions of Sandburg bluegrass (*Poa secunda*) and bottlebrush squirreltail (*Elymus elymoides*) were precision-planted in recent die-offs and adjacent near-monocultures (controls) under six treatments: fungicide application, litter removal, and no treatment; each with and without water addition. After six months, there has been substantial establishment in die-offs, though significantly less than in controls. Squirreltail benefited more from watering treatments than did bluegrass. During spring monitoring of emergence and survival, commercial seeds were outperforming local seeds for squirreltail, and vice versa for bluegrass. Fungicide treatments were involved in complex interactions for both species. Monitoring of establishment and mortality will continue for two growing seasons.

Growth, blight-resistance, and fungal mutualisms of backcrossed American chestnuts in ecological restoration

Bauman, Jenise M.; Amy Santas, Carolyn Keiffer, Brian C. McCarthy
Miami University

Anthropogenic disturbances such as mining for coal have caused significant fragmentation to the Appalachian forests of North America. Recovery of these disturbed landscapes is highly dependent on restoration methods that encourage natural succession. Experimental planting methods such as deep ripping and plowing were applied to a reclaimed surface coal mine in Ohio, U.S.A. Coupling these methods with plantings of pure American chestnut (*Castanea dentata*) and two types of blight-resistant backcrossed chestnuts (BC2 and BC3) have resulted in high seedling survival and healthy root colonization by beneficial ectomycorrhizal fungi after the first growing season. The objective of this study was to assess seedling survival, growth, and ectomycorrhizal associations of chestnuts after five field seasons. Chestnut blight cankers caused by fungus *Cryphonectria parasitica* have been recorded to assess the disease resistance potential of the backcrossed seedling lines. The growth and survival of chestnuts in plots that employed a soil treatment method were significantly higher than the untreated control plots ($P < 0.0001$). Plots that applied deep ripping had higher survival and growth when compared to traditional plowing ($P < 0.05$). Chestnut growth appeared positively correlated to an increase in root colonization by beneficial ectomycorrhizal fungi. Survival was higher for the BC3 seedlings, which exhibited a pure American growth form with adequate resistance to chestnut blight ($P = 0.0006$; $P < 0.0001$). Established trees have the potential to aid in forest succession by adding organic matter to the soil, attracting seed-carrying wildlife, and providing beneficial symbionts to incoming woody plant species.

Challenges in monitoring populations of an early successional endemic sedge, *Rhynchospora knieskernii* L.

Baumgarten, Joni M.; Matthew I. Palmer
Rutgers University

Monitoring dynamic plant populations with patchy distributions presents difficulties at both the local and landscape scale. A population with high inter-annual variation may be at greater risk of extirpation, but the capacity for rapid increases from remaining plants and propagule banks complicates decisions about management intervention. Restoration efforts are additionally complicated by the difficulty in defining what population size represents restoration success. Populations of *Rhynchospora knieskernii* L., a federally-threatened sedge endemic to southern New Jersey, are variable in both space and time. Populations occur primarily in disturbed habitats where annual variation in density may be influenced by both hydrological variation and successional change. Rigorous monitoring will facilitate the establishment of appropriate population size targets and inform minimum monitoring requirements of restoration sites for this species. Nine sites with *R. knieskernii* populations were surveyed annually between 2008 and 2011. At all locations, a permanent transect with regular 0.042 m² (20.5cm by 20.5cm) plots was established and supplemented by [x] to [y] haphazardly placed plots of the same size. All *R. knieskernii* plants were counted, and the height, inflorescence production, and production of perennating buds were recorded for five plants per plot. The populations showed high variability at the plot scale, ranging in density from zero to 234 plants/plot. Bayesian hierarchical modeling was used to quantify population trends over time. This monitoring protocol is transferable to other systems where variable population dynamics necessitate detailed monitoring and modeling to evaluate restoration success.

Does Maya knowledge of forest succession provide important information for managing pastures in Yucatan today?

Bautista, Francisco; Salvador Flores
Centro de Investigaciones en Geografía Ambiental

The transformation of seasonal tropical forests to pastures has had negative ecological impacts. Indigenous knowledge and the millenary experience in management of natural vegetation on karstic landscapes are important factors that should be considered in animal production. However, the Mayan knowledge of plants has been ignored in the search for solutions to environmental problems. The aim of this work was to make an inventory of forage plants used by Maya communities in order to assess which of them has the greatest potential for use in major livestock areas of the peninsula of Yucatan. The work was carried out in 27 Mayan communities on karstic landscapes. Samples were taken of forage plants together with corresponding floristic and ethnobotanical information. Data were processed in dynamic tables, grouped by plant family, geofoms and soils, life forms, and animal consumers. Results indicate that Maya communities use 196 plant species as forage. These plants are fed to cows (115), horses (127), pigs (58), goats (29), and poultry (39). On pastoral areas located in karstic plains with Leptosols, there are 81 forage plants in the Aw0 climate zone and 102 forage plants in areas with Aw1 climate. On karstic plains with association of Leptosol/Vertisol/Gleysol, there are only six forage plants for cattle. On karstic hills with

ORAL ABSTRACTS (CONT'D)

association of LP/VR/GL we found 86 forage plants. The main areas of pork production are located in karstic plains with Lithic Leptosols and include 89 forage plants. In these same areas are located 71 plants ingested by goats.

Success of the tamarisk biological control program necessitates landscape-scale riparian restoration

Bean, Dan W.; Nina P. Loudon, Tom L. Dudley
Colorado Department of Agriculture

The invasive riparian shrub tamarisk (*Tamarix* spp.; a.k.a. saltcedar) is the target of one of the most widespread and successful weed biological control programs in North America. The northern tamarisk beetle, *Diorhabda carinulata*, was released into the open in 2001 and has since expanded its range in Utah, Colorado, Wyoming, Oregon, Idaho, New Mexico and Arizona. A related species, *D. elongata*, has been established in Texas and California and two other *Diorhabda* species, *D. sublineata* and *D. carinata*, are now established in Texas. Beetles regularly defoliate tamarisk over a wide area of the western US and at some monitored sites tamarisk mortality has exceeded 50%. Rapid evolution of developmental traits has increased the time during which the northern tamarisk beetles are reproductively active, especially at more southern latitudes, enabling beetle populations to quickly expand and tamarisk stands to be swiftly suppressed. The tamarisk biocontrol program began with a consensus that tamarisk suppression was the desired outcome, and that the benefits of tamarisk suppression greatly outweigh the risks of introducing the tamarisk beetle. It was widely accepted that ecosystem services provided by tamarisk were minor compared to those provided by native plant species. The rapid transition away from tamarisk dominated ecosystems presents opportunities to move toward communities mostly composed of native species, but there are major challenges with riparian restoration on a large scale. Biological control now plays a critical role by providing a cost effective method of tamarisk suppression with minimal disturbance to other elements of the ecosystem.

Setting priorities for biodiversity management on privately-owned lands in the Waikato Region, New Zealand

Beard, Catherine; Yanbin Deng, Ross Martin, Craig Briggs
Waikato Regional Council

The Waikato Region is a unique biodiversity stronghold. This biodiversity is however under threat, with pressures from introduced pests and habitat fragmentation resulting from intensification/expansion of farming, horticulture and forestry practices and general development. Central government policy in New Zealand directs regional government to protect indigenous biodiversity on privately-owned lands, and regional policies call for maintenance, and enhancement of biodiversity and no net loss. However, with an estimated 696,000 hectares of fragmented terrestrial indigenous vegetation in the Region (much of this privately owned), along with some 35,000 km of waterways, 96 lakes, 74% of New Zealand's geothermal habitats, a large area of calcareous (karst) landscapes, around 1,170 km of coastline and a vast marine area; priority setting is essential if the resource is to be managed effectively. Waikato Regional Council has responded with initiatives which aim not only to provide a clear understanding of the regional biodiversity resource, but also methodologies that allow biodiversity management priorities (focussing on privately owned lands) to be set across the region. A project compiling a comprehensive regional spatial inventory of ecologically Significant Natural Areas (SNA) is currently underway. The resulting information is being integrated within ecological and numerical prioritisation frameworks developed in Council; allowing both priority-setting to be more systematic and explicit, and baselines for regional biodiversity monitoring to be set. The work is now moving into an implementation phase, with Council applying the methodology to identify biodiversity restoration priorities and develop incentives for landowners to protect high biodiversity values on their land.

Woody species composition of restored and unrestored urban streams segments in the Baltimore area.

Beauchamp, Vanessa B.; Christopher Swan, Katalin Szlavecz
Towson University

Urban streams in the eastern United States often suffer from erosion and entrenchment due to increased stream flow caused by impervious surfaces in the watershed. A common objective of urban stream restoration is to stabilize stream banks and reconfigure channel geometry and gradient to better match geomorphology to the new hydrology. This intensive re-engineering often necessitates complete active revegetation. Riparian areas are important habitat for wildlife and play a crucial role as dispersal corridors, particularly when imbedded in an urban matrix. We were interested in how well the vegetation composition of restored reaches approximates the spectrum of naturally occurring riparian communities in the region. This study compares tree and sapling community composition between paired restored and unrestored reaches located in Baltimore, MD. The majority of trees in the restoration sites were planted, whereas most saplings had recruited post-restoration. Tree communities were similar between reference and restored reaches in nearly all aspects measured, while sapling richness and density were higher at restored sites, reflecting the younger age of these sites. Differences in the dominant species between restored and unrestored sites were also driven by early successional state of the restored reaches. *Salix* spp. and *Acer rubrum* were more common in restored reaches, while *Acer negundo* was more common in reference reaches. These results indicate actively revegetated urban streams in the Baltimore region closely match the composition of reference reaches and ecosystem processes are functioning at level that allows for the continued recruitment of desirable riparian vegetation.

Technologies for ecological restoration of Brazilian tropical forests

Bechara, Fernando; Maurício Gorenstein, Daniela Aparecida Estevan, Paulo César Conceição, Huilquer Vogel, Michele Potrich, Everton da Silva, João Luís Batista, Regiane Franco, Mauricio Vicente Alves, Elson Felipe Rossetto, Bruna Elisa Trentin, Gilmar Brizola, Murilo Barddal
Universidade Tecnológica Federal do Paraná / University of California, Berkeley

ORAL ABSTRACTS (CONT'D)

How does the adoption of different paradigms for forest restoration process affect its efficacy? This is an important question to be explored by using an ecosystem approach with the aim to clarify how the main models of forest restoration behave over time. In this work we applied tropical forest restoration technologies widely used in Brazil: passive restoration (natural regeneration); nucleation (set of techniques applied in nuclei: artificial perches and shelters for animals; bank and seed rain planting; ground-covering herbaceous shrubs; trees and bromeliads planted in dense islands); plantation with filling and diversity lines (high diversity of trees planted in lines of pioneer and non-pioneers species in 3 x 2 m spacing). The experiments were implanted in permanent plots of 54 x 40 m, with four replications in randomized block design, adding up to approximately 1 ha per treatment at the Federal Technological University of Paraná, Southern Brazil. For three years, soil, vegetation and fauna (soil macrofauna, entomofauna and avian fauna) have been monitored allowing an integrated analysis of data over the forest development. At the current state of the art of restoration ecology, it became important to investigate and monitor the paradigms that guide the future restored forests, in order to assess costs and the extent by which these technologies enable the development of forest communities as close as possible to their original condition. Finally, we consider that planning the future forests is beyond complying with environmental laws. It is to assume an ethical commitment to upcoming generations.

Large-scale restoration through connectivity: The whole is greater than the sum of its parts

Beier, Paul

Northern Arizona University

Restoring relatively small connectivity areas can link larger natural areas in a way that allows the network to be “restored to largeness.” Restoring or conserving corridors involves 4 major steps at increasingly smaller spatial extent and finer resolution (1) Defining natural landscape blocks throughout a state or region and developing a map of ‘fuzzy’ linkages between neighboring blocks. The Western Governors’ Association recently mandated such “decision-support maps” for each western state. I describe lessons learned from my work on the Arizona Wildlife Linkage Assessment (2006) and California Essential Habitat Connectivity Project (2010). (2) Developing optimum linkage designs (implementable plans) for priority linkages, including detailed restoration plans. I offer insights from my experience developing 50 linkage designs in California and Arizona. (3) Evaluating practical alternatives to the optimum linkage design. Because the optimum design (#2) will rarely be fully implemented, I developed tools to help decision-makers identify biologically good compromises. I describe use of these tools in one linkage near Tucson, Arizona, USA. (4) Implementation, which includes conserving land, ameliorating barriers, and restoring habitat. I describe 2 examples in southern California.

A multi-tiered catchment analysis of Upper Redwood Creek, an urban, trout bearing stream in Oakland, CA.

Beitz, Pamela

California State University East Bay

Upper Redwood Creek watershed (596 acres, 241 hectares) in Oakland, CA is an urban stream with high recreational use that supports the spawning and rearing of native rainbow trout. This research combines tracer studies (d18O, TDS and temperature) with hydrometric and GIS analysis to develop a conceptual model of the surface and subsurface hydrologic regimes for future stream restoration work. Stream flow and precipitation data were manually collected to provide data for this previously ungauged watershed during the water years 2009-2011. The use of multiple methods of analysis and manual data collection provides a variety of analytical tools for small government, non-profit, and citizen groups involved in restoration projects. Tracer methods showed some agreement in residence time and groundwater contribution analysis. Mixing plots however, illustrate tracer affinity to different reservoirs of groundwater. d18O tracer analysis suggests a large volume of groundwater contribution to annual stream flow with a relatively short Mean Residence Time (MRT) while temperature analysis implies smaller groundwater volume contributing to annual stream flow with a longer MRT. Landscape organization (geology, soil, vegetation and slope) paired with MRT suggests that forested cover, soil depth and watershed area have the strongest correlation to flow path length and residence time. Temperature studies on the reach scale indicate that groundwater inflow rather than canopy cover exerts more control on damping stream temperature fluctuations. Results indicate that this steeply sloped watershed has significant groundwater resources and perennial flow in upper reaches due to tectonic fracturing and its remaining second growth redwood forest.

Updates in the Plant a Billion Trees campaign: Promoting large scale restoration in the Atlantic Forest, Brazil

Benini, Rubens de Miranda; Aurelio Padovezi, Marina Merlo Campos, Letícia Couto Garcia

The Nature Conservancy

Brazil’s Atlantic Forest (AF) is one of the world’s most diverse biomes and has been reduced to 12% of its original size. A major restoration initiative is vital to improve ecological functions of the AF. The Plant a Billion Trees (PBT) campaign has taken a science-based approach to defining priority areas to be restored in the AF, identified degraded areas within the restoration priorities, engaged landowners, local NGOs, private companies, universities, and governments in order to enable restoration initiatives on those degraded areas. Since launching the PBT Campaign in 2008, The Nature Conservancy has restored 4,044.61ha of degraded areas on 1,131 properties in six Brazilian States, representing more than 10 million trees. 327 farmers, rural workers, and restoration practitioners were also trained in restoration techniques. Several restoration techniques are being used to jumpstart natural processes. The most used is assist natural regeneration. PBT has helped several Brazilian states to establish state-wide payment for environmental services programs, also is an important tool to help scale restoration initiatives in the Brazilian AF, as the AF restoration Pact. Every restored area is monitored until a satisfactory growth. Ecological indicators are measured to assure that degraded areas are successfully evolving into forests. An online system to track donations to their result on the ground provides greater financial transparency. The goal of this work is to establish the basis for a large scale restoration initiative in AF, creating jobs, protecting watersheds, and building awareness of the relationship between humans and our environment.

ORAL ABSTRACTS (CONT'D)

Session 4: Mississippi River Basin: Working toward Integrated River Basin Management

Benjamin, Gretchen

The Nature Conservancy

Over the last 15 years, the Corps of Engineers along with numerous public and private groups are conducting small and large scale demonstrations to provide additional ecological benefits beyond the standard authorized project purposes of commercial navigation and flood risk management. In six pools on the Upper Mississippi River dam operations have been seasonally altered to increase the production of essential aquatic macrophytes while maintaining commercial navigation and recreational access. Along the Mississippi River mainstem channel training structures have been deconstructed to reconnect severed channel habitats or in other cases redesigned to manage the channel and provide valuable fisheries habitat, all without impacting the commercial navigation channel or flood risk management. Dredge material has been transformed from an expensive by-product to be managed, to a beneficial use for commercial purposes or building material to recover lost fish and wildlife habitat. These demonstrations provide successes that we can learn from and elevate into systemic management changes across the larger geographic range and expand the potential uses. In the end, these types of incremental changes should lead to a Mississippi River system that functions for multiple purposes while potentially reducing federal spending and creating a more resilient river system for people and nature.

Restoration of novel stream systems to optimize ecosystem services

Berg, Joe

Biohabitats, Inc.

Based on the definition of novel systems, existing streams are novel systems, modified through the release of sediment from colonial land clearing, construction of many thousands of low head dams, loss of 85% of urban headwater reaches, hydrologic and hydraulic regime radically altered, and allowed to adjust to these anthropogenic material and energy inputs without management. Stream restoration is a large and well funded area of effort, and it is clear from the language of stream restoration that many do not understand the novel nature of the current stream resource, and as a result, may not have the benefit of the full breadth of restoration options. The most common stream restoration approach is 'Natural Channel Design', which uses information collected from decades of study of novel streams to support the 'restoration' of novel streams in equilibrium with their sediment supply, using better condition 'reference' streams as a template to improve poorer condition streams. Alternatives to this approach include converging techniques that strive to replicate conditions that existed prior to the novel conditions resulting from post-European settlement. This presentation compares characteristics of the streams that existed for tens of thousands of years prior to the pre-colonial and industrial period, contrasts these with our novel streams, discusses our current stream restoration approaches, and will present and discuss monitoring results for stream restoration approaches that support the replication of pre-European settlement streams. These approaches appear to deliver greater ecosystem services than the more established stream restoration approach that replicates the post-European settlement streams.

Restoration of Lake Superior coastal wetlands in Michigan's Keweenaw Peninsula.

Bess, James A.; Rodney Chimner

Michigan Technological University

Great Lakes coastal wetlands have been negatively affected by anthropogenic activities for more than 200 years. Dredging, filling, pollution, lake level alterations and invasion by non-native species have all greatly reduced acreage and quality of these important plant communities. The coastal wetlands of Michigan's Keweenaw Peninsula were negatively impacted by copper mining activities in the late 19th and early 20th centuries. Dredging and filling with stamp sands left over from copper extraction destroyed thousands of acres of coastal wetlands on Lake Superior, Torch Lake and the Portage Waterway. In the fall of 2009, the authors received grant monies from Michigan Technological University to develop methodology for creating and restoring local coastal wetlands. Two sites, "The Marsin Center" and "Sand Point", were selected on the Portage Waterway and Lake Superior, respectively. We used a combination of geotextile materials, peat and locally collected seeds from 48 species of native wetland herbs and shrubs. Peat was used as a soil amendment to hold seeds, water and provide basic nutrients. Vegetative response has been very good so far and vegetation is growing and expanding across both planting sites. Peat addition enhanced plant growth and cover and the combination of seeds and geotextiles appears to be a viable and cost-effective method for establishing Lake Superior coastal wetlands.

People at Emiquon: Recreation and Education

Beverlin, Jason; Dr. Mike Wiant, Dr. Mike Lemke

The Nature Conservancy

Why are people important to floodplain restoration and what are the methods Emiquon uses to engage them? One of the objectives at Emiquon is to build support for functional floodplain management by sharing science and restoration techniques that will lead to the replication of floodplain restoration projects along the Illinois and Mississippi rivers and rivers around the world. Support is built by demonstrating to target audiences how restored floodplains provide habitat for native plants and animals, contribute to a more natural hydrology by storing storm waters, provide improved water quality and manage sediments and nutrients, while providing excellent recreational opportunities and driving local and regional economic development. The Conservancy has worked with partners in determining target audiences and the most effective delivery and marketing opportunities for those audiences. Current demonstration efforts include an observation area with interpretive materials, museum exhibits, websites, education and outreach programs, special events, symposiums, hunting, boating and fishing. These efforts have seen significant public response with approximately 270 vehicles per week in the observation areas and 1600 boating and fishing permits distributed annually. Since restoration began in 2007 we have

ORAL ABSTRACTS (CONT'D)

seen attendance at our hunter selection drawings double with 2012 having 1100 attend the drawings and more than 800 hunter use-days. Additionally Dickson Mounds Museum has seen attendance increases, bucking national museum attendance trends and the University of Illinois Springfield Therkildsen Field Station at Emiquon is seeing increases in facility use and educational programming requests.

Community Engagement and Support: Boardman River Case Study

Beyer, Amy; Nate Winkler

Conservation Resource Alliance

The largest dam removal project in Michigan's history is underway in the small destination town of Traverse City on northern Lake Michigan's shoreline. The first of four dams on the Boardman River was removed in 2012, re-connecting 145 miles of blue ribbon stream habitat for the first time in 100 years. The project was founded on a non-traditional community engagement model, and is overseen by an inter-agency team representing 8 tribal, federal, state and local partners. This presentation examines the strategies, challenges, successes, and lessons the team learned through involving the community in the project. The project team, authorized under a Settlement Agreement to oversee dam removal on behalf of the municipal owners, has explored various mechanisms for involving and communicating with the local community since 2005. More than 1,000 people worked over 2 years to evaluate options and scenarios for dam removal and helped to shape a vision of prosperity for the river post-dam removal. Professional public relations support was retained with a careful eye toward the limited funding available to support the project. The communications work emphasized listening sessions and fact-sharing with community leaders, anticipating concerns, and transparency. A dedicated project website serves as a repository for project materials, including a gallery for media. When a major mishap occurred during dewatering the first dam, the community's confidence and support was tested. The unexpected response from the team and the community provides unique insights that will be valuable for others tackling visible, large scale restoration projects.

Blue Carbon Maladaptation or Sustainable Adaptation Policies for Tanzanian Mangrove Forests?

Beymer-Farris, Betsy A.; Ian Bryceson

Furman University

This paper critically examines adaptation efforts to address global climate change and increase mangrove forest or "blue" carbon stocks in Tanzania, East Africa. In a quest to ecologically restore mangrove forests and increase their carbon stocks, we argue that adaptation efforts are ill-conceived on both ecological and social dimensions. Through a combined ecological resilience and political economy theoretical framework, we illuminate mangrove forest adaptation efforts that are based on planting mangrove forests "by convenience and not ecology" (Primavera and Esteban, 2008) and do not account for the livelihoods of Tanzanian communities living in mangrove forests. We show how these policies can impede livelihoods and result in "maladaptation" for both the mangrove forest dependent communities as well as the mangrove forest itself. In response, we provide new insights to guide policies for adaptation efforts for new blue carbon initiatives.

Species Recovery and Restoration of a Critically Endangered Ornithophilous Mangrove taxon *Bruguiera sexangula* Poir. in the West Coast of India

Binai, Nagarajan; Jesubalan Doss, Selvaraj Palanisamy, Vekataramanan K.S

Indian Council of Forestry Research and Education

Bruguiera sexangula Poir. is a globally endangered ornithophilous mangrove. The extinction vortices to the species are hypersalinity, land compacting and pollinator limitation. Hortus Malabaricus a 16th century flora describes *B. sexangula* as a common species in the west coast of India. Subsequent floristic surveys could not locate the species and taxon was assumed to be locally extinct. It was subsequently rediscovered in 2004 in the west coast region at Panangad (09°09'N; 76°31'E) and Kumbalangi (09°08' N; 76°27'E) which consisted twenty individuals each. Species recovery studies were initiated during 2008 and continued until 2013. A major reproductive bottleneck was poor visitation of sunbirds (8 ± 3 visits/day/tree). In peak flowering seasons 97% of senesced flowers showed no pollen deposition. Using DNA assay high level of genetic relatedness between and within the populations were confirmed. Studies on breeding behavior indicated that the species was adapted to mixed mating. Control pollination resulted in 90% of fruit set. The propagules were allowed to mature for 160-180 days on trees and then were harvested and raised in nursery. Seedlings over one feet were reintroduced in to mangrove patches or developed as linear rows. About 800 individuals were successfully reintroduced until May, 2013. Over 90% of control pollinated propagules planted during July, 2012 have grown over 1 meter in height. In future it seems control pollination could be an effective and efficient tool in restoring RET mangroves with reproduction related bottleneck.

Evaluation and communication of genetic risks in plant restoration

Birchenko, Inna; Ted Chapman, Kate Hardwick, Robin Probert

RBG Kew

A benchmark of successful restoration is preserved genetic complexity of the ecosystem. Restoration practitioners are aware that small population sizes and bottlenecks reduce genetic diversity of re-introduced populations. Less recognized are the negative effects that re-introductions can have on genetic diversity and adaptations of remnant indigenous populations, such as outbreeding depression and gene swamping. To facilitate decision making in restoration projects, both types of genetic risk must be accurately assessed and efficiently communicated. I present a framework for evaluation of genetic risks on a species-by-species basis being developed at the Royal Botanic Garden Kew's Millennium Seed Bank. The risk is reported as one of three categories: high, moderate and small. Small genetic risk means that sensibly collected and multiplied germplasm can be planted anywhere in the British

ORAL ABSTRACTS (CONT'D)

Isles with no adverse effects on indigenous or introduced populations. Moderate genetic risk species should only be planted within the same seed zone as the collection site. Germplasm of high genetic risk species should be used only to augment the original population. To demonstrate the risk evaluation process and provide guidance for Kew's UK Native Seed Hub and UK National Tree Seed projects, I estimated genetic risks for 60 British native species. Estimates of genetic risk were made using existing data on distribution, pollination and seed dispersal, karyotypic, infraspecific and clinal variation and patterns of hybridization. In many cases, information on genetic diversity was limited or absent, identifying areas for further study.

Ecological restoration of a suburban area in a Mexican city; lessons after 20 years

Blanco-García, Arnulfo; Oscar Valle-Díaz, Mariela Gómez-Romero, Roberto Lindig-Cisneros

Facultad de Biología, UMSNH

Ecological restoration is a complex activity, especially in urban and suburban areas which have experienced a continuous process of degradation during dozen of years in the vicinity of inhabited zones, where a variety of disturbing agents have combined. We present the history and current condition of the state park "Cerro Punhuato", a site adjacent at the Morelia City where a reclamation project was initiated en 1991 in order to protect and rehabilitate a private 78 ha area. During this time the site experienced reforestation with native and nonnative species, soil conservation efforts, control of wildfires and exotic species, and nowadays the project has been adopted by the local government. The project is now promoted as successful study case where scientist, government and society have involved. Although the altitudinal range of Cerro Punhuato (2030-2320 m asl) may have allowed the existence of pine-oak forest, currently there are several factors that impede restoration efforts, most of the native conifer and oak species used in the reforestation program show low survival values due to high temperatures during the dry season (up to 43 ° C) and are probably a consequence of the phenomenon of heat urban island. On the other hand, subtropical scrub species and tropical deciduous forest show higher natural regeneration. After twenty years Cerro Punhuato has increased in native vegetation cover but social acceptance of these species must be evaluated because the disadvantage of being deciduous between 6 and 7 months of the year.

Shoreline bioengineering - evaluating long-term, short-term and future success

Blickenderfer, Mary

U of MN Extension

Anthropogenic pressure within the watershed of a lake can place a complex set of challenges on shoreline restoration efforts. These pressures can include native vegetation removal, widespread use of aquatic herbicides, increased boat wakes, introduction of invasive species, increased nutrient and sediment load, unnatural water level fluctuations (e.g., dam-controlled lake levels, unnatural flooding and drought duration, severity and timing). The results of two recent studies shed light on approaches to some of these shoreland restoration challenges. The first study subjected eight species of herbaceous wetland/aquatic plants to normal, wet and dry season water level scenarios, as well as a modeled climate change water level scenario. The species varied in their flood and drought tolerance, distance they can spread and competitive ability to colonize unvegetated areas. The results of this study can guide the selection of appropriate plants for shoreland restoration. The second, two-part study compared several shoreland bioengineering methods and "soft armor" products, side-by-side, on some challenging sites. This study also involved revisiting historic shoreland restoration sites to evaluate the effectiveness of the installed plants and bioengineering methods at controlling shoreline erosion under the specific site conditions. An expert panel assisted in interpreting the range of site conditions for which bioengineering methods are effective for shoreland erosion control.

Management of Alien Invasive Algae in Kaneohe Bay, Oahu through the Use of Mechanical Removal and Bio-control Efforts

Blodgett, Jono; David Cohen, Frank Mancini

Dept. of Land and Natural Resources

Kaneohe Bay on the windward side of the island of Oahu (21°27'35"N 157°48'15"W) is a complex estuarine and coral reef ecosystem consisting of fringing, patch and barrier reefs that is struggling with multiple anthropogenic stressors. Stressors include, but are not limited to: land based pollution, recreational activities, fishing pressure and the introduction and establishment of alien species. One group of alien algae in particular, the *Kappaphycus/Eucheuma* spp. complex (K/E), poses a serious threat to coral reefs. The negative impacts of invasive algae on Hawaii's coral reefs have been well documented however, relatively few management techniques have been developed to protect threatened and restore impacted coral reefs. In partnership with The Nature Conservancy and the University of Hawaii, the State of Hawaii's, Division of Aquatic Resources developed a novel approach to manage invasive algae. The partnership developed a modified dredge, nicknamed the "Super Sucker," that is capable of removing large quantities of alien invasive algae (5000 lbs. per day). K/E was physically removed from three large patch reefs (13 acres total) in Kaneohe Bay which were then stocked with native hatchery raised urchins at a density of 2/m². These reefs are being surveyed quarterly to monitor changes in the benthic, fish and invertebrate communities and assess effectiveness of bio-control efforts. The artificial propagation and out-planting of the native sea urchin, *T. gratilla*, is a viable management approach until longer-term, ecosystem wide, solutions can be implemented.

The future of Emiquon: sustaining and leveraging high-quality functional floodplain long term

Blodgett, K. Douglas

The Nature Conservancy

While The Nature Conservancy's floodplain restoration at Emiquon has been extremely successful to date, challenges remain for sustaining the project and achieving its full potential. Such challenges include addressing altered hydrology, water quality, sedimentation, and invasive species. Hydrology and

ORAL ABSTRACTS (CONT'D)

the dynamic relationship between a river and its floodplain are key drivers for sustaining floodplain wetlands such as Emiquon and the large-floodplain river ecosystems to which they contribute. While historic records and computer modeling provide guidance for desired hydrologic and connectivity regimes at Emiquon, the Conservancy is presently constrained by inadequate water control and connectivity infrastructure. Pending construction will provide a cost-effective way to manage hydrology and the movement of water and its constituents between Emiquon and the river, affording aquatic organisms access to floodplain wetland habitats essential for carrying out life requisites and delivering high-quality primary and secondary production to the river. Additionally, the infrastructure will facilitate strategies for managing threats such as excess sedimentation and invasive species. Beyond management, scientific research at Emiquon will continue adding to our understanding of large-floodplain river ecology and documenting the many benefits these systems provide for nature and people. Along with opportunities for recreation and compatible economic development, promoting this better understanding of functional floodplains will build constituency for more effective conservation at all scales, from local to global-- Emiquon will be the best it can be when it guides and promotes wise management and use of floodplain wetlands well beyond its physical borders.

Landscape-scale monitoring of the tamarisk leaf beetle (*Diorhabda* spp.)

Bloodworth, Ben; Shannon Hatch

Tamarisk Coalition

Over the last six years, Tamarisk Coalition (TC), a non-profit organization advancing the restoration of riparian lands through collaboration, education, and technical assistance, has been coordinating efforts to monitor the dispersal and establishment of the tamarisk leaf beetle (*Diorhabda* spp.), a biological control agent utilized in the management of tamarisk (*Tamarix* spp.). In 2007, in partnership with Colorado Department of Agriculture Palisade Insectary, TC developed a landscape-scale monitoring program to collect data and information to help: 1) Inform public and private land managers of the presence of beetles and potential impacts to riparian systems, 2) Guide restoration planning efforts, especially those associated with watershed partnership groups focused on the holistic management of tamarisk and other woody invasive species, 3) Encourage federal agencies to respond to the potential impacts of the beetle through funding of monitoring, research and/or restoration activities, and 4) Garner public and private support to enhance native plant communities in areas where defoliation will potentially impact the endangered Southwestern Willow Flycatcher critical habitat and other sensitive riparian areas. While beetle distribution data have been invaluable, many managers are also interested in assessing long-term ecosystem changes associated with beetle establishment. TC is currently working with partners to develop more detailed monitoring protocols that can be used by land managers to quantify and report on factors such as vegetative response, tamarisk mortality, and trophic cascade impacts.

Samish traditional ecological knowledge and wisdom: From songs, stories and practices to environmental restoration on Cypress Island, WA

Bluhm, Jodi D.

Samish Indian Nation, Department of Natural Resources

Since “time immemorial”, Samish People have been stewards of the places they live. Traditional Lifeways require close observation of the natural world to know when to schedule important events. Times to harvest, times to preserve and times to rest are all shared by the environment. The Samish Indian Nation continues to care about our natural environment holistically and is concerned by changes in climate, ocean acidification, and loss of habitat that birds, animals, fish and humans depend on. Samish traditional knowledge is carried in song, stories and practice that deepen understanding of connection and human relationship with our natural surroundings. The Samish Indian Nation’s Department of Natural Resources is working to integrate this knowledge into current restoration and preservation projects that we are involved in. This presentation will include examples of how we are doing this, using our partnership involvement in the Cypress Island estuarine and salt marsh restoration project as an example. Working with State, Federal and local agencies to identify, preserve, protect and enhance all natural resources within Samish historical and cultural territory is important to the Samish Community, continuing a long tradition of natural resource stewardship.

Learning from the Chesapeake: The Utilization of Tree Shelters in Riparian Restoration Strategies

Bogue, David; Chris Kelsey

Tubex

Riparian zones represent a critical point for habitat preservation and restoration and are key to restoring healthy waterways. Maintaining healthy riparian zones is heavily dependent upon securing not just the health of waterways but of vegetation. The survivability of tree seedlings is especially vital to ensure proper ecosystem diversity. In the United States, the Environmental Protection Agency (EPA) has moved closer to establishing a Total Maximum Daily Load (TMDL, or “pollution diet”) to improve waterway health from fertilizer, stormwater, and sediment migration pollution. Much of the research for this is tied to the on-going restoration of the Chesapeake Bay watershed. Strategies utilized in this watershed have been well-documented and have effectively reduced hypoxia—a condition that threatens far more areas than just the Chesapeake Bay. While the selection of certain species for habitat restoration may be regionally or locally determined, the strategies implemented to promote diverse, healthy vegetation may be replicated elsewhere. Tree shelters have played a strong role in protecting seedlings from drought and damage (mechanical, chemical and animal). Furthermore, tree shelters have beneficially impacted the establishment of roots and promoted faster growth. We discuss the strategies executed in the Chesapeake Bay, particularly in regards to their impact on vegetation health, and how these strategies may be replicated elsewhere (e.g., Gulf region restoration, Mississippi Watershed). Additionally, we discuss the variety and implications (benefits and challenges) of tree shelter system selection, summarize research on tree shelter utilization, and provide specific project examples.

ORAL ABSTRACTS (CONT'D)

How to increase species diversity in phytostabilization strategies near Lubumbashi (Katanga – D.R.C.)?

Boisson, Sylvain; Julien Collignon, Soizig Le Stradic, Arnaud Monty, Grégory Mahy, Mylor Ngoy Shutcha
Gembloux Agro-Bio Tech (ULG)

Copper contamination of soils represents a threat to natural areas and to human health. Phytostabilization, i.e using plants to immobilize contaminants, represents a well-known technology to hemper heavy metals spread across landscapes. In Katanga (Congo D.R.), *Microchloa altera* was recently identified as a candidate species to stabilize copper in soil. This grass naturally tolerates and accumulates high copper concentrations and belongs to the typical copper flora of Katanga. However more than 600 species compose this flora and other grasses may be used in phytostabilisation strategies. But little is known about the phenology reproductive strategy and demography of these species, which makes their use in current phytostabilization strategies difficult. The present study aims to characterize the reproduction capacity of seven other dominant grass species for future phytostabilisation tests. A total of 67 quadrats (1m²) were randomly placed across three sites. At two periods over the fruiting season, three inflorescences per species per quadrat were collected in order to estimate the number of spikes, spikelets and viable seeds. All species have sexual reproductive strategy and spikelets number presents little variation between populations. Three species are very common (*Andropogon shirensis*, *Loudetia simplex* and *Eragrostis racemosa*) and represent potential candidates to increase species diversity in phytostabilization strategies in Katanga. Further research, including germination tests and phytostabilization tests in situ, is planned in a near future.

Simulated restoration of wildebeest migratory pathways in the Athi-Kaputiei Plains of Kenya

Boone, Randall; Jared Stabach, Jeff Worden, Robin Reid, Rob Lillieholm, Mohammed Said
Natural Resource Ecology Laboratory

The Athi-Kaputiei Plains are framed by the metropolis of Nairobi to the north, the Rift Valley to the west, brush lands on rough terrain to the south, and the Lukenya Hills and large colonial-era ranches to the east. At its northern extent is Nairobi National Park. Nairobi National Park maintains populations of a variety of wildlife, and is fenced on its northern, eastern, and western boundaries. Migratory wildebeest and zebra move into Nairobi National Park as the dry season deepens in July, drawn to permanent water. When the rains return in October, the migrants move south into the Kitengela dispersal area. Fragmentation south of the park has reduced migration and wildlife populations have declined 72% from 1977 to 2002. Human land use is primarily livestock grazing - 80% of ungulate biomass is livestock - but includes cultivation, quarries, settlements, and an Export Processing Zone. Fences were mapped in 2004 and again in 2010, and team members have modeled fragmentation in the region to 2040. We created an agent-based model of wildebeest migration that used estimates of primary production from 2001 to 2010, the fragmentation maps, and more than 300,000 wildebeest locations reported from GPS-equipped collars to simulate movement by wildebeest through the landscape. Our evidence suggests that migration is no longer possible. Using the model we estimate minimum sets of developed parcels that must be restored to grassland to allow animals to migrate, and areas where future development may be redirected to maintain animal movements.

Research perspectives on restoration of longleaf pine ecosystems: successes, opportunities and challenges

Boring, Lindsay R.; Katherine Kirkman, Steven B. Jack
Jones Ecological Research Center

During the past 20 years efforts to restore longleaf pine (*Pinus palustris* P. Mill.) woodlands have gained considerable interest and momentum. These initiatives represent a wide range of restoration objectives and starting points. Progress in artificial regeneration and production of high quality seedlings has resulted in large acreages of young plantations on public and private lands. With appreciation of longleaf pine's ecological characteristics and associated fire-maintained habitats, there has been greater support for research on restoration of longleaf pine woodlands to promote this species-rich ecosystem. A greater understanding of process-based ecosystem restoration is emerging through studies addressing ecosystem processes, silviculture, fire ecology, fauna and landscape scale issues. Research challenges include silviculture for aging plantations that further ecosystem development and community reassembly. Long term studies of thinning, prescribed fire, and reintroduction of native ground cover are needed. Seed sources for ground cover restoration, adaptive management intervention, fuels, fire behavior and regional air quality are also research topics. Appropriate metrics that quantify progress and predict wildlife response to habitat development over time are needed. The greatest challenges are with an uncharted future for the pace and scale of change in the physical environment. Managers will face a complex task of evaluating the implications of climate and land use change coupled with exotic invasive species and pathogens. Tools to track restoration sites and reference condition, or in some cases "no-analog" reference sites, will be essential to adapt long-term management approaches.

Methods for establishing rich fen mosses on reclaimed peatlands in Alberta's oil sands region

Borkenhagen, Andrea; David J. Cooper
Colorado State University

Northern Alberta's oil sands deposit is the largest in the world and mining operations remove vast areas of upland forests and peatland ecosystems. Reclaiming peatlands is challenging as they require a precise hydrologic regime and take thousands of years to accumulate peat. Restoration has been conducted on degraded fens and bogs but innovative approaches are required in a post-mining landscape. Our research focuses on methods to establish moss on constructed fens and initiate carbon storage processes. We evaluated the establishment of five important rich fen moss species in response to water level and cover treatments. Moss species were introduced in equal proportions as a 1:10 ratio propagule blend to peat-mineral mixture mesocosms. Moss establishment was measured along a water table gradient of 0 to 40 cm below the peat surface to determine species distributions along hummock-hollow microsites. Three cover treatments were tested to assess the effect of microclimate moderations. Total moss cover was not

ORAL ABSTRACTS (CONT'D)

significantly different between water level treatments but species distribution was. Hollow species *Drepanocladus aduncus* and *Bryum pseudotriquetrum* outcompeted hummock species *Aulacomnium palustre* in the wettest treatments. The opposite pattern occurred in treatments with deeper water levels. *Tomentypnum nitens* dominated all treatments and was unaffected by water level. Moss species percent cover and height was enhanced under wood-strand mulch and impeded under high density seedling plantings. Implications for constructed fens include applying wood-strand mulch to increase establishment and introducing a mixture of mosses that occur along natural hydrologic gradients to allow for variations in water table.

10 years of restoration of the Azorean Laurel Forest, home of the Azorean Bullfinch: lessons learned

Botelho, Rui; Ruben Heleno, Jaime Ramos, Joaquim Teodosio, Azucena De La Cruz, Filipe Figueiredo, Luis Costa
Portuguese Society for the Study of Birds (SPEA)

The Azores bullfinch (*Pyrrhula murina*), one of the rarest European bird species, survives only in the remaining fragment of a single Azorean island. Until recently, the population of this Critically Endangered passerine was estimated in 200 couples, largely threatened by the replacement of native forest by exotic plantations, agriculture, plant invasions and predation by introduced mammals. Since 2003, a large conservation project coordinated by the SPEA with EU LIFE funding was implemented to save the Azores bullfinch from extinction by restoring its natural habitat, in the SPA Pico da Vara/Ribeira do Guilherme. In order to restore the ecological dynamics of these habitats highly invasive plant (e.g. *Clethra arborea*, *Hedychium gardnerarum*, *Pittosporum undulatum* and *Gunnera tinctoria*) were removed from c.300 hectares of the native forest and over 150000 native plants were planted. More recently, a similar effort is being applied into restoring the blanked bogs of the central plateau, another highly threatened habitat. So far c.100 ha have been restored, with the removal of invasive plants and recovering of the hydrological dynamics of the bogs, promoting soil waterlogging. The results have been highly encouraging, showing that the natural dynamics of these native habitats can be recovered, which was translated in the bullfinch being recently downlisted to Endangered species. Notwithstanding, the results show the importance of using appropriate methods for the control of alien plants and also of rigorously monitoring the restored areas in order to secure the early detection of new focus of invasion.

Stocktype development and selection for improved restoration success in Lebanon

Bouazza, Karma; Olga Kildisheva, Matthew Aghai, Anthony S. Davis
Lebanon Reforestation Initiative

Prior to 2012, the majority of seedlings used for forest restoration in Lebanon were produced in an assortment of large containers over several years. Culturing techniques were inconsistent with container size, species growth habits, and outplanting objectives. These practices often resulted in the production of suboptimal seedlings and subsequent restoration failure due to additional stresses from drought, vegetative competition, rocky soils, and ungulate damage. Further complicating restoration efforts was minimal record keeping, leaving little evidence to guide improvement in seedling production and restoration outplanting practices. Currently, the Lebanon Reforestation Initiative has developed new culturing practices that provide a basis for producing high quality nursery stock, building on both local experience and global knowledge. Science-based irrigation and fertilization practices, container selection founded on outplanting conditions, and crop scheduling have resulted in a marked improvement in seedling quality and exceptionally high rate of adoption by private, community, NGO, and public nurseries. We discuss the methods, successes, and challenges of introducing new seedling production techniques to improve restoration success in Lebanon.

Urban stream restoration in a changing world: Alternative pathways in the Southern Piedmont USA

Boudell, Jere A.; Japhia M. Jacobo, Serge A. Fariñas
Clayton State University

Urban streams are highly impacted by urbanization and often exhibit “urban stream syndrome.” Urban stressors are difficult to remove or attenuate, yet the majority of stream restoration occurs in metropolitan areas. Climate change models have predicated increased drought frequency and longer intervals between rainfall events in the southeastern USA. The changing climate complicates urban stream restoration issues by altering ecosystem demands and creating alternative recovery pathways. An urban stream restoration gradient in the Georgia Piedmont served as a model for new approaches to urban stream restoration and was evaluated for project success and alternative recovery pathways according to changing climate scenarios. Under current success criteria, the restored urban stream failed to be truly restored as it was more similar to an unrestored urban reach than to the older, more successfully restored reference reach. However, the reference reach, a protected managed reach that developed under more humid climate conditions, is predicted to change as the climate becomes drier and stream conditions change. The restored urban stream, while highly dissimilar to current reference conditions, had greater herbaceous cover and a wider variety of plant communities. The greater range of species types may allow the failed restored stream to respond to changing climate conditions more successfully than the reference stream. As a drier climate impacts southern Piedmont ecosystems our reference conditions and our success criteria must become more flexible to allow urban streams to best meet changing ecosystem demands.

Interim outcomes and lessons learned during an intermediate phase of ecosystem restoration

Bousquin, Stephen G.
South Florida Water Management District

Examination of the causes of ecological responses to restoration projects during interim or intermediate stages of project completion is a crucial step toward effective adaptive management to enhance project success. The South Florida Water Management District's Kissimmee River Restoration Evaluation Program (KRREP) has monitored ecological criteria for the Kissimmee River Restoration Project since the 1990s, before and after partial

ORAL ABSTRACTS (CONT'D)

hydrologic reestablishment by Phase I construction, completed in 2001. Recovery of the ecosystem is expected to be driven by hydrologic changes resulting from (1) reconstruction of the physical form of the river/floodplain and (2) implementation of a revised water regulation schedule designed to modify inflows to the project to improve our ability to mimic historic hydrologic conditions. However, neither of these drivers will be fully in place until completion of the restoration project, currently projected for 2015. In the interim period since 2001 during which hydrologic restoration is partially incomplete, KRREP has documented changes indicating a partial return of the system to conditions comparable to those found before the river was channelized. However, some ecological components have been slow to return or have not responded as expected, providing useful information about potential future responses. This talk will present a brief overview of ecological responses during the interim period and their hypothesized causes, and will underscore the importance of ecological monitoring during ecosystem recovery as a means to gauge the status of recovery and provide feedback to guide appropriate water and land management practices to enhance restoration outcomes.

Near-shore to deep-sea marine restoration: Venturing into the abyss

Bowers, Keith

Biohabitats, Inc.

Oceans form one of the key operating systems of our planet, but they are in trouble. Climate change, overfishing, acidification, habitat destruction, pollution and the introduction of alien species are having a profound effect on ocean ecosystems. Similarly, near-shore environments are rich, complex and an important interface between our terrestrial and marine ecosystems. Near-shore habitats are critical to populations of biologic and economic value, including shellfish, sport fish, seabirds, and marine mammals. They are also home to most of the world's population, providing recreation, sustenance, commerce, energy, minerals and a place for people to work and play. But they are in trouble too. The loss of coastal wetlands, coral reefs, sea grass beds and shellfish combined with the increase in shipping, telecommunications, energy production, mineral extraction, and fishing is quickly altering near-shore ecosystems. The world is also embarking on the industrialization of the deep sea. From trawling to impending deep-sea mining, ocean floor habitats and wild marine fisheries are being impacted at accelerating rates. In order to mitigate and reverse these impacts, ecological restoration of both near shore and deep-sea environments is desperately needed. This session will explore some of the pioneering thinking and initiatives taking place throughout the world to restore both near shore and deep sea environments. From post larval wild marine fish capture, rearing and restocking to using biomimicry to develop living sea walls, to conceptualizing the restoration of ocean bottom habitat at depths greater than 200m, we aim to move the field of restoration to new depths.

Restoring Tallgrass Prairie (and Associated Ecosystems)

Bragg, Tom

University of Nebraska - Omaha

The loss of 99% of the original tallgrass prairie ultimately resulted in numerous restorations, most of which included fire because of its historic importance (along with grazing and drought). Observations from the 65 ha Allwine Prairie Preserve hint at the complexity of such restorations but also suggest some useful generalizations. Generally, fire is not useful early in a restoration, partly because of insufficient fuel and partly because resulting environmental conditions may stress seedlings. Mowing or haying the first 2-3 years seems more effective at reducing ruderal species cover (usually annuals) thereby increasing light and soil moisture available for native (usually perennial) seedlings. Fire's role increases a few years after a successful restoration. At a 3-4 year return interval, spring fires facilitate prairie restorations by removing litter, increasing primary productivity, and preventing woody plant establishment, although effects of fire during other seasons may differ. Over decades, however, the use of fire needs careful monitoring since even high forb diversity restorations may lose their diversity should burning occur repeatedly at the same season and frequency. Fire used in conjunction with bison or cattle grazing (i.e. patch-burn grazing) holds some possibility for management of diverse restorations, although this approach needs more study to assess decades-long effects. In the end, fire is critical to managing tallgrass prairie restorations, although alone it may not provide the results sought. In prairie (restoration) management, effective monitoring is crucial as is the willingness to objectively assess and alter treatment when observed results take us away from our objectives.

Workshop: Partnering ecological rehabilitation with ecosystems services towards achieving sustainable subsistence

Braid, Samantha

Aurecon South Africa (Pty) Ltd

Ecosystems offer a range of services and functions to the benefit of human society. The restoration/rehabilitation and sustainable utilization of these services and functions can help promote poverty reduction, sustainable livelihoods and job creation. Rehabilitation can improve many of the services and functions impaired through ecological degradation. In first world countries ecological rehabilitation projects are usually community driven, whereas in developing parts of the world such as Sub-Saharan Africa, South America and Asia, these types of projects are viewed as a luxury expenditure competing with the expenses of providing basic standards of living and meeting the MDGs. Rehabilitation can improve many of the services and functions impaired through ecological degradation. Whilst for new projects some form of environmental impact identification, such as Strategic Environmental Assessments (SEAs), is usually undertaken; while rehabilitation of already degraded ecosystems is often left to NGO's and foreign aid initiatives. By changing the perception of ecological rehabilitation projects as being "luxury expenses" to an integral component of poverty reduction, we seek to achieve sustainable subsistence practices, increased resilience to climate change, reduced risk from natural disasters and improved food and water security. We propose a workshop to look at some example case studies of impacts and/or successes of partnering ecosystems services and sustainable subsistence and then a facilitated discussion of how to further promote these efforts and drive ecological rehabilitation, especially in the African continent.

ORAL ABSTRACTS (CONT'D)

Tools to support riverine restoration in enforcement driven cases

Braid, Samantha

University of the Witwatersrand

Initiative driven restoration projects, tend to comply with environmental authorising requirements prior to initiation. However, smaller cases of illegal or non-compliant activities requiring restoration works tend to 'slip through the cracks', as the sections of legislation relating to compliance and enforcement mechanisms are not as prescriptive as the formal authorising requirements. Further, the enforcing officials usually have backgrounds in law enforcement rather than aquatic sciences. Therefore enforcement processes tend to be focused on 'legal box ticking' rather than the appropriate restoration of ecological degradation as a result of non-compliant activities. This administrative oversight is indicative of the immature/evolving state of the enforcement and compliance regimes in developing countries. In time, the enforcement and compliance units will be capacitated with appropriately qualified staff; until such time, an alternative remedy is the development of tools to support the current staff capabilities. In South Africa a set of three tools was developed to facilitate this support, these include: Legislation Search Tool - to assist the officials in identifying both overlapping legislation and institutional mandates. Rapid Site Assessment Tool - to promote a more comprehensive site inspection and thereby the identification of the actual ecological degradation as a result of the illegal activities. This is based on "layman" science, to cater for the current skills of enforcement officials. Decision Support System - that will inform the enforcement officials of the impacts to ecological services occurring on the site and thereby guide the specialists as to what the rehabilitation objectives should aim to achieve.

Finding the money for tropical forest restoration

Brancalion, Pedro; Ricardo Viani, Bernardo Strassburg, Ricardo Rodrigues

Universidade de São Paulo

In human-modified landscapes in developing countries, tropical forest restoration projects must not only assist the recovery of ecosystems, they must also bring economic rewards to landowners. In this perspective, restoration cannot compete with productive land uses. It has to be focused primarily in marginalized agricultural lands, like extensive, low-productivity pasturelands, where better agricultural practices may improve productivity and free up marginal areas for restoration. It is then necessary to create space for large scale restoration in a world with intense competition for land, so that restoration practitioners have to work in partnership with professionals in charge of improving agriculture. In addition, the restoration process can be seen as a way of providing landowners with an economic return, rather than a waste of land and money. To meet this challenge, restoration models have to foresee the opportunities to transform this activity into an economically viable land use, with returns higher than those provided by degrading and unproductive uses. There are multiple options, like crop production in agro-successional restoration schemes, the exploitation of timber and non-timber forest products, and payments for carbon- and water-related ecosystem services, which should be integrated to increase income and reduce risks. If economic forces are not incorporated into the design, implementation and management of restoration projects, they may not revert degradation at the necessary levels to support human welfare and biodiversity conservation. Upscaling tropical forest restoration is urgent and necessary – and eminently viable economically.

Successional changes in the vegetation communities of an eastern deciduous forest and implications for restoration

Breen, Daniel B.; Vanessa B. Beauchamp

Towson University

Succession is the process in which herbaceous plants, shrubs, and trees progressively replace each other as the dominant features of a community. Historical land use can strongly influence succession, and sites with a longer forested history tend to exhibit higher species richness and fewer invasive plant species than regrowth forests with an enduring legacy of agriculture. The Middle Patuxent Environmental Area (MPEA) comprises a 413 ha secondary successional forest in Howard County, Maryland, USA. One hundred ten long-term monitoring plots were established in the MPEA in 2001 and re-sampled in 2009. We collected additional data in 2012 with the purpose of grouping the MPEA into logical vegetation communities dominated by similar species, thus providing insight into succession and the influence of historical land use. Herbaceous vegetation data have been classified into seven community types using noise clustering in the R package *vegclust*, and an indicator species analysis has identified the species most associated with each type. These results define three distinct communities characterized by native understory herbs and four communities associated with at least one early-successional invasive species. Spatial analyses were also conducted using ArcGIS to relate our results to historical land-use data and other landscape features. Our findings are being compiled into resource management recommendations for the MPEA that will identify the community types in greatest need of restoration efforts and predict areas that are most at risk of further invasive species spread.

Crown fire hazard and simulated thinning of pine barrens forest at the wildland-urban interface

Bried, Jason; Neil Gifford

Oklahoma State University

Pine barrens contain some of the most volatile fuels in North America's sub-boreal forest region and occur across some of the most densely populated areas on the continent, raising concerns about catastrophic fire at the wildland-urban interface. We modeled pitch pine (*Pinus rigida*) canopy fuels and crown fire hazard in urbanizing pine barrens forest, and estimated crown fire potential under simulated harvest scenarios to develop guidance for thinning operations. The data come from six mature pitch pine stands at the Albany Pine Bush Preserve (New York State, USA), one of the largest remaining inland pine barrens and a microcosm for ecological management at the wildland-urban interface. We used previously derived allometric

ORAL ABSTRACTS (CONT'D)

equations to estimate canopy base height and bulk density from pitch pine diameter, crown height, and crown dominance. These canopy fuel properties along with surface fuel moisture, weather, and topography were then used for predicting fire type along with crown fire initiation (Torching index) and propagation (Crowning index). In several cases conditional crown fire was predicted and local wind speeds exceeded the Crowning index, suggesting that active crowning is possible if fire reaches the canopy. Harvest simulations prescribed up to 70% reduction in stand density and basal area, and recommended a residual density of 30–50 trees per acre to prevent crown fire disasters in a heavily developed area. In addition to being potentially dangerous at the wildland-urban interface, we argue that contemporary pitch pine density is essentially “artificial” and counterproductive to pine barrens biodiversity conservation.

Scaling Up Conservation: ecological restoration and fostering stewardship at Wolong Nature Reserve (Sichuan) offer lessons to conserve biodiversity, secure livelihoods, and adapt to climate change

Brody, Marc; Peng Luo, Hemin Zhang, Anna Beech, Justin Grothe

Panda Mountain – USCEF

The IUCN World Conservation Forum (Sept. 2012) issued the Jeju Declaration stating: “Scaling Up Conservation” is necessary to conserve the Earth’s biological diversity, and “all parts of society must take determined measures.” This presentation highlights how “Scaling Up Conservation” is achievable through participatory ecological restoration programs that inspire hope and stewardship, and demonstrate how humans can be positive ecological change agents to conserve biodiversity, secure livelihoods, and adapt to climate change. Science-based restoration programs at the Wolong Nature Reserve (Sichuan, China) will target monoculture stands of the exotic Japanese Larch (*Larix kaempferi* L.), degraded and fragmented natural forests suitable for Giant Panda habitat, and overgrazed alpine grasslands. Wolong, an International Biosphere Reserve and World Heritage Site at the center of the world’s largest block of contiguous panda habitat, can serve as a replicable model for restoration and best practices for adaptive ecosystem management. Scaling Up Conservation will require a shift in resource management policy from restricting human activity to fostering engagement and long-term stewardship. Starting at Wolong, Panda Mountain (NGO) will engage scientists, ecologists, indigenous villagers, protected area personnel, tourists/volunteers, and students in these restoration programs. 1. Establish a “Training and Learning Center” to guide science-based restoration and training programs. 2. Restore stands of the exotic *Larix kaempferi* (L.) to native forest and create restoration nurseries of native plants/trees. 3. Demonstrate how restoration-based tourism can fund habitat conservation, inspiring participants to be positive ecological change agents. 4. Coordinate Site-specific Restoration Gifting (crowd sourcing/funding from donors throughout the world).

The Fargo Project: from urban stormwater basin to restored prairie commons

Brookner, Jackie

Ecological Artist at Brookner Studio / Parsons The New School for Design

The Fargo Project in Fargo, ND is a pilot project to explore and demonstrate how holistic ecological restoration, socially engaged ecological art, and active community process can synergize to transform a functioning 18-acre urban stormwater detention basin into a vibrant urban green space. The basin will become a multifunctional commons with 17 acres of restored native prairie and wet meadow, with walking trails and outdoor spaces for natural play, gathering and celebration. The complexity of establishing native plants in Fargo’s unique soils and in a functioning stormwater basin requires a dynamic process adaptive to emerging conditions. Ongoing monitoring of the interaction of the soils, plants, and water will inform this process. Programming to encourage connection and stewardship, build capacity, and help sustain the project will provide diverse populations with training in prairie restoration, monitoring and maintenance practices. We are aiming for a fully participatory community process from concept through design, implementation, use and long-term care. Because Fargo is located in the floodplain of the frequently flooding Red River, water is seen by many as the enemy. The urgent need to transform cultural attitudes toward water and the City’s support makes Fargo an opportune place for this project. The project’s long-term goal is to transform many of Fargo’s stormwater basins into neighborhood amenities. Water quality, flood control, biodiversity, cultural diversity, and human health and well-being will become the beneficiaries of recognizing and celebrating stormwater as a valuable resource.

Riparian restoration in the context of dam removal: lessons from the Elwha River, Washington

Brown, Rebecca L.; Patrick B. Shafroth, Aaron J. Clausen, Laura G. Perry

Eastern Washington University

River damming can degrade riparian vegetation by altering flow regime, fluxes of sediment and woody debris, and associated fluvial processes. Dam removal may help restore riparian vegetation by reversing these alterations. However, transport, deposition and exposure of large volumes of trapped sediment can complicate a simple return to pre-dam conditions. Riparian restoration objectives following dam removal include restoring natural riparian vegetation dynamics, expediting revegetation of former reservoirs, and minimizing invasion of exotic species. On the Elwha River, we hypothesize that in the first years following removal of two dams, transport and deposition of large volumes of sediment downstream of the former dams will bury some existing vegetation and create new surfaces for vegetation establishment, while in the long-term, restored sediment fluxes will generate more gravel bars and associated diverse early-successional vegetation. We are evaluating these hypotheses and restoration success through long-term monitoring of riparian vegetation on the Elwha River before and after dam removal in three river reaches: above (reference reach), between, and downstream from the two dams. Before dam removal, downstream reaches had fewer young geomorphic surfaces and ~25% lower vascular plant species richness. Following partial dam removal, some former reservoir surfaces were rapidly dominated by exotic species, such as Canada thistle (*Cirsium arvense*) and reed canary grass (*Phalaris arundinacea*), while others contained typical, native pioneer communities dominated by *Salix*, *Alnus*, and *Populus*. We also documented sediment deposition on low surfaces downstream. Future monitoring will reveal further changes to riparian vegetation communities as removal of the dams is completed.

Effects of 20 years oak savanna restoration on avian and mycological species in a southern Iowa oak savanna remnant

Brown, Sibylla

Twenty years of restoration management have significantly increased density and diversity of birds and ectomycorrhizal fungi at Timberhill oak savanna. In 1993 we began restoring Timberhill oak savanna. Restoration management has been limited to thinning the overstocked woodland and frequent prescribed fire. This has restored habitat for a heterogeneity of bird species: raptors, neotropical migrants, and permanent residents all thrive in the restored woodland. Restoration has created a structural complexity that provides nesting sites for diversity of birds: standing dead trees and snags for cavity nesters, shrubs and scattered mature trees for open nesters, forbs, grasses and patches of dead leaves for ground nesting species. Opening the woodland has also increased native plant density. Timberhill is able to support a higher bird density because seeds and flowers present from early spring through late fall are host to diverse insect population which provides abundant food for nesting and brood rearing. As restoration proceeded I also observed an increasing diversity of ectomycorrhizal (fungi that have a symbiotic relationship with plants) fungi. Boletes, fungi with pores rather than gills on the underside of the cap have exhibited the most diversity. Before restoration the only bolete fruiting at Timberhill was the common bitter bolete. Now 26 species have been collected there. Even species such as *Gastroboletus turbinatus* which is normally associated with coniferous woodlands fruit regularly at Timberhill.

Leveraging funding and volunteers to combat woody invasive species and lesser celandine (*Ranunculus ficaria*) in southwest Ohio.

Brownknight, Jason
Cincinnati Nature Center

Cincinnati Nature Center (CNC) lands exist as islands of biodiversity surrounded by urbanization and agricultural land use. One of the largest threats to CNC biodiversity is nonnative invasive species. Over two dozen species of nonnative invasive species exist on CNC lands; including Amur "bush" honeysuckle, garlic mustard, tree of heaven, Japanese wisteria, Japanese honeysuckle, autumn olive, and lesser celandine. Each of these species present significant threats to native biodiversity at CNC, however lesser celandine (*Ranunculus ficaria*) may be the most difficult to combat. This herbaceous invasive plant poses a grave threat to native spring flora. Currently, 300 acres of mature hardwood forest at CNC is infested with lesser celandine. To combat this threat CNC is leveraging funding and volunteers to combat both woody invasive species and lesser celandine. In 2011 CNC enrolled in the USDA Natural Resource Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) to improve 100 acres of hardwood forest by removing woody invasive species over a five year period. The EQIP program reimburses CNC for every acre that is treated for woody invasive species in the project area. The first two years of this program have been completed with over seventy volunteers contributing over 3,000 hours toward the treatment and re-treatment of woody invasive species on 55 acres at CNC. As a result, CNC has received over \$20,000 from the EQIP program. This funding is being used to hire a local environmental contractor to treat lesser celandine in a section of over-mature hardwood forest at CNC.

What are the effects of restoration on exotic species? A meta-analysis

Brudvig, Lars A.; Jennifer A. Lau, Tyler Bassett, Brett R. Blaauw, Ellen K. Holste, Douglas A. Landis, Catherine A. Lindell, Kristen M. Nolting, Elizabeth M. Stelzner
Michigan State University

Invasive exotic species are among the world's greatest threats to native biodiversity and may negatively impact restoration efforts. The tools of ecological restoration have potential to control exotic species, yet we currently lack a general understanding of how restoration impacts invasions. We evaluated how restoration impacts exotic species through a meta-analysis of published restoration studies which report the diversity and/or abundance of exotic species. For each study, we compared restored areas (fields, plots, etc.) to pre-restored conditions or otherwise comparable unrestored (i.e., 'degraded') areas. Across all studies, restoration activities significantly increased exotic diversity (i.e., richness), but had no impact on abundance (cover, biomass, etc.). To understand whether these results were consistent across restoration approaches, we compared the effects of four common types of restoration: prescribed fire, habitat construction (e.g., wetland creation), planting of (generally) native species, and direct removal of exotic species. None of these approaches decreased exotic species' richness or abundance. Creating new habitats increased the richness and abundance of exotic species, prescribed fire increased abundance and had no impact on richness, and neither planting nor direct removal had an effect on exotic richness or abundance. Our findings suggest a neutral to positive influence of ecological restoration on biotic invasions, which may relate to the disturbances that accompany restoration activities. Future work should investigate the consequences of exotic species for important restoration outcomes, such as native biodiversity and ecosystem function, and where invasions are detrimental, determine restoration approaches that maximize native biodiversity and desirable functions, while minimizing invasion.

The harvester ant *Messor barbarus* as a new tool in ecological engineering: the case of the restoration of a dryland destroyed by an oil leak.

Bulot, Adeline; Erick Provost, Marielle Renucci, Thierry Dutoit
Université d'Avignon - IMBE

In one site of a species-rich Mediterranean steppe plant community destroyed by an oil leak in 2009, we suggest to use as an ecological sustainable engineering technique, the behavioral characteristics of an harvester ant (*Messor barbarus*) to complete the restoration of the typical steppe vegetation

ORAL ABSTRACTS (CONT'D)

after a soil transfer realized from a nearby quarry with classical with classical non sustainable civil engineering techniques. Potentials of refuse piles to concentrate and increase the survival and germination of plants were studied to confirm the role of harvester ants as ecological engineers for the regeneration of the steppe plant community. We sampled 10 refuse piles and 10 areas without nest on 100cm² in september 2012 and March 2013 to measure the species-richness and density of the transient and persistent seed bank. Our first results show that ants increase significantly species-richness and density of typical steppe species in their refuse piles. Then, transplantation of some *Messor barbarus* founders on the restored area and in the reference steppe as a control was tested and results were compared to natural recolonization. After one year, 39% of transplanted founders are still alive in the restored area and 24% only in the reference steppe where natural predators of ants have not been removed. No natural colonization occurred in the preliminary restored area because of the lack if suitable habitats (pebbles). The effects of these new artificial nests on vegetation will be now followed during several years in comparison with areas where no founder queens have been transplanted.

Ecosystem Restoration: A Critical Component of Sustainable Mining and Reclamation

Burger, James
Virginia Tech

Restoring native ecosystems after mining is a critical component of sustainable mining and reclamation. In 1999, the International Institute for Environment and Development (IIED) was commissioned to undertake a project called Mining, Minerals and Sustainable Development (MMSD) on behalf of the World Business Council for Sustainable Development (WBCSD). The project was initiated globally to develop ways for the mining industry to become sustainable. In the final report called *Breaking New Ground*, the MMSD group couched sustainable mining and reclamation within the “triple bottom line” used by other industries: economically viable, ecologically benign, and socially desirable. Putting concept to practice has been challenging. A holistic restoration approach is needed that includes landscape geomorphic design, stream reconstruction, soil replacement, restoration of the original flora and fauna by replacing seed pools, creating micro and macro habitat, and by planting and seeding selected native species. My research in the Appalachian region of the U.S. shows that an ecosystem restoration approach can be done in the context of current mining operations and regulations and at little or no extra cost to the coal operator. Benefits include greater land value for the owner including tax incentives in some states, potential for carbon credits, enhanced relationships with business partners, better watershed protection and quality, and greater levels of ecosystem services provided to local communities. An ecosystem reclamation approach aligns mining industry’s values with those of the societies in which it operates.

Monitoring regionally, reporting nationally: terrestrial biodiversity monitoring down under

Byers, Dave; Kevin Collins, Peter Bellingham, Fleur Maseyk
Waikato Regional Council

Waikato Regional Council is a key player in the development of a nationally focussed terrestrial biodiversity monitoring system that will greatly enhance the Council’s ability to respond to their statutory responsibilities to report on the efficiency and effectiveness of policies, rules, or plans to maintain indigenous biodiversity. Councils annually commit a substantial level of resourcing into restoration and enhancement efforts for indigenous biodiversity. More effective monitoring will also enable councils to better target this expenditure and optimise biodiversity outcomes. The monitoring system itself sits within a framework underpinned by the desired national outcome of ecological integrity, reported on through three components: indigenous dominance; species occupancy; and environmental representation. A minimum set (18) of indicators required to effectively monitor and report on the state of ecological integrity across New Zealand has been agreed on. Current work is focussed on the development of standard methodologies and protocols for data capture for each of the 18 indicators, and a standard operating plan for the implementation of the monitoring framework to maintain these standard methodologies across councils. This will allow not only the national aggregation of regional biodiversity data, but also the data collected by councils on private land to be aligned with data collected by the Department of Conservation on the public conservation estate. This ability has been lacking until now. This presentation will describe the technical, practical, and political challenges of establishing such an ambitious monitoring system and why it is critical for the maintenance of biodiversity that we overcome these challenges.

New U.S. Transportation Act provides authority to restore habitat connectivity and mitigate the environmental effects of roads

Callahan, Renee
Center for Large Landscape Conservation

The U.S. has 4 million miles of roads that support our nation’s mobile lifestyles and account for one-tenth of our gross domestic product. At the same time, our network of roads contributes to habitat destruction and fragments connectivity. Previously, managers who sought to alleviate some of the negative effects of roads faced an uphill battle. In 2012, however, a new transportation law was enacted that, for the first time, offers managers a blueprint for restoring habitat connectivity and mitigating the environmental effects of roads. That law, *Moving Ahead for Progress in the 21st Century* (MAP-21), includes provisions that empower transportation officials to restore and maintain terrestrial and aquatic connectivity, to mitigate the environmental damage that roads cause to wildlife and fish, natural habitats and wetlands, and ecosystem connectivity. MAP-21 also introduces a new program that provides for environmental mitigation at the regional, ecosystem, watershed, or statewide scale. Considered a seminal event in reducing the impact of roads on the environment, MAP-21 is the first national transportation law to weave throughout its programs the authority to mitigate the effect of roads on wildlife and connectivity. The Act’s mitigation provisions are extensive and include federal, state, tribal and metropolitan highway programs. These programs allow managers to spend their highway dollars on programs aimed at facilitating safe wildlife and fish passage, promoting habitat connectivity, and mitigating environmental harm. Examples of these new ecological provisions and their implications will be presented.

ORAL ABSTRACTS (CONT'D)

Implementing tidal wetland restoration in the San Francisco Bay in the face of climate change

Callaway, John C.; Lisa M. Schile, Evyan L. Borgnis, V. Thomas Parker

University of San Francisco

There is large-scale interest in restoring tidal wetlands in the San Francisco Bay Estuary, with projects ranging from a few hectares to thousands of hectares. Many of these restoration sites have subsided substantially, including those within the South Bay Salt Pond Restoration Project (SBSRP). All tidal wetlands will have to keep pace with climate change, including increased rates of sea-level rise, with subsided sites having the added challenge of accumulating enough sediment to reach threshold elevations for plant establishment. We have measured sedimentation rates at multiple sites to evaluate how sediment dynamics may affect the development of restored tidal wetlands in the Estuary, under current conditions and in the face of climate change. Highly subsided sites within the SBSRP have the potential for rapid sediment accumulation, as they are frequently inundated and suspended sediment rates are relatively high; however, there is growing concern that reductions in suspended sediment concentrations could limit future wetland resiliency. More than 20 cm of sediment accumulated in the first three years post-breach at one restored salt pond, with a gradual reduction in sediment accumulation over time as the site increased in elevation. Vegetation established rapidly at the site once suitable elevations were reached. A more subsided salt pond was breached in December 2010, with even more rapid accumulation; however, this pond still needs to accumulate additional sediment before reaching suitable elevations for plant establishment. These data will aid the development of models that can simulate tidal wetland development under a range of climate change scenarios.

Restoration ecology as for climate change adaptation in protected areas in the northeast and eastern Sierra Madre region, Mexico

Camacho, Fernando; Andrew Rhodes, Juan Manuel Frausto, Vanessa Valdez, Edgar Gonzalez, Mariana Bellot

CONANP

This project is being implemented by Mexico's National Commission of Protected Areas (CONANP), in collaboration with the Mexican Fund for the Conservation of Nature (FMCN), with funds from Parks Canada Agency in the Northeast and Eastern Sierra Madre region. It aims to: identify priority conservation objects through a participatory process that incorporates local stakeholder's knowledge and experience; determine the vulnerability to climate change of the region's ecosystems and conservation objects found within and around the region's protected areas; incorporate climate change adaptation measures in the protected area's management actions; and undertake on-the-ground adaptation actions which return structure and functionality to local ecosystems. Additionally, the project will incorporate three innovative components to climate change adaptation measures in federal conservation areas: 1) a Regional Technical Committee as a participatory advice mechanism; 2) implementation of restoration actions as mechanisms to increase resilience to climate change; and 3) a communication component. At the end of the project, local communities and stakeholders will understand and support the role of protected areas as mechanisms to increase resilience to climate change impacts through the conservation and restoration of biodiversity, at the same time they are fully trained and equipped to develop the necessary restoration plans and actions required to achieve this.

Do Maya Home Gardens Mimic Nature?

Campbell, David G.

Grinnell College

Yucatec Maya domestic gardens are extractive reserves of native plants, derived from an intergenerational biophilia that has been sustained since precolombian times. In Cayo District, western Belize, we used nonmetric multidimensional scaling ordination to compare the species compositions of ten Yucatec gardens with those of three edaphically dissimilar samples of nearby forest, to test the hypothesis that those gardens were representative (and therefore were guardians) of the forest that surrounded them. Our data comprised 37,700 individual plants, 645 species, 515 of which were native to Belize. Our analysis revealed that the species compositions of the gardens were not only representative of the forest plots, but that those gardens harbored more native species than the plots. Indeed, our data suggest that ancient Maya domestic gardens may be the prototypes of the contemporary Maya Forest, making la selva Maya, for all practical purposes, a feral domestic garden.

Bees and restoration: A natural history primer

Cane, James

USDA-ARS Pollinating Insect Research Unit

Bees prevail as pollinators of most natural and agricultural ecosystems. Because many plant species benefit from or require pollinators, bee communities should strongly influence enduring floral diversities and shape trajectories of terrestrial plant community restorations. The influences of habitat restorations on bees, however, are little known. A few intrinsic traits of bees are key to broadly defining their heterogeneous responses to habitats, and so plant community restoration. Few bee species are social, but one or more social taxa often abound in many biomes. Like most social species, most solitary bee species nest underground, often at characteristic soil depths, textures and moistures. Unlike social species, many solitary bees have only one annual 3-4-week period when adults are active and foraging. Many solitary species are pollen specialists, foraging from the same few related genera or tribes of plants in a community. Many locales have (or had) several hundred bee species. Without bees, most restored plant communities will lose substantial floral diversity. We don't or can't "reseed" bee species (colonization), although twig-nesters should be tried. However, we can provide a suitable "seed bed" for bees' establishment by accommodating their seasonality and nesting needs, and deploying an informed selection of timely, widely

ORAL ABSTRACTS (CONT'D)

used floral hosts. These same criteria help guide successful management of bees in agriculture. A case study produced ¼ million solitary Megachile bees on 20 ha of degraded rangeland seeded to grass and sweetclover, which illustrates the untapped potential for accommodating bees in habitat restoration

The management of invasive water soldier (*Stratiotes aloides* L.) in Ontario

Canning, Robert; Eric Sager

Trent University

In 2008, the invasive macrophyte, *Stratiotes aloides* L., was identified within the Trent Severn Waterway in Ontario. Despite this being the first known occurrence of this plant within a natural ecosystem in North America, it is recognized as a noxious weed and a prohibited aquatic plant species within the United States and among several other countries. In few short years, *Stratiotes aloides* has become one of the dominant macrophytes in the section of the river where it was introduced, outcompeting the native aquatic plant communities found within the province's historic waterway. Besides non-native macrophyte competition, fish and macroinvertebrate habitat, waterway navigation and recreational opportunities are all at risk following the arrival and spread of this invasive aquatic plant. Past research has shown that although both chemical and physical treatments were effective in eradicating the plant, a significant effect was observed between the control type and the recovery of the vegetation community following treatment. Herbicide application was shown to allow for a more diverse macrophyte community to form compared to manual plant removal in the period after the initial application. The objective of this study is to determine the efficacy of using chemical and physical treatments for the control of *Stratiotes aloides*, while developing a management plan that both eradicates the plant and promotes the highest degree of native macrophyte recovery post-treatment. Control will be applied outside of peak biomass periods to limit the negative effect towards desirable non-target vegetation, which is commonly observed with mid-summer treatment applications.

Landscape and local factors affect tropical forest restoration

Cardoso, Fernanda C. Gil; Érico Emed Kauano, José Marcelo D. Torezan, Márcia C. M. Marques

Universidade Federal do Paraná

The efficiency of ecological restoration is potentially affected by factors acting in both micro- (microsites for seedling establishment) and meso-scales (landscape features). Assessing the proportional role of local and regional factors is important to assure the effectiveness of restoration for diversity conservation. We evaluated restoration areas aiming to define the relative importance of local factors (soil type, restoration method, grass species, and age of restoration) and regional factors (proportion of old-growth forest, immature forest, degraded and humid areas, and the nearest-neighbor distance) on the forest structure (tree abundance, basal area and species richness) of the restored areas. The models that best described tree abundance, species richness and basal area include the following explanatory variables: proportion of old-growth forest, nearest-neighbor distance, grass species, restoration age and restoration method. The proportion of old-growth forest was consistently the explanatory variable more important to affect the abundance, species richness and basal area in four of nine cases. We found that the restored forest had higher species richness and abundance if preserved habitat areas (old growth forests) were present in greater proportion in distances up to 500m. These results show that restoration methods and land use may have a secondary role in the success of restoration and that the presence of preserved forests is a key factor to be considered when planning forest restoration.

Workshop: Remote sensing applications for ecological restoration and natural areas management

Carlson, Jason; Fugui Wang

Applied Ecological Services

The evolution of remote sensing technologies is making large-scale inventory, monitoring and assessment of ecological services a cost-effective solution. Improvements in technologies such as computer infrastructure-processing and storage efficiency, software automated classification techniques as well as availability of data – satellite and aerial imagery, have drastically improved effectiveness of ecological applications for land management. The repeatable, synoptic abilities of remote sensing have made it an ideal tool for the study of invasive species at the landscape scale and have the capability of documenting the biological and geochemical character of vegetative communities. As the science grows and remote sensing devices become more pervasive, this information and the associated analysis will become available to the broader community of land managers and planners. This workshop will take a land managers perspective to show how remotely sensed data and classification processes can provide baseline and decision making information to a wide range of ecological and management objectives. The workshop will cover uses of data from satellite & airborne platforms.

Soil biotic communities under shelter belts within agricultural landscapes and the effect of plant functional type

Carnovale, Daniela; Geoff Baker, Peter Thrall, Andrew Bissett, Philip Gibbons

Australian National University, Fenner School of Environment and Society

In Southeastern Australia, linear strips of planted trees and shrubs (shelter belts) are frequently established to restore ecosystem services that have been altered due to agriculture. Despite their wide use little is known about the effect of shelter belts on soil biotic diversity and how they alter aboveground – belowground interactions. This study aims to: 1) understand how shelter belts affect soil biotic communities and how time since establishment may drive soil community trajectories; 2) explore aboveground - belowground linkages by investigating soil communities under dominant shelter belt tree genera (*Acacia* and *Eucalyptus*). We compared the abundance and structure of bacterial and fungal communities using quantitative PCR (qPCR) and terminal restriction fragment length polymorphism (T-RFLP), earthworm community composition and biomass, microbial biomass (C and N) and soil physiochemical properties between shelter belts, the adjacent pasture and remnant native vegetation. Findings thus far demonstrate significant

ORAL ABSTRACTS (CONT'D)

differences in the soil bacterial and earthworm community composition in shelter belts compared with adjacent pasture sites. Soil earthworm communities under belts are often divergent from the soil communities under native vegetation. In terms of heterogeneity within shelter belts tree genus may contribute to community composition within the first 10 cm of the soil profile, while at greater depths soil biota tend to be influenced by abiotic soil properties and soil depth. These preliminary findings suggest high variability within belts and recovery of the biotic communities with restoration reflects a range of soil and environmental conditions, which impacts on soil processes.

New ecological understanding from old restoration sites: Relationships between species composition and ecological function, and building a unifying framework for restoration and general ecology?

Carrick, Peter J.; Katherine J. Forsythe

NRI, University of Cape Town

In 1999 Steven G. Whisenant published a conceptual model which has become arguably one of the most important unifying concepts in restoration ecology in the last 20 years. The model simply conceptualizes, firstly a physical threshold, and secondly a biological threshold, which must be breached by restoration interventions in order for an ecosystem to transition from a fully degraded state to a fully restored state. Here we present a third dimension to this model, a revision of the original dimension of environmental condition, but a counterpart to the original dimension of time. We show that the single dimension, best termed environmental condition, conflates a recovery in species composition with a recovery in ecological function. Our global meta-analysis indicates that there is a poor relationship between ecosystem function and species composition, and it would thus be unwise to use one as a proxy for the other. Overall there is a wider range in species composition than ecological function in both intact ecosystems (reference communities) and in restoring ecosystems. Moreover, ecological function can often recover to pre-degradation levels with only a partial recovery in species composition. The revised model is widely generalizable, and the thresholds in the model neatly distinguish among the processes of disturbance, succession, degradation and restoration, thereby providing a unifying framework for understanding these broad ecosystem processes. The model is particularly relevant for the 21st century where natural succession from primary disturbances (glaciation, landslides, volcanoes etc.) is a rare event, but human induced degradation of ecosystems is ubiquitous.

Active habitat restoration on a former high explosive training range, Former Fort Ord Army Base

Carroll, Mary C.; Kristie K. Reimer, Stan Cook

ARCADIS US

The Fort Ord Reuse Authority (FORA) and the U.S. Army (Army) successfully negotiated the early transfer of land and funding to privatize the munitions remediation for a National Priorities List (NPL) site located in California's Central Coastal region. The ARCADIS Team is implementing this munitions remediation program for FORA on 3,300 acres located in maritime chaparral and coastal oak woodland, with varied geographical challenges and federally and state protected species. The site contains pre- and post-WWII practice and live training ranges, which are proposed for a mix of development, residential, and habitat reserve uses. One habitat reserve site required significant efforts to address residual sensitively fused high explosives. Remedial site work included sifting of more than 44,000 cy of soil, resulted in significant impacts to habitat resources. A restoration plan was developed in accordance with installation specific documentation and three Biological Opinions issued to the Army to enable compliance with the federal Endangered Species Act. An aggressive restoration program has entailed a 2-year-long seed/cutting collection, nursery germination and cultivation effort of 18 native maritime chaparral species; seedbank salvaging; site preparation activities; irrigation system installation; and installation of more than 40,000 container plantings on an 11-acre site in early 2013. A number of quantitative success criteria and performance targets have been proposed, which will provide the basis for reporting of progress towards and achievement of performance standards. Key elements, requirements, and challenges, coupled with installation data and survival to date, will be covered.

Assessing the response of bees to habitat restoration across agricultural landscapes in the UK

Carvell, Claire; Andrew Bourke, Juliet Osborne, Seirian Sumner, Richard Pywell, Matthew Heard

NERC Centre for Ecology and Hydrology

Up to half of the UK's native bee species are thought to be in decline. The implications of these declines in bees and other insect pollinators, for food production and wider biodiversity, have led to substantial attention being directed towards research and conservation efforts. Bee declines have been attributed to multiple interacting pressures, but key among these is the intensification of agriculture and resulting loss and fragmentation of suitable habitats. This talk will summarise the findings of several experiments designed to assess the response of bees (especially bumblebees) to both newly created and restored habitats on farmland across the UK, taking both local and national perspectives. We use a combination of intensive field studies, molecular genetic techniques and landscape modelling to assess effects on individuals and populations. Our work involves overcoming challenges associated with social vs solitary lifestyles, species' contrasting foraging preferences and dispersal distances, temporal continuity of resources and differential responses depending on the structure and habitat quality of the surrounding landscape. For example, sown flower mixtures delivered greater net benefits for bumblebees in more intensively farmed landscapes than in heterogeneous landscapes where existing foraging habitats may have buffered populations. Logistical challenges include the selection of plant species and establishment of seed mixtures under a variety of soil and weather conditions. Close collaboration with agronomists and land managers is vital here and for allowing the research to directly inform UK Government policies such as the agri-environment schemes.

ORAL ABSTRACTS (CONT'D)

Vegetation response to restoration and management of Emiquon Preserve, 2007–2012

Casper, Andrew; Heath Hagy, T.D. Van Middlesworth, Nerissa Michaels, Christopher Hine, Aaron Yetter, Michelle Horath, Randolph Smith, Joshua Stafford

Illinois Natural History Survey

Emiquon Preserve is a unique 1,820-ha wetland complex along the Illinois River that was farmed for almost 80 years. We monitored restoration of this floodplain from 2007–2012 relative to The Nature Conservancy's key ecological attributes (KEA). During each summer and fall, we mapped vegetation communities and documented more than 100 species of plants. Native submersed and floating-leaved vegetation (i.e., aquatic bed) typically comprises more than 50% of the wetland area at Emiquon, an important community because it has been largely eliminated in the Illinois River valley. However, aquatic bed communities have declined since 2009 concurrent with an increase in the area of open water and a decrease in light penetration of the water column. Similarly, hemi-marsh communities have declined since 2008 and appear to have been replaced by persistent emergent vegetation, mainly cattails. Extent of nonpersistent emergent vegetation (e.g., annual plants including "moist-soil" vegetation) is highly variable, but generally is a small percentage of the overall wetland plant community at Emiquon. Similarly, seed production of moist-soil plants has ranged from 200 kg/ha to >1100 kg/ha, but is generally less than other areas intensively managed to produce moist-soil vegetation. Non-native species remain a small component of the overall plant communities, but Eurasian watermilfoil has recently increased to nearly 20% of the aquatic bed community. Continual monitoring of plant communities should be part of an integrated plan based on KEAs and used to guide adaptive management of hydrology and vegetation communities to produce desirable outcomes.

Using the Green Energy Landscape Facilities to Enhance the Ecological Restoration

Chang, Yuan-Hsiou; Chen-Ruei Ku

Department of Landscape and Architecture, Mingdao University

This study uses solar artificial floating islands (SAFI) for water purification and ecological restoration. The site of experiment is set up on a lake shore on a university campus, where the eutrophic contents of lake and sewage from the student dormitory are used for result assessment. The study demonstrates that the SAFI is able to reduce the EC of the eutrophic contents by 30% and enhance dissolved oxygen (DO) by 2.8 times. The SAFI is also able to reduce electric conductivity of dormitory sewage by 34% and increase dissolved oxygen by 982 times. After the improvement, the oxidation-reduction property is above +100mV and the oxidation activities in samples are vigorous. The ecological restoration of *Ischnura senegalensis*, *Leucauge magnifica* Yaginuma, and *Duttaphrynus melanostictus* can be observed in the SAFI enhanced water area, while the area without the influence of the SAFI lacks dissolved oxygen and water plants, which results in the common *Culicidae*, *Hirudo nipponica* Whitman, and *Chironomida* in rotten water. This research shows that the SAFI has determinant influence on the ecological restoration and water quality improvement.

Royal Botanic Gardens Kew and the UK Native Seed Hub: supporting landscape-scale restoration in the South Downs.

Chapman, Ted; Iain Parkinson, Kate Hardwick, Stephanie Miles, Robin Probert

Royal Botanic Gardens, Kew

The 40,000 hectare South Downs Way Ahead Nature Improvement Area (NIA) was created in 2012, one of 12 NIAs in England and Wales created by the UK Government to restore and reconnect nature on a landscape scale. The Royal Botanic Garden Kew's UK Native Seed Hub is providing local-origin seed and botanical, horticultural and scientific expertise to the NIA, helping deliver a "better connected and inspirational chalk ecosystem, sustainably managed to enhance biodiversity and people's well-being for now and the future." Demonstration plots have been established to trial chalk grassland restoration techniques and share best practice with land managers, conservation organisations and other NIA partners. Training and support in seed collecting, processing and storage is being provided, and crops of difficult-to-source species such as *Phyteuma orbiculare*, *Centaurea calcitrapa* and *Blackstonia perfoliata* are being grown in our seed production site from South Downs origin seed stored in the Millennium Seed Bank. Research is underway to investigate the effects of seed-priming on seedling establishment and restoration success, and new protocols are being developed for the propagation and restoration of grassland orchids. The work builds on RBG Kew's involvement in other large-scale restoration projects in the South East of England, including floodplain meadow restoration on the River Ouse. Work to date is presented and the contribution of RBG Kew to this important landscape-scale initiative is discussed.

Effects of species variation in allometry, wood specific gravity, and carbon content on estimations of tree biomass and carbon storage in tropical second-growth forests

Chazdon, Robin; Benjamin Plourde, Vanessa Boukili

University of Connecticut

Tree biomass within forest plots is widely used as a standard measure of stand structure and carbon storage during forest succession and restoration. These measures generally assume constant values of species-specific characteristics, such as wood specific gravity and carbon content of leaf and wood tissues. Moreover, biomass equations derived from old-growth forests are often applied to second-growth forests, despite architectural and allometric differences between trees in young vs. old forests. We tested these assumptions in four second-growth forests monitored over 15 years in NE Costa Rica. Biomass estimates using old-growth equations were, on average, 48% higher than estimates based on a second-growth equation. Many studies using species-level WSG data ignore variation due to radial gradients, tree size, or forest type. Over 74% of the abundant tree species examined in second-

ORAL ABSTRACTS (CONT'D)

growth forests in NE Costa Rica exhibited radial gradients in WSG compared to 24% in old-growth forests. Failure to correct for radial gradients in WSG leads to underestimation errors up to 14% for individual trees. Moreover, 7 of 33 tree species exhibited significant size-related variation in WSG, and 4 species showed significantly lower WSG in second growth than in old growth. The carbon content of wood and leaf tissue showed highly significant species- and plot-level variation. Species means of wood carbon content (% C) varied from 41.3 to 49.8. Incorporating species- and site-level variation in tree allometry, WSG, and carbon content will permit more accurate estimation of biomass change and carbon storage in regenerating and restored tropical forests.

Demographic drivers of tree biomass change in second-growth rain forests

Chazdon, Robin; Danaë M.A. Rozendaal, Bryan Finegan

University of Connecticut

Secondary tropical forests are crucial for carbon storage. Chronosequence data show that tree biomass increments are greatest early in succession when trees recruit and increase in size, and decrease later in succession due to lower rates of diameter growth and increased tree mortality. Our study is the first to evaluate biomass changes within sites over time during succession. We evaluated the contributions of tree diameter growth, recruitment, mortality, and species-specific wood density to biomass change during succession. We measured stem diameter of trees, tree recruitment, and mortality in ten second-growth tropical forests in Costa Rica that initially ranged in ages from 1-27 years, every 1-3 years over a 15-25 y-period. We used allometric equations developed for second-growth forest species to calculate tree biomass, and classified species as second-growth specialists, generalists, or old-growth specialists. Across time and stand ages, standing biomass increased, while biomass change and basal area-weighted wood density declined with increasing stand age. Second-growth specialists and generalists accounted for nearly all standing biomass and biomass change in second-growth forests. Diameter increment decreased, and biomass loss from mortality increased with stand age, but recruitment was not a significant driver of biomass change. Drivers of tree biomass change shifted over succession: diameter growth is the main driver in early successional forests, but tree mortality becomes an equally important driver of biomass change in older secondary forests. We compare these results to results of similar studies on tree biomass dynamics from secondary rain forests in Mexico and Brazil.

Distribution variation of *Littoraimelanostoma* Gray (Littorinidae) in rehabilitated *Kandelia candel* and *Aegiceras corniculatum* mangroves with different ages

Chen, Guang C.; YongYe, Bin Chen, ZhiY. Ma

Third Institute of Oceanography, State Oceanic Administration, PRC

Seasonal surveys were conducted from April 2005 to January 2006 to compare the distribution of *Littoraimelanostoma*, a dominant snail species, in rehabilitated *Kandelia candel* and *Aegiceras corniculatum* mangroves with different age (4-year, 7-year and mature) in Jiulongjiang Estuary, China. Density of *L. melanostoma* ranged from 8.3 to 54 ind m⁻² in these mangrove, with its biomass ranging from 3.13 to 23.00 g m⁻². Repeat measure two-way ANOVAs results showed that *L. melanostoma* density was higher in *A. corniculatum* than *K. candel* forest, and the descending order among mangrove ages was 7-year > 4-year > mature forest. Significantly higher *L. melanostoma* density was recorded in *A. corniculatum* forest than in *K. candel* forest with the same age. However, greater percentages of middle (shell length 15~20 mm)-to large (>20 mm)-size snails were found in *K. candel* and mature *A. corniculatum* forests compared to the two younger *A. corniculatum* forests which were dominated by small-size snails (*A. corniculatum* plants, are short with dense canopy, and have a higher density of twigs, therefore could support more *L. melanostoma* individuals and protect them from environmental stresses and predators.

Carbon sequestration and greenhouse gas (GHG) emissions in restored wetlands

Chen, Hua

University of Illinois at Springfield

Terrestrial ecosystems play important role in carbon (C) cycle. The loss of wetlands for croplands results in a release of significant amount of C from soil organic matter into atmosphere. Wetland restoration from croplands has potential for C sequestration. However, restored wetlands from croplands may emit more CH₄ and other GHGs. The overall goal of this study was to study C sequestration in two restored wetlands from croplands at Emiquon and Spunky Bottoms in Illinois and review three GHGs including CO₂, CH₄, and N₂O emissions in restored wetlands in Midwest of USA. The two restored wetlands Emiquon and Spunky Bottoms were created in 2007 and 1997, respectively. Aboveground plants, roots, and soil (top 40 cm) were collected along two 100-m long transects at each site. C concentration of plant, root, and soil samples was analyzed with a CHN Elemental Analyzer. Overall, the total ecosystem storage of organic carbon (OC) at Emiquon was 37.4 Mg ha⁻¹ and Spunky Bottoms was 40.4 Mg ha⁻¹. At both sites, soil organic C (SOC) is the most important C storage. Spunky Bottoms had significantly higher total SOC storage than Emiquon. Restored wetlands increase C sequestration in comparison with croplands. According to the metadata analysis, CO₂ emission contributed the most to net-GHG flux, followed by CH₄ and N₂O. Our study suggest restoring croplands to wetlands shows potential for increasing C sequestration and the emission of GHGs would not offset the potential of C sequestration in restored wetlands.

ORAL ABSTRACTS (CONT'D)

Study on coastal and marine ecological compensation in China

Chen, Keliang; Xingguang Yu, Jinkeng Wang
Third Institute of Oceanography, SOA

The significant differences between domestic experiences from China and international ones from abroad can be found in the diverse regimes about coastal and marine ecological compensation. This explains the reasons why China took the coastal and marine ecological compensation recently. In the short term, it seems that the current management system is still imperfect to implement eco-compensation. In the long term, however, it would be desirable to establish a unified regime which would enable all actors to direct their energies toward handling ecological damage and environmental pollution due to coastal and marine engineering. The thematic study on coastal and marine eco-compensation provided detailed suggestions and recommendations for the drafting eco-compensation legislation in China. The case studies of the coastal and marine eco-compensation are researched on the basis of the analysis carried out related measures in the three coastal cities including Weihai in Shandong, Shenzhen in Guangdong and Xiamen in Fujian of China. It provides scientific references to establish marine ecological compensation mechanism from concept, standard, funding sources, assessment methods and legislation in China.

Social-organizational dimensions of ecological restoration: collaborative forest restoration on the Uncompahgre Plateau, Western Colorado

Cheng, Antony S.
Colorado Forest Restoration Institute

Ecological restoration is increasingly a priority policy and management goal on federal forest lands due to decades of forest degradation caused by past management policies and practices. While there is broad political and social agreement that restoration is needed, there remains considerable controversy among federal forest stakeholders about the location, scale, and types of treatment prescriptions necessary to restore desired ecological structure and functioning. In western Colorado, community leaders, environmental organizations, forest industry, locally-elected officials, and state and federal resource managers have been working collaboratively since the early-1990s to build local citizen science and stewardship capacity to define and address ecological restoration goals and activities on the Uncompahgre Plateau. This history of capacity-building has culminated in an ambitious, collaboratively-developed strategy to restore forest structures and fire behaviors that likely occurred under historic fire regimes, and promote local jobs and economic activities associated with restoration projects. This presentation will discuss the key structure, process, attitudinal, and capacity attributes associated with community-based collaborative ecological restoration learned from the Uncompahgre Plateau. The goal of the presentation is to contribute to greater understanding of the human and organizational dimensions associated with restoration on federal public lands.

Assessment of prairie restoration in Taltree Arboretum in Valparaiso, Indiana, USA

Choi, Young D.; Eric J. Bird, Samantha A. Kinsman, Rachel N. Shmagranoff
Purdue University Calumet

Prairie restoration has been advocated for various reasons such as recovery of biological diversity and ecosystem services. During 2008-2012, we conducted an assessment of a restored prairie in the Taltree Arboretum for plant species richness and diversity, primary production, soil carbon stock, and litter decomposition. Our DCA ordination revealed a conversion of abandoned farmland to tallgrass prairie. Forty-four of the fifty native plant species that were introduced as seeds in 1998 established in the prairie. Along with 41 species, which arrived voluntarily, the prairie exhibited significantly higher species richness (85 species) and diversity ($H' = 3.05$) than a nearby reference old field (21 species; $H' = 1.50$). However, the restoration did not change the soil seed bank significantly. The introduced natives constituted <5% of the prairie seed bank. In addition, the higher species richness and diversity did not enhance primary production, soil carbon, and decomposition yet. Biomass production (8.6+1.1 kg), soil organic carbon (5.0+0.6%), and decomposition rate (29.0+1.7% mass reduction) was higher in the old field than the prairie. Litter decomposition was also faster in the old field than the prairie (6.0+0.5 kg, 3.9+0.7%, 15.9+1.5%, respectively). The higher biomass in the old field was likely due to "selection effect" of *Solidago* species. The enhanced species diversity or richness did not promote primary production, soil carbon stock and litter decomposition 16 years after the restoration.

Collaborative Efforts to Restore Ecosystems Surrounding Major Tributaries within Wisconsin's Lake Michigan Basin, Wisconsin, USA

Choy, Steven; Betsy Galbraith, Sarah Warner
U.S. Fish and Wildlife Service

Lake Michigan, Green Bay, and their tributaries have been historically important centers of industry in Wisconsin. As cities grew around these important shipping ports, river and harbor sediments were polluted by contaminants, and fish and wildlife habitat were lost. The impairments at several of these major tributaries, including the Menominee River, Sheboygan River, and the Lower Green Bay/Fox River, led to individual designations as an Area of Concern (AOC) by the International Joint Commission of Canada and the United States. In recent decades, various conservation partners have collaborated to implement remediation and restoration projects focused on removing contaminated sediment and improving fish and wildlife habitat at these 3 AOCs. Millions of cubic yards of contaminated sediment have been removed from these tributaries through remedial programs led by state and federal agencies. Natural Resource Damage Assessment (NRDA) activities directed by federal, state, and tribal trustees have contributed to a deeper understanding of fish and wildlife injury due to contaminants and in some instances, provided settlement funding for restoration projects.

ORAL ABSTRACTS (CONT'D)

AOC conservation partners have also implemented restoration projects focused on improving fish and wildlife habitat and restoring their populations. To achieve successes at these sites, a collaborative approach among agencies was integrated that improved project efficiency and implementation, data sharing agreements, communication among various partners, and public outreach. Case studies exploring the collaborative approach to ecosystem restoration at these three AOCs will be presented.

Response and resilience of rivers to historical resource use in the Greater Yellowstone Region: an analysis using repeat photography

Clark, Heidi; Duncan Patten
Montana State University

Repeat photographs provide a glimpse of the past and thus tell a story of how time has shaped the landscape. The dynamic nature of rivers, along with limited historical data, makes it difficult to judge the dramatic changes that have taken place over time. Repeat photography of historical oblique and aerial photos provide comparative riverine images that span over a century, which can be used as a baseline for ecological restoration and determination of river resilience. With the use of repeat photography, this study analyzes how historical resource use in the Greater Yellowstone Region (i.e. tie driving, mining, ranching, and dam building) has affected headwater rivers over the last century. Photos were used from the Gallatin, Madison, Snake, Henry's Fork of the Snake River, Yellowstone, Clark's Fork of the Yellowstone, Shoshone, Wind, and Green Rivers. Through both qualitative and quantitative spatial analysis of historical and recent photos, we examined how the riparian vegetation, river sinuosity, and channel width changed between historic and recent photos. Photo comparisons revealed that historical resource use resulted in significant changes where riverine areas recovered through increased vegetation and decreased channelization.

Bioregional wetland restoration in Waikato, New Zealand

Clarkson, Beverley
Landcare Research

The extent and condition of wetlands in New Zealand have declined significantly since the arrival of humans. More than 90% of wetlands have been destroyed and many continue to degrade because of reduced water, additional nutrients, and impacts from invasive species. Regional councils and the Department of Conservation have responsibilities to maintain indigenous biodiversity, including protection and restoration of wetlands. In the Waikato Region, only 28,000 ha or 8% of wetlands remain. A comparison of historical and extant wetlands was used to determine wetland priorities for restoration according to extent, type and distribution. This identified the widespread loss of an endemic and threatened restiad (dominated by Restionaceae) raised bog ecosystem type over most of the Waikato Region. Experimental trials in a cut-over restiad bog showed vegetation recovery was most successful when it emulated the major phases of restiad bog development (accelerated succession). We used a patch development approach to restoration, which has allowed stakeholders (NGOs, councils, community groups and private landowners) to establish three new populations of the bog type at sites which it had been absent from for more than 50 years. The next steps are enhancement plantings of other late successional bog species and translocation of invertebrates to improve biodiversity and educational benefits.

Bringing indigenous biodiversity back into Hamilton and other New Zealand cities

Clarkson, Bruce D.; Catherine L. Kirby
Environmental Research Institute, University of Waikato

New Zealand's 20 largest urban centres vary considerably in terms of their extant indigenous biodiversity resource in the built up matrix (<1% to 9% cover) and in their approach to protecting and enhancing it. To achieve a universal target of 10% cover, urban ecosystems dominated by indigenous species will require a range of approaches from restoration of existing remnants to reconstruction of ecosystems. Ecological barriers to overcome include altered soil conditions and processes, rapidly shifting and often warmer microclimates, and novel species assemblages. Despite these limitations, there are unique opportunities to conserve indigenous plants and animals within these urban environments that are not present in extensive wildland tracts. For example, grazing by farm animals can be completely controlled and predators such as weasels and stoats are less abundant in city environments, also the volunteer worker is nowhere more abundant and capable of being mobilised. Perhaps the most significant challenge to achieving the 10% target, however, is to coordinate action between management agencies so that regional or catchment scale ecosystem processes and function are restored. Further, a convergence of many skills including engineering, landscape architecture, aboriculture, horticulture and ecology is needed to undertake successful restoration in city environments. Examples will be drawn from Hamilton and other North Island cities to illustrate how coordination, convergence and integration can assist in bringing indigenous nature back into the city and reconnecting urban dwellers with their natural heritage.

Community efforts to restore the Waikato region: The role of the Waikato Biodiversity Forum and other community initiatives

Clarkson, Bruce D.; Moira Cursey, Judy van Rossem
Environmental Research Institute, University of Waikato

The Waikato Biodiversity Forum was established in 2002 to coordinate regional efforts and follow a "bioregional" approach to biodiversity management. The Forum includes representatives from the agencies that have a role in promoting the restoration and enhancement of the region's biodiversity, as well

ORAL ABSTRACTS (CONT'D)

as community groups, individual landowners and iwi (Māori) representation. It seeks to increase the level of coordination and cooperation between the agencies and communities involved through collaborative action. The priority for the Forum is maintaining, enhancing and restoring biodiversity on private land. Fostering relationships between members is a primary purpose of the Forum and helps coordinate and integrate biodiversity conservation efforts. Workshops and biannual Forum events held around the Waikato region attract a consistent number of attendees and are a valued way of sharing information. The major constraints affecting the Forum's effectiveness are time, money and the level of priority it has among members, particularly territorial local authorities. Continued representation of iwi is also a challenge. However, while it is difficult to quantify how the Forum is making a difference to on-the-ground efforts, members value the benefits from better networking. It saves them time, keeps them in the big picture, reduces isolation, gives them access to information about and support for biodiversity management and allows projects and strategies to be aligned. This paper will discuss the role of the Forum, the constraints, advantages and future direction.

Mitigating continental scale bottlenecks: How small-scale highway mitigation has large-scale impacts

Clevenger, Tony

Western Transportation Institute - Montana State University

Roads are a primary contributor to habitat destruction and fragmentation, yet have only recently become a major focus of conservation efforts. Road ecology originated from the realization that sprawling road systems can have substantial effects on species and ecosystems. Large-landscape connectivity efforts focus on mitigating habitat fragmentation and increasing ecological connectivity at the landscape scale; however, local scale mitigation is equally important. Wildlife crossing structures are an increasingly popular strategy for restoring connectivity across highways, but are only as effective as the management strategies developed around them. Coordination is needed between land management and transportation agencies for local scale mitigation to be of value to landscape scale conservation planning. The Trans-Canada Highway (TCH) in the Canadian Rocky Mountains has long been recognized as a lethal barrier to wildlife and a potential fracture zone for population connectivity at local and landscape scales. To mitigate these impacts, during the last 30 years man-made corridors in the form of wildlife underpasses and overpasses were built across this major transportation corridor. Currently there are 40 man-made corridors for wildlife consisting of 4 different designs along 83 km of the TCH in Banff National Park. I report on the key findings of 17 years of research assessing efficacy of the Banff mitigation at individual and population levels. To date, the Banff research is recognized by transportation, wildlife and land management agencies as a leading source of information for the field of road ecology, providing science-based guidance for resolving highway-wildlife conflicts throughout North America and abroad.

A sculpted River of Grass: Harnessing the power of a model - a historical look at the construction and operation of an Everglades "living laboratory".

Cline, Eric A. ; Thomas Dreschel, Fred Sklar

South Florida Water Management District

The Loxahatchee Impoundment Landscape Assessment (LILA) facility is an 80-acre (32.4 ha) physical model of the Everglades containing three key habitats; tree islands, ridges and sloughs. As a laboratory for biological, ecological and landscape research; LILA allows scientists to design controlled experiments to investigate the impacts of hydrology on the Everglades landscape. Since its construction in 2003, LILA has hosted a variety of studies to understand the influence of hydrology on Everglades structure and function including: wading bird foraging success, prey production and behavior, tree survival, and ground water/surface water hydrology. The success of these research projects at LILA depends on an efficient planning and oversight process. All research proposed must be approved by the LILA Science and Coordination committee. This committee is made up of multi-disciplinary researchers from the South Florida Water Management District, ARM Loxahatchee National Wildlife Refuge, Florida International University and Florida Atlantic University. A key to the success of research at LILA is the coordination and integration of concurrent research projects at the site. This presentation will describe the ongoing and completed research at LILA; how using a physical model influenced the outcome of that research; and how this approach integrates adaptive management and applied restoration science.

Restoration of connectivity between lowland rivers and floodplains: Opportunities and constraints

Collier, Kevin J. ; Bruno O. David, Melany A. Ginders, Konrad Górski

University of Waikato/Waikato Regional Council

The Waikato Region of northern New Zealand was characterised historically by extensive lowland floodplains adjacent to three main river systems, including New Zealand's longest river - the Waikato River. Connection of rivers with these floodplains and associated lakes and wetlands has been severed to a large extent by networks of dykes, tide gates and flood gates that control interaction with floodwaters so that land can support pastoral farming. Disconnection of floodplains and other lateral habitats has been linked to the decline of native river fisheries, including eels (*Anguilla* spp.) and lowland Galaxiidae which are focal species for current restoration initiatives. Reconnection of river side-arms to restore off-channel processes and habitat for aquatic species was shown to sequester sediment and nutrients and enhance zooplankton abundance during low rivers flows. Extended inundation of floodplains also enhanced abundances of large-bodied zooplankton, most noticeably in flooded forest suggesting that restoration of structural complexity of floodplain vegetation would play a key role in enhancing food delivery for migrating fish larvae in the main river as floodplain waters subside. However, flooded terrestrial habitats were also shown to support high densities of larval koi carp and goldfish suggesting that controlled connectivity with floodplains would be required to limit recruitment of invasive fish species. Floodplain bottlenecks provide opportunities to trap carp, which can sequester nutrients from stored sediments during feeding, and these fish are being composted to supply fertiliser for restoration planting in floodplain areas.

ORAL ABSTRACTS (CONT'D)

Novel ecosystems: opportunities for operationalising cultural ecosystem service provision

Collier, Marcus John

University College Dublin

Globally, landscapes have been subjected to severe direct and indirect anthropogenic processes, yet some are re-emerging from resource extraction, resulting in a plethora of abandoned, unused and in some cases naturally regenerating areas. Though many landscapes may never recover to their historical referent within current policy timeframes ultimately, and with minimal further disturbance, these nascent anthropogenic landscapes or 'novel ecosystems' exhibit a potential for re-instating some of the ecosystem services that were removed or impeded during and after human management activities. However, certain scarred landscapes may be revealing the emergence of newer ecosystem services that were minimal or perhaps absent from their historical referent and this can be a dilemma for policy makers and planners. It is especially poignant when seeking to develop policy prescriptions that operationalise cultural ecosystem services into planning and design, a key desire in cultural landscapes. Though this is the subject of current discourses in 'green infrastructure' within spatial planning, little is known of the potential for drawing upon novel ecosystem theory when developing prescriptions for these planners and policy makers. This paper draws on social-ecological research in mined landscapes to propose that a novel ecosystem approach has the best potential for providing a pathway for operationalising ecosystem service policies in damaged and recovering landscapes. In so doing, this paper underscores the synergistic linkages of spatial and temporal planning that are contained in the discourses within green infrastructure planning, cultural ecosystem services and novel ecosystem theory.

Nurturing your community to watch, witness and work

Collins, Dan

Landscapes of Place LLC

Bayshore Blufflands is a 4200 acre State Natural Area patchwork of woodland preserves, farms and homes along seven miles of the Niagara Escarpment in Wisconsin's Door Peninsula. Our corner of this landscape is 130 acres, mostly northern mesic forest, alder thicket, tussock sedge swamp, cedar and black ash swamps. We have documented and pressed many of the 290 native plant species in our herbarium, tracked FQI, published rich online content, obtained grants, monitored effectiveness, shared techniques, engaged in community events and organizations. Fifteen years ago we estimated an unimaginable one million RCG stems on our parcel. As we worked on our parcel and neighboring parcels we developed and documented some quite effective regional approaches to invasive species control. We realized that the number, a million stems of RCG, was an accurate number but not the only important number. At least as important are the number of people and days worked with friends and neighbors building history, trust and a future - an ecologically functional one. This restoration work began because we are a community, and the community has provided lasting meaning to the work. As restoration becomes management, there is no outcome to be won, no glorious day of the last buckthorn; there is the process and the learning. To help a degraded land reclaim sustained ecological function requires people to watch and witness and work.

IUCN Red List of Ecosystems for the Americas: application of the categories and criteria to strategies for ecosystem restoration

Comer, Patrick; Jon Paul Rodriguez, David Keith, Don Faber-Langendoen, Edmund Barrow, Carmen Josse

NatureServe

The IUCN Red List of Ecosystems (RLE) is an emerging global standard for documenting the risk of rangewide ecological collapse for a given ecosystem type. Under the standard, a series of rangewide analyses for a given ecosystem type results in its categorization as least concern, near threatened, vulnerable, endangered, or critically endangered. Analyses quantify both past and forecasted change in extent along with the proportional area affected by ecological degradation or alteration to biotic interactions. Degradation may come in the form of altered natural dynamic regime (e.g., hydrology, wildfire), invasive species, and/or effects of climate change. We will present a cross-section of findings of this effort focused on the Americas. As a compliment to related IUCN species assessments, we anticipate that the RLE will be of great value to a number of different sectors, including those engaged in land use planning and ecosystem restoration. By highlighting relative risks faced by ecosystems, the resulting RLE categories support priority-setting components of land use planning, such as those aiming to conserve natural heritage values and/or ecosystem services like clean water, soil fertility, pollination, and other natural products. Because RLE analyses document type-specific forms of ecological degradation, they highlight aspects of ecosystem sensitivity and resilience of direct applicability to ecological restoration, mitigation, and management over upcoming decades. The RLE should help to provide a globally accepted standard that will enable planners to evaluate the risk and related economic costs of losing ecosystems, and, conversely, the potential economic benefits of improved management.

Putting the pieces back together: from gully to a functioning mountain meadow in Sequoia National Park

Cooper, David J.

Colorado State University, Department of Forest & Rangeland Stewardship

Meadows in the Sierra Nevada were very heavily grazed in the middle to late 1800s by sheep and cattle. This legacy effect produced many impacts including changes in vegetation and the development of gullies in meadows that lowered water tables and resulted in severe erosion. The construction of a highway across Halstead Meadow in Sequoia National Park included a culvert that channelized the natural sheet flow of the meadow, further channelizing flow and triggered gully erosion to more than 5 m deep that drained most of the meadow triggering vegetation changes. The restoration of Halstead was based upon completely filling the gully with more than 20,000 cubic yards of sediment to recreate the natural contours of the entire meadow and restore sheet flow hydrologic regime. To accomplish this, the road built on fill was removed and a bridge constructed. A number of

ORAL ABSTRACTS (CONT'D)

different plant establishment techniques were implemented including transplants of turf, greenhouse grown seedlings, and pre-vegetated coir matting. Planning started in 2005 and the last plantings were accomplished in 2013. The goal of restoring a meadow with sheet flow hydrologic regime dominated by native *Scirpus microcarpus* was achieved with these methods.

Endangered species re-introduction – habitat revival in limestone quarries

Copp, Corrina J.; Luise Hermanutz
Memorial University

Endangered species habitat is threatened by historic and current human-activities. Quarrying, a global activity known to cause large-scale landscape degradation, alters local geomorphology, affects hydrology and disturbance regimes, and causes habitat and biodiversity loss. Additionally, it presents legacy effects limiting native recolonization. On the at-risk northern Limestone Barrens of the Great Northern Peninsula, Newfoundland (Canada) gravel pits remain abandoned, highly disturbed, and lacking both natural habitat characteristics and recolonization. Considered a biodiversity hotspot, the Limestone Barrens is home to the endangered plant Long's braya (*Braya longii*). The study's goal is to develop protocols that address recovery actions within the Braya Recovery Strategy. An historical context report used a time series of aerial photographs (i.e. 1948 – 1995) to illustrate temporal landscape change and reconstruct the study site's original conditions to inform restoration actions. Findings suggest that approximately 50% of the study site's pre-existing potentially optimal Long's braya habitat (i.e. bare and non-vegetated) remains intact. Using these areas as a reference, restoring heterogeneous substrate characteristics is critical for the recovery of the disturbance regime and optimal Long's braya habitat. To facilitate recovery, the quarried overburden was assessed and found to deviate significantly from natural substrates with high organic content, reduced silt/clay content, as well as non-native species composition which limit re-establishment of the disturbance regime and recolonization of Long's braya. Hence overburden should be removed prior to restoration actions. Furthermore, appropriate substrate characteristics need to be created to re-initiate the disturbance regime, inform gravel quarry rehabilitation and re-introduce endangered species.

Incorporating plant diversity into our understanding of how biotic interactions influence the restoration of Great Lakes sand dune grasslands

Crawford, Kerri M.
Washington University in St. Louis

Grassland restorations face many different challenges depending on the degree of degradation and habitat-specific limitations. The restoration of grasslands on the coastal sand dunes surrounding the Great Lakes may be particularly unique because heavily disturbed sites are typically completely denuded. Unlike other grasslands in the US and Australia, invasive species do not limit restoration at these sites. Rather, like European grasslands, propagule limitation is a major concern because limited dispersal, along with abiotic and biotic stress on seeds and seedlings, limits natural colonization. It is common practice for dune restorations to introduce adult plants in bare sites. Therefore, a key question is whether we can influence the restoration outcome by carefully choosing plant material, thus managing biotic interactions in the restored system. During natural primary succession, *Ammophila breviligulata* colonizes bare dunes and traps sand, allowing less sand-burial tolerant species to colonize. Restored sites are generally composed of a single genotype of this species. Interactions among plants play a large role in structuring these communities, and the limitations of decreased diversity are unclear. In this talk, I will broadly discuss the limitations to restoration in this system (dispersal limitation, abiotic stress, seed herbivory) and present results from an experimental restoration of the sand dunes that tested if incorporating greater amounts of genetic diversity within the dominant colonizer, *A. breviligulata*, and greater species richness influenced the outcome of restoration. I will then discuss the utility of incorporating an awareness of how diversity influences biotic interactions in restorations of this system.

Floodplain wetland restoration in Vermont: A practitioner's perspective

Crehan, Ryan
U.S. Fish and Wildlife Service

Wetland restoration is a priority practice employed by many individuals, agencies and groups due to the multiple functions and values that wetlands provide. While specific goals of wetland restoration may include providing wildlife habitat, increasing sediment and nutrient removal, and flood-flow alteration, combining efforts of interested parties can accelerate and improve the implementation of wetland restoration projects. Over the last 5 years, an innovative and collaborative effort has developed to restore wetlands along Otter Creek, Vermont's longest river and a major tributary of Lake Champlain. The Otter Creek target area includes notable wetlands that harbor rare plants and provide important breeding and stopover habitat for waterfowl, wading birds, and songbirds. The target area also includes extensive acreage where wetlands and riparian habitats have been cleared, leveled, bermed, ditched and drained for agricultural use. Working in partnership with the Natural Resource Conservation Service, the Vermont Agency of Natural Resources, and Ducks Unlimited, the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program has implemented wetland restoration projects on over 25 parcels encompassing over 2,100 acres for the benefit of wildlife, water quality and floodplain function. This presentation will discuss how resources and technical expertise have been pooled and explore the many "moving parts" that are needed to put a successful wetland restoration project on-the-ground and conserve wetlands for the long-term. Specific topics to be covered include how to identify potential wetland restoration sites, create designs, navigate permitting requirements, and implement the restoration work while avoiding potential pitfalls.

ORAL ABSTRACTS (CONT'D)

Direct seeding native trees as a restoration strategy for rural Andean agroecosystems: Empirical data from south Ecuador

Crespo, Antonio M.; Carrie R. Adams
University of Florida

The Andean region of Ecuador is in critical need of active restoration, especially in rural areas where livelihoods depend highly on natural capital. In this context, direct seeding can provide a cost-efficient alternative to reestablish native tree cover in rural agroecosystems. This study aimed at developing the ecological bases for this method using field experiments. Research was conducted in rural south Ecuador at the Pamar River Valley and in close collaboration with the Pamarchacrín community. Four native tree species (*Caesalpinia spinosa*, *Erythrina edulis*, *Oreocallis grandiflora*, and *Prunus serotina*) were sown on degraded lands owned by the community. A total of 32 experimental plots were placed along an altitudinal gradient of 2500-2700m a.s.l. Our main research questions included: Is early establishment possible if herbivory and competing vegetation are controlled for? Does weed competition and herbivory have a significant effect on germination and early establishment? Experiments took place between March 2012 and May 2013. Seeds were monitored biweekly for 3 months and surviving seedlings were sampled at 3 and 6 months post-seeding. Treatments included weed suppression (by hand) and herbivore exclusion (wire cages). Germination rates varied for each species but were higher overall inside cages ($p = 0.0005$), while the interaction between weed competition and germination was not significant ($p = 0.9059$). Seedling height and biomass are still under evaluation. Protective structures will be necessary to guarantee establishment but intensive weeding will not be. The easy application and low cost of direct seeding makes it a good fit for rural scenarios.

Valuing the role of private landowners in the ecological restoration of watersheds damaged by the 2002 Hayman Fire, Colorado, USA

Cruz, Elizabeth B.
(Independent Researcher)

Ecological restoration of burned areas is significant because of prohibitive costs. The 2002 Hayman Fire burned about 560 km² of forest in Colorado and was the most expensive in terms of fire suppression and immediate mitigations of the damaged forests. The expenses from 2003 to 2010 are not available due to lack of accounting, both from the implementing agencies and from any recipients of financial assistance for the long-term post-fire restoration of the area and private properties. Burned areas need restoration, but require allocation of resources for increased hydrologic, vegetation monitoring, and strategies for restoration of priority burned areas. My research focused on restoration efforts by private landowners impacted by the fire, which is often overlooked. A survey was sent to three hundred landowners in Teller and Park counties, the most severely burned area. The survey documented information on mitigation treatments used, property ownership, damaged properties, problems affecting their environment eight years after the fire, and landowner's opinion about progress in the landscape. Sixty five percent of surveyed landowners believed both ground and aerial seeding application as effective short-term mitigation measure while forty percent believed tree planting is effective in the long-term. The research contributes to the 2002 Hayman Fire in the context of environmental, social, and economic research by involving landowners impacted by the fire. The research results will benefit policy makers, environmental planners, and organizations working in the Hayman burn area, and results are transferable to communities that will experience future wildland fires in the Colorado Front Range.

Economic impacts of ecosystem restoration: Case studies of jobs and income supported by federal investments in restoration

Cullinane Thomas, Catherine; Kristin Skrabis, Lynne Koontz
US Geological Survey

Federal investments in ecosystem restoration and monitoring protect Federal trusts, ensure public health and safety, and preserve and enhance essential ecosystem services; furthermore, these investments support jobs. This project is an ongoing effort to increase the available information on the costs and required inputs for ecosystem restoration and to develop methods for quantifying the resultant job impacts of these investments. The project is comprised of a series of case studies. As of 2012, nine case studies of a wide range of restoration projects have been published. These case studies illustrate the substantial economic benefits that restoration projects provide for local communities. Results find a large amount of variation in economic impacts supported by restoration investments, and suggest that restoration type, costs and availability of inputs and labor, and modeling methods all play large roles in impact estimates. Because of this substantial variation, this study makes it clear that applications of generic economic impact multipliers are likely to result in large errors in impact estimates. Over twenty additional case studies will be completed in 2013 and will be incorporated into a database of impact estimates. Case studies include examples of collaboratively funded and managed projects to restore a wide range of ecosystems. In addition to providing improved information on the economic impacts of restoration, these case studies highlight DOI restoration efforts and tell personalized stories about each project and the communities that are positively affected by restoration activities. Project methods include the collection of primary expenditure data and economic input-output modeling.

The FRAME Program Part I: Building a Network for Urban Forest Ecology

D'Amico, Vincent; Greg Shriver
USDA Forest Service

The Earth's northern mid-latitude temperate zone contains the greatest portion of urbanization on the planet. In the eastern US, Europe, and eastern China, the dominant mid-latitude biome is the temperate deciduous forest. These forests are fragmented, degraded, and sometimes indifferently

ORAL ABSTRACTS (CONT'D)

managed. Established on disturbed soils - often abandoned agricultural land - they are often populated with dense understories of nonnative vegetation. These in turn alter overall forest structure, nutrient cycling, and aesthetics. Despite these problems, however, urban forests provide a host of services that range from the most basic and physical, such as shade and soil retention; to the abstract, such as providing a sense of well-being to urban dwellers. In 2010 we established a long-term urban ecology and restoration program that now includes 32 sites in DE and PA. The program was named FRAME, Forest Fragments in Managed Ecosystems. As of 2013 we have completed baseline data collection: these delineate soil, vegetation, invertebrate and vertebrate community structure and composition. In brief, the goal of the FRAME is to 1) measure those characteristics of urban forest fragments most likely to positively influence source-sink dynamics for desirable plant and animal taxa and 2) eventually assess the effectiveness of selected manipulations on these dynamics. We here present baseline data from that study.

How seed banks vary across a degradation gradient and their restoration potential

Damschen, Ellen I.; John Orrock, Lars Brudvig, Philip Hahn, Joseph Veldman, Brett Mattingly, Joan Walker
University of Wisconsin Madison

Dormant, viable seeds that are stored in the soil constitute seed banks, which may either play a positive or negative role in restoration depending on the composition and abundance of species present. The potential for the seed bank to contribute positively or negatively to restoration remains largely unknown and may vary with the pre-restoration 'degradation' status, dictated by past land-uses and management actions. Here, we examine the composition of soil seed banks along a degradation gradient in upland longleaf pine woodlands. We quantified the seed bank from 1728 samples from 108 sites spanning three locations (Fort Bragg, NC; Fort Stewart, GA; and Savannah River Site, SC) across the range of the longleaf ecosystem, which vary in how frequently they were burned and whether they were formerly used for agriculture. Samples were grown out in a greenhouse and the number and identity of each germinant was recorded. 25,641 individuals emerged, comprising over 80 species. Although we find that more seedlings emerged from post-agricultural seed banks, we found that the seed bank generally has the same composition of largely ruderal species regardless of the degree of degradation. Because species of restoration interest were rarely members of the soil seed bank community, our results suggest that the seed bank has a limited capacity to contribute to restoration goals of upland longleaf pine woodlands. Future work should examine the community-level consequences of releasing the largely-ruderal seedbank through restoration actions such as overstory harvesting and prescribed burning.

Evaluating biological control efforts in a Wisconsin American chestnut stand

Davelos Baines, Anita; Mark L. Double, Andrew M. Jarosz, Dennis W. Fulbright, William L. MacDonald
University of Wisconsin - La Crosse

The American chestnut stand in West Salem, WI has about 5,000 trees covering 50 acres. Chestnut blight, caused by the fungus *Cryphonectria parasitica*, was first noticed in the stand in 1987. In 1992, biological control treatments of the infection were initiated using hypovirus. At that time, this stand appeared to offer an ideal setting for biological control because all isolates of *C. parasitica* from different cankers were of the same vegetative compatibility (vc) group, which would allow the hypovirus to be transmitted readily among fungal isolates. Subsequently, treated cankers and new, untreated cankers were sampled to assess the persistence and spread of the hypovirus. After disappointing spread of hypovirus and continued dieback of trees, a different hypovirus was deployed in 1995. Hypovirus treatments were suspended from 1998-2003 but disease and hypovirus spread were still monitored yearly. After continued poor spread of the hypovirus was documented, treatments were resumed in 2004. Within the past five years, numerous trees that previously exhibited dieback have begun to form new branches and leaves at 20-50'. In 2011, bark samples taken from trees in the area that has received hypovirus treatment since 1992 revealed that 78% of cankers on trees that had never been treated had acquired hypovirus. These findings suggest that, given adequate time, hypovirus spread was sufficient enough for the West Salem trees to show visible signs of recovery (survival, growth, and reproduction) from chestnut blight infection (biological control).

Potential impacts of plowing legacies on fen-restoration projects: Effects on species richness, soil moisture, and available nutrients

Davenport, Tara E; Austin Yantes, David Bart
UW-Madison

Although land-use legacies are known to alter biota and edaphic conditions, few attempts have been made to determine how these alterations might impact restoration planning. Here we present results of a study describing associations among plowing and current herbaceous and abiotic conditions in southern Wisconsin fens, with special focus on restoration relevancy. Species cover and composition for herbaceous species were recorded from 20 plots within 11 fens. We determined soil conductivity, soil volumetric water content, and root-zone N and P availability for each plot. Plowed fens had significantly higher amounts of nitrogen and phosphorus and greater invasive species richness than never plowed fens. Never plowed fens had significantly greater herbaceous, wetland generalist graminoids, and fen specialist species richness, as well as higher levels of soil moisture. The same patterns were generally found in plowed vs. never-plowed plots within partially plowed fens. This study suggests that saturated, nutrient-poor root zones predict desirable assemblages of wetland generalists, even when plowed. Therefore, maintaining strong ground-water influence and low nutrients are essential goals in managing and restoring fens.

ORAL ABSTRACTS (CONT'D)

The Target Plant Concept can help you reach your restoration objectives

Davis, Anthony S.; Jeremiah R. Pinto
University of Idaho

To re-establish vegetation following a period of absence, restoration often depends on seedlings. Traditionally, a unidirectional relationship existed, whereby the plant material used on a restoration site was often provided by a standard one-size-fits-all stocktype from the nursery. This particular method overlooks potential survival, performance, and growth gains that can be achieved by properly matching nursery stocktypes to specific outplanting conditions. The Target Plant Concept (TPC) incorporates five variables: Objectives and Constraints, Limiting Factors on the Outplanting Site, Stocktype, Source of Plant Material, and Outplanting and Follow-up Practices that should be considered as determining factors for how, where, and when nursery stock are produced for restoration projects. Using the TPC as a standard for successful restoration, the procurement of plant material moves from being based on availability and economics to inclusion of specific seedling attributes that are likely to result in establishment success. This presentation will build on current research and operational examples as well as serve as an introduction for the following five presentations.

Achieving ecosystem scale oyster reef restoration: A trajectory of shellfish restoration in the U.S.

DeAngelis, Bryan M.; Boze Hancock
The Nature Conservancy

Filter feeding bivalves, particularly oysters, have the ability to regulate the functioning of nearshore ecosystems. Because of the importance of bivalves as ecosystem engineers and the scarcity and continued exploitation of the habitat they create, the Nature Conservancy (TNC) has been actively involved in conservation and restoration of shellfish habitats for over a decade. Since 2001 TNC and NOAA's Community-based Restoration Program have partnered to restore habitats critical for the marine resources of the U.S., funding over 135 projects including 65 shellfish restoration projects. Projects have targeted clams, oysters, scallops and abalone with the majority focused on restoring habitat of either Olympia (*Ostrea conchaphila*) or Eastern oysters (*Crassostrea virginica*). The NOAA-TNC Partnership has been a major contributor to the development of restoration techniques and methods of measuring success that have propelled shellfish restoration. Projects have been selected to raise the profile of the ecosystem services provided by bivalves. Documenting the poor condition of most exploited shellfish species and the beneficial services they provide has been important for influencing policy and decisions about management of shellfish reefs as habitat. The proof-of-concept projects have also laid the foundation for larger scale projects bringing shellfish restoration to ecologically meaningful scales. A summary of shellfish restoration to date, mechanisms for increasing the scale, and possible future directions for shellfish restoration in the U.S. will be presented.

Calumet Prairie: An example of using combined management techniques to enhance effectiveness and efficiency in high quality natural areas.

DeAngelo, Chip; Carl Peterson
Encap Inc.

By using management tools and seasonal variances as part of a broad strategy, invasive removal in highly sensitive areas can be effective and efficient. At Calumet Prairie, IN controlled burning, tree removal, broadcast and spot herbicide treatments, and wick application were used to remove 90% of invasive species in 2 seasons with minimal loss to the native communities that include state and federally endangered species. Burning is an effective tool in managing plant communities, but can also enhance herbicide applications later in the season by removing thatch. Seasonal variances in the plant community can leave invasive weeds susceptible to control methods due to height differences or dormant stages. Utilizing frozen ground conditions, areas of the site may be accessible to equipment used for tree removal. By targeting invasive species when there is a distinct disadvantage and using management tools that complement each other, effective invasive control can be obtained even when in close proximity to valuable plant species.

Historical riverine landscape dynamics knowledge as a tool to assess ecological restoration practices for headwaters ecosystems.

Delisle, Marion; Ivan Bernez, Jérôme Sawtschuk
INRA

Headwaters ecological restoration is a key issue to improve water quality and aquatic ecosystem functioning. Our study concerns headwaters surrounded by traditional pasture in a rural landscape of Normandy (France). Passive restoration operation of riparian vegetation has been tested where stream banks were degraded by cattle. Results showed that fencing consisted in an efficient way to restore woody riparian vegetation. Nowadays, there is a need to further consider restoration and management practices at the landscape scale to assess the real impact of such vegetation dynamics on headwater ecosystem quality. Therefore, this study aims at describing riverine landscape dynamics by an historical approach to assess aquatic ecosystem response. The headwaters study site is a salmonids nursery's where fish populations have been monitored for more than twenty years. Riparian vegetation dynamic was studied by photointerpretation of available aerial photographs since 1970. Temporal transitions analyses were performed by GIS to characterize historical disturbance regime that is used as a descriptor of riparian wood management and grazing practices, which is then compared to diachronical datasets on salmonids. Results show that salmonids populations are both positively and negatively impacted by woody riparian vegetation development. Therefore, riverine landscape restoration can be considered as a way to restore headwater but heterogeneity of landscape must be integrated to optimize restoration operation. These results are also compared to historical riverine landscape dynamic that happened on other headwaters without long term monitoring on salmonids.

Observations on habitat parameters and site usage by Karner blue butterfly in Central Wisconsin

Demchik, Michael; Robert Hess, Anna Hess, Sophie Demchik
University of Wisconsin Stevens Point

Karner blue butterfly (*Lycaeides melissa samuelis*; KBB) is a federally endangered species whose larvae feed exclusively on lupine. The objectives of this study were to: 1) compare vegetation characteristics on high-occupancy sites (HI) to low-occupancy sites (LO) to determine parameters of importance to KBB, 2) to determine if clustering of KBB occurs within one large population site indicating preferential use of habitat. To test objective 1, in 2011, sites within three areas were assessed: area 1 (1 HI and 3 LO), area 2 (1 HI and 7 LO) and area 3 (1 HI and 7 LO). Sites were assessed for cover of woody plants, grass, bare ground, lupine, native and invasive forbs and flowering shrubs. HI sites tended to have more plots with occurrence of lupine ($P < 0.058$) than LO sites when controlled for block. All other factors were not significantly different. To test objective 2, transect distance sampling was conducted weekly during the second KBB flight 2011 (4 times) and 2012 (3 times). Coordinates were collected for each observation. Observed distance was determined as the shortest distance to another KBB on the transect. A z-test was used to compare observed to expected distance between KBB observations. For all 7 time periods tested, KBB were non-randomly distributed, indicating clustering of observations. Further study will address what factors influence this clustering. In conclusion, coverage of lupine is the best predictor of KBB HI sites; however, within those HI sites, other factors may be influencing habitat usage.

Rangeland management strategies for adapting to climatic variability: Enhancing the positive and mitigating the negative effects

Derner, Justin; David Augustine
USDA-ARS

Rangeland management strategies for adapting to climatic variability are needed to reduce enterprise risk, increase resilience of rangeland/grassland ecosystems and deliver sustainable provision of ecosystem goods (e.g., livestock production) and services (e.g., wildlife habitat) from western North American rangelands. Projections of more extreme and variable intra-annual precipitation, more intense and protracted droughts, and continued increases in atmospheric carbon dioxide (CO₂) and resultant warmer temperatures provides challenges and subsequent opportunities to develop effective grazing management strategies for adaptation. Successful development of such strategies will be dependent upon (1) appropriate spatial and temporal movement of livestock on the landscape with sufficient flexibility to opportunistically obtain desired outcomes and mitigate negative effects, (2) incorporation of human dimensions through integration of experiential, experimental, social and biophysical knowledge to provide a more comprehensive framework for grazing management, (3) fundamental application of adaptive management which incorporates appropriate monitoring of key metrics to provide feedback for tactical (within season) and strategic (across seasons) changes in grazing management to achieved desired outcomes, and (4) restoration of historical interactions between fire and grazing, using the patch burn grazing approach where prescribed fires are strategically (across year) and tactically (within year) applied to influence grazing behavior and subsequent landscape-level vegetation heterogeneity. We will showcase examples of grazing management strategies to adapt to climatic variability through (1) a collaborative stakeholder group-driven new experiment in shortgrass steppe of the western Great Plains, and (2) recently completed patch burn grazing experiment.

Continued ruination and ruderal ecosystems at Orford Ness

DeSilvey, Caitlin
University of Exeter

The U.K. Ministry of Defence initiated construction of its Atomic Weapons Research Establishment (A.W.R.E) facility on the Suffolk coast at Orford Ness in 1953. The facility closed in 1971, and the vegetated shingle spit is now managed as a National Nature Reserve, a Site of Special Scientific Interest and a Special Area of Conservation. But the site's nature conservation value is held in tension with its significance as an iconic symbol of Cold War secrecy and threat. In 1993, when the National Trust acquired the site, they decided to manage the remnant A.W.R.E structures—a complex of massive reinforced concrete test cells and lab facilities—through a policy of 'continued ruination'. These buildings now accommodate thriving ruderal ecosystems, which are gradually degrading the physical integrity of the structures. Interpretation encourages visitors to engage with both the aesthetics of decay and the imperatives of ecology. The site guidebook states: 'We aim in our management to preserve evidence of past use at the site and at the same time allow natural processes to run their course'. Preservation of the material past and accommodation of natural process are conventionally presumed to be incompatible aims. At Orford Ness, it is possible to imagine a more expansive and hybrid approach to restoration, which discloses complex landscape histories and blurs the distinction between cultural and natural heritage.

Does management affect secondary succession after clearcutting of Atlantic Forest?

Devides Castello, Ana Carolina; Eliana Cardoso Leite, Janaína Braga do Carmo, Samuel Coelho, Dimitrio F. Schievenin, Juliana Coelho
Federal University of São Carlos campus Sorocaba

The Atlantic Forest is considered a biodiversity hotspot by holding species diversity, high degree of endemism. Almost 50% of this Biome is located in Vale do Ribeira (São Paulo State), however these are threatened by the agricultural expansion. The study area is located in Vale do Ribeira, with portions of native forest, pasture and regeneration areas. Our aim was to evaluate if the management history affected secondary succession in abandoned areas as a subsidy to choose restoration methodologies. Two strata were sampled (1st: DBH > 15cm; 2nd: DBH ≤ 5cm, height ≥ 1.5m) in the treatments (P) forest clearcutting, pasture implanted, (N) forest clearcutting without management, both abandoned six years ago and (F) native forest, to analyse

ORAL ABSTRACTS (CONT'D)

phytosociology. To avoid bias, we conducted soil analyses. The H' for (F) (both strata) was higher than those found in (N) and (P). In (N), the 2nd stratum showed greater diversity and density than the 1st, but lower biomass, the same result was observed in (P). For the 1st stratum, all parameters showed significant differences ($p < 0.01$) between (F) and (N), and (N) and (P). For the 2nd stratum of (P) and (F), density and biomass showed significant differences ($p < 0.01$). The soil is considered poor in basic cations and rich in aluminum concentration and showed no differences among the treatments. The results demonstrated that differences in management after cutting has influence in secondary succession and pasture implementation slows this process. In some cases the area abandonment can be a great strategy.

Strategies for restoring tree regeneration in abandoned cardamom plantations in a tropical montane forest

Dhakal, Balram; Michelle Pinard, I.A.U. Nimal Gunatilleke, C.V. Savitri Gunatilleke, David Burslem

University of Aberdeen

Cash crops have been cultivated in tropical forests for centuries, but the effects of cultivation on tree regeneration and the options to restore regeneration following disturbances are poorly known. We investigated the impacts of cardamom (*Elettaria cardamomum* Maton.) cultivation on tree regeneration and the strategies to restore tree regeneration in a Sri Lankan montane forest with abandoned cardamom stands through experimental manipulation. Cardamom plantation had higher number of and diverse recruited seedlings than adjacent natural forest, but the additional seedlings emerging in cardamom plantations were mainly those of pioneer or disturbance-dependent species of low conservation value. Removal of cardamom by slashing or uprooting, or weeding of cardamom stands increased seedling emergence over the unmanipulated control plots, although the cover of herbaceous plants also increased in response to cardamom removal. The density of cardamom plants had recovered through re-sprouting when cardamom stands were slashed, but did not recover when cardamom plants were uprooted and removed. We conclude that the presence of cardamom may inhibit tree seedlings regeneration in abandoned cardamom plantations. The removal of cardamom is an effective strategy for enhancing tree seedling regeneration, but the high labour costs required for these interventions may limit uptake of this method. Thus, we recommend that tree seedling recruitment can be enhanced through facilitation of the process by deliberate weeding of cardamom stands through removal of dead cardamom stems. This technique elevates irradiance at ground level whilst avoiding the soil disturbance associated with cardamom removal.

Overcoming limitations of the past through collaboration of science and practice

Dickens, Sara Jo M.; Katherine Suding

University of California, Berkeley

Bridging the science-practice gap is of critical importance and requires creative blending of respectful collaboration, replicable science and utilization of current technologies. Too often restorations fail due to a lack of time, money and/or information. Collaborative efforts between scientists and practitioners allow for honest recognition of management needs and research that is logistically feasible and applicable to management practices. We collaborated with the managers of the Nature Reserve of Orange County, CA to assess restoration success at a landscape scale. Using vegetative surveys, soil sampling and currently available topographic and climate data we examined how the effects of common management approaches (e.g., seed and mycorrhizae addition, herbicide) influenced restoration success, and in particular, how underlying environmental conditions interacted with management (e.g., target exotics are reduced to a greater extent by herbicide at pH 6.0 to 7.0). Identification of interactions between management and environment has the potential to reduce management costs and increase the likelihood of a successful restoration. These relationships along with interviews and workshops with practitioners drove the design of a web based decision aiding tool. The tool provides topography information and a long term, expandable database. Involving practitioners in the designing of this tool ensured successful interpretation of practitioner needs and solutions to long-term problems.

Ecoart as planting seeds of creativity and turning poor soils into spaces of imagination; a metaphorical exploration

Dieleman, Hans

Universidad Autónoma de la Ciudad de México

Over the past years I dedicated myself to the topic of resilient cities in the context of climate change. The key to resilience, I concluded, is to liberate creativity and to create spaces where communities have the opportunities to develop their own answers to climate change. It involves planting seeds of creativity and creating spaces of imagination or in the words of David Haley, stimulating ecopoiesis as a „living organisation“ from which art - or its Sanskrit origin *rta* - may emerge. The paper expands on the above using creative conservation as a metaphor. The seeds to plant are social-artistic or art-ecological interventions. Should they be wildflowers that respect native cultures and traditions? The soil is the social and cultural environment that often is, creatively speaking, poor and needs to be changed into spaces of imagination and exploration. This process is not about rigid planning and control, but about opening, liberating creativity and stimulating the emergence of new forms to come into being. Here we find the essence of *rta* as the origin of art: dynamic processes of incessant creation with potentially ever new creative practices. The paper presents various concrete examples of artistic interventions and observes that their focus is mainly on the mere intervention - the seed - overlooking the importance of fertile ground. This leads to the question how to work with the soil and some possible 'sociological soil inversion' techniques will be explored that can turn poor soils into spaces of imagination and art into *rta*.

ORAL ABSTRACTS (CONT'D)

Effects of a “natural” flood event on the riparian ecosystem of an impaired large-river system: The 2011 flood on the Missouri River, USA

Dixon, Mark D.; Christopher J. Boever, Victoria L. Albers, Michael L. Scott, W. Carter Johnson, Terrence Malloy
University of South Dakota

The Missouri River, like many other north temperate rivers, has been modified by flood control and navigation infrastructure, significantly altering fluvial, geomorphic, and ecological processes. Cumulative effects of flow regulation are evident in altered floodplain forest age structure and composition, decreased sandbar and shallow water habitat, and declines in rare species of birds and fishes. Although a national scientific panel recommended restoration of fluvial geomorphic processes to address these problems, management constraints have limited process-based restoration. In late spring, 2011, record runoff exceeded flood storage capacity of the reservoir system, leading to the highest flows in nearly 60 years and exceptionally long flood duration (>2 months) at many stations. We assess the initial effects of this large infrequent disturbance on floodplain forest vegetation along six river segments between Montana and Missouri and discuss possible longer-term constraints to ecosystem integrity. Extensive recruitment of cottonwood seedlings occurred on newly created sandbars and the stem density and area of young (*Elaeagnus angustifolia* and *Juniperus virginiana*) that are post-dam colonizers of the floodplain forests than of the native plains cottonwood (*Populus deltoides*). Implications for long-term forest successional trends will depend on the degree to which this new recruitment compensates for losses of young forest. In addition, other physical and biotic stressors and operational constraints may limit forest recovery. True process-based restoration of riparian ecosystem structure and function will require restoration of sediment regimes, channel dynamics, and flows that more closely mimic historical conditions.

White-tailed deer (*Odocoileus virginianus*) as drivers of ecosystem change: Mechanisms that may contribute to alternate stable states in unmanaged mature temperate forests

Djorjevic, Alexandra E.; Paul Grogan, Lonnie W. Aarssen
Queen's University

The overabundance of white-tailed deer (*Odocoileus virginianus*) populations within North America has led to increasing concern over the potential for long-term regeneration failure in forests where their selective foraging persists. A growing body of evidence suggests that deer have the ability to shift the trajectory of their habitats towards an alternate stable state, but the mechanisms underlying this phenomenon remain unknown. Using six-year old replicated 10 m x 10 m exclosures in a mature, mixed hardwood, second-growth forest in Eastern Ontario, we have identified a change in community structure in which browse-avoided tree seedlings and saplings are now the most dominant in both control and treatment plots, with no increase in the abundance of browse-preferred species even where browsing pressure is absent. This suggests that recovery in our mixed deciduous study system has yet to occur, and an additional series of mechanistic experiments will identify the potential for sapling competition, sedge interference, and a shift in functional group dominance to generate the feedbacks that would maintain the system in this depauperate state. This is one of very few studies that focuses not only on browsing impacts in unmanaged forests, but more importantly, explicitly investigates the factors that may affect regeneration potential at the seedling and sapling stage. These findings are critical as they will better inform management practices designed to restore heavily browsed forest ecosystems, and ultimately they may be used to circumvent the community-level shifts in species composition that can reduce ecosystem health and integrity.

Creating mounds to restore sedge meadow heterogeneity and species diversity

Doherty, James M.; Joy B. Zedler
University of Wisconsin-Madison

Urban wetlands are often dominated by highly productive species that form monotypes. At small scales, substrate heterogeneity can provide unique habitats for other species. Natural examples are tussocks (plant-created mounds) of *Carex stricta*, which dominates southern Wisconsin wetlands without excluding other species. We created artificial tussocks (mounds), aiming to increase habitat heterogeneity and diversity within a sedge meadow restoration project. We planted *C. stricta* plugs into plots with: flat ground, three sizes of mounds (8, 16, and 32 cm tall), soil+woodchip mounds, soil-filled peat pots, and control plots with unplanted flat ground, as well as unplanted mounds; all treatments were replicated six-fold. Compared to flat ground, our small-, medium-, and large-mound treatments increased surface area by 12, 25, and 82%, respectively. Soil+woodchip mounds eroded (lost height) most and peat pots eroded least. Taller mounds increased the difference in soil moisture between mound tops and bases ($R^2=0.56$, for 54 total plots), and moist mound tops produced longer *C. stricta* leaves ($R^2=0.46$, for 36 planted plots). Leaves were significantly longer on flat ground and in peat pots, i.e., treatments that usually maintained moist soil. In early spring 2013, we doubled the number of experimental plots and seeded all with a mix of 12 sedge meadow species, hypothesizing that topographic variation added by artificial mounds will allow more species to establish.

Ecological filters at the landscape level driving tropical forest restoration success

Domingues Torezan, Jose Marcelo; Lya Carolina da Silva Mariano Pereira, Carolina de Cassia Cainelli de Oliveira
Londrina State University

While both site history and physical environment are crucial during the first years of Tropical Forest restoration, the fate of the developing community will also depend, for a long time, on the arrival of diaspores from neighbouring sources. However, landscape ecology studies have been pointing out that there are filters operating at landscape level that determine species ability to survive amidst scattered habitat remnants and human-dominated matrix. For forest restoration in fragmented landscapes this means that the species composition of restoration sites can be very limited for a long time,

ORAL ABSTRACTS (CONT'D)

and result in biased assemblages. Thus, knowledge about patterns in species ability to disperse through the matrix is critical for restoration planning and management, allowing the development of strategies for restoring in fragmented landscapes. Nonetheless, information about the effect of landscape filters on tropical forest restoration can also be of interest for landscape ecology. Here we present a case-study from a large restoration project (4,200 ha) in a strongly fragmented Atlantic Forest landscape in southern Brazil. Results showed that woody species regeneration under reforestations is biased towards small-seeded and matrix-dwelling species. Also, abundance of regenerating species is more related to the distance from seed sources, while species richness depends on surrounding habitat area. In isolated sites, synergism between limited recruitment of late succession species and the presence of exotic C4 grasses is harming restoration goals.

Degradation of grassland ecosystems in the developing world: tragedy of breaking coupled human-natural systems

Dong, Shikui; James P. Lassioe

Beijing Normal University

About 73% of the world's 3.3 billion ha of dry grasslands are facing moderate desertification/degradation, having lost more than 25% of their carrying capacity. Although the adverse effects of grassland degradation in the developing world have been widely recognized, there is long debate among professionals and practitioners worldwide about its cause, e.g. overgrazing vs. climate change. We argued neither overgrazing nor climate change can alone explain the degradation of grasslands worldwide. The traditional grassland management strategy represents a complex form of natural resource management, involving the direct interaction between natural resources and their users carried out within a larger geo-political context. It is not effective to study human and natural systems of grassland separately when addressing social-ecological and human-environment interactions over the long-term. Understanding the mechanisms that regulate grassland health will contribute to our knowledge of complex coupled human-natural systems (CHANS). This will require the integration of multiple, complementary and independent methods of CHANS to open new opportunities for dialogue among natural and social scientists, particularly with regard to the interplay between ecological, social and economic systems in grassland management. In this paper, four case studies from African Savanna, Central Asian Steppe, Tibetan alpine meadow and Nepali Himalayan grasslands are examined to demonstrate how important the concepts of CHANS are to clarifying the questions of driving forces for grassland degradation and how the approaches of CHANS work for promoting the sustainability of grassland ecosystems in the developing world

Ecological Restoration in Korean National Parks in Response to Climate Change

Doo ha, Yang

Korea National Park Service

This presentation showcases four important examples of planning and implementation of ecological restoration projects in Korean national parks as a response to climate change. Climate change, associated habitat loss, and other factors are contributing to declines in populations of key species in Korea, including endangered insects (*Callipogon relictus*) and plants (*Abies koreana*; *Pinus pumila*) as well as other ecologically important species such as eel grass (*Zostera marina*). National parks in Korea protect important remaining habitat for these species. For example, *Pinus pumila*, which has been classified as a national biological indicator species for climate change, is found only in the area of Daecheongbong Peak of Seoraksan National Park. The Korea National Park Service and its partners are planning and implementing strategies such as transplantation, artificial breeding, and habitat restoration in an effort to conserve these species and ensure the health and resilience of important ecosystems over the long term. *Pinus pumila* is being transplanted and visitor facilities in the park are being modified to support the long-term viability of this species as the climate changes. Similar strategies are being implemented for the *Abies koreana*, an endangered Arctic alpine plant that is also a national biological indicator for climate change. Artificial breeding is being undertaken to restore populations of the endangered insect *Callipogon relictus*, while in coastal areas, efforts to restore eel grass (*Zostera marina*) in Hallyeohaesang and Taeanhaean Marine national parks are focused on maintaining and restoring the health and productivity of coastal ecosystems as a response to climate change.

Interpreting landscapes and restoring meanings in a postmodern age

Drenthen, Martin

Radboud University Nijmegen

Ecological restoration of cultural landscapes demands that we know what landscapes mean to us, and for that, we need to interpret them, read them as meaningful texts. Most cultural landscapes, however, are like palimpsests that contain different legible layers. A focus on recent layers may urge us to appreciate and restore those landscape patterns that support cultural heritage and identity. Deeper layers, on the other hand, stress the importance of natural history and might convince us to attempt to restore the continuity between the human and the natural world. These perspectives on 'landscape legibility' can sometimes be combined, but will often contradict. Moreover, like most texts, legible landscapes are more than mere information carriers. Texts afford different readings, all of which simultaneously reveal something about the texts and about us as readers involved in that text. Similarly, understanding the meaning of a landscape requires more than just reconstructing its factual history, it also requires that we recognize the storylines inscribed in the landscape and relate them to ourselves – find out what a landscape has to say to us. Cultural landscapes are complex and layered, and expressing their meanings demands multiple interpretations. An appropriate restoration of cultural landscapes should therefore not impose one particular story to the land, should not suppress the potential tensions between different readings of a place. On the other hand, restorationists should help seek a common understanding of the meaning landscapes. This presentation will argue that environmental art might be helpful in finding appropriate restoration practices.

ORAL ABSTRACTS (CONT'D)

Making the case for ecological restoration on private agricultural lands

Duff, Alison J.; Paul H. Zedler, Jeb Barzen

Nelson Institute for Environmental Studies

Agricultural lands represent the dominant land use in Wisconsin and much of the Upper Midwest. Many farms retain remnant native ecosystems that support a diversity of species and provide important ecological services. Even more have marginal lands that may be restored to native communities. Despite a general willingness of most farmers to engage in conservation practices, there are significant barriers to restoration. The challenges multiply where the objective is a regionally harmonized agro-ecological landscape. To understand the nature of these barriers and potential solutions we conducted a study that examined Wisconsin vegetable farms enrolled in an ecolabel certification program. Our study consisted of: (1) A plant community diversity assessment of farm non-crop lands using a multi-scale Modified-Whittaker sampling methodology, (2) Interviews of farm managers to gauge landowner interest in conservation of biological diversity and ecosystem services, and (3) An evaluation of farm ecological restoration plans in the context of plant community and grower survey results. While all enrolled farms contained plant communities of conservation value, the relative success of ecological restoration on the farms was variable and correlated with landscape context, resources available for restoration planning and implementation, and size and contiguity of non-cultivated land. Our data show that a science-based, adaptive management approach to measurement and restoration of biological diversity and ecosystem services is critical to ensuring significant conservation gains. Farmer survey data illustrate the importance of crafting restoration plans that engage the landowner in the decision-making process and are responsive to the social, economic, and ecological farm context.

Funding for wildlife habitat restoration projects with a climate adaptation focus

Dunning, Kathryn

Wildlife Conservation Society

While the science and planning for climate adaptation are rapidly advancing, there exist relatively few projects testing applied, on-the-ground management actions for climate change adaptation focused on biodiversity and ecosystems. To jump-start new implementation efforts, the Wildlife Conservation Society (WCS), with the generous support of the Doris Duke Charitable Foundation, established the Climate Adaptation Fund in 2011. This national grantmaking program funds on-the-ground conservation actions that assist wildlife in adapting to changing climate conditions. A primary goal of this program is to provide resources to conservation practitioners, allowing them to move from science and planning efforts to taking tangible actions that mitigate the impacts of climate change on ecosystems. Restoration activities are among those at the forefront of these actions, but because climate change poses an entirely new set of challenges, new ways of thinking about and implementing actions are necessary to effectively address these challenges. Illustrations of climate change adaptation projects with an innovative restoration component will be provided with current Climate Adaptation Fund grantee examples from across the country. Details about the funding focus of the program, including the upcoming 2014 Request for Proposals will also be highlighted.

Can we predict and change the trajectory of restored Tropical Forests?

Durigan, Giselda; Marcio Seiji Suganuma

Forestry Institute of São Paulo State, Brazil

Analyzing the successional trajectories of restored ecosystems offers a unique opportunity to test the still controversial theories on ecological succession. The central question which arises in the context of Restoration Ecology is: 1) is the final state of the restored ecosystem predictable? If it is predictable, other questions emerge: 2) which factors drive the ecosystem for the desired end state? 3) Is it possible to manipulate the restored ecosystem to rectify or accelerate its path towards the desired state? I will present the results of two research projects aimed at elucidate these issues in the context of Atlantic Forest, Brazil. In the first project, we analyzed the trajectory of 26 forest patches restored by practitioners, aged from 04 to 53 years, having as reference four pristine forests, to explore answers to questions 1) and 2). In the second project, we set up experiments in the context of adaptive management (sensu Zedler and Callaway) in selected restored forests to address question 3). The first study suggested community attributes that followed both predictable and unpredictable trajectories and identified factors that favored or constrained the successional processes. The second study is still in progress, but preliminary results indicate management interventions that can enhance the successional processes and others practices that are range from neutral to negative. Our results suggest that the effectiveness of adaptive management depends on the understanding the ecological filters involved in the community assembly rules.

The tough challenge of restoring the Brazilian Cerrado grasslands after biological invasions

Durigan, Giselda; Rodolfo C.R. Abreu, Natashi A.L. Pilon

Forestry Institute of São Paulo State, Brazil

In tropical countries, where the most rich and exuberant forests of the planet exist, efforts and resources for ecological restoration have been primarily allocated to them, in detriment of other biomes. That is the case of Brazil, where the Cerrado (the Brazilian savanna) has only recently become a global hotspot for conservation, and attempts to restore its vegetation are still incipient. The Cerrado comprises a gradient from grassland to woodland savanna, and the information presented at this symposium is based on two experiments aiming to restore the campo cerrado. It can be described as a grassland with sparse and small woody plants, occurring on sandy and poor soils, subjected to a long dry season in the winter, sporadic frosts and frequent fires. Over the recent decades it has been converted to agriculture, forestry or pasture, and the remaining natural areas have been heavily threatened by biological invasions, loosing most of the plant diversity in a very short time. The first experiment was performed in an area densely

ORAL ABSTRACTS (CONT'D)

invaded by a tree species – *Pinus elliottii*, aiming at eradicating the invasive trees and stimulating the regeneration of native plants. In the second experiment we tried top soil and hay transfer to restore the native vegetation that was suppressed by an invasive African grass (*Urochloa decumbens*). Challenges, successes, surprises and frustrations provided by the two experiments will be presented. We believe that restoring this neglected ecosystem will be a much harder task than it has been to restore the tropical rainforests.

Restoring a Mediterranean steppe by using soil tranfert after a pipeline leak (Plain of La Crau, Southeastern France).

Dutoit, Thierry; Adeline Bulot, Marielle Renucci, Erick Provost
IMBE

The 7th August 2009, an important pipeline leak occurred in a Mediterranean semi-arid steppe and spilled 4700 m³ of oil. In 2010, over 5 ha of the polluted soil and steppe vegetation were totally destroyed by excavation. Then, the rehabilitation of the steppe vegetation was set up via civil engineering techniques with the transfer of 72 000 tons of the same type of soil coming from a nearby quarry. Various experiments of soil vertical reconstruction testing the importance of respecting the vertical organization of the main soil layers were conducted. Vegetation resilience via its seed bank and/or propagules according to the different modalities were tested. Quadrats (10m x 10m) were placed at random in each case: the reference steppe, in the zones which include the organic layer (0-20cm deep) with compaction or without compaction, the mineral layer (20-40cm deep) or only the geological basement (>40cm deep) constituted by gravels. After three years, our results show that the soils with the transfer of the organic layer (with or without compaction) and with the mineral layer has the closest vegetation to the reference steppe vegetation in terms of composition, species-richness, diversity and similitude, in spite of the presence of some ruderal species which have germinated from the seed bank and the seed rain. At the opposite, the soil with gravels only has the poorer vegetation that mostly included pioneer species with strong capacity of dispersion. Nevertheless, none of these treatments were able to restore the structure of the reference steppe community.

Workshop: Assessment to Recovery: Setting priorities for restoring ecosystem capacity

Edwards, Stephen
IUCN Commission on Ecosystem Management

At the 2012 World Conservation Congress the IUCN adopted a major new conservation program for quantifying the level of risk that any given ecosystem might have for collapsing or transitioning to a different state. This first of this two-session workshop will explore priority setting options for the restoration of identified at-risk ecosystems. The second session will consider how resources may be mobilized to facilitate restoration of those ecosystems. Three keynote presentations will provide a framework for participant engagement and workshop outcomes: An overview of the Red Listing criteria and assessment process – Michael Jennings. Resilience assessment tools for identifying future options for ecosystem management – Mike Jones. Practical insights into restoration of ecosystems – Keith Bowers. Participants will then work in facilitated breakout groups to explore such questions as: Who should participate in priority setting? What social and ecological criteria might guide setting priorities? In the second session, breakout groups will explore different means for making technical, sociological, and financial recovery resources available to citizens and land managers. The goal of the workshop is a roadmap for developing procedures, priorities and concrete recommendations for ecosystem restoration anywhere in the world. A key component of the concluding discussions will be financial structuring. Come prepared to share your expertise and to help guide and develop a collaborative process involving members of the Society for Ecological Restoration and the IUCN.

History of Ecological Restoration: A History of Multiple Communities of Interpreters

Egan, Dave

The history of ecological restoration is a multi-perspective narrative. In my analysis, these perspectives about ecological restoration legitimately arise from communities (i.e., groups) of interpreters rather than from individuals and/or individual projects--current or historical. Such communities of interpreters include Midwestern United States prairie restorationists (who I claim are the original community of interpreters), academics, internationalists, indigenous peoples, organization builders, and reclamationists. I will describe the particular interpretation of ecological restoration of each community, why and how their interpretations are formed from their value sets, and where these interpretations find commonalities and where they have disagreements. I will explore these interpretations of a practice and discuss how they make a rich, diverse historical record while at the same time create confusion and uncertainty for ecological restoration practitioners in terms of definitions, goals/objectives, and activities.

Ectomycorrhizal community recovery following exotic species invasion and restoration in an oak woodland

Egerton-Warburton, Louise; Robert D. Hevey Jr
Chicago Botanic Garden

Invasive plants can have a multitude of impacts on plant communities through their direct and indirect effects on soil chemistry, nutrient pools and fluxes, and ecosystem function. Considerably less is known their effects on belowground microbial communities and the subsequent plant-soil feedbacks during the restoration of native systems. We conducted a multi-year field study to examine the effects of removing an invasive species, *Rhamnus cathartica* (European buckthorn), on soil N and P fertility and ectomycorrhizal (EM) community recovery in *Quercus macrocarpa* (bur oak) woodlands. That buckthorn invasions can increase soil N levels and increasing soil N fertility negatively affects ECM communities is well recognized. A key question is whether EM communities can recover after buckthorn removal owing to a reduction in soil fertility. While there was no significant decline in soil N fertility (total %N, NO₃, NH₄) after buckthorn removal, we did find a significant decrease in soil P levels in comparison to the invaded site. Buckthorn

ORAL ABSTRACTS (CONT'D)

removal also resulted in significant increases in the abundance of EM root tips and species richness. Although there was no difference in EM species richness between invaded and cleared stands in the first year, we detected greater mid-season EM richness (up to 30% higher) in cleared versus invaded stands in the second and third year after clearing. These findings confirm the importance of invasive plants in regulating EM communities, and implicate soil P levels as an additional mechanism by which invasive plants can modify the EM community.

Restoring Rocky Mountain ecosystems with Fire and Wolves

Eisenberg, Cristina; David E. Hibbs
Oregon State University

We investigated the relationship among wolf (*Canis lupus*) predation, herbivory, aspen (*Populus tremuloides*) recruitment into the forest canopy, and fire by measuring aspen in Glacier National Park, Montana and Waterton Lakes National Park, Alberta. We assessed herbivory and bottom-up influences (e.g., incident radiation and temperature, moisture, disturbance). We included as a predictor the hypothesized behaviorally-mediated mechanism whereby in ecosystems containing wolves, elk (*Cervus elaphus*) avoid sites with topography, debris, or deadfalls that make it more difficult to see or escape wolves. The complex behaviorally-mediated wolf effects on elk in our study area may indirectly facilitate aspen recruitment, a top-down effect. We stratified our observations across three geographically separate valleys in the two Parks, valleys with similar ecological characteristics, but different levels of wolf population (Saint Mary: low; Waterton: moderate; North Fork: high). Saint Mary and Waterton had no wildfire since 1890. In the North Fork, 90% of aspen stands burned between 1988 and 2003. North Fork burned stands had significantly more recruitment than unburned stands ($p=0.007$). While bottom-up processes (e.g., fire) stimulated aspen regeneration in the North Fork, we did not find significantly higher total aspen stem density in burned vs. unburned stands. The differential recruitment between burned and unburned stands in the North Fork demonstrates the importance of bottom-up effects. Further, in all valleys, fire was necessary for aspen to recruit above elk browse height at all levels of wolf population observed. We recommend that practitioners consider both fire and trophic cascades effects when restoring aspen ecosystems.

Partnering to create a landscape-scale Longleaf pine forest restoration and prescribed fire program in the NC Sandhills

Elting, Ryan
The Nature Conservancy

The North Carolina Sandhills is the northernmost, intact, landscape-scale example of the once vast longleaf pine forest ecosystem, and the home of an innovative partnership of Federal, State, non-profit, and private sector stakeholders that arose out of crisis, through the recognition that the interests of all could be served by the protection and restoration of this culturally, economically and biologically significant landscape. Over the past 12 years, the NC Sandhills Conservation Partnership has emerged as a regional leader in longleaf pine forest ecosystem restoration as its conservation focus have expanded from buffering military training and endangered species habitat, to the re-connection of the two core blocks of longleaf on the landscape, and the re-establishment of a single, functional network of longleaf forest habitat. Through a combination of strategic land protection and restoration efforts, major successes have been achieved by leveraging the resources and strengths of the individual partners and tapping into the knowledge base and momentum behind this region-wide longleaf restoration initiative. Together, this multi-scale approach has dramatically increased local capacity for longleaf reforestation, native groundcover establishment, and fire-regime restoration, and established the Partnership as a local implementation team of a much larger range-wide effort, and this presentation will discuss the longleaf conservation achievements of the Partnership and the lessons learned. I want to address the two pronged approach to our work which involves actually applying the longleaf knowledge that has been regained over the past 15 years in the Southeast to a local project on our local landscape.

Can we expect a cash flow from restored forests? A study case from the Atlantic Forest in Brazil.

Engel, Vera Lex; John A. Parrotta, Danilo Scorzoni Ré, Diego Sotto Podadera, Liz Miyo Sousa Ota, Rodrigo Minici Oliveira, Elder Candido Mattos
University of São Paulo-UNESP

Effective restoration of tropical forest landscapes depends strongly on farmer's involvement as a significant proportion of degraded areas are privately owned. Although the improvement of forest restoration techniques in the last few decades, recovery of species-rich forests is still too costly to be afforded by the majority of small and medium land holders. Combining biodiversity restoration and forest management in ways that provide landholders some sort of income is one of the biggest challenges to overcome socio-economic barriers. We summarize some results of a set of experiments established 15-16 years ago testing different mixed-species plantings to restore the Atlantic Forest in small and medium properties, including: a direct-seeding system (5 species), an agroforestry system (20 species) and a combination of fast and slow growth commercial species (25 species). The plantations were designed to be managed for firewood, timber and non-timber forest products with selective cuttings, and at the same time promoting the natural regeneration of native vegetation. Although timber production after 14 years ranged from 127-166 m³ ha⁻¹, this was predominantly from fast-growing species with lower wood quality. Our results indicate that plantation costs not only can be paid back by the management of crops, firewood coming from thinning and non-timber products, but also that positive internal rates of return could be expected. Additional income is expected from selective harvesting of timber trees in longer rotation cycles. Although the promising results, we emphasize some limitations that should be overcome before we could recommend these approaches for broader scale application.

ORAL ABSTRACTS (CONT'D)

The biodiversity threshold for ecosystem functioning: a meta-analysis of tropical forest restoration

Engel, Vera Lex; Susanne Schmidt, Luke Shoo, Jennifer Firm

University of São Paulo-UNESP

There is consensus that biodiversity loss decreases the capacity of ecosystems to provide essential services, including resource capture, decomposition and recycling. The relationship between Biodiversity and Ecosystem Function, the so-called BEF theory, has emerged as an important paradigm in ecology. BEF theory states that a degraded ecosystem that has suffered a reduction in biodiversity will also exhibit reduced function. Conversely, restoration actions that serve to increase the number of species should result in improved function. Despite the importance of this concept, especially for the restoration practice within mega-biodiverse tropical forests ecosystems, there is insufficient empirical evidence demonstrating the specific effects and magnitude of the BEF relationship. Most studies testing the BEF theory have been conducted within herbaceous communities, or simple contrived ecosystems under controlled conditions within terrestrial and aquatic ecosystems. High-diversity ecological plantings are widely employed to restore forest throughout the tropics. However, the high costs associated with this practice have also prompted a search for alternative, more cost-effective approaches to tropical forest restoration. Knowledge of the minimum species number required to reinstate the function of restored forest over different time-frames may be one way to realize this objective. Here we present a meta-analysis integrating data of restoration plantings of different ages and site conditions from the Brazilian Atlantic Forest and the Australian wet Tropics. Specifically we ask: (a) is there a minimum species richness threshold to assure functioning; (b) how important is complementarity among species (i.e. species interactions); and, (c) is functional diversity more important than taxonomic diversity?

Germination signatures of 89 arid zone species: A comprehensive dormancy classification assessment that highlights the germination requirements for species required for restoration

Erickson, Todd E.; David J. Merritt, Shane R. Turner, Phillip J. Ainsley, Kingsley W. Dixon

University of Western Australia / Kings Park Botanic Garden

Germination is an essential link in the transition from a seed to a seedling. Seeds of the majority of species from hot arid regions possess innate dormancy mechanisms to control germination timing. As restoration practitioners plan to scale up to deliver seeds to thousands of hectares of disturbed land, failure to remove seed dormancy may increase the likelihood of recruitment failure during periods normally suitable for germination. We assessed germination traits for 89 species from the northern arid zone of Western Australia. Of these, 73% (n=65 spp.) possessed some kind of dormancy. Seeds with physiological (33.7%, n=30 spp.) or physical (31.5%, n=28 spp.) dormancy were found in the largest proportions. Non dormant seeds comprised 27.0% (n=24 spp.) of species. By examining the seed germination response of each species to various incubation temperatures and chemical germination stimulants we were able to determine nine distinct patterns, or germination signatures. Within the germination responses observed, which ranged from 0 – 100%, these germination signatures grouped species into three primary groups: (1) those that were low germinating and deeply dormant (2) those that positively interacted with warmer incubation conditions and germination stimulants, and (3) those with an un-restricted germination potential at all temperatures and regardless of the presence/absence of chemical stimulants. In this presentation we will (1) outline the methods used to classify the different dormancy classes, (2) the novel approach taken to develop the germination signatures, and (3) how we are using this germination analysis to translate seed-based knowledge to on-ground restoration practitioners.

Soil bioengineering techniques for riverbank protection: ancestral techniques facing the new challenges of sustainable development in a changing world

Evette, Andre; Sophie Labonne, Catherine Lavaine, Paul Cavaille, Fanny Dommanget

Irstea

Besides hard engineering, soil bioengineering techniques for riverbank protection are very old and have been used for centuries throughout the world. Known from Antiquity, they were largely developed during the 18th and mostly 19th centuries with the production of a number of technical guides in several countries. A bit forgotten during part of the 20th century, they are currently being revived and are expanding. These techniques are designed to achieve two objectives simultaneously, which earlier could be considered as paradoxical, first to protect anthropic investment from erosion and secondly to fulfil essential ecological functions such as ecological corridors or biodiversity support. Soil bioengineering techniques are both artificial protection works and ecological restoration techniques. We conducted studies on Prealps riverbanks in Western Europe and have shown that these techniques can simultaneously ensure a high level of mechanical erosion control and contain a high level of plant and animal biodiversity. In some cases, these techniques can even favour endangered species. Furthermore, riverbank soil bioengineering techniques can limit the development of exotic invasive species, which are especially numerous along river stretches. In a context of climate change, they may also offer solutions to restoring riparian woodland with species or populations adapted to harsh drought. Soil bioengineering techniques are therefore promising in the achievement of complex human goals on riverbanks in a context of global change.

Invasive plant litter is slower to decompose than native litter and reduces native plant richness and abundance in restored and reference vernal pools

Faist, Akasha; Sharon Collinge

University of Colorado

Vernal pools, or ephemeral wetlands, commonly found in regions with Mediterranean climates have been rapidly converted to agriculture and land development worldwide. Vernal pools often host many rare or endemic plant species raising concern over continuing rates of habitat loss. In California,

ORAL ABSTRACTS (CONT'D)

vernal pool ecosystems are also threatened by the encroachment of invasive plant species. Many invasive species are physically larger than natives, and thus could alter litter accumulation and decomposition rates within vernal pool boundaries. Thicker litter layers appear to influence the abundance and success of native plants, so we studied the dynamics of invasive plant litter and plant communities in both restored and naturally occurring pools. We investigated the effects of invasive litter by manipulating litter depth in both restored and naturally occurring pools in a long-term study site in the central valley of California. We found that overall species richness declined with increasing litter depths ($P < 0.0001$), and that native species richness and abundance was drastically reduced, while invasive species abundance was maintained. Using litter bags filled with a prolific invasive grass (*Lolium multiflorum* L.) and a native grass (*Pleuropogon californicus* L.) revealed that *P. californicus* had a significantly higher decomposition rate ($P < 0.0001$) than its invasive counterpart. Overall, our results suggest that once invasive species are established in vernal pools, invasive litter is slower to decompose and inhibits native plant abundance through higher litter depths. This effect appears to be reinforcing plant invasion, thus reducing the success of native plants and undermining restoration projects.

From restoration to resilience ecology: Rapid ecosystem shifts are triggered by interactions of landscape disturbance and climate change.

Falk, Donald A.

University of Arizona

Many studies predict changes in species distributions in response to changing climate. Both modeling and empirical studies suggest that such changes due to climate alone are likely to be expressed at multi-annual to decadal time scales. In contrast, severe large-scale disturbances can reorganize ecosystems on much shorter time scales of days to months. To understand these dynamics, we are studying the impacts of multiple successive fires and post-fire succession in southwestern North America, which are leaving large areas of landscape with nearly total tree mortality. We posit that it is the combination of climate change and severe disturbance that is most likely to trigger abrupt ecosystem transitions into novel configurations, rather than either factor acting separately. These new configurations can be resilient in their new state, and resistant to return to pre-disturbance conditions. Such abrupt transitions are predicted to become more common under conditions of altered future climate and amplified disturbance regimes: climate provides the envelope within which these dynamics occur, but disturbance provides the trigger for abrupt system reorganization. At larger scales we have compiled the largest-ever data set for historical fire regimes in western North America to understand how climate variation has regulated disturbance regimes historically. We explore the implications of rapid ecosystem responses for design and practice of ecological restoration in a rapidly changing world, and the emergence of resilience ecology as a new paradigm in the evolution of restoration ecology.

Genetic Consideration for reintroductions of rare species: Lessons learnt from *Cirsium pitcheri* and *Asclepias lanuginosa* reintroductions

Fant, Jeremie

Chicago Botanic Garden

The goal of any plant reintroduction is to create self sustaining populations which mirror the genetic structure of the local native populations. This goal can usually be met by using propagules collected from a large local population. This is known as the "local is best" paradigm of restoration. It is based on three genetic principles, Adaptation (matching conditions at re-introduction site to those of source material), Provenance (maintaining local patterns of gene flow and genetic structure), and Genetic Diversity (providing sufficient genetic diversity to prevent inbreeding and adapt to current and future selective pressures). Unfortunately for some rare or narrow endemics, finding large local populations with sufficient genetic diversity to serve as source material is not always possible. In these cases it becomes important to determine which genetic principles are most important for meeting reintroduction goals. Here we present case studies of two rare endemic species *Cirsium pitcheri* (Pitcher's Thistle) and *Asclepias lanuginosa* (Woolly Milkweed) and discuss how selection of source material meets reintroduction goals.

Restoration of contaminated lands and water; Where do we go from here?

Farag, Aida M.; Susan Finger

USGS

Water and lands that were once deemed unusable after mining, drilling, etc. activities now hold promise for potential remediation/restoration activities. Government agencies with natural resource obligations and private companies with good steward responsibilities have interest in developing new science and approaches that could complement these efforts to remediate and restore ecosystems. The actual restoration of previously contaminated ecosystems should not be confused with clean-up efforts that remove or render a proportion of contaminants. Equally important is utilization of restoration techniques, such as "restore as you go", to prevent contamination of ecosystems during extractive or exploratory activities. Restoration of previously contaminated lands has unique issues that must be addressed: For example, will the restored land be an attractive nuisance for wildlife? What methods can be used to reconstruct the ecosystem? Will the restoration process release additional contaminants over time? How is baseline defined on land altered by human activity hundreds of years ago? How can restoration proceed if reclamation has failed at legacy contaminated sites? A potential way to effectively and readily answer these and other questions is to link two important areas of study, restoration ecology and environmental toxicology, the primary focus areas of the Society of Ecological Restoration and the Society of Environmental Toxicology and Chemistry. Scientists from SER and SETAC are developing a workshop would bring experts from both disciplines together to exchange ideas and lessons learned, identify key areas of research, and to outline a path forward to go beyond remediation to restoration.

ORAL ABSTRACTS (CONT'D)

Changes to Maya Forest Gardening en Pich, Campeche.

Faust, Betty
CICY, Mexico

For decades now, Maya farmers in Pich, Campeche, have experimented with fertilizers, herbicides, “improved varieties” of corn, tractors, green cover crops, imported pasture grasses, and shortened periods of forest re-growth with intensified weeding. Rising prices for corn increase conflicts between planting now and keeping areas in forest re-growth. Tractor cultivation is more easily combined with full-time employment than traditional farming. National laws favor forest clearing and land fencing for pasture. Thus, the traditional 20-year agricultural cycle (with forest re-growth and polycropping) is being replaced by four-years of bush fallow with grazing cattle and sheep, followed by two years of mono-cropped corn. The increase in deforestation is likely to further worsen the local climate, which was previously affected by massive deforestation for rural development projects in the 1970s and 1980s. The combination of climate change, incentives for ranching, and government restrictions on agricultural burning are all minimizing traditional Maya agriculture in this area. Resulting new variations do contribute to our understanding of the resilience of Maya agricultural practice. A few grandfathers still maintain small plots a quarter their former size, as refugia of an agro ecological system that evolved by experimentation during three thousand years under diverse climatic conditions; a few young men still help their fathers and grandfathers, and thus are learning. If political conditions changed, they could become the teachers of agro-ecological wisdom to a new generation.

Designing future nature through ecological land planning and research-based design

Felson, Alexander J.
Yale University

Urban ecology is at the crossroads of theory and application. Through the integration of design with experimental ecology (“designed experiments”), the practice of ecological land planning and research-based design (“ecological urban design”) is evolving to address issues of urban sustainability and resilience in constructed ecosystems, which have emerged in response to the persistent pressures of urbanization and human modification of urban environments. Whether these modified ecosystems and hybrid anthropogenic, biological systems provide the anticipated ecosystem services remains to be tested. Embedded designed experiments can facilitate such testing and furnish data on what these systems contribute to urban sustainability. Designed experiments are also transdisciplinary: they involve ecologists in design and planning and designers in translating research into the urban social systems.

Challenges and future of the restoration of harsh environments in the tropics

Fernandes, Geraldo; Daniel Negreiros
Universidade Federal de Minas Gerais

Eco-efficient restoration in semi-arid of Brazil is rare. In spite of the existence of strong laws, the lack of reinforcement in the inspection, surveillance, and monitoring of the restored areas represents a bottle neck that prevents its success. In the semi-arid mountainous regions where most mining operations and new roads that cross the rough terrain expose the soil to the harsh weather, the use of mixes of exotic species is still a widespread strategy. Our data indicate that the use of exotic species is paving the way to serious environmental problems. The main excuse to not engage in a sound program of ecological restoration is the lack of knowledge and availability of commercial species in the market. In an attempt to bring to light evidences to dismiss such erroneous approach and provide the fuel to engage on serious and solid ecological restoration we present pioneer data on a long term experiment on the restoration of the rupestrian field mountains. Selected species were studied in detail, cultivated, propagated, inserted in the degraded land and monitored. This knowledge was then successfully transferred to a real situation to restore large areas in the wild. We also provide pioneer information on ongoing restoration of boreholes of iron ore rupestrian field formations in the Amazon region of Brazil, and the revegetation of slate sterile piles in the southeastern, indicating new perspectives and solid possibilities to bring back ecosystem biodiversity, functioning, and services.

Furnas Landscape Laboratory - Furnas Lake Watershed Ecological and Landscape Restoration Project (Azores islands) - Awarded Portugal's National Landscape 2012

Ferreira, Miguel; Malgorzata Pietrzak
Azorina

The intensification of dairy farms in the last decades has led to the eutrophication of Furnas Lake. Therefore, to restore its water quality a legally binding Furnas Watershed Plan took place, aiming at a major change of the soil use. It was a turning point in the landscape management and economic activities of the last five decades. Since 2007, about 300 ha of agricultural land within the watershed were bought by the Azorean Government, which enabled the management team to implement an ambitious plan. Furnas Landscape Laboratory, a future multifunctional forest landscape is being created to act as a large experimental ground, pioneer in the Azores islands, to implement new ecological restoration techniques, economical activities and management practices, promoting a wide spread public involvement, to achieve sustainability at all levels (ecologic, economic, social, cultural and aesthetic). Furnas Landscape Laboratory aims to create and restore a landscape that is in continuous transformation, hence appealing to: the local community, biodiversity, tourism, nature sports, artists, investors, entrepreneurs, science and education. It is innovative, interactive and in a constant sustainable evolution throughout time. It must continue to be dynamic and adaptive, as this is a long-term project that will never be concluded and which concepts will be extrapolated to new sites. Due to its innovative approach and dynamic management with the involvement of many partners from different institutions Furnas LandLab has already been awarded two first prizes at Portugal national level, the last one due to the exemplary implementation of the European Landscape Convention.

ORAL ABSTRACTS (CONT'D)

Measuring effects of planting density on surface-water runoff quality, soil organic matter and carbon sequestration

Fevold, Brick; Michael Meyer
Wisconsin DNR, Science Services

In Ashland, Wisconsin, USA, state and local government are working together to evaluate the effectiveness of lakeshore restoration as a tool to remediate the detrimental effects of deforested lakeshore habitat along an urban waterfront of Lake Superior's Chequamegon Bay. A component of this collaboration includes cooperative research between the Wisconsin DNR and the City of Ashland to determine whether shoreland reforestation has potential to reduce storm-water runoff and allow for the recovery of soil functional integrity. Specifically, we are conducting an experiment to determine whether converting open grassy shoreland habitat to closed-canopy woodland reduces total sediment, nutrient and runoff volume, as well as the loss of soil organic matter. In this talk, we present early results from a long-term repeated measures experiment (2012-2022) comparing surface water and nutrient run-off, soil organic matter and carbon storage as measured in in-situ plots assigned one of two levels of native tree and shrub stocking density (restored) or an open grassy control (unrestored). We predict that nutrient levels in runoff samples, initially spiked due to planting of fertilized potted stock, will decline sharply in the short-term (2-5 years) in the planted plots as the amended potting soil associated with the planting stock becomes fully utilized through plant metabolism. Long-term experimental comparison is expected to show that reforestation will result in lower levels of surface-water runoff, sediment and nutrient loading relative to open grassy plots as soil organic matter depth and water storage capacity increases.

Ecological restoration of moorland ecosystems through the use of natural and naturalized promissory forage species. A case of study in the Chimborazo-Ecuador moorland zone.

Fiallos Ortega, Luis Rafael; Silvia Carina Jimenez Granizo
ESPOCH

The moors are considered basically as biological corridors almost uninterrupted, which play an important role in the economy of Ecuador and the world. Under experimental conditions, agronomic and productive evaluations were assessed over a period of two years. The experiment was deployed in the Chimborazo moors and used two promising forage species: (1) *Arrhenatherum elatius* and (2) *Poa palustris*. The assessment protocol included separate analysis of multiple parameters that influence the production of seeds and fodder and also contribute to the ecological restoration of the Paramo. The main significant results of the experimental work, it was observed that, on one hand, *Arrhenatherum elatius* registered the following parameter values: 115.7cm as vegetation height, 24.4 t / ha / cut as forage production and 6.9 t / ha / cut as dry matter production. On the other hand, *Poa palustris* smaller values recorded parameters were: 95.1% as a percentage of canopy cover, 19.9 t / ha / cut as production of green fodder and 5.89 tons / ha / cut and dry matter production. Given the two sets of results, through this experimental work it was concluded that the use of promising forage species can contribute to the restoration of wilderness ecosystems. *Arrhenatherum elatius* and *Poa palustris* are natural promising species through its creation, contribute to the elimination of the desert lands with plants that are established, these species ensure better coverage of the plant in the soil, yield efficient and avoids the soil erosion in the upper reaches to 3.500msnm

Controls on soil organic matter dynamics during woody plant expansion in a degraded grassland enclosure.

Filley, Timothy
Purdue University

The dynamics of soil organic matter cycling in intensively grazed semi-arid and arid grassland ecosystems is dramatically altered following encroachment of woody leguminous trees and shrubs, as nutrients become rapidly concentrated under the developing canopy and amplify a number of biogeochemical feedbacks that act to alter (SOM) stocks and establish biogeochemical legacy effects lasting many decades. This ecosystem shift has been documented in grasslands and savannas throughout the world and is controlled by a number of interacting factors including intensive grazing, suppression of fires, an altered nitrogen cycle, changes in atmospheric CO₂, and a changing climate. Woody legumes also have the capacity to stabilize soils, generating significant below and above ground organic matter input, and have, in fact, been intentionally planted in overgrazed regions undergoing desertification, such as in Inner Mongolia. In this presentation, controls on soil organic matter accumulation and exchange will be discussed in the context of a study in the Rio Grande Plains region of southern Texas where previous work has shown woody encroachment by leguminous *Prosopis glandulosa* increases soil C and N both absolutely and relative to soil microbial biomass, converts soil N to a more refractory form, increases soil lignin relative to carbohydrates and amino sugars, and progressively alters the specific activities of soil-bound enzymes targeted for C and N acquisition. Studies on the controls and effects of SOM accrual under such conditions are important for predicting ecosystems response to woody encroachment as well as how woody-legume introduction strategies alter soil organic matter dynamics.

Integrating climate change and other disturbances to assess vulnerability and restoration of grassland, shrubland and desert ecosystems.

Finch, Deborah
USDA Forest Service, Rocky Mountain Research Station

Recent research and species distribution modeling predict large changes in the distributions of vegetation types and plant species populations in the western interior of the United States in response to climate change. This presentation reviews existing climate models that predict species and vegetation

ORAL ABSTRACTS (CONT'D)

changes in the West, and it synthesizes knowledge about climate change impacts on native plants and animals of grasslands, shrublands and deserts of the interior American West. Species' responses depend not only on their physiological tolerances but also on their phenology, establishment properties, biotic interactions, and capacity to evolve and migrate. Current and likely responses of species and habitats to climate change are examined in relation to taxonomic group and ecoregion and with regard to other disturbances and stressors such as wildfire, invasive species, and human activities such as energy development and urban expansion. This synthesis ends with a review of management decision support needs and tools for assessing vulnerability of natural resources and conserving and restoring ecosystems that are or may be stressed or altered by climate change.

Assessing changes in functional trait diversity to guide restoration efforts in invaded grasslands

Firn, Jennifer

Queensland University of Technology

Restoration efforts to control invasive plants are often evaluated as successful when invader abundance declines and native abundance increases. However, in many cases the original native species are unknown, unavailable or unable to recruit. Increased native richness and abundance may then provide little indication of how ecosystems are functioning following management actions. Information on how different management actions influence function, is useful information for guiding future actions and developing. Numerous studies have shown leaf traits such as specific leaf area (SLA), leaf dry matter content (LDMC) and leaf nutrient content correlate with strategies used by plant communities to uptake resources and these strategies in turn influence ecosystem function. Here, I show how soft traits (easily measured) can be used to evaluate the outcomes of four different control strategies for an invasive grass, *Eragrostis curvula*, i.e. grazing (control), grazing/fertilizer addition, grazing exclusion, and grazing exclusion/fertilizer addition. I will also show how traits can be used to evaluate the quality of species assembling in response to restoration practice. Management actions in the short-term can change the suite of functional traits characterizing a plant community. Even if the original plant assemblage cannot be recovered, the community can be monitored to assess recovery of functional traits and management actions adjusted according to explicit restoration goals.

Quantifying existing and potential floodplain habitat for California's coho salmon

Fleenor, Adam; Matthew Cover

CSU Stan

The coho salmon (*Oncorhynchus kisutch*) Central California Coast evolutionary significant unit has declined from an estimated 50,000-125,000 adult returns to 500 spawning adults, and is at high risk for extinction. Lagunitas Creek (Marin County, CA) supports 10% of the remaining population. where all but a small reach has incised stream banks and disconnected floodplains. Most of the mainstem stream channel has incised and become disconnected from historic floodplains, and previous studies have identified juvenile overwintering habitat as a major limiting factor and the priority for restoration efforts. We used Light Detection and Ranging (LiDAR) data to compare the floodplain attributes in areas of Lagunitas Creek where coho juveniles are successfully overwintering and areas with poor smolt production. We also constructed a flood inundation model to identify and prioritize disconnected floodplain habitat for ongoing restoration. Good overwintering habitat is characterized by less incised channels with frequently inundated floodplains, as well as dense riparian vegetation with a diversity of structural elements. Opportunities for restoration of winter refugia include installing large woody debris (LWD) jams, levee removal, reconnecting palaeochannels, and riparian planting. An understanding of the geomorphic landscape attributes and vegetation structure on floodplains that support productive overwintering salmon habitat will contribute to a multiple-agency effort to save the last remaining wild coho on the California coast.

Artificial selection and breadth of genetic background affect switchgrass (*Panicum virgatum*) biomass but not biodiversity in experimental prairies

Flint, Shelby A.; Nicholas R. Jordan, Ruth G. Shaw

University of Minnesota

Successful restoration requires balancing establishment and over-dominance in restored populations. This balance may be affected by population-source characteristics including the intensity of artificial selection and the number of source populations used in developing restoration plant materials. Determining the relationship between these population-source characteristics and the establishment-dominance balance is of particular importance for switchgrass (*Panicum virgatum*). This native grass is commonly used in prairie restorations and is being developed as a biofuel feedstock. We performed a 3-year, multi-site common garden experiment with 11 commercial switchgrass strains, testing the extent to which artificial selection (cultivar, ecotype) and source-population number (one, multiple) affected (a) biodiversity in establishing prairies, (b) community productivity, and (c) switchgrass establishment, persistence, and productivity. We found no evidence that source-population characteristics affect community biodiversity or aboveground community biomass. However, artificial selection, source-population number, and site significantly affected the switchgrass portion of aboveground community biomass. These portions ranged from <1% (single-source cultivars and ecotypes, Waseca (MN) site) to 14.5% (single-source cultivars, St. Paul (MN) site). In contrast to these differences in productivity, source-population characteristics did not affect switchgrass establishment or persistence. These results suggest that (a) differential growth rather than mortality may be responsible for differences in productivity among source-populations of switchgrass, (b) artificially-selected switchgrass strains do not significantly reduce community productivity or biodiversity when seeded at the densities used, (c) which may be insufficient for establishment of switchgrass ecotypes in prairie restorations.

ORAL ABSTRACTS (CONT'D)

Catchment landscape restoration: seedling recruitments and soil organic carbon sequestration as measures of ecological restoration success

Florentine, Singarayer; Kristin Monie, Peter Dahlhaus, Tricia Wevill, Graeme Ambrose, Peter Gell, Martin Westbrooke
University of Ballarat

The last 50 years intensive human activities have altered ecosystems more extensively and rapidly than during any other comparable period. Human intervention is required to diminish further impact and enhance function in degraded ecosystems. Globally, restoration efforts attract a budget of over \$A1.6 trillion p.a. Australian government invests heavily in vegetation restoration projects but there is little evidence upon which to assess their success because funding applications or reports often do not require a performance assessment. To redress this problem, a landscape scale project was conducted in two major catchments in western Victoria, Australia. Revegetated riparian sites of various ages were compared with reference sites. It documented their biodiversity, vegetation structure and other ecological variables, particularly the associated avifauna, soil microorganisms, soil seed-bank and soil carbon. We surveyed farmers' attitudes to, and reasons for, revegetation to elucidate factors that influence landholders to carry out such work. Results show that 45 tree and shrub species of local provenance were successfully planted. Vegetation structure was well established by 4-8 years. Of the 129 species germinated from soil seed bank at restored, remnant and unrestored sites approximately half were weeds. Restored and remnant sites held 59 bird species, with higher diversities at 4-8 year old restored sites and remnant sites. Differences in the overall functional group composition (of all vascular plants) were highly significant among age classes. However, there was no clear trend in remnant composition with age. Divergence or deviation from the restoration trajectory highlighted potential barriers to be overcome.

Overlooked components of stream restoration design and assessment: Energy production and flow

Follstad Shah, Jennifer; Phaedra Budy, Nira Salant
Utah State University

The production and flow of energy through streams and adjacent riparian corridors are fundamental processes that support ecological integrity. Results from a meta-analysis of scientific literature published over the last decade show that assessment of stream restoration projects has increased but less than 15% of published assessments have focused on the production or flow of energy annually. We classified stream restoration projects into 14 categories. Twelve of these categories included assessment of energy production or flow, but at low frequency. Such assessment was most common for projects focused on in-stream habitat improvement. Primary through tertiary production was measured more commonly than catabolic processes or trophic transfer. Energy flow related parameters can provide valuable information that may alter restoration design or adaptive management decisions. Assessment frameworks for two types of energy flow exist (leaf litter breakdown and whole-stream metabolism). These frameworks have typically been used to assess system degradation but also could be used to assess restoration success in combination with structural attributes. However, use of these frameworks must take into account natural variability of the system to avoid erroneous conclusions regarding restoration success. A case study of existing and potential restoration strategies associated with a large, flow-regulated desert system, the San Rafael River, Utah will be used to illustrate these points.

Rehabilitation of the uMhlanga estuary, South Africa: Restoration of environmental flows

Forbes, Anthony; Nicolette Forbes, Bill Pfaff, John Harrison
Marine & Estuarine Research/University of Kwazulu Natal

A combination of steep catchment topography, rainfall patterns and a micro-tidal high energy coast with strong longshore sediment drift results in the majority of south-east African estuaries being small and seasonally closed off from the sea by sand bars. During such closure periods tidal effects are lost but the bar impounds any incoming flow and results in backflooding which may raise the water level well above that due to tidal forces during open periods. Present understanding indicates that these high water levels significantly increase the functional estuarine area but this has been historically disrupted by artificial breaching to protect flood plain developments. A similar situation arises when these small systems receive increased inputs from waste water treatment works where water is derived from other catchments. The use of these estuaries as conduits for waste water arises from adverse perceptions of marine outfalls and the cost of such structures. Despite treatment, the added waste water not only disrupts the natural breaching pattern but also contributes to eutrophication and periodic deoxygenation. The uMhlanga estuary north of the city of Durban is one such system which represents a significant attempt at rehabilitation as the waste water discharge is now being re-directed to the source catchment following environmental flow requirement study recommendations regarding the distribution of flows required by the estuary which would restore natural mouth dynamics and nutrient loading. Baseline physico-chemical and biological data from the early 1980's are available and these are being used to assess the effectiveness of the attempted rehabilitation.

Historical actions, new philosophies and the restoration of the St Lucia Estuarine System in the iSimangaliso World Heritage Site, KwaZulu-Natal, South Africa

Forbes, Nicolette T.; Bronwyn James, Andrew Zaloumis
Marine and Estuarine Research

The St Lucia System is the largest estuarine lake complex in South Africa contributing 80% of the estuarine area of the subtropical region and 60% nationally. Its unique size and biotic diversity in combination with surrounding habitats have earned it recognition under the RAMSAR convention and more recently World Heritage Status. Past activities influencing the system include a century of agricultural development in the floodplain of the

ORAL ABSTRACTS (CONT'D)

uMfolozi River, sixty years of mouth manipulation and the separation of the uMfolozi River from the St Lucia system for the past sixty years. These together with a sequence of below average rainfall years from 2002–2010 culminated in the closure of the mouth and the unprecedented drying up of the estuarine system. The isolation of the uMfolozi, mouth closure and shrinkage of St Lucia removed estuarine nursery function and resulted in the concomitant decline in the inshore shrimp fishery and disruption of the life cycles of estuarine dependent migrant fish. Increased understanding of estuarine dynamics in combination with a review of current scientific knowledge of the St Lucia system resulted in the development of the iSimangaliso Authority's new management strategy for restoration. This has been progressively implemented as part of the iSimangaliso GEF programme and culminated in the relinking of the uMfolozi River to the St Lucia system in July 2012. This action began the process aimed at the restoration of the 365 km² estuarine system. The systems response to the restorative management actions and current condition will be described.

The archaeology of traditional Maya farming

Ford, Anabel; Keith Clarke
UCSB

Traditional Maya farming, land use, and forest knowledge provide a basis for interpreting ancient settlement patterns and an appreciation of the time depth of these practices. Data on settlements of the Late Classic Period Maya reflect a continuum of past land use linked to the milpa-forest garden cycle. The densely settled areas of major and minor centers would have been intensive infield home gardens, other settled areas would be the extensive outfield milpa-forest gardens, and the unoccupied area the extractive zones. By exploring solutions past, a geographic predictive model of Maya settlement patterns reveals the efficacy of the milpa – forest garden cycle as a model of the ancient land use that co-created the Maya forest and forms a basis to restore the Maya forest garden for the future.

Water Works Park: Restoration and Design in the Urban Landscape

Ford, Gina; Kim Chapman
Sasaki

Water Works Park is comprised of 1,500 acres bisected by the Raccoon River and a 3-mile-long infiltration gallery, which is a major source of drinking water for Des Moines. In 2011, Des Moines Water Works, working in partnership with Iowa State University Department of Landscape Architecture, held international competition for proposals to integrate the ecological and social functions of the park and river into a unified landscape, inspire the community, and generate discussion about watershed issues. The competition also called for solutions for ecological and recreational challenges specific to Water Works Park. The competition was won by an interdisciplinary three-part team - Sasaki Associates (Watertown, MA), RDG Design (Des Moines, IA) and Applied Ecological Services (Minneapolis, MN). The winning plan imagines Water Works as a place of adventure and water experience that serves as entrée to a restored, easily accessible wilderness and beyond—to a river system, a watershed, and a new understanding of the role of everybody in the region's water story. The park becomes a re-imagined public space on the Raccoon River, where the dynamic floodplain, the engineered water systems, ecological restoration, and active recreation come together. Join Gina Ford (Sasaki) and Kim Chapman (Applied Ecological Services) as they discuss the collaborative design effort, the integration of ecology in the design, and the park's broader restoration narratives.

Transforming Forest Road Restoration by Integrating Lessons from a Decade of Adaptive Monitoring

Forestieri, David A.; Rebecca A. Lloyd, Cara Nelson
Big Spruce Restoration

The Nez Perce Tribe-Watershed Division (NPT) and the Nez Perce-Clearwater National Forest (NPCNF) collaboratively manage an innovative landscape-scale watershed restoration program in north central Idaho. The collaborative program is now entering its 16th year. Project work focuses on restoring watersheds heavily impacted by past forest management activities, with an emphasis on restoring failing forest roads. Since 1997, the partners have removed and restored over 600 miles of roads no longer needed for forest management. Early on, the NPT and NPCNF initiated a monitoring program designed as a feedback loop to evaluate whether road removal techniques successfully achieved restoration goals including mitigating erosion, restoring stream connectivity, and restoring native plant communities. After five years of monitoring, the program began to apply lessons learned and transitioned from using engineering approaches for sediment mitigation (stabilization) to an integrated ecological restoration approach (restoration). We evaluate how this change in approach influences ecological recovery. We established 24, 150 m linear transects across a restoration age gradient at 1, 5, and 10 years since road removal; we compare recovery gradients between stabilized roads and restored roads. Transect data includes vegetative density and percent cover and estimates of surface erosion. Preliminary results show that restored roads have lower incidence of surface erosion after only 1 year and an increase in cover of native vegetation on the road corridors and at stream adjacent sites. Results also suggest that a design focus on ecological restoration accelerates ecological recovery.

Understory Plant Response to Mastication Treatments in Forested Ecosystems of Colorado

Fornwalt, Paula J.; Michael A. Battaglia, Monique E. Rocca, Charles C. Rhoades
USDA Forest Service, Rocky Mountain Research Station

Forest mastication treatments – the disposal of woody biomass by chipping or shredding the material and broadcasting it on the forest floor – increasingly have been utilized by land managers in the last decade to restore forest structure and reduce the risk of catastrophic wildfire. Because mastication treatments are relatively novel and have no natural analog, their potential ecological impacts are poorly understood. Thus we initiated a study in 2007 to examine the effects of mastication on understory plants and other critical ecosystem components. We established 17 sites across Colorado,

ORAL ABSTRACTS (CONT'D)

with seven in lodgepole pine – dominated forests, five in ponderosa pine – dominated forests, and five in pinyon pine – juniper forests. Understory plant sampling at each site occurred in 2007 or 2008 (two to four years post-treatment), and again in 2012 (six to nine years post-treatment), along six 50-m transects located in both masticated and adjacent untreated stands. Data are currently being analyzed for each forest type to address the following questions about the short- and long-term impacts of mastication treatments on understory plants: (1) What are the impacts of mastication treatments on understory plant richness and cover? (2) Do mastication treatments influence understory plant composition? (3) Do mastication treatments favor exotic plant invasions? Our findings will allow managers, scientists, and others to improve their ability to anticipate short- and long-term understory dynamics following mastication treatments, and to determine if, when, and where additional activities are required to meet desired understory conditions in masticated areas.

Re-establishment of flower-visitor communities in restored areas of Atlantic Semi-deciduous Forest

Fragoso, Fabiana Palmeira; Luciano Palmieri, Elenice Mouro Varanda
Programa de Pós-Graduação em Entomologia, Universidade de São Paulo

Restoration of Atlantic Forest plays an essential role in maintaining biodiversity. In Southeastern Brazil – where this ecosystem is now scarcely distributed in few, small and isolated fragments – restored areas are usually established by planting tree seedlings. Animal pollination underpins reproduction of the majority of plants and this ecosystem function must be re-established in order to perpetuate restored forests. We investigated flower-visitor networks in six restored areas by recording flowering-plants (introduced and spontaneously regenerated), flower-visitors and their interactions bimonthly during a year. Three areas were implemented alongside natural habitats and three were located at least 1000 meters from forest patches. There were no differences in the metrics of flower-visitor networks between forest categories, although richness of plant and visitor communities was slightly higher at sites restored alongside remnants. The similarity of flower-visitor communities between all sites was correlated with the similarity of flowering plants between the same sites (Mantel $r = 0.64$, $p = 0.004$). Spontaneously regenerated herbs and shrubs represented about 60% of flowering-plant richness, and its similarity also correlated with the similarity of visitors ($r = 0.56$, $p = 0.04$). Our results indicate that at early stages of restoration, plant community richness and composition have a critical role in determining flower-visitor communities. The proportion of introduced/regenerated plant in each site seems to be more related to differences in practical management than to site distance to natural habitats. Restoration practitioners should consider this aspect when planning restoration with specific targets such as recovering pollinator-friendly environments in agricultural landscapes.

Avian protection program of a power delivery company (PHI)

Frank, Cristina A.
Pepco Holdings, Inc

Avian protection is a critical issue for electric power lines. When birds interact with electric utility infrastructure, the result can be bird fatalities and power outages due to damage to electrical facilities. These risks increase in the Delaware Estuary where large raptors and other breeding and migratory birds concentrate. While utility poles can benefit birds by providing perching and nesting opportunities, utility structures also pose a threat to birds through electrocutions or collisions. To minimize avian hazards from its overhead infrastructure, Pepco Holdings, Inc. (PHI), a power delivery company serving two million customers in NJ, DE, MD, VA and D.C. developed an Avian Protection Program. The goal of the program is to ensure compliance with federal and state regulations protecting birds, while improving system reliability and addressing avian risk. As part of the Avian Protection Program, PHI maintains and implements comprehensive utility-specific Avian Protection Plans which provide a strategic roadmap to protect and manage for avian issues into the changing future. They provide management and field personnel with regulatory compliance procedures, training programs for utility personnel, retrofits for identified risk and avian-friendly construction design standards. PHI's Avian Protection Program is collaborative in nature, pulling together government agencies, conservation partners and community leaders to focus on protection and restoration projects benefitting birds, other wildlife and local communities. We will present about the strategies, initiatives and accomplishments of PHI's program, demonstrating the company's commitment to balancing avian protection with its primary responsibility of providing safe, reliable and affordable energy to its customers.

Establishing compatible ground covers for hardwood forests after Appalachian coal mining

Franklin, Jennifer
Department of Forestry, Wildlife and Fisheries, University of Tennessee

Forest establishment can be challenging on severely disturbed sites such as reclaimed surface mines. Nutrient deficiency, sediment movement, planting stress and winter mortality are common causes of death in planted seedlings, and these factors are influenced by herbaceous ground cover. Reclaimed sites are typically seeded to reduce sedimentation, with fertilizer and lime applied along with the seed mix. On some sites a dense, herbaceous ground cover develops that competes with planted trees, while on other sites ground cover is more sparse and. Herbaceous plants covering less than 60% of the ground surface do not greatly hinder tree survival and growth, and in some cases appears to facilitate tree establishment. We have found that herbaceous species vary greatly in the competitive pressure they exert on tree seedlings. Interactions between roots of competing species may explain these differences, and the competition for water and nutrients appears to be greater than competition for light on young reforested sites in TN. However, short-term tree survival does not appear to predict long-term forest development. Tree-herbaceous interactions change as the community develops, and the persistence of planted ground covers may be an important factor influencing forest establishment. Ground cover seed mixtures for reforestation should contain annual, perennial and legume components that are regionally selected to create moderate early growth, and promote successional processes through the natural recruitment of native vegetation.

ORAL ABSTRACTS (CONT'D)

Challenges of applying carbon biosequestration funding for woodland restoration of agricultural land in south west Western Australia

Freudenberger, David; Rachel Standish, Michael Perring, Michael Rooney
Australian National University

Greening Australia established in 2008 a 250 ha planting of locally native woodland species as described by J. Jonson (2010). This planting was part-funded by a contract to deliver voluntary carbon credits that provided a planting budget of less than \$2000/ha. The aim was to re-establish a self-replicating semi-arid woodland consistent with the local soil heterogeneity. A diversity of woody species were planted by direct seeding and seedlings and have been annually monitored for survival and growth across 2,146 marked individuals found in 42 fixed plots (140 or 280 m² in size). On average, 32.7 ± 3.8 (SE) tree and shrub species were sown to each soil-landscape, but only an average of 10.9 ± 0.6 (SE) woody species have been recorded in each plot. Mortality of recruits from direct seeding was high during the first two years after sowing (Hallett et al submitted), but mortality post this period has been low (3.2 % mortality rate across all individuals during 2012). Growth has been patchy. By April 2012 total biomass varied between 0.42-25.71 t DM/ha (mean 6.11 t DM/ha). This variation was driven by high variation in woody stem densities (range: 321-8,642 stem/ha; mean: 2850 stems/ha) and variation in the presence of fast growing species. This highly degraded agricultural land has been set on a new trajectory with significant floristic diversity with high spatial heterogeneity. The large spatial variation in carbon sequestration rates poses challenges for carbon accounting.

Measuring progress towards an ecological restoration goal of recovering environmental naturalness

Froude, Victoria
Pacific Eco-Logic

This presentation discusses a new approach for measuring progress towards an ecological restoration goal of environmental naturalness. To successfully implement this goal in a particular environment or location it is necessary to determine appropriate reference conditions and how progress towards those reference conditions would be assessed. Recently developed quantitative methodology for measuring environmental naturalness and its change across New Zealand's terrestrial and aquatic coastal environments (QINCCE), uses a reference condition of "present potential natural state" (PPNS). PPNS is what would be expected if humans and the tools and the alien species they brought with them had not arrived in New Zealand and disturbed the natural environment, but natural processes had continued. This concept is particularly useful for environments with high levels of natural disturbance. It can be used for biological cover, fauna, geomorphology, hydrology and related attributes. Measuring progress towards a PPNS reference condition is explored in relation to several New Zealand ecological restoration projects: an area of formerly degraded New Zealand near-shore open coast where human extraction and disturbances have been prohibited since 1975; and a programme to restore a drained alluvial plain currently dominated by alien plant species to the PPNS of mature lowland indigenous swamp forest. The presentation concludes with an exploration of potential uses of PPNS (or an equivalent) beyond New Zealand to locations with a longer history of human settlement where it may be more difficult to distinguish between historical human impacts and natural disturbance.

Forest ecosystem development in post mining sites after reclamation and during natural succession

Frouz, Jan
Institute for environmental studies, Charles University

Mining, and surface mining in particular, causes severe disturbance of ecosystem. Here we compared development of soil and vegetation in sites reclaimed by planting alder tress (*Alnus glutinosa* and *Alnus incana*) and sites overgrown by spontaneous succession (dominated by *Salix caprea*, *Populus tremula* and *Betula pendula*) on post mining sites near Sokolov Czech Republic. Study of historical aerial photographs show that within 20 years, 30-90% of the area can be covered by woody vegetation on heaped sites are left untouched, in sites leveled by earthmoving machinery grass cover develops and woody establishment is low. Comparing woody biomass on reclaimed sites and sites established by natural succession do not show significant differences in woody biomass and soil carbon, unreclaimed sites show lower value in first 15-20 years then differences disappear. Reclaimed alder plantation have faster development of A soil horizon, higher moisture and higher water holding capacity, but wilting point increase as well and consequently water availability is comparable in both reclaimed and unreclaimed sites. Unreclaimed sites show higher diversity of understory vegetation than reclaimed alder plantation. Establishment of latter succession woody species (*Fagus sylvatica* and *Quercus robur*) is more successful in unreclaimed sites than in reclaimed ones. Results show that incorporation of unreclaimed sites with promising development in reclamation schema may increase ecosystem services provided by post mining landscape.

Selection of native tree species to enrich tropical living fences as restoration strategy: an ecological and socio-economic perspective

Fuentealba, Beatriz; Miguel Martínez Ramos
CIEco - UNAM

Enrichment of tropical living fences could be an important strategy to restore ecosystem functions in livestock systems and increase biodiversity in human-modified tropical landscapes; however, little research has explored ways to identify target native tree species to this enrichment. This study examines selection of native tree species, including the cost-benefit trade-off, and conditions to establish these species in tropical living fences. We selected seven native tree species with restoration and cultural value. Seedlings of selected species were grown in greenhouse and they were transplanted at three tropical livestock ranches located at Hueytamalco (central-east of Mexico) with different access for cattle (none/medium/high). Performance

ORAL ABSTRACTS (CONT'D)

(survival and growth) and damage were measured in all seedlings during one year, and costs associated with propagation, transplantation and protection of seedlings were calculated per species. An index was developed to integrate ecological and economic measures and identify species with the best performance at lower costs. Our results showed that damage, caused mainly by cattle, reduced the performance of transplanted seedlings. All selected species exhibited high performance in area without cattle access. Propagation costs were the most expensive for all species. The cost-benefit index indicated that *Dendropanax arboreus* was the best species at site with moderate cattle activity, and *Trema micrantha* and *Sauraria scabrida* at site with high cattle activity. *Heliocarpus appendiculatus* was not recommended to transplant in presence of cattle. Criteria to select species and cost-benefit index could be applied in other restoration and agroforestry context.

Restoration and private landowners: A case study of the rehabilitation of riparian habitat in the Kenai Keys on the Kenai River, Alaska

Fuller, Heather E.

USFWS

Approximately 73% of land in the United States is privately owned and the majority of our fish and wildlife resources occur on those lands. Because of this, it has become increasingly important to facilitate private landowner-centered and results-oriented programs to protect and enhance natural resources. Partnerships are critical to the success of these programs. Since 1995, the United States Fish and Wildlife Service (USFWS) has worked cooperatively with private landowners and other agencies to fund over 500 habitat restoration and protection projects on the Kenai Peninsula. This program partners with private landowners to conduct voluntary habitat restoration projects primarily on the Kenai River. These projects attempt to provide improved habitat for fish and wildlife by rehabilitating human impacted and eroding shorelines using bioengineered techniques simulating natural banks and native vegetation. Habitat rehabilitation and protection is necessary due to land use activities that have seriously impacted fish habitat and bank stability. The Kenai Keys, an area we have focused rehabilitation efforts, has a high density of human development. In order to mitigate the effects of erosion on their banks, landowners used varied methods ranging from bulkheads, gabions, and rip-rap, to placing old cars in their banks. Collaborating with private landowners offers a unique set of challenges. Working on private lands means establishing or reestablishing trust in government, faith in the techniques used, and landowner education. Through an iterative communication process and landowner education, we removed structures that were detrimental to fish habitat and rehabilitated the bank on five different landowners' properties.

A regional training approach to capacity building for ecological restoration professionals

Galatowitsch, Susan M.; Julia Bohnen

University of Minnesota

Ecological restoration is increasingly relied on as a conservation strategy even though project failure rates in many regions remain high. Lack of skill and knowledge can contribute to project failure, especially where opportunities for restoration are high relative to the number of experienced and competent professionals. Practical restoration training has been limited to what is gained on-the-job, often through trial-and-error. To address this limitation in Minnesota (US), we developed training opportunities for practicing professionals. Because high-quality training opportunities need to reach a large, dispersed population, our approach is a combination of online and field-based instruction. Five online courses (25 hours each) offered through the University of Minnesota were developed in partnership with state agencies responsible for restoration programs: 1) site assessment and goal setting, 2) designing and using native seed mixes, 3) native planting design and implementation, 4) managing restored ecosystems, and 5) monitoring ecological restorations. As part of each course, participants use virtual sites with interactive maps and resources that provide evidence typically relied on for real-world decision-making. Participants successfully completing the online courses are eligible for field training sessions that teach skills requiring hands-on experience to master. These courses are taught at Minnesota State Parks by experienced restoration professionals using a standard curriculum. The elements of the curriculum focus on widely used but often misapplied techniques. Following the basic courses, professionals can stay current through webinars, an online problem-solving forum organized by ecosystem and region, and annual workshops that have been ongoing over the past three years.

Economic and Cultural Benefits of Ecosystem Restoration in the Lower Fox River/Green Bay, Wisconsin

Galbraith; Betsy

U.S. Fish and Wildlife Service

The Lower Fox River/Green Bay Natural Resource Damage Assessment (NRDA) has contributed to landscape-scale restoration of the ecosystem in northeast Wisconsin, USA, leading to economic and cultural benefits. Utilizing settlement funds from Responsible Parties and leveraging other partner funds, the federal, state and tribal Trustees and their partners have implemented 68 restoration projects to compensate for PCB-related injuries to natural and cultural resources. Habitat preservation and restoration, fishery resource enhancement, and natural resource-based public use projects demonstrate the wide variety of restoration projects that have been implemented. Many of these projects also provide cultural value to the Indian Tribes of the area, whose practices were affected by the release of PCBs. The economic benefits of restoration include stimulating the local economy, creating jobs, and providing environmental benefits to local communities. Various project examples will be provided to explore the economic, cultural, and environmental benefits of restoration projects implemented by the Trustees and their partners. The Trustees currently include the State of Wisconsin, the Menominee Indian Tribe of Wisconsin, the Oneida Tribe of Indians of Wisconsin, and the U.S. Department of the Interior (represented by the U.S. Fish & Wildlife Service).

ORAL ABSTRACTS (CONT'D)

Two strategies for the rehabilitation of riparian buffers in an Andean landscape dominated by exotic pastures

Galindo Canabal, Víctor Andres; Zoraida Calle Díaz, Inge Armbrecht

Fundación CIPAV

Riparian buffers are functionally important in agricultural landscapes because they intercept sediment, nutrients and pesticides, provide habitat for wildlife, reduce erosion and connect natural ecosystem fragments. The historic demand for land in the Central Andes of Colombia promoted the large-scale replacement of riparian forests with exotic grasses and agricultural crops. With the aim of developing methods for restoring riparian buffers, we evaluated the initial changes in succession following the high-density planting of two pioneer shrubs, *Tithonia diversifolia* and *Piper auritum*, and their effects on i) ground cover and biomass of grasses, ii) the survival and growth of six native tree species and iii) the microclimate underneath the shrubs. Over a 15 month period, *P. auritum* covered only 4.4% of the planted area, which was insufficient to inhibit the growth of competitive grasses. In contrast, *T. diversifolia* covered 81% of the area, henceforth limiting the growth of grasses such as *Pennisetum purpureum*, *Paspalum paniculatum* and *Cynodon plectostachyus*, by intercepting 90% of the photosynthetically active radiation (PAR). However, the low PAR resulted in a low diversity of plant regeneration under *T. diversifolia* compared with *P. auritum* and the control (only grasses). The dense cover of *T. diversifolia* facilitated the survival of five of the six native trees, but inhibited the growth of two open-gap tree species. This study suggests that nurse shrubs such as *T. diversifolia* may facilitate the establishment and survival of native trees, but should be pruned periodically to increase light availability and promote tree recruitment and natural regeneration.

Post-fire seed drilling effects on soil water infiltration in the Great Basin

Ganguli, Amy C.; Beth A. Newingham

New Mexico State University

Seed drills used on rangelands are designed to handle rough terrain and are used to create desirable seedbed characteristics for perennial vegetation re-establishment. With increasing emphasis on utilizing diverse seed mixes in restoration efforts, modifications have been made to drills to improve seedbed conditions and seed placement for establishment success. We investigated how physical modification of seedbed properties by two seed drills (rangeland and minimum-till) affects infiltration properties after wildfire at two sites in Utah and Idaho. We measured Infiltration with a mini-disk infiltrometer (2-cm suction) in unburned, burned, and burned plus drilled plots, measurements were also taken in furrows and areas for broadcast seed. At the Utah site, seedbed modification reduced infiltration in broadcast areas for the rangeland drill plots. In contrast, seedbed modification at the Idaho site had no effect on broadcast areas but increased infiltration in the furrows for both type of drills. However, furrows in the rangeland plots had 35% greater infiltration rates than the minimum-till furrows at the Idaho site. At each location infiltration in the interspaces of the sagebrush canopy on non-burned plots were similar to burned controls, however, infiltration was considerably reduced under sagebrush canopy presumably due to subcritical water repellency. Differential effects of the seed drills on our sites are likely due to a combination of soil texture, soil chemistry, and soil erosion/deposition. Improved understanding of physical modifications of seed beds on hydrological properties could facilitate planning to promote seedling establishment and survival.

Relative impacts of climate change and human activities on alpine grassland ecosystems

Gao, Qingzhu; Yunfan Wan

Chinese Academy of Agricultural Sciences

Climate change and human activities affect ecosystems simultaneously. To distinguish their respective roles, we analyzed the relative impacts of climate change and human activities on alpine grasslands in Northern Tibet, China. The changes and their causes were determined using Normalized Difference Vegetation Index (NDVI) and climatic and socio-economic factors at different intensities of human activity within sampling plots (including depopulated land without human influences) from 1981 to 2006. Mann-Kendall test (MK) was used to test the trend of NDVI change and Pearson correlation analyses was utilized in multiple regressions between NDVI and the influencing factors. Abrupt changes of NDVI occurred at different times in plots that differed in human activity. Regional climate change has produced more negative than positive changes on alpine grasslands. The alpine grasslands significantly benefited and ecological restoration was found under a moderate intensity of grazing activities. With the increased human activity, negative changes in NDVI were pervasive in Northern Tibet.

Mobile Eco-Studio: Restoring Vacant Urban Space in the Sonoran Desert utilizing Social Art

Garcia, Matthew

Kansas State University

Over the past 100 years American Western desert regions have witnessed massive population growth resulting in a transplanting of native desert ecology. This transplantation has left urban residents disconnected and unaware of local desert agricultural and culinary practices. This presentation will explore a Phoenix-based art intervention, Mobile Eco-Studio, a production of desert ArtLAB. The Mobile ECO-STUDIO acts as a portable native ecology site where cacti, desert seeds, oral histories and embodied epistemologies are shared. The Mobile ECO-STUDIO conducts workshops on traditional Sonoran desert food practice reacquainting residents with the growth, preparation and tasting of cactus based foods, specifically nopalitos. The Mobile Eco-Studio is an initiative to restore urban vacant space with native desert ecology in the Phoenix metropolitan area, spreading the desertArtLAB message of ecological awareness, food justice, and action. This multimedia performance and social art project seeks to question what we forfeit when our relationship with native ecology is sacrificed for a more desired manufactured environment. The project utilizes bicycles, urban space, and cactus as tools to engage residents to reclaim desert ecology through ecological intervention. The project informs a discourse and critique of Phoenix's urban

ORAL ABSTRACTS (CONT'D)

landscape, while challenging residents to consider how native ecology can inform identity, progress and the sustainability of our communities. desert ArtLAB is a Phoenix-based initiative dedicated to a social art practice exploring connections between ecology, culture and community.

Strengthening the capacity for integrating conservation and restoration objectives into agricultural landscapes: Case studies and lessons learned from Colombia and Panama

Garen, Eva; Alicia Calle, Cecilia Del Cid-Liccardi, Jacob Slusser
Environmental Leadership & Training Initiative (ELTI)

While the benefits of integrating conservation and restoration objectives into agricultural landscapes are gaining recognition, there are few field based training opportunities for landholders and practitioners on the theory and practice of this approach in different contexts and at varying scales. The Environmental Leadership & Training Initiative (ELTI) provides decision makers with the knowledge, tools, skills and networking opportunities to conserve and restore tropical forests in human modified landscapes. In Colombia, ELTI partners with the Center for Research in Sustainable Agricultural Production Systems (CIPAV) to train the technical staff of the Mainstreaming Biodiversity in Colombian Cattle Ranching project (GCS), a first attempt at promoting sustainable ranching practices at a national scale, on the theory, practice and sustainability of large-scale restoration of connectivity corridors. Several alumni of these trainings are applying what they learned in practice and plans to scale up the training are underway. In Panama, ELTI provided field-based training to landholders in the Azuero Peninsula on silvopastoral systems and restoration strategies in productive landscapes and supported the creation of the region's first community-based silvopastoral and agroforestry cooperative (APASPE). ELTI provides on-going support to APASPE on establishing and managing silvopastoral demonstration sites and is developing a permanent training site in the region that will cover themes including ecosystem services and forest ecology and restoration. Continued efforts are needed to scale up and replicate this kind of field-based training and follow up support to ensure the long-term integration of forest ecology and restoration principles into the productive aspects of agricultural landscapes.

Wetland restoration in the context of mitigation due to mountain recreational development: relevance of short-term success criteria

Gaucherand, Stephanie Albertine; David J. Cooper, Christopher Hazen
Irstea

The enforcement of rules protecting wetlands and the obligation to compensate impacted wetlands has lead to many restoration programs. However, these programs rarely utilize measurable success criteria or long-term monitoring. The publication of feedbacks for restoration projects monitored for more than 10 years remains rare. This situation makes it difficult to predict the trajectories of restored wetlands. Since 2000 though, monitoring restored wetlands and the use of success criteria have become an obligation. This research investigated 13 wetland restoration projects implemented 12 to 15 years ago on the Telluride Ski and Golf Course, near Telluride, Colorado. Filled illegally to build a golf course these wetlands were restored between 1998 and 2001 as part of a compensation for damage to 28 hectares of wetlands. We evaluated how short-term success criteria, measured over the first 5 years after restoration, represent longer-term trajectories for the development of wetland ecosystems. This program restored 3 different wetland types (fens, wet meadows, willow riparian) covering a total of 14 hectares at 2700 and 3200 meters elevation. The success criteria included hydrology (weekly water table depth relative to undisturbed reference sites), plant cover (survival and growth of transplanted species, occurrence of invasive species) and soil erosion compared to reference wetlands. Hydrologic measurements in over 300 monitoring wells provided excellent information on the restoration trajectory. Herbaceous plantings had high survival and formed a persistent perennial ground cover. Success criteria for *Salix* provided a good indicator of the long-term formation of a dense and tall woody plant cover.

Community-based management and restoration of *Mauritia flexuosa* palm swamps (aguajales) in the Peruvian Amazon

Gilmore, Michael P.; Christa M. Horn, Bryan A. Endress
George Mason University

Throughout the Peruvian Amazon, fruit from the palm *Mauritia flexuosa* (aguaje) is harvested for commercial and subsistence purposes. The vast majority of this fruit is harvested by felling and killing adult female aguaje trees in the forest resulting in serious over-exploitation and degradation of naturally occurring *M. flexuosa* palm swamps (aguajales). Like many communities, the Maijuna, an indigenous group in the region, are interested in halting destructive harvest of *M. flexuosa* and developing aguaje management and restoration plans. In order to develop such plans in a manner that incorporates and accounts for the multiple cultural and economic needs of the Maijuna people, we used interdisciplinary methods to understand past and present aguajal use and its impacts. Despite a shift in the manner and intensity of aguaje fruit harvest beginning in the early 1990's, the Maijuna maintain a complex relationship with aguajales and its numerous resources. Thus the Maijuna are concerned not only about how destructive harvesting has affected the future commercial harvest of aguaje but also about its effects on game animals given the importance of hunting to Maijuna subsistence, income generation, and cultural identity. Ongoing community-based initiatives targeting the management and restoration of aguaje and aguajales in Maijuna lands will be detailed, including training people how to climb instead of cut aguaje and incorporating aguaje into agroforestry systems. Lessons learned from this project will be explored providing insights into community-based resource management and restoration projects in general.

ORAL ABSTRACTS (CONT'D)

Perceptions of nearby nature and the adoption of ecologically-minded landscaping practices by Chicago residents

Gobster, Paul

Northern Research Station

Urban natural areas have traditionally been considered islands of diversity, but increasingly natural areas managers are coming to understand that the protection and restoration of natural values depends upon how properties surrounding their sites are managed. This presentation examines homeowner perceptions and values of urban nature, particularly with respect to how preferences, cultural norms and ecological ethics might influence the landscaping practices of those living near natural areas. New data from a Chicago area study is presented in the context of previous studies conducted in the Midwestern U.S. and other locations.

Ecological and ethnobotanical knowledge of tree species in Northern Senegal: an action research approach for the Great Green Wall for the Sahara and Sahel Initiative

Goffner, Deborah; Khoudia Niang, Moustapha Bassimbé Sagna, Thierno Ibrahima Wade, Ousmane Ndiaye, Papa Sarr, Axel Ducourneau, Aliou Guissé, Gilles Boetsch

Centre National de la Recherche Scientifique

In response to increasing desertification in the Sahel, in 2007 eleven African nations in the Sahel region signed an unprecedented agreement: the Great Green Wall for the Sahara and the Sahel Initiative (GGWSSI). Far beyond a giant “wall of trees”, the vision is more a series of cross-sectorial actions to address issues affecting the lives of people in the Sahelo-Saharan regions. Determining the impact of GGWSSI-triggered shifts on these social-ecological systems requires expertise in scientific disciplines ranging from biological and environmental sciences to social and health sciences. Toward this end, The French National Centre for Scientific Research (CNRS) created the GGWSSI Human-Environment Observatory, an interdisciplinary “research space” designed to facilitate exchange amongst GGWSSI researchers. The OHM funds several small-scale research projects annually that fall into four categories: biodiversity, water and soils, social systems, and health. I will focus my presentation on a project that aims to improve tree biodiversity along the GGWSSI. As a first step, we revisited tree species availability and performed ethnobotanical surveys with local populations in the Ferlo region of northern Senegal where GGWSSI tree planting is currently underway. A “short list” of highly useful, low abundance indigenous tree species was established. In collaboration with the Senegalese GGWSSI National Agency, we are currently setting up field trials and testing parameters (seed provenance, improved water use efficiency) to determine whether these species can be realistically adapted to high throughput GGWSSI planting activities, and the potential ecological and human benefits associated with their reintroduction.

Establishing a long-term lake and water quality monitoring program for Lake Cocibolca / Nicaragua, Nicaragua and Costa Rica, Central America.

Goggin, Patrick O.; Victor Cedeno, Daniel Ingram, Juan Francisco Rodriguez, Ronald Blandon, Eric Olson

University of Wisconsin-Stevens Point

Lake Cocibolca/Nicaragua is the largest freshwater lake in Central America and one of the largest in the Americas. 83% of the Lake Nicaragua watershed is in Nicaragua and 17% is in Costa Rica. Thirty-two municipalities are located on the Nicaraguan side of the watershed and ten on the Costa Rican side. The Lake Nicaragua watershed flows through at least eight distinct terrestrial ecosystems. Regional studies carried out between Central Americans and assorted international partners has underscored the freshwater importance of the Lake Nicaragua watershed; it is vital to meeting the future development needs of the semiarid Pacific slope of Central America, the regions most populated area. Current threats to the watershed include agricultural chemical and excess nutrient pollution, sedimentation, loss of habitat and biological diversity, invasive species, and unsound human development activities. This project seeks to begin establishing a social capacity and private-public institutional infrastructure for achieving long-term water quality monitoring of Lake Nicaragua and its watershed. Short-term project goals include establishing three pilot water quality monitoring stations in Granada, Mayales, and Cardenas modeled after citizen volunteer monitoring programs. Another near-term goal is laying the groundwork for a new Lake Nicaragua Environmental Observatory which will conduct educational outreach and research that engages local citizens, water managers, and other lake enthusiasts. Long-term goals include strengthening Central American water governance mechanisms through international partnerships and enhancing water quality and habitat conditions within the watershed through baseline monitoring data. Examples of how this project affects restoration efforts watershed-wide will be highlighted as well.

Symposium conclusion: Looking ahead to more successful and effective shoreland rehabilitation projects in the Midwest and beyond.

Goggin, Patrick O.

University of Wisconsin-Stevens Point

For many of us, lakeshores represent the sweep of one's heart, a place filled with memories of catching fish, watching frogs, and whiling away the sweet summer days. However, during the past few decades especially, domestication of Midwest lakeshore habitats has altered the character of these shores in damaging ways. The 2007 Environmental Protection Agency's National Lakes Assessment, in tandem with decades of other lake research from the Midwest begun in the 1990's and going on through to today, highlights the loss of habitat as the number one stressor of lakes in the region. But do not despair, change is afoot! Shoreline property owners are returning their shorelands to an increasingly more natural state through assorted lakeshore

ORAL ABSTRACTS (CONT'D)

restoration projects. These Midwestern shoreland rehabilitation projects have come in all shapes and sizes. They range from minimal efforts that let the lakeshore restore naturally to more sophisticated measures that involve significant planning, bioengineering or other erosion control treatments, and installation of substantial native plant material. Current best management practices and time-tested themes for effective lakeshore rehabilitation projects will be shared. Lessons learned from twenty years of experience in the Midwest will be communicated. Effective approaches transferable to other lake enthusiasts interested in practicing this emerging art and science will be offered. Reflections on the past and directions for the future that can solidify and improve this form of intelligent tinkering will be discussed. An open exchange of ideas and thoughts related to challenges for the future will be facilitated.

Intraspecific variation of invader impacts: Do invasive lineages differ in their competitive ability? Investigating the exotic *Aegilops triuncialis* in California grasslands

Gomola, Courtney; John McKay, Erin Espeland

Colorado State University

The competitive effects of invasive species are widely recognized as a hindrance to restoration efforts in myriad habitats across the globe. Consequently many studies have investigated the competitive abilities of invasive species with heterospecific competitors in the introduced range. However, little work has been done comparing intraspecific variation of invasive species regarding these impacts. As invasions are often characterized by multiple introductions in the invaded range, more work must be done to investigate whether the degree of these impacts are ubiquitous across genotypes. *Aegilops triuncialis*, barbed goatgrass, offers an excellent opportunity to study both competitive effects and intraspecific variation. A selfing, annual, exotic grass, *Ae. triuncialis* is currently invading arid and semi-arid grasslands throughout Northern California, where it forms dense monocultures that reduce biodiversity and outcompete native species upon establishment. There are currently only 3 invasive lineages invading these grasslands, each occupying discrete areas throughout California. This study investigates the two most tenacious lineages, and whether they differ in their competitive ability against annual and perennial grasses found in California grasslands. The implications of these findings could inform management decisions depending on the lineage that inhabits the managed area, and whether certain grasslands species are better suited to outcompete this troublesome invader. Knowing which species confer the greatest amount of competition for each specific invasive genotype will allow land managers to create more individualized and targeted restoration efforts for their land.

Designing and implementing restoration as strategy to reduce vulnerability to climate change in Central Sierra Madre Oriental

González, Yazmín; Fernando Camacho, Xochitl Cantellano, Alejandro von Bertrab, Andrew Rhodes, Mariana Bellot

GIZ MEXICO

“Climate Change and Protected Area Management“ (01.2011-11.2014), commissioned by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), is implemented together with the National Commission on Protected Areas (CONANP) of Mexico’s federal government in the central region of the Sierra Madre Oriental. This region is considered a biodiversity hotspot and hosts a wide variety of forest and wetland ecosystems. There are several protected areas in the region with which the German Development Cooperation (GIZ) is working with CONANP to ensure that protected areas integrate climate change as a key element in their strategies, management plans and concrete actions that contribute to climate change adaptation and mitigation as well as to nature conservation. One of the activities carried out in the onset of the project is a multidisciplinary vulnerability analysis to climate change and other factors (such as land use change, ecosystem degradation, among others) of ecosystems and local rural populations. Based on the findings, a catalogue of adaptation and mitigation measures and various practical tools for project implementation have been developed in order to assist the GIZ and CONANP in working with local rural communities and municipalities in planning and implementing measures. Key themes addressed in the measures include the promotion and implementation of ecological restoration as a cost effective activities to reduce vulnerability. In 2013 GIZ and CONANP implement the restoration of high diversity cloud forest together with local populations, thus insuring that various perspectives are included in project designing and promoting capacity development.

Drivers of success in 53 cutover bogs restored by a moss layer transfer technique

Gonzalez Sargas, Eduardo; Line Rochefort

Peatland Ecology Research Group, Université Laval

The moss layer transfer technique is a restoration method that has been applied to peat-extracted bogs of North America since the 1990s. In this work, the influence of hydrological, peat physicochemical, meteorological, management and landscape factors on the vegetation composition of bogs restored by this peat moss reintroduction technique was assessed, drawing upon data from a unique long-term monitoring program covering 53 restoration projects across eastern Canada. Cutover bogs ranged from 3 to 15 years after restoration and included 246 permanent plots where plant composition was surveyed every two years. Redundancy analyses showed that successful restoration defined by the dominance of a *Sphagnum* carpet (54% of all plots at the end of the survey) was mainly associated to an effective blockage of the former secondary drainage network within the restored sector, while failure (plots dominated by bare peat, 24% of all plots) occurred more often after a hot summer following project implementation and at a higher proportion of the surrounding lands being peat-extracted. Management decisions such as the season when restoration work was executed also had a great influence on restoration outcomes. For example, restoring in spring increased the likelihood of falling into an alternative successional trajectory characterized by a dominance of the pioneer moss *Polytrichum strictum* (22% of all plots). However, a tendency towards *Sphagnum* colonization and development over time was observed in practically all plots. These are promising results for the effectiveness of the moss layer transfer as a bog restoration method that will inform future restoration efforts.

ORAL ABSTRACTS (CONT'D)

Factors influencing bee communities on reclaimed mine and their response to restoration

Goodell, Karen

The Ohio State University

Reclaimed mined lands could promote bee diversity if managed for bee habitat. Although native plants and trees are scarce, reclamation seed mixtures often include legume species that provide resources for bees. Native flower richness may limit bee richness, but the paucity of woody nesting substrate may be more limiting. I report on an observational and experimental study examining the influence of floral and nesting resources on bee communities on a reclaimed coal surface mine. I compared bee abundance and richness to natural variation in floral resources and nest substrate. I experimentally augmented nesting substrate for wood-nesting bees. I sampled foraging bees, flowers, and nesting substrates over two years. Although floral richness significantly predicted bee richness, nesting substrate variables were more important in predicting bee richness and abundance. The addition of nest substrate slightly, but not significantly, increased twig-nesting bee abundance. One species dominated the nest blocks, which may explain the weak response for the twig-nesting bee community. The importance of nesting resources suggests that development of pollinator communities in prairie restoration plots on reclaimed mine may depend on proximity to forests and woodlands that provide woody nest substrate. Support for this hypothesis was found using experimental restoration plots of prairie plants, where bee richness was halved 400 m from forest edge. This pattern applied to wood-nesting bees and early spring bees, the most abundant of which was a ground-nester that specializes on a forest understory plant. This result suggests the additional influence of spring floral resources in the forest understory.

The compatibility of farm income generation with ecological restoration

Gossman, David

Hidden Bluffs Farm

Hidden Bluffs Farm is 670 acres of non-glaciated diverse habitat and microclimes on the southern edge of the Driftless Zone in northern Jackson County, Iowa. Aerial photos taken in the 1930s reveal cropped acres on steep hillsides, little in the way of remaining trees and ground heavily grazed by cattle. Since then, initially as marginal ground was no longer used for crops and pasture, and more recently as purposeful ecological restoration proceeded over the last 19 years, the farm has been transformed into a model of how modern farming and farm income production is not incompatible with ecological restoration. An overview of farming, logging and restoration practices will be presented with a focus on how this is done in different and sometimes ecologically sensitive areas of the farm. During the past 18 years there has also been a special focus on the development of educational opportunities both for students and the property owner. The ultimate question for the owner is how this effort can be leveraged into the broader context of responsible private ownership and management of ecologically sensitive property and where that fits into the global perspective.

Increasing prescribed fire capacity across the Longleaf pine landscape

Gottlieb, Sara; Troy Ettel

The Nature Conservancy

The Nature Conservancy recently developed a Plan to identify our unique niche in the Longleaf landscape and define our role in implementing the Range-Wide Conservation Plan for Longleaf Pine. Among other things, the Conservancy will build on its history as a leader in prescribed fire management. Over the past decade, we responded to demand for prescribed fire for restoration, building fire crews in all nine states while adopting federal standards that allow us to burn cooperatively with federal agencies. Although 51% of prescribed fire conducted in the United States occurs in the Southeast (~6.5 million acres annually) there is demand to scale fire operations up, despite constricting federal and state budgets. In recognition of the limited capacity for our partners to expand the existing model and build more fire crews using public funds, the Conservancy is working on new models that will export expertise with fire, engage new partners, and expand opportunities for application of fire within existing partnerships. Part of this strategy involves targeting underserved and under-engaged groups in communities within significant longleaf pine landscapes to participate in fire management. In doing so, the Conservancy hopes to create pools of trained fire practitioners to serve on local fire crews, and also for the private sector to take advantage of contract opportunities to execute prescribed fire. TNC is working with partners including the National Wild Turkey Federation and USFS to use funds generated from timber sales on national forest to pay for longleaf restoration costs that include prescribed fire.

Ants as environmental indicators. What do the various taxonomic levels tell us?

Gove, Aaron D.

Astron Environmental Services

To efficiently assess habitat restoration, subsets of taxa are often employed as environmental indicators. Taxonomic minimalism or higher-taxon surrogacy is often advocated where resources are limited. The ideal indicator of post-disturbance succession would be one which is sensitive to disturbance, yet insensitive to other environmental variation, such as those associated with different habitats, climate, or season. I tested the ability of ant species, genus, sub-family, and functional group to respond to anthropogenic disturbance, while remaining insensitive to natural contrasts in habitat type and seasonal variation. I used data from a range of natural and disturbed sites of the seasonally dry tropics of Mexico and tested for multivariate correlations between the ant assemblage matrices and habitat types, disturbance level and season. All higher-level responses were correlated with the species level response. No classification was able to distinguish the effects of disturbance while remaining insensitive to differences in habitat type, but the functional group classification was more sensitive to the contrast in habitats than disturbance and was unable to distinguish pasture from natural grassland. Subfamily was the only classification that was insensitive to seasonal variation. As all taxonomic classifications are equally sensitive to habitat disturbance and to habitat type, it appears possible to apply taxonomic minimalism when examining successional gradients. Subfamilies have the added

ORAL ABSTRACTS (CONT'D)

advantage of being insensitive to season - a useful trait in changing climates. Functional groups may be of more utility if divided into 'response groups' defined by responses to restoration, and 'functional groups' related directly to ecosystem functions.

Bloodroot (*Sanguinaria canadensis*) as a deterrent to garlic mustard (*Alliaria petiolata*) invasion in deciduous forests

Govers, Gwyneth L.; M. Alex Smith, Stephen D. Murphy
University of Waterloo

The invasion of garlic mustard (*Alliaria petiolata* (M. Bieb.) Cavara & Grande) has been devastating to the understory species of deciduous forests of eastern North America due to its chemical suppression of mycorrhizal fungi symbiosis. Following a previous study suggesting that high densities of the spring ephemeral bloodroot (*Sanguinaria canadensis* L.) are able to inhibit the nearby establishment of garlic mustard, further investigation was commenced as to the viability of its use in management. A seed germination bioassay was conducted, exposing garlic mustard seeds to sanguinarine, the predominant root exudate of bloodroot, to determine the rate of germination suppression. The alteration of the ant community by garlic mustard is also an important consideration if self-sustaining deterrence is to be achieved as bloodroot seeds are ant dispersed. Four deciduous forests in the Waterloo-Guelph region were used for field study - two fragmented, urban woodlots and two larger, semi-rural protected areas; sampling sites containing bloodroot alone were designated as 'control' while those also including garlic mustard were designated as 'invaded'. Using pitfall traps and Winkler litter extraction, it was found that ant species richness and diversity were not significantly altered by the presence of garlic mustard. The nests of *Aphaenogaster rudis*, a significant seed-dispersing species, were excavated and the soil tested for plant available nutrients. The seed bioassay indicates effectiveness in reducing viability of garlic mustard within the seed bank. The results show promising first steps in the formation of a bloodroot management plan for garlic mustard invasion.

Economic valuation of ecosystem services provided by oyster reefs

Grabowski, Jonathan H.; Robert D. Brumbaugh, Robert F. Conrad, Andrew G. Keeler, James J. Opaluch, Charles H. Peterson, Michael F. Piehler, Sean P. Powers, Ashley R. Smyth
Northeastern University

Valuation of ecosystem services can provide evidence of the importance of sustaining the ecosystems that provide them, as well as to help guide restoration decision-making to recover lost services. Long appreciated only as a commercial source of oysters, oyster reefs are now acknowledged for the other services they provide, such as providing nursery habitat for finfish and crustaceans, enhancing water quality, and stabilizing shorelines. Here we develop a framework to assess the value of these services. We conservatively estimate that the economic value of oyster reef services, excluding oyster harvesting, ranges between \$5,500 and \$99,000 per hectare per year, and that reefs recover their median restoration costs in 2–14 years. In contrast, when oyster reefs are subjected to destructive oyster harvesting, they do not recover the costs of restoration. Shoreline stabilization is the most valuable potential service, although this value varies greatly by reef location. Quantifying the economic values of ecosystem services provides guidance about when oyster reef restoration is a good use of funds.

Planning for transboundary connectivity: a case study of the “Three-Borders” landscape linkage that straddles Maine, Quebec and New Brunswick

Gratton, Louise
Two Countries, One Forest (2C1Forest)

Connectivity is a key component of conserving biodiversity. It provides wildlife populations with flexibility to respond to natural disturbances and changing environmental conditions, including habitat fragmentation and climate change. Therefore, connected populations have a higher likelihood of surviving. Few concerted efforts have been made, however, to plan for reservation and restoration of connectivity across international, provincial and state borders. Since its inception, Two Countries One Forest (2C1Forest), a conservation NGO incorporated in Canada and the US, has established and maintained a comprehensive database for the Northern Appalachian/Acadian region shared by northeastern Canada and the US. A critical set of wildlife linkage areas representing real and potential tears in the region's connective tissue were identified, and a network of partners was convened to share information and mobilize action in those linkages. Several public and private initiatives have emerged with ties to 2C1Forest. The Three-Borders linkage straddles Maine, Quebec and New Brunswick. Its implementation will bring together conservation stakeholders in all three political jurisdictions. The project will reach beyond the “choir” of conservation and academic actors to include the forestry, fishing, recreation and community development spheres, including First Nations. This expanded network will meet in a variety of workshops to identify shared values, map the landscape from multiple perspectives (ecological, economic, and cultural), identify challenges and opportunities, and pursue a collaborative planning process for connectivity. Demonstrating that this landscape-scale, multiple-use approach can work across this transboundary landscape could serve as a model for ecologically comparable areas of the US and Canada.

Resurrecting extinct grazing and seed dispersal interactions using non-native tortoises

Griffiths, Christine
Ebony Forest Ltd

The extinction of large herbivores can dramatically modify plant communities and impose key biotic thresholds threatening native biodiversity. In the absence of keystone species, restoration practitioners face an increasing challenge to rehabilitate degraded ecosystems. An innovative, yet controversial,

ORAL ABSTRACTS (CONT'D)

landscape-based long-term restoration approach is to reinstate missing plant-herbivore interactions using replacement, exotic, herbivores. Aldabran giant tortoises (*Aldabrachelys gigantea*) which are taxonomically and functionally similar to the extinct Mauritian giant tortoises (*Cylindraspis* spp.) were introduced to two offshore Mauritian islands to restore missing seed dispersal functions and to control the exotic vegetation threatening the native flora and fauna. On Ile aux Aigrettes introduced tortoises have resurrected dispersal of the critically endangered large-fruited endemic ebony, *Diospyros egrettarum* (Ebenaceae). On Round Island, early results suggest the introduced tortoises are not only controlling invasive herbs and grasses and dispersing native seeds, but are a more cost-effective approach to control exotic vegetation than manual weeding. Since the plant communities on these islands have been severely degraded, the introduction of tortoises by itself will be insufficient to restore species with small populations and possibly limited genetic variability. Human intervention, ecological monitoring and adaptive management are needed to ensure that the replacement herbivores promote the recovery of the native flora. Exploring pioneering, long-term, low cost and technologically simple landscape-based approaches to restoration such as ecological replacements is important to enhance our ability to strengthen ecosystem resilience and persistence to future perturbations.

Back to Eden? Restoration and its meanings in 17th-century England

Guerrini, Anita

Oregon State University

The restoration of the British monarchy in 1660, after two decades of strife, signaled for many a return to political stability. But how to restore “England’s green and pleasant land”? Two widespread beliefs made restoration of the land possible: that history was cyclic rather than linear, and that an anthropomorphic God had made the earth in the image of a garden. The naturalist John Evelyn’s (1620-1706) project of an “Elysium Britannicum,” a British paradise, centered on the restoration of a garden landscape that was classical in inspiration but Edenic in concept. This restoration encompassed not only an idealized agrarian and pastoral landscape but also the restoration of forests and trees. The notion that human actions could undo the malign impacts of earlier humans and bring nature back to an ideal pre-impact state was therefore neither as new nor as unique as many environmental historians believe. Although Evelyn acknowledged natural agency, human agency was much more central to his ideas. Nature declined not on its own (as many of his contemporaries believed) but through human action, and that same action could restore it. His concept of restoration was, moreover, profoundly conservative. The cycles of history could, with human help, bring kings back to their rightful place in the natural order, and also bring nature back to its proper state.

Incentive Arrangements in Turkish Law to Increase Existence Of Forest

Guloglu, Yavuz; Alper Bulut, İlnur Karata

Kastamonu University

In Turkey, the protection, expansion and surveillance of the forests are carried out by the state. Forest in Turkey are divided into three group in terms of ownership and state forests and public legal entities generate more than 99% of the total forest area. The existing forestry law was adopted in 1956. In the law there are items which covers forest protection and encourages increasing of forest existence. Beside to these law articles, the special regulations was also enacted only to increase the forest existence during the time such as giving free seedlings/ trees, land tax exemption, transferring the ownership of the fields to people who make them forest areas. In the relevant law, there are some incentives, such as technical assistance to people who make afforestation works, supplying free seedlings for afforestation purposes, allocating of lands for constructing nurseries which are used for the purpose of free seedling production, releasing afforestation owners from the obligations of land and property tax payments. Besides, a law titled “National Afforestation and Erosion Control Mobilization Law” has been in effect since 1995. In this law, there are also similar incentives, such as land allocations, tax allowances, construction of village forest. In this study, efforts to reforestation of the open fields among the state forests and these intensives in the frame of statism principle which takes part in Turkish constitution are examined.

Collaborative Opportunities to Restore Wetland Functions in an Urbanized Setting - Moses Creek Restoration Case Study

Gumtow, Jon H.; Tom Nedland

Stantec Consulting Services

The Moses Creek stream and riparian wetland restoration project is an excellent example of ecological and social benefits achieved through collaboration and applied science. Lessons learned from this case study can be applied to other corridor projects near urban settings. In the 1930s segments of Moses Creek, on the outskirts of the growing community of Stevens Point, Wisconsin were dredged and channelized to drain wetlands for farming, and later diverted into stormsewer pipes to control flood waters resulting from urban growth. Currently, the daylighted portions of Moses Creek exist as part of an unmaintained ditch on Schmeekle Reserve, a natural area and outdoor classroom located on the UW-Stevens Point (UWSP) campus. The Moses Creek restoration project is a 40-acre site that is a collaborative venture between the UWSP and the Wisconsin Department of Transportation. Since completion in 2010, the site has restored hydrology to 20 acres of riparian emergent, scrub-shrub, and forested wetlands; 23 acres of upland buffer habitat; 4,240 linear feet of naturalized stream habitat; and, 1-mile of interpretive trail. Incorporating educational opportunities, interpretive boardwalks and signage enhances the overall function and use of the area in an urban campus setting. Success of this project required restoring hydrology and understanding the interaction between surface water and groundwater discharge within Moses Creek and the adjacent drained lands. Stantec biologists completed a 2-year study in cooperation with UWSP to understand baseline field conditions and design a naturalized stream channel and functioning floodplain wetland that benefits the community for future generations.

ORAL ABSTRACTS (CONT'D)

Ecological Response to Large-scale Wetland Restoration and Stream Realignment in Wisconsin's Central Sands Region

Guntow, Jon H.; John Wiater
Stantec Consulting Services

Historic agriculture practices within the Lost Creek headwaters has degraded the water supply, isolated large wetland tracts and channelized native brook trout (*Salvelinus fontinalis*) habitats creating large-scale wetland and stream restoration opportunities. In 2005, the Wisconsin Department of Transportation acquired 350 acres of agricultural land to restore wetland and stream habitat, offsetting impacts from highway development. Comprehensive on-site and reference reach baseline monitoring and modeling of hydrology and groundwater were completed in conjunction with aquatic and geomorphologic surveys to create an effective wetland and stream design. Team partners included multi-discipline technical specialists, UW-Stevens Point faculty and students, and regulatory staff. The project design included ditch filling, 7,250 linear feet of naturalized stream channel, 7 online ponds, 20 acres of riparian wetlands, 200 acres of palustrine wetlands and 130 acres of native prairie. Construction was completed in fall 2009 with oversight by the biological design team. Annual monitoring and aggressive adaptive management included invasive species ID and management, wildlife use, water quality analysis, aquatic insect sampling and stream mechanics surveying. Reuse of salvaged organic soils promoted immediate native species response. Fisheries surveys (electroshocking and hook and line surveys) indicate brook trout populations have established all portions of the new stream corridor. The site is a seasonal stopover site for migrating tundra swans and waterfowl and is birding "hotspot". Annual post-construction sampling show YOY brook trout represent a concentration of roughly 300 trout per mile. Adult brook trout hook and line sampling yielded catch rates of approximately 33 trout per hour.

Performance of the tandem *Pinus pseudostrobus*-*Eysenhardtia polystachya* in a restoration mediated by mycorrhizal fungi

Gómez, Mariela; Roberto Lindig, Javier Villegas
Universidad Nacional Autónoma de México

Under extreme soil erosion, ecological restoration projects are needed to guarantee the establishment of a vegetation and subsequent soil recovery. This is the case of severely degraded sites throughout the Trans Mexican Volcanic Belt. The soils, mostly Acrisols, are prone to form gullies with extremely low levels of fertility, particularly of phosphorus. We tested several treatments for reestablishing the phosphorus cycle and improve soil aggregation. Our results suggest that in eroded Acrisols, microorganisms mycorrhizic interactions are needed to solubilize phosphorus. We tested the tandem formed by *Pinus pseudostrobus*-*Eysenhardtia polystachya*, for evaluating the effect of the mycorrhizic fungi *Pisolithus tinctorius* and *Glomus intraradices*, alone and in interaction, in the performance of the tree and shrub species. The experiment consisted on an orthogonal design with eight treatments. The highest performance was observed in plants inoculated with *G. intraradices*, alone or in interaction with *P. tinctorius*. Presence of *E. polystachya* was determinant, because *P. pseudostrobus*, cannot establish a symbiotic relationship with *G. intraradices*. EF promotes the formation of macro-aggregates, and AMF promotes the formation of micro-aggregates. The highest concentration of phosphorus was obtained in pines associated with the legume and in the presence of the AMF. Presence of *E. polystachya*, was indispensable to reestablish the phosphorus cycle because it can establish a symbiotic relationship with the AMF, which are responsible of solubilizing phosphorus that can be assimilated into the plant biomass, having a direct positive contribution for the restoration of severely degraded sites.

Responses to frost of tropical dry forests species: Consequences for restoration of "novel communities" and implications for assisted migration

Gómez Ruiz, Pilar Angélica; Roberto Lindig Cisneros, Erick de la Barrera Montpellier
Universidad Nacional Autónoma de México, Centro de Investigaciones en Ecosistemas

Many plant species in tropical ecosystems are expected to migrate to higher elevations in response to environmental changes caused by global climate change. At present, incorporating this migration to restoration processes implies that plants will face most often the risk of frost. Under simulated conditions, we evaluated frost tolerance at different temperatures below 0°C, in seedlings of three species typical from tropical dry forest of Mexico: *Albizia occidentalis*, *Cedrela dugesii* and *Ceiba aesculifolia*, which were propagated in nursery and fertilized with different concentrations of potassium (without K, 114, 189, 264 and 528 ppm). After eight months, we found that all species have a differential resistance to frost related with potassium concentrations. Older tissues exhibit a reduction in release of electrolytes at higher concentrations, which is associated with less injury of the cell membrane. This demonstrates the positive effect of potassium at physiological level in preventing frost damage. Young tissues have an extensive damage independent of the potassium concentration, confirming the susceptibility of these species to frost. Potassium fertilization to young individuals before sowing in higher areas, may help species succeed in adapting now at early stages of establishment to remain in these areas at future, where it is predicted they could have their optimum climate. As a result, new communities can be generated as consequence of species adaptation to new abiotic and biotic conditions. To avoid local extinction, assisted migration can be a viable strategy to restore the populations of these species, which are currently under different risk status.

ORAL ABSTRACTS (CONT'D)

Fighting severe carbon loss of degraded peatlands by jump-starting original ecosystem functions with restoration

Haapalehto, Tuomas; Santtu Kareksela, Teemu Tahvanainen, Rose Matilainen, Janne S. Kotiaho, Riikka Juutinen
University of Jyväskylä

Degradation of ecosystems is one of the greatest concerns for the maintenance of biodiversity and ecosystem services. To fight the degradation, ecological restoration aims at recovering ecosystem functions and structures, such as carbon (C) sequestration and plant communities responsible for the C sequestration function. With an experiment of 38 boreal peatlands covering pristine, drained and restored sites we studied the effect of drainage and restoration on surface peat of these valuable C sinks in Finland. We asked i) what is the long term effect of drainage on the surface peat C storage ii) is restoration an effective tool in recovering the degraded ecosystem functions (peat accumulation and subsequent C sequestration) and structures (producer community composition) and iii) is recovery of the original structures needed for the ecosystem functions to recover. We found that during the post-disturbance time scale (a few decades), drainage of peatlands had resulted in a substantial release of C from the surface peat. Perhaps surprisingly, restoration was successful in jump-starting the surface peat growth function already in five years since restoration. Furthermore, the regenerated surface peat of restored sites accumulated C at a rate approximately similar to pristine peatlands. Despite some recovery, producer community compositions of restored sites were considerably dissimilar to those of pristine sites still 10 years after restoration. We conclude that restoration can be used to jump-start key functions of degraded peatland ecosystems. Furthermore, it appears that the original ecosystem structure is not needed for the recovery of studied ecosystem functions.

Seedling quality: Physiological and morphological targets

Haase, Diane L.
USDA Forest Service

Seedling quality is a critical component toward optimizing plant growth and survival after outplanting. Morphological and physiological characteristics such as height, stem diameter, root architecture, phenological condition, and foliar nutrient concentrations can be targeted for their suitability to specific outplanting environments and project objectives. In addition to using genetically appropriate seed of native plant species and preparing the site to minimize environmental stressors, selecting seedling quality targets that can be quantitatively linked to outplanting performance should be routine for all reforestation, restoration, and conservation plantings. Establishing these targets before sowing in the nursery and collecting periodic data during plant development can help to identify possible crop problems and to make informed decisions for culturing, lifting, storing, and planting. Furthermore, seedling quality data can increase understanding of annual patterns among species, stocktypes, seed lots, and cultural treatments to refine target specifications for future crops.

Session 3: Mississippi River Basin: Working toward Integrated River Basin Management

Haase, Steve
The Nature Conservancy

After years of severing our rivers from their floodplains, river restoration must involve integrating and reconnecting river floodplains. Tremendous complexities were overcome to reconnect 16,000 acres of floodplains at Mollicy Farms on the Ouachita River in Northeastern Louisiana. Restoration of Mollicy Farms also reconnected severed drainages surround the site, bringing the effective hydrologic restoration footprint of the project to 70,000 acres. Mollicy Farms was cleared for row crop agriculture in 1969 and a 17 mile main line levee was constructed to reduce flooding impacts and disruption of natural flooding cycles from the Ouachita River. Mollicy Farms represents the largest floodplain restoration effort in the Mississippi Valley and has and continues to undergo the transformation in these steps: 1) design phase resulting in plan to breach existing levees 2) collect water quality, flow dynamics, and biological community condition baselines, 3) controlled breaching of the levees, 4) multi-year monitoring program to document long-term trends in water quality and biological community condition, and 5) restore interior hydrology. Adaptively managed since the reconnection in 2010, the natural and human capital associated with project implementation will be presented by the project scientist.

Spatial dynamics of vernal pool amphibians: Using translocations to identify spatial scales of habitat selection

Habberfield, Michael W.
University at Buffalo

Vernal pool restoration is increasing, often to provide critical habitat for amphibians. Discerning spatial patterns of amphibian use of these landscapes is critical for successful restoration. Individual-level habitat selection of a vernal pool facultative species, the green frog (*Rana clamitans*), was investigated in an experimental forest consisting of 39 constructed pools arranged in clusters of one, three, or nine pools. Movement parameters and habitat selection were measured by tracking movements, using fluorescent powder, following local translocations ($n=139$) across different types and scales of habitat. At each density, translocations were performed at three spatial scales: pool (mean=13 m), intra-cluster (mean=57 m), and inter-cluster (mean=344 m). For all translocation scales, step-length and turning angle were significantly, negatively correlated. Inter-cluster scale translocations resulted in significantly longer step-lengths and total movement distances. This suggests frogs may move differently when dispersing amongst pools at larger, metapopulation scales versus smaller-scale clusters of pools. Translocation scale did not, however, influence the selected pool's spatial association with other pools. Because scale influences movement parameters but not pool selection, the design of pool networks should consider species dispersal characteristics for how animals might encounter pools, but specific design criteria for increasing or decreasing selection of pools in particular spatial

ORAL ABSTRACTS (CONT'D)

settings may be difficult to obtain. This information can be taken into account when predicting colonization of constructed pool complexes and used to recommend pool spatial arrangements and associations with existing source populations.

Presentation Title: “Keystone Species Conservation – a Critical Tool in Landscape Level Restoration at the Northern Jaguar Reserve”

Hadley, Diana; Sage Goodwin
Northern Jaguar Project

Conservation efforts by the Northern Jaguar Project and its Mexican partner, Naturalia, A. C., focus on preservation of the western hemisphere's northernmost breeding population of endangered jaguars, along with rehabilitation and expansion of critical jaguar habitat. These bi-national collaborators established the Northern Jaguar Reserve (NJR), a 50,000-acre protected private reserve, surrounded by a 42,000 acre buffer zone in which multiple ranch-owners sign agreements to protect wildlife. During the past decade, reported incidents of poaching and livestock depredations by felines in core and buffer areas have undergone steep declines. Although preservation of the region's keystone wildlife species is the primary goal of conservation efforts, our multi-pronged approach to landscape-level restoration employs multiple strategies. The tools include: wildlife protection with special emphasis on four felid species; expansion of the protected wildlife reserve; incorporation of neighboring ranch-owners and vaqueros into conservation efforts through the innovative Viviendo con Felinos program; environmental education/outreach at local schools and community organizations; support for local ranchers with vegetative restoration and augmentation of water resources; assistance to ranchers with enrollment in government agency conservation programs; and identification of ecological connectivity and assessment of viable wildlife corridors between the NJR, protected areas in Sonora, and the US border. As a location of crucial connectivity, the NJR was the starting point for the “TrekWest” journey from Mexico to Canada. This presentation will describe and assess relative success for each of the specific tools in the NJP toolbox, and describe efforts to improve bi-national collaboration and expand regional support for conservation efforts.

Response of waterbirds to wetland restoration in the Illinois River Valley: A case study at the Emiquon Preserve

Hagy, Heath; Christopher Hine, Aaron Yetter, Michelle Horath, Randolph Smith, Joshua Stafford
Illinois Natural History Survey

The Illinois River valley (IRV) is a critically-important region for migrating wetland birds during fall and spring; however, extensive wetland drainage for agriculture has dramatically reduced the availability of habitats. Emiquon Preserve is a unique 1,820-ha wetland complex along the Illinois River that was recently restored following almost 80 years of agriculture. Waterfowl and other wetland birds have extensively used Emiquon each fall, spring, and summer since restoration began in 2007. We have counted more than 4.8 million birds totaling more than 49 million use days (UDs) during fall and spring. American coots and dabbling ducks (90% of UD) use Emiquon more than any other wetland or lake in the Illinois River valley (IRV), especially mallard, American green-winged teal, and northern pintail during fall and lesser snow geese, northern shoveler, and ruddy ducks during spring. During the springs 2008–2013, Emiquon was used extensively by diving ducks (50% of UD), snow geese (3.1 UD), and American coots (3.6 million UD). During summers 2008–2012, numbers of waterbird broods have dramatically declined, while those of wood ducks and mallards have increased or remained stable. Compatibility of uses of Emiquon continues to be an object of interest for many stakeholders; increased human use in fall of 2012 coincided with a dramatic decline in proportional use by dabbling ducks. Continual monitoring of waterbird communities should be part of an integrated management plan that addresses ecological indicators through adaptive management.

Indicators of restoration success in a sand plain forest

Hahner, Jason; Mike Bowie, Cathy Mountier, Stephane Boyer, Nicholas Dickinson, Carol Smith
Lincoln University

One outstanding issue in restoration ecology is the need to set measurable goals. Restoration practitioners seek few simple indicators of restoration success by quantifying species, population or ecosystem gains. Current research undertaken by Lincoln University at the Punakaiki Coastal Restoration Project (PCRP) focuses on identifying early indicators of restoration success. The PCRP is a collaboration between Rio Tinto, Conservation Volunteers New Zealand and the Department of Conservation, that aims at restoring the sand plain forest habitat on the Barrytown flats 4 km south of Punakaiki Township. On this site, most of the native vegetation has been cleared for agriculture and was subject to extensive grazing in the past few years. A comprehensive set of potential indicators are being monitored and compared between unplanted exotic grassland, replanted areas (4 year old) and mature reference sites from the directly adjacent Nikau Reserve. These indicators include recolonisation by invertebrates (monitored using pitfall traps, wooden discs, soil and leaf litter sampling, weta motels and light trapping) and vertebrates (bird, lizard and mammalian pests) as well as native vegetation cover and abiotic parameters (soil analysis, water quality). Early results indicated that some animal species were able to re-colonise quickly after restoration, these included carabid beetles for which the number of species increased significantly in replanted areas after just 4 years, but also earthworms and birds for which the proportion of endemic species increased in replanted areas when compared to unplanted sites. Such species could therefore be considered as good early indicators of restoration success.

ORAL ABSTRACTS (CONT'D)

Accelerating restoration of salt marshes by tidal channel excavation and mangrove transplantation in Saudi Arabia

Hale, Jason A.; Christopher D. Cormack, Linos Cotsapas, Thomas Minter, Dr. Jacqueline Michel
Pandion Technology, Ltd.

Nearly 20 years after the 1991 Gulf War oil spill released an estimated 10 million barrels of oil into the Arabian Gulf, almost 1,200 hectares of salt marsh and tidal flat habitats (of more than 2,000 ha surveyed) remained in a severely degraded state. Factors contributing to slow ecological recovery included clogged tidal channels, persistent ponding across the marsh plain, overgrowth of laminated algal mat, and other physical barriers to fauna and flora recruitment. Spatially variable but persistent oiling of marsh and channel substrate also played a role. A large-scale habitat restoration program is underway to overcome these factors. This program differs from other restoration efforts by focusing on remediation of natural processes rather than (solely) removing oil-contaminated sediments. Therefore, the principle remediation activities include excavation of new or existing tidal channels, and transplantation of mangroves (*Avicennia marina*). More than 120 km of tidal channels are being excavated through degraded salt marsh habitats, from the fringing tidal flat (near mean sea level (MSL)) to the upper edge of the intertidal zone, usually +0.8 m MSL. This arrangement maximized valuable intertidal habitat, and extended the frequency of tidal flooding and draining into upper salt marsh areas. Demonstration projects showed that excavated tidal channels were quickly colonized by key fauna such as burrowing crabs (*Nasima*), amphipods (*Grandidierella*), and snails (*Potamides*). Burrowing crabs and annual halophytes (*Salicornia*) also responded well to transplanted mangroves on excavated channel banks. Adaptive management has been a key component of this very large and challenging restoration program.

Recovery of tidal channel habitats in remediated salt marsh habitats

Hale, Jason A.; Christopher D. Cormack, Thomas Minter, Lincoln Smith
Pandion Technology, Ltd.

Oil released at the end of the 1991 Gulf War severely degraded coastal and marine habitats of Kuwait and the Kingdom of Saudi Arabia. Even after 20 years, persistent negative ecological impacts to intertidal habitats include reduced abundance and distribution of salt marsh flora and fauna, persistent oiling in channel bank and bottom micro-habitats, and clogged tidal channels which fail to drain during ebb tide. Excavation of tidal channels removes algal mat, clean, and oil-contaminated sediment; increases the volume of water that may flood and drain channel and marsh habitat during each tidal cycle; and increases potential channel bank and bottom habitat. We evaluated the short-term progress of ecological restoration by monitoring sediment re-distribution within tidal channel segments, and patterns of colonization by three benthic taxa in channel bank and bottom micro-habitats. Evidence of sediment redistribution, including deposition of organic and inorganic fines along channel bottom, thalweg development, areas of erosion and deposition at channel bends, and point bar accretion, indicated substantial differences in channel habitat response to excavation. These differences may be related to sediment characteristics, stream morphology, surrounding marsh topography, and dynamics of local tidal regime. The spatial extent of colonization by three important bioturbators (*Nasima* crabs, *Grandidierella* amphipods, and *Potamides* mud snails) stabilized within four months of completion of excavation. However, density of individuals within individual channel segments was related to patterns of sediment accretion and substrate development. Considered together, these indicators of ecological recovery become key components that help improve subsequent large-scale habitat restoration efforts.

Post-urbanism: are cities ecologically fit for purpose?

Haley, David
Manchester Metropolitan University

When disturbed by change, the myths of permanence, predictability and assuredness may provoke angst, fear and even anger. We must, therefore, learn to manage and adapt to diverse futures. Fate, or indeterminacy will intervene as temperatures rise and the effects of climate change accelerate. The destiny of nine billion people trying to live in cities that are no longer fit for purpose may well be played out as a 'plateau of despair', or an ecological whole systems collapse. Among the most dramatic shifts in future human dwelling, will be climate provoked migrations, or new forms of nomadism, rather than the city-style, urban norms our societies continue to promote. From continuous productive urban landscapes (CPUL) to continuous productive forest landscapes (CPFL), the shifting land-time-scapes will demand new life support systems. But ecological perturbation, also offers opportunities for diverse creative responses. To some extent, these phenomena are expressed through the contemporary notions of and quest for resilience, or 'capable futures', but how might such seismic transformations of cultural norms and ecological forms be choreographed with grace? This paper will explore these issues and the potential for human and other species to survive the course of evolution. Economies, cultures and means of dwelling will need to be reinvented, or permitted to emerge. The human dilemma is whether to act through strategies of design, planning and determinism, or to forgo all strategies and respond to change with constant vigilance, or to 'wildly, madly, let go'?

Navigating the hybrid space: Social barriers as an excuse for inaction?

Hall, Carol M.
University of Victoria

By definition, what distinguishes novel ecosystems from historical and hybrid ones is a condition of practical irreversibility: a novel ecosystem cannot be practically restored to historical conditions. Understanding when such thresholds have been crossed is important in informing a management framework for deciding when and how to intervene. Hybrid systems fall within a murky territory and pose challenges for management intervention. One such challenge involves social barriers, such as limited funding, social norms, knowledge gaps, etc., that may be difficult to remove. In theory, with enough

ORAL ABSTRACTS (CONT'D)

money, resources and long-term management commitment, it often may be technically possible to reverse changes and restore historical conditions. In practice, limited resources and competing interests mean it is unrealistic to overcome social barriers to restore all priority systems across the landscape. At the same time, social barriers should not be served up as an easy excuse to abandon traditional restoration practices. Further work to develop practical guidance around these issues is needed. How much should we invest in attempting to overcome social barriers to restore systems to historical conditions? And at what point do we accept that such barriers cannot be overcome and decide to manage as hybrid or even novel ecosystems? How do we avoid “giving up” too easily? Finally, while social factors are often associated with barriers to effective restoration, how can we alternatively harness them to lead to positive action and investment in more effectively managing the changing landscape?

Effects of spoil type on microbial activity following surface mining in central Appalachia, USA

Hall, Sarah L.; Christopher D. Barton, Patrick N. Angel
Berea College

Upon removal of coal from surface mines in Appalachia, reclamation efforts to restore forests often utilize topsoil substitutes. Previous research has shown large differences in physical, chemical, hydrological, and vegetation characteristics between different spoil types, with the conclusion that brown weathered sandstone is a better topsoil substitute compared to others. However, soil microorganisms play essential roles in forest ecosystems and data regarding their activity is lacking, and if present, could strengthen the recommendation. This study looked at differences in microbial activity for plots established in 2005 (six total, two of each type) in eastern Kentucky consisting of: 1) predominantly brown, weathered sandstone (BR); 2) predominantly gray, unweathered sandstone (GR); and 3) mixed weathered and unweathered sandstones and shale material (MX). Microbial activity was assessed using Ecoplates to determine differences between the treatments, and to compare microbial activity with vegetation parameters. Preliminary data collected in 2012 showed a significantly higher average well color development (AWCD; at 144hrs $p=0.008$) for the BR ($1.5+0.12$) compared to the GR ($0.22+0.06$) and MX ($0.17+0.17$). Although not significant ($p=0.088$), total number of substrates utilized showed a similar trend between treatments. These preliminary results indicate soil microbial activity and diversity that is higher in BR compared to GR and MX. Results will be presented for a more robust sampling in 2013, as well as correlation with vegetation data from 2013. In addition, a review of research findings and future directions for soil microbial research to inform reclamation practices will be summarized.

Development of a regional monitoring approach for assessing ecological restoration: Riparian-influenced systems

Hallett, James G.; Margaret A. O'Connell, Ray D. Entz (Kalispel Tribe of Indians)
Eastern Washington University

Monitoring and evaluation are considered key elements in the adaptive management of ecological restoration projects. When project outcomes are compared to a reference (i.e., desired future condition), one can either revel in the project's success at moving toward the reference or modify management prescriptions to increase the likelihood that this will occur. Unfortunately many projects either do not articulate their objectives at the outset or do not incorporate a monitoring mechanism. Monitoring has typically been considered too expensive. In 2002, we developed a monitoring program to assist the Kalispel Tribe in evaluating restoration projects in the Pend Oreille River valley of eastern Washington and northern Idaho. These projects were part of a mitigation program for habitat losses that the Kalispel as well as other regional Tribes suffered following creation of the Albeni Falls Dam in 1955 and were funded by the Bonneville Power Administration (BPA). In 2007, all funding for monitoring was suspended although it represented <5% of overall costs. Funding for monitoring was restored when all five tribes coordinated a regional monitoring effort to support the restoration activities across tribal lands. Management goals reflected the natural and cultural resources of importance to tribal communities, and monitoring was adapted accordingly. We describe both the program and how it is being used to assess restoration success.

How common is the historical reference ecosystem? A review of community-based restoration projects

Hallett, Lauren M.
University of California, Berkeley

Designing and evaluating ecosystem restoration projects in relation to historical references systems has been a commonly advised practice for several decades. More recently the approach has been questioned, with some arguing that restoring historical ecosystems is unrealistic in light of accelerating rates of environmental change, and others emphasizing the need to restore ecosystems in ways that explicitly speak to social needs. To understand this debate, I first describe a survey of 200 restoration projects to ask whether and when actual restoration projects incorporate historical references into their goals. Based on this review, I use case-studies from community-based restoration and restoration in working landscapes to illustrate that, while a consideration of historical ecosystems can enrich our understanding of restoration, strict fidelity to the goal of restoring historical ecosystems can undermine the success of community-based restoration efforts.

Maximizing the value of ecological restoration: Setting goals that are both desirable and resilient

Hallett, Lauren M.; Katharine N. Suding
University of California, Berkeley

A primary concern for ecological restoration is that, in addition to being feasible and desirable, restoration goals should be resilient – the time and effort required to achieve many restoration goals is of little value if they cannot be maintained into the future. However, a longstanding challenge is to identify the appropriate management goals and strategies that increase resilience, particularly in the face of strong human impact. We address this challenge in

ORAL ABSTRACTS (CONT'D)

three ways. First, we review how resilience has been addressed in the restoration literature, and highlight the need to consider the resilience as well as the desirability of the current ecosystem before initiating restoration. Additionally, while the importance of ecological processes, such as functional diversity and connectivity, have been widely emphasized, social processes have been less emphasized in ensuring the resilience of ecosystems to change. Then, in a survey of 200 restoration projects, we ask how actual projects have addressed resilience and future change. Here, we find that ecological resilience was rarely discussed but the importance of social elements was often linked with the resilience of the project. Lastly, we suggest ways the restoration practitioners can better incorporate resilience objectives, integrating both ecological and social elements.

Best practice tools of ecological restoration planning in protected areas in Finland

Halme, Kati

Metsähallitus Natural Heritage Services

Majority of habitat restoration in both state-owned and private protected areas in Finland is done by the Metsähallitus Natural Heritage Services, a governmental organization. MNHS manages ca 20% of the land and water areas in Finland, e.g. all the state-owned protected areas, northern wilderness reserves, national hiking areas and the state-owned public waters. MNHS has a long history and strong expertise in management of natural resources and protected areas. Ecological restoration has been carried out extensively for over a decade, mainly in forest and mire habitats. Restoration planning also targets habitats where continuous management is needed in order to maintain the desirable habitat characteristics. The foundation of restoration planning in MNHS is exceptionally comprehensive standardized data gathered throughout the country's PA network at a detailed spatial scale. These data include a multitude of variables on vegetation, habitat classes and species. If necessary, during the restoration planning process additional information is gathered, e.g. inventories of rare and threatened species and cultural heritage are carried out. This information is used for determining the objectives and methods of restoration. A case study demonstrating the planning process, methods and the main challenges is presented. The challenges and future developments in restoration planning methodology are discussed. Currently the restoration planning process is under construction: new information management systems and analytical methods are being developed in order to make the restoration planning more efficient, which is crucial for efficient allocation of the limited resources available for ecological restoration nationwide.

The restoration of the Senegal Delta, 20 years of learning together

Hamerlynck, Olivier; Stephanie Duvail, Zeine El Abidine ould Sidaty, Sidi Aly Moulaye Zeine, Maurice Benmergui, Grazia Borrini-Feyerabend
Kenya Wetlands Biodiversity Research Team (KENWEB)

In 1993, a restoration project was initiated to repair the damage caused by the Dama dam, some 30 km upstream of the Senegal River mouth. The floodplain and deltaic wetlands on the Mauritanian bank were no longer flooded and turned into a saline desert. The characteristic vegetation: flooded *Acacia nilotica* forests and mangrove systems, perennial grasses for mat-making by women and annual pasture for dry-season grazing from a vast semi-arid hinterland was strongly affected. Finfish and prawn fisheries declined and most of the young male population emigrated. Using an ecosystem approach with strong community participation, sluiceways and embankments were constructed to allow managed flood releases into the system and progressively larger areas were restored, each time the subject of joint evaluations to improve on flood release scenarios. Initial results were promising and biodiversity, local livelihoods and human well-being saw spectacular increases e.g. from 3 to 200,000 waterbirds in mid-winter counts. Now, after twenty years, the 100,000 ha area is a thriving co-managed wetland and part of the trans-boundary biosphere reserve of the Senegal Delta. New challenges have come up as the infrastructure has aged and would need to be expanded and strengthened. Main flows would need to be redirected to counter the impacts of a breach made through the coastal dune in 2003 to alleviate flooding of the city of St. Louis. The shared governance situation needs strengthening and better integration with the biosphere reserve which remains a potential rather than an optimally functioning conservation reality.

Challenges posed in restoration of shallow lowland lakes: a case of multiple stressors in the Waikato region, New Zealand

Hamilton, David P.; Rebecca Eivers, Tracie Dean-Speirs, Keri A. Neilson

Environmental Research Institute, University of Waikato

The Waikato region has an abundance of shallow, lakes associated with the lowland region of New Zealand's longest river, the Waikato in the North Island. These lakes are associated either with the historical Waikato River floodplain or with bogs and peatlands. They once represented an abundant food source (e.g., eels, whitebait) for local Māori and had high biodiversity value including numerous endemic bird and submerged macrophyte species. Since European settlement the lake and wetland area of the region has contracted with land clearance and draining, and lakes have been subject more recently to pressures from introduced fish (koi carp, catfish, goldfish) and increasing agricultural nutrient loads from dairy intensification. Many of the shallow lakes have undergone regime shifts from a clear-water phase with abundant submerged macrophytes to a devegetated phase with low water clarity. Rehabilitating these lakes is at least partly contingent upon restoring submerged macrophyte beds. We outline multiple rehabilitation measures that are being undertaken to address the degraded state of the Waikato lakes. They include catchment-based methods (e.g. farm nutrient plans, riparian planting, artificial wetlands and sedimentation basins) and in-lake measures (e.g., removal of exotic fish, use of nutrient-adsorptive materials and removal of bottom sediments). Whilst significant progress has been made with halting and reversing biodiversity loss in terrestrial catchments, water quality remains the greatest challenge. Progress in this area will likely be most closely associated with reversing past vegetation regime shifts.

ORAL ABSTRACTS (CONT'D)

Ecological restoration and conservation outreach in the tallgrass prairie of Oklahoma.

Hamilton, Robert

The Nature Conservancy

The 1.5M ha Flint Hills of Oklahoma and Kansas comprise the largest tallgrass prairie landscape in North America. Fire is regularly applied by ranch managers across a sizable portion of this privately-owned landscape. Grazing regimens typically stress uniformity which combined with high fire frequency result in a largely homogeneous landscape with lowered biodiversity potential. Increasing landscape heterogeneity is a goal of The Nature Conservancy (TNC) in the Flint Hills. The first step in addressing the landscape homogeneity concern has been development and demonstration of biodiversity-focused range management tools. At TNC's 16,100 ha Tallgrass Prairie Preserve in northeastern Oklahoma, a free-ranging bison herd interacts with randomly selected burn patches that approximate the historic seasonality and frequency of fire. The resident herd of 2,700 bison graze on 9,600 ha of tallgrass prairie and crossttimbers woodlands. The fire-bison interaction produces a vegetative structural and compositional heterogeneity in an ever-shifting landscape patch mosaic. Recognizing that the fire-bison regime is not likely to be exportable to the region's private rangelands, TNC has been working with Oklahoma State University in the development of "patch-burn grazing" regimes that promote heterogeneity using cattle. Over 4,600 ha at the Tallgrass Prairie Preserve are dedicated to cattle patch-burn grazing research and demonstration. Research results have been encouraging: heterogeneity and biodiversity can be enhanced with little or no decrease in livestock production. An additional outreach strategy has been engaging ranchers in an effort to restore Greater Prairie-Chickens through fire management practices that promote grassland heterogeneity.

Setting oyster restoration goals to meet society's needs.

Hancock, Boze; Philene zu Ermgassen, Mark Spalding, Robert Brumbaugh

The Nature Conservancy

Oyster populations worldwide are at very low levels with the habitat that is created by this ecosystem engineer being functionally extinct in many areas. At the same time the ecosystem services, or benefits provided to humans by oyster habitat, such as water filtration, denitrification, fish production or shoreline protection, are becoming recognized as a means to mitigate human impacts on coastal ecosystems. Oyster restoration techniques have been proven and in several countries mechanisms for scaling up restoration are being pursued. This raises the question of how much oyster restoration is enough? Bay-wide oyster restoration goals have traditionally been set to return a bay to some point described in terms of historic abundance. An alternative, and more constructive approach, might be to set restoration goals in terms of the amount of an important service that society would like to see returned. The development and application of this logic is being advanced by a coalition of researchers. An overview of oyster restoration goal setting will be provided and developed by subsequent presenters.

Protecting shorelines with oyster reefs: A coastal resilience toolkit

Haner, Judy

The Nature Conservancy

Globally, an estimated 85 percent of oyster reefs have been lost, more than any other marine habitat. In Mobile Bay, where research has shown only a 9 percent decline in reef area, there has been an 80 percent loss in reef biomass. Recent projects across the Gulf of Mexico show that large scale restoration can create man-made oyster reefs that duplicate many of the environmental benefits of natural reefs. The ecosystem services restored by these reefs also benefit coastal communities, providing shoreline protection, water filtration and turbidity reduction, removal of nitrogen and the production of finfish and crabs. These services have economic value to coastal communities including improved fisheries stocks, coastal protection, community resilience and improved water quality. While the people of the Gulf coast know that the environment and the economy are connected, scientists have struggled with measuring the natural environment's influence on human wellbeing, specifically the economic values and community benefits of coastal restoration efforts, until recently. Protecting and restoring these important habitats strengthens Gulf coast communities and economies and makes them more resilient in the face of struggling economies, dwindling fisheries and coastal hazards such as storms and flooding. In combination, these factors create social and economic flexibility in local communities, sustain tourism and other coastal businesses, provide critical nursery areas for Gulf fisheries and reduce damages from storms. The coastal resilience toolkit provides natural resource information along with demographic, social and economic data for local leaders to make informed decisions for the future of their communities.

An Update on Invasive Issues of Concern in the United States: Threats to Restoration

Harper-Lore, Bonnie L.

ISAC Member

In 1981, the field of ecological restoration was not yet named. We could not foresee the firestorm of invasive plants, let alone other invasive species that would plague future efforts. The first U.S. restoration in Madison, Wisconsin was troubled by invasive plants from the beginning. Mowing and spraying were methods of control we borrowed from modern agriculture. Those methods did not prevent sweet clover from reappearing annually in Curtis Prairie. We had yet to develop an ecological approach to invasive control. At that time, no one foresaw the ecological and economic threats of invasive species. Now the perfect storm of reduced budgets, climate change, and the spread of invasives threaten all restoration efforts. Adaptation appears key, but what does it really mean to future restorations in light of national policy regarding invasive species in the United States. This paper will discuss existing obstacles and opportunities from a unique national viewpoint.

ORAL ABSTRACTS (CONT'D)

An inventory and recommendations for management of invasive alien plants in Point Pelee National Park

Harrington, Andrea; Stephen Murphy, Brian Craig, Gregory Michalenko

University of Waterloo

Point Pelee National Park in Ontario, Canada has been affected by a long history of human activity. This activity has encouraged the establishment of approximately 276 exotic invasive plant species. As part of this study an inventory of the high priority exotic invasive plants and their spatial extent in the Park, was created. Emphasis was on creating a standard inventory method that can be repeated in future years and that the data be comparable among inventories. Comparing results in future years will help the Park monitor the success of management. *Alliaria officinalis* is the only non-native species that is widespread within the study area. Other non-native species with a high potential for invasiveness were observed but only consisted of a few individuals along roads and paths. *Osmorhiza longistylis*, a native species, was observed to be dominating in some areas and was widespread throughout the study area. The continued existence of non-native species and the dominance of some native species is likely a symptom of the low diversity, caused by the history of disturbance. Recommendations include removal of some non-native species deemed to be a potential threat to native richness and diversity, followed by re-vegetation with native species, and continued monitoring. Future restoration efforts are best directed in areas with the lowest diversity and native richness. Recent budget cuts will make it difficult to employ some of these recommendations but the maps of high priority species make it possible to focus remaining resources in those areas.

Workshop: The development and application of the Integrated Constructed Wetland (ICW) concept; origins, design concept and application.

Harrington, Rory

Water and Environment Section, Waterford County Council

The 25 km² Dunhill-Annestown stream catchment (Anne valley) in south County Waterford, Ireland has been the focus for the development of the Integrated Constructed Wetland (ICW) concept since 1996 (Harrington, et al. 2002). The ICW concept, based upon reanimating marsh-type infrastructure, was developed out of the need to address point and diffuse sources of polluted water in an intensive agriculturally-managed landscape. The ICW concept is fundamentally an over-arching land use strategy that recognises the fundamental biogeochemical interconnectivity between water, land and climate (Van der Valk, 2006). Through the explicit integration of three objectives; water treatment, landscape-fit and biodiversity, ICW systems generate synergies and a range of ecosystem benefits in addition to that obtained from pursuing water treatment alone. These multiple benefits along with significantly lower capital and operational costs make the competition for the necessary land achievable, even under conditions of high land prices and other pressures (Harrington & McInnes, 2009, Doody et al., 2010). The ICW concept has been applied to treat both point sources of pollution; typically dairy washings and farmyard soiled water run-off, effluent from industrial kitchens and municipal sewage, and diffuse sources including that from roads and agricultural fields. The monitoring of ICW performance has included biological, chemical and environmental assessment (Becerra-Jurado, et al. 2009; Harrington et al., 2002; 2007; 2009; Scholz et al., 2007). The ICW concept takes a systemic approach to the design and construction of an appropriate wetland infrastructure to meet the specific conditions of each source of polluted water, its topography and landscape setting including the use of on-site soil materials. Today, sixteen ICW systems have been established within the Anne valley catchment, covering a total area of approximately 25ha (or 1.0% of the total catchment and 0.1% of individual farm areas). In addition, the concept has successfully been applied to treating municipal sewage, the other main point-source of polluted water within the catchment. About 40% of diffuse sources are intercepted by wetland infrastructure. The social, economic and environmental coherencies of ICW systems in the management of water, which when tackled together, convert often considered problematic challenges into new sustainable resources, particularly that of reanimating marsh-type habitats.

Characterizing novel ecosystems: challenges for measurement

Harris, Jim A.; Stephen D. Murphy, Cara Nelson, Micheal Perring, Pedro M. Tognetti

Cranfield University

In order to characterise novel ecosystems we have three features to elucidate which distinguish them from hybrid or unaltered systems, namely: Differences in composition, structure and/or function; Thresholds in these attributes that are currently irreversible; and, Persistence or self-organisation. We shall discuss the challenges, conceptual and practical, faced in measuring differences in ecosystem state, and which variables we might choose to them; identification of thresholds; and how we can determine that the novel system is in a state of self-organisation, including the important field of non-species biological metrics, and thermodynamic status.

Monitoring of riparian vegetation restoration along the reconstructed Red Hill Creek, Hamilton, Ontario Canada, 2008-2012

Harris, Zack R.; Jim Dougan, Vladimir Kricsfalusy, Steve, B. Hill, Todd Fell

Dougan & Associates

The Red Hill Creek Valley is a significant natural feature that extends from the Niagara Escarpment (a UNESCO Biosphere Reserve) to Lake Ontario, bisecting the City of Hamilton, one of the largest urban centres in southern Ontario. The construction of a controlled access parkway within the valley in 2005-2007, prompted the reconstruction of the Red Hill Creek using natural channel design to address the impacts of five decades of watershed urbanization, remediation of closed landfills, restoring floodplain habitats and functions, and improving fish habitat and water quality. In conjunction with relocation of more than 8 km of the creek, vegetative strategies were applied including exotic controls, sod transplants, seeding, soil seedbanks, and

ORAL ABSTRACTS (CONT'D)

plantings. The success of this project in reestablishing and maintaining a native-dominant flora was assessed by monitoring the riparian zone from 2008-2012. Transects were established at 37 locations along 9 km of restored and remnant creek, and monitored alternately over the 5-year period. Transects were photo monitored annually. Six plots along each transect were surveyed to determine the abundance of species. Several metrics were derived from this data and used to identify trends in community structure and composition over the 5-year period; species richness, Floristic Quality Index, species diversity, and relative importance. The results from this monitoring are presented that identify key changes and trends within the riparian vegetation over the monitoring period, and further steps for the long term management of this important natural heritage system.

The influence of social factors on land restoration in developing countries: Watershed rehabilitation and wet meadow (bofedal) restoration in the Bolivian Andes

Hartman, Brett D.

UC Santa Barbara, Geography

Many montane zones in developing countries have undergone a cycle of poverty and land degradation, including severe erosion and reduced productivity. The theory and practice of restoration ecology offers a promising new approach to address this problem. However, its application has been limited by a poor understanding of the social dynamics that influence project implementation in a development setting. This research evaluated the social factors that influence restoration success at a watershed rehabilitation and wet meadow (bofedal) restoration project in the Bolivian Andes. The project encompasses 26 indigenous Aymara communities, where approximately 26,000 check dams, terraces, and infiltration ditches have been built since 1992. Based on the number of erosion controls/km², 4 high restoration management intensity, 4 low restoration management intensity, and 4 non-project control communities were selected. Social variables included outmigration and off-farm labor, perceived benefits and motivating factors, incentives such as food-for-work programs, accessibility, land tenancy, institutional factors, and indigenous knowledge. These were linked with indicators of restoration success through 1) remote sensing methods that included terrain analysis, a time-series of Landsat TM images from 1986 – 2009, and ground-truth data; 2) a questionnaire administered to 237 households; and 3) scenario methods to quantify indigenous knowledge of soil-plant-water relationships, erosion control, and ecosystem restoration. Results suggest land restoration can help reduce rates of rural-urban migration, and that focus on specific aspects of institutional development, regional cooperation, effective farmer-scientist collaborations, incentives, and reconciling international donor objectives (biodiversity, carbon sequestration) with local priorities (economic stability) will help ensure project success.

The Johnstone field: A case study at the intersection of ecological, social, and cultural values.

Haselmayer, John; Cavan Harpur, Jeff Truscott

Parks Canada

The 'Johnstone Field' presents a useful case study in the theory and practice of ecological restoration in National Parks in Canada, and in protected areas generally. As part of its on-going property acquisition program for the completion of Bruce Peninsula National Park, Parks Canada purchased the 350-acre parcel in 2010. Portions of the parcel have been in hay cultivation since the 1870's, while others have been variably impacted by cattle grazing over the same time period. In December of 2012, Parks Canada embarked on a planning exercise to determine an appropriate set of restoration prescriptions for the parcel. The planning process includes a significant public consultation component. Beyond the abiotic and biotic factors driving our decision-making and contributing to the effectiveness of our restoration efforts (e.g. historic forest cover, existing adjacent forest type, soil conditions, mycorrhizal community, etc.), there are also significant social values to consider. In its current state, the site is a popular local attraction for wildlife viewing and has cultural importance for its representation of early settlement history in the region. Further, legal constraints are a major consideration as the site is inhabited by Bobolink, a listed species under the federal Species at Risk Act. Finally, the site is under land claim litigation by the Saugeen-Ojibway Nation and Parks Canada is legally compelled to consult with and accommodate the interests of that community. The challenge before park managers is to determine a path forward that achieves real ecological gains while balancing these sometimes conflicting values.

Benefits of adding downed woody material to lakeshore restorations

Haskell, Daniel E.; Christopher R. Webster, David J. Flaspohler, Michael W. Meyer

Michigan Technological University

Residential development has increased exponentially in the northern Great Lakes region, with the majority of the development concentrated near lakeshores. This development can have a negative impact on terrestrial and aquatic taxa. Recently, lakeshore restoration has occurred on privately owned property in Vilas County, Wisconsin and elsewhere in the upper Midwest, but little is known about the benefit, if any, from these restoration efforts. A partnership between government agencies and academia has launched a long-term research project investigating the ecological benefits of lakeshore restoration. We investigated the impacts of using downed woody material (DWM) to increase the success of restoration projects. Specifically, we tested the hypothesis that down woody material would reduce the variation in soil temperature, retain soil moisture, and improve plant survival and growth rates. We randomly assigned three DWM coverage treatments (0%, 25%, and 50%) on 3 m × 3 m experimental plots (n = 10 per treatment). The mean maximum soil temperature, temperature variation, and change in soil moisture content were significantly lower in the 25% and 50% DWM plots. We found no difference in survival, but snowberry (*Symphoricarpos albus*) and Barren strawberry (*Waldstenia fragaroides*) growth was significantly greater in the 25% and 50% DWM plots. DWM addition can be considered a useful technique to physically manipulate soil properties and improve plant growth.

ORAL ABSTRACTS (CONT'D)

Planning for the use of native plant materials in a changing climate

Havens, Kayri; Pati Vitt

Chicago Botanic Garden

Faced with a changing climate, plants may respond via plasticity, such as by altering flowering phenology. Over time, plants may either adapt to the new climatic conditions, migrate to regions where climatic conditions are more suitable, or go extinct locally or globally. Phenological shifts are well documented in many plant species, with most of the species studied exhibiting earlier leaf break and flowering in response to warming temperatures. Some studies have suggested that phenology changes in plants are better explained by temperature than in animals, suggesting there may be phenological mismatches between plants and their animal mutualists (pollinators and seed dispersal agents) as the climate warms, thereby limiting reproductive success. During past changes in climate, plant species were able to respond by adaptive evolution and/or shifting latitude or elevation. However, the potential to respond to today's rapid climate change is limited by the speed of climate change and land use changes that curtail gene flow and migratory routes. Using native plant materials for restoration, and possibly assisted migration implemented in a restoration context, may help maintain species that might otherwise be lost from the landscape. However, continued research is needed to better understand appropriate current and future seed transfer zones. Banking native seed now is necessary to maintain these future options.

Restoration and Meaning on Former Military Lands in the United States

Havlick, David

University of Colorado Colorado Springs

Former military lands in the U.S. have been converted to many different new uses, including more than a million acres designated since the late 1980s as national wildlife refuges. Restoration and remediation at these sites often privilege an ecological focus informed by pre-European reference conditions. New names and land use missions can serve to further obscure the prior histories and cultural significance of these lands. Against this tendency toward erasure, this paper considers how cultural meanings can be retained and integrated with ecological restoration efforts. As layered geographies with significant cultural and ecological features, former military bases transitioning into wildlife refuges illustrate the importance of resisting simple categories or narratives and confronting instead the complexity of history and ecology, restoration and meaning as they emerge from these places. Research from more than a dozen sites of recent military-to-wildlife conversion in the U.S. suggests that conceptions of place and meaning can vary considerably, and that differences in these conceptions reflect social constructions as well as physical and ecological conditions. Using two military-to-wildlife refuges in Colorado and Massachusetts as case examples, the paper examines how refuge visitors, refuge managers, and citizens who self-identify as having interests in the history of these sites differently interpret what is important to restore, preserve, and manage in these places.

Vegetation responses to forest restoration in pine-dominated boreal forests

Hekkala, Anne-Maarit; Oili Tarvainen, Anne Tolvanen

Finnish Forest Research Institute

Forest restoration is widely used in Finland to bring back essential components typical to natural forests, which have been reduced by efficient forest management. The structural variety of monoculture conifer stands is increased by adding dead wood and by re-introducing fire-disturbance, which has been almost eliminated from the forests. Vegetation succession is expected to be initiated after forest restoration, although the type and level of restoration influence how the succession proceeds. We compared the effects of two forest restoration methods on the vegetation succession. The restoration treatments included tree felling with two levels (20 % and 40 % of initial stand volume) of added dead wood, with and without subsequent fire, and intact controls. We surveyed the vegetation cover, species richness and composition from each experimental plot (n=58) prior to the restoration, one year after and five years after restoration in 2005, 2007 and 2011, respectively. The results show that tree felling with fire affects the succession of the forest vegetation by increasing the cover of pioneer species such as graminoid, forb and moss species and deciduous saplings, and by decreasing the cover of forest species such as shrubs and lichens. Five years after restoration, the cover of pioneer species still exceeded their initial cover, while forest species had not yet recovered to their initial level. Tree felling without fire did not have any significant effects on the cover, species richness or species composition. Practical implications of the results concerning restoration will be discussed.

Shifting goals from endpoints to practice in restoration activities

Heller, Nicole E.

Duke University

Restoration for biodiversity protection demands valuation about desired conditions – a goal or vision of how a place should be ecologically. This is often defined through historic benchmarks. Yet, this focus on the past is complicated by global change. The use of historical benchmarks to guide goals may not be sustainable or adaptive in the face of rapid change. Making decisions, such as when to focus on restoring historic species compositions, when to accept novelty, or when to facilitate migration, or state shifts, can raise difficult tradeoffs. Valuable species and community types may not survive. Systems may get stuck in cycles of endless intervention. In making decisions, how can we blend the desire for preservation, with the need for adaptation and sustainability? Here, I discuss a proposed framework for basing management decisions on desired practice rather than desired endpoints. A goal setting exercise could start with the question: What species assemblages are compatible with an appropriate set of practices (considering issues like scale of intervention, disturbance rate and magnitude, technology)? This shifts the goal from an endpoint and using of any means possible to establish that endpoint, to a human and non-human relationship that is deemed consistent with the natural processes and biotic interactions that are to be honored in natural areas. A focus on practice is likely to increase the adaptive capacity of the restoration enterprise to global change.

ORAL ABSTRACTS (CONT'D)

Restoring viability to fragmented grasslands with prairie restoration (reconstruction)

Helzer, Chris

The Nature Conservancy

Prairies within fragmented landscapes are vulnerable to the loss of species and ecological function. The best long term solution is to increase the size and connectivity of those prairies through the restoration of adjacent lands. In The Nature Conservancy's Platte River Prairies (east-central Nebraska) we are working to develop and test strategies for converting crop fields to diverse prairie seedings that functionally enlarge and reconnect nearby prairie fragments. Our work is being done in close communication with other members of the Grassland Restoration Network, a loose affiliation of practitioners and researchers working to make prairie restoration an effective conservation strategy. The success of our efforts is not measured by whether or not seedings mimic the appearance or composition of reference sites, but rather by whether or not they reduce the impacts of fragmentation on adjacent remnant prairies. Most of our restored sites along the Platte River (approximately 1,500 acres total) have an established community of more than 150 plant species, and we have been able to maintain that diversity through fire and grazing management. More importantly, we are now investigating how well those new seedings act as supplemental and complementary habitat for species within formerly fragmented prairie remnants. Early work with regal fritillary butterflies, bees, and ants has shown that most species in remnants appear to be using restored habitat as well. We continue to build upon those data and to focus on other taxa such as small mammals, reptiles, and amphibians.

The Chicago Wilderness Land Management Project: A Long-term Evaluation of Restoration Management in the US Midwest

Heneghan, Liam; David Wise, Lauren Umek, Rebecca Tonietto, José-Cristian Martínez, Matthew A. McCary

DePaul University

The Chicago Wilderness Land Management Research Program (CWLMP), also known as "100 Sites for 100 Years" is a cross-disciplinary research program connecting on-the-ground land management efforts across the region with cutting-edge ecological research. In 2005, members of the Science Team began conversations with other CW members on how research could help Chicago Wilderness (CW) achieve its goals. It quickly became clear that there was a need for a mechanism for academic and research institutions to investigate ecological questions that were of particular interest to land managers. The 100 Sites for 100 Years began in 2008 and is now a network of over 100 woodland, prairie remnant and former agricultural prairie restorations, replicated along a management gradient. These sites represent degraded and unmanaged sites, recently managed and long-term managed sites. This session will introduce the history of the project and highlight the regional impacts of restoration on plant community structure, soil properties, earthworms, ground dwelling insect communities, native pollinator communities and song bird communities.

The Uses and Disadvantages of History for Restoration

Heneghan, Liam

DePaul University

A central tenet of classical ecology is that each species has a unique niche. Niche theory suggests that globally we have millions of species each plying their independent ecological trades in local environments. This "equilibrium paradigm" predicted that niche separation of local assemblages is regulated primarily by competition and a tight relationship between species composition and ecosystems processes might be expected. Under these assumptions, restoration strategies that protect ecosystems processes and services maps quite nicely onto the traditional conservation focus of protecting species. However, the role of non-equilibrium forces, disturbance, and so forth, are now increasingly appreciated as contributing to the structure of local assemblages. That species are redundant with respect to their contributions to ecosystem processes is an important component of the "biodiversity and ecosystem function" debate. One could expect the recovery of processes in degraded systems without a concomitant recovery in species. Thus, although communities and ecosystem processes are inextricably linked, they are not necessarily tightly linked. Using these various frameworks we can evaluate two target poles for restoration: Prioritize "saving all the pieces" in a system, using historical reference systems as a guide, or prioritize recovering the ecosystem functions, accepting the novel ecosystems paradigm. I will discuss these tradeoffs from a variety of perspectives. In my remarks I draw upon the surprisingly helpful work of Friedrich Wilhelm Nietzsche whose metric for evaluating the utility of history was the degree to which historical sensibilities served the needs of "a mighty new current of life."

Practitioners of Intimate Restoration: Introduction

Henkes, Rollie

Publisher, Woodlands and Prairies magazine

Landowners play a vital, and perhaps undervalued, role in the success of ecological restoration. The quarterly publication Woodlands and Prairies highlights this work. Landowner practitioners in the midwest are restoring oak savanna, prairie, woodland and wetland. These are often vertically integrated practices: one lifetime restoration project, serves as a primary resource, and an intimacy with the land and awareness of its responses. The combination is effective: long-term relationship, and, without traditional funding, the ability to freely pursue ecological knowledge, the neglected areas of basic natural history, and ecosystem function (to paraphrase one of the landowner practitioners). This symposium will consider landowner contributions to the field in three areas. First, that site-specific restoration approaches and protocols, developed over a long relationship with the land, provide valuable models for other restoration work. Although any particular method used might be well-known, it is the whole of the work - the adaptation in approach and tuning in techniques - that gives insight and suggests innovation elsewhere. Second, the long-term observation, data collection and pursuit of knowledge by citizen scientists. Third, that deep awareness of their land's role in a larger scale landscape mosaic leads

ORAL ABSTRACTS (CONT'D)

landowners to interactions in strengthening that mosaic. Landowner practitioners profiled in the magazine in recent years will speak, and the symposium will conclude with thoughts and discussion for how to connect these contributions with traditional consultant and governmental practices and academic research.

An investigation of the impacts of seed origin on grassland restoration success

Herget, Mollie E.; Kristina M. Hufford

University of Wyoming

While the use of local plant genotypes is ideal to restore historical site conditions, widespread biological invasion represents a significant complicating factor for ecological restoration. Some environments are so radically altered by exotic, invasive weeds that original environment conditions may no longer exist. Under these circumstances, non-local cultivars of native species may have a competitive advantage at highly disturbed sites, and the assumption that local genotypes are better adapted to site conditions than cultivars may no longer hold. In addition, different cultivated or local seed sources may represent a range of competitive ability. To test this hypothesis, a common garden study was conducted in the greenhouse and field to test the competitive interaction of native Sandberg bluegrass (*Poa secunda*) and invasive cheatgrass (*Bromus tectorum*). Multiple cultivated and local/wild varieties of *P. secunda* were challenged with cheatgrass and compared with controls. Final dry weights were tested to determine whether cultivar or local genotypes of the same native species have a competitive advantage in the presence of cheatgrass, and whether competitive differences are consistent among seed source categories. Results are discussed in light of biological invasion and seed sourcing for ecological restoration of invaded sites.

An 18-year study of breeding birds within grassland restorations in Illinois: Can restorations replicate the real thing?

Herkert, James R.

Illinois Department of Natural Resources

Restoration ecology could be described as an effort to recreate a natural or self-sustaining community or ecosystem. And while, whole systems can be created through restoration, their resemblance to natural communities needs to be evaluated. In fact the available information suggests that many restorations do not resemble “the real thing” even after more than a decade. For birds, numerous studies have shown that many grassland restorations are colonized relatively quickly and provide habitat for a wide variety of species. However, studies comparing bird communities in grassland restorations to bird communities in appropriate reference sites are rare. I report on an 18-year study of grassland bird communities within two grassland restorations in northeastern Illinois. These restorations have been quickly colonized by a variety of birds, with 31 species observed between 1995-2012. As the restorations have matured bird communities have changed, and time series analyses indicate the communities are undergoing directional change. Comparison of bird communities within the restorations with bird communities within an adjacent native prairie remnant show that the two are converging, with communities within the restorations becoming more similar to the native remnant through time. The data also suggest that bird communities within the restoration are currently indistinguishable from the bird community within the native remnant.

Restoration planning: Developing targets and key ecological attributes to guide ecological restoration and management at Emiquon

Herkert, James R.; Maria Lemke, Doug Blodgett, Jeff Walk

Illinois Department of Natural Resources

The Nature Conservancy and its partners have developed a framework for evaluating the success of conservation work. The framework, which was published by Parrish et al. (2003; *Bioscience* 53,851-860), includes four core components, (1) identification of a limited number of focal conservation targets, (2) identification of key ecological attributes for these targets, (3) identification of an acceptable range of variation for each attribute as measured by properly selected indicators, and (4) rating of target status based on whether the target's key attributes are within acceptable ranges of variation. The approach provides a foundation for setting conservation objectives, assessing threats to targets, identifying monitoring and research needs, and evaluating conservation progress. Beginning in 2004, The Conservancy initiated an effort to apply this framework to the Emiquon Preserve located along the Illinois River in Fulton County, Illinois. Conservation targets identified in the Illinois River Site Conservation Plan were used as the initial set of potential targets for the Emiquon Preserve. Key ecological attributes and indicators were then developed during a meeting of The Nature Conservancy's Emiquon Science Advisory Council in April 2004. These key ecological attributes and indicators have served as the basis for restoration and management planning at Emiquon and also have provided the framework for evaluating the progress of the ecological restoration at this site. A monitoring program focused on collecting data on these key attributes has been initiated and these monitoring data are being used to drive an adaptive management process.

Sowing seeds of doubt: Trans-national cultivation and selection of European grassland species and implications for restoration

Hermann, Julia-Maria; Johannes Kollmann

Chair of Restoration Ecology, Dept Ecology and Ecosystem Management, Technische Universität München

C3 grassland species have been bred and cultivated in Europe for centuries, and were introduced to overseas countries for fodder production and erosion protection, especially when native species were not commercially available. Other species were accidentally introduced but possibly subjected to selection by humans in their home range. This creates a dilemma for ecological grassland restoration with its increasing demand for regionally

ORAL ABSTRACTS (CONT'D)

sourced native plant material. It is feared that artificial selection de-selects ecotypes and increases competitive ability, jeopardizing species diversity of the restored site. The effects of breeding and cultivation on native target species in ecological restoration must, however, be judged in the context of the effects of breeding and cultivation on colonizing and competitive ability of co-occurring European-origin grassland species. This has rarely been done. Cultivation catalyzes naturalization of a wide range of nonnative species. Invasion researchers have, moreover, proposed several mechanisms that may increase competitive ability of nonnatives in a novel range. Would breeding and cultivation add to competitive advantage? – We attempt to synthesize the body of knowledge of invasion ecology and agricultural sciences for a set of European species in temperate grassland eco-zones. The following questions are of main interest: (1) Which traits in grassland cultivars are selected so that their invasive potential may be increased? (2) How relevant is cultivation in the novel range and in the native range? (3) How relevant is „hidden cultivation“, e.g. of arable weeds observed in restored grassland? (4) What are the implications for cultivation in native grassland restoration?

Building flexible ecological quality models for land management decision-making

Heslinga, Justin L.

Cardno JFNew

Every day, land managers must make decisions on how to use limited time and financial resources to achieve management or restoration goals in parks, preserves, and other natural areas. Too often, “shotgun” or other ad hoc approaches are employed in the management of natural areas, resulting in ineffective or inefficient management. Using objective, science-based approaches to rank natural areas in terms of ecological quality offers a better way to prioritize areas for management, leading to more effective management outcomes. These types of models have been developed for use at the landscape scale and within specific ecosystem types, but are not widely used within the context of on-the-ground management and restoration. In this presentation, I will describe the process of creating a simple, flexible model that uses quantitative ecological data to prioritize management areas and can be used to inform management decisions.

An ecological approach to flood hazard reduction and associated floodplain restoration along urban streams

Hesseldenz, Thomas F.; John H. Humphrey, David W. LaPlante

Tom Hesseldenz and Associates

Cities are often located in active floodplains. Traditional methods of reducing flood hazards have consisted of structural solutions such as levees, revetments, channelization, and upstream dams and diversions. While these solutions have worked to varying degrees, they have also reduced the ecological health of affected streams. Urbanized streams also tend to become highly incised due to increased hydraulics from loss of floodplain access and increased peak flows. Ecological approaches to urban stream restoration are limited by the inability to raise or re-route streams to re-access historic floodplains due to the extent of adjacent development. A different ecological approach has been developed in the City of Yreka, California, that consists of lowering the banks along deeply incised channels to create new accessible floodplains close to existing stream levels. Modeling has shown that this approach can potentially contain up to 100-year or larger flood events within the newly-created floodways, and can also satisfy geomorphological requirements for healthy channels and floodplains. Once floodplain function has been restored, instream and riparian restoration can also be achieved. In Yreka, this approach has been implemented along 1 mile of streams to date, and funding has been obtained for 2 more miles. Changes to adjacent development are being kept to a reasonable level, and spoils from floodplain widening are being used nearby to raise building pads in backwater flood zones. The new floodways will double as greenways through the city that will include paved multi-use trails and various interpretive facilities.

Trees communities and filters to restoration along a periurban gradient of tropical forest degradation: the case of miombo in the region of Lubumbashi (DRC)

Hick, Aurélie; Martin Tooth, Alain Tshibungu, François Muyemba, François Malaisse, Grégory Mahy

Université de Liège

Periurban african dry forests are under high pressure for energy demand due to exponential development of cities. In the region of Lubumbashi (Katanga, south RDC), Miombo forest has declined dramatically during the last 20 years with a loss of about 80% of forest surfaces. In this study, we characterize the pattern of floristic variation of Miombo tree communities in relation to soil chemical properties and herbaceous biomass in reference and degraded forests/savannah ecosystems in the periphery of Lubumbashi. Our specific aims are : 1) to identify limits to spontaneous regeneration of miombo communities after degradation, 2) test for change in chemical soil properties and herbaceous biomass that may hampers regeneration of miombo. PCA followed by Kmeans classification revealed six major floristic groups. Floristic variation among plots showed a homogenization of species composition in savannas ecosystems. Species composition differed among adults and regeneration in most stages. Two communities were distinguished in reference forest : “*Marquesia macroura*/*Brachystegia longifolia* forests” and “*Brachystegia spiciformis* forests”. Two species were presents in all communities: *Diplorhynchus condylocarpon* and *Baphia bequeartii*. Chemical variation (PCA) of soil was not related to communities and/or stages of degradation. Our study highlighted differences in regeneration potential between two references Miombo forests on deep red soil, highlighting potential differences in dispersal capacities and/or vegetative regeneration after disturbance. Modification of chemical soil conditions do not appeared as a major filter to restoration. Increase in herbaceous biomass in degraded stages is hypothesized to be a filter to spontaneous regeneration of miombo forests.

ORAL ABSTRACTS (CONT'D)

Native and non-native invaders challenge restoration efforts in the Central and Southern Great Plains (US)

Hickman, Karen R.; Gail W.T. Wilson

Oklahoma State University

Grasslands of the central and southern Great Plains (US) are being invaded by exotic legumes (*Lespedeza cuneata*), exotic C4 grasses (*Bothriochloa* spp; *Dichanthium annulatum*; *Pennisetum ciliare*), native C4 grasses (*Heteropogon contortus*), and native juniper (*Juniperus virginiana*). The exotic invaders, native to Europe, Asia, and Africa, were introduced to the U.S. and planted extensively throughout the central and southern Great Plains. Similarly, the native juniper has rapidly expanded its range, because of extensive planting and land management changes. Within the past 15 years, research on these species has shifted from an agriculture/forage production/landscaping focus to studies on restoration of invaded areas. Thus, in this region restoration challenges are not only ecologically, but also culturally challenging, as many citizens still desire these species for their use. In our research program the focus for restoration efforts has been on determining the best management practice to eradicate the invader, which frequently has been met with limited success. We propose that limitations to grassland restoration projects in these nutrient-limited systems might be overcome if focus were placed on more mechanistic traits of the invaders: propagule pressure, extensive seed banks, competitiveness, allelopathic effects, and subsequent plant-soil feedbacks. We will provide case studies describing our restoration challenges and successes, suggesting that successful restoration may require the use of soil remediation designed specifically for the invasive species of interest.

Back to a future landscape: prospects for ecological restoration

Higgs, Eric S.

University of Victoria

The fact of novel ecosystems--those without historical analogue, self sustaining and impractical to restore--is unsettling for restorationists. The concept of novel ecosystems is even more so, because it augurs a future in which we loosen the ethical tethers on human ambition. Such concerns are warranted, but the fact of novelty compels restorationists to develop a flexible palette of options to intervene responsibly in historical, hybrid and novel ecosystems (and landscapes). The challenge going forward is developing a moral basis for acting responsibly in ecosystems that lack historical continuity: can we do so without human ambition (and hubris) taking over? How can biodiversity and ecological autonomy be respected? In this presentation I sketch out the importance of taking novel ecosystems seriously, why we should be concerned about their rise, and some strategies, including "wild design," for expanding the scope of ecological restoration.

Managing the whole landscape: expanding the restoration paradigm

Higgs, Eric S.

University of Victoria

The concept of novel ecosystems evolved from the fact that a growing number of ecosystems worldwide are severed from historical trajectories and are without precedent. That these ecosystems are generated through direct and indirect human causes gives rise to obligations for restoration or similar interventions. In this presentation I set the stage for the symposium, and argue for a whole landscape approach, in which novel, hybrid and historical ecosystems are used to inform conservation and restoration decisions. This approach pushes the ecological restoration paradigm past austere notions of historical fidelity toward a more appropriate response to the variegated landscape that results from rapid human induced change. Attendant with such a proposal are concerns about how people will engage with ecosystems in the future, and the moral conditions that will guide responsible intervention.

Creating a successful public-private conservation partnership: integrating natural resource and transportation agencies into the Staying Connected Initiative

Hilke, Jens

State of Vermont Fish and Wildlife Department

Currently, considerable attention is being focused on working at the landscape scale to address habitat connectivity as a way of mitigating the impacts of habitat fragmentation and climate change. For State fish & wildlife, as well as transportation agencies in the eastern U.S., attention to this scale presents challenges for both conservation science as well as implementation. The Staying Connected Initiative (SCI) is a private (NGO)-public partnership that has helped state agencies to understand the broad context of regional-scale habitat connectivity and implement solutions that are locally appropriate. SCI has teams of partners working on conservation science, land protection, land use planning, landowner education and outreach as well as road barrier mitigation. Teams in these parallel tracks all work towards the same end of maintaining habitat connectivity, but, by operating on multiple fronts, the partnership is uniquely suited to scale down regional level science into a range of options for locally-appropriate implementation. This enhances the capacity of public agencies by ensuring that investments in one track (e.g. transportation infrastructure improvement for wildlife movement) are done in conjunction with other work (e.g. land use planning for connectivity adjacent to transportation infrastructure improvements). Partnerships such as this can provide ecological restoration practitioners with additional context for their work, integrating site-level efforts into landscape scale vision and action.

ORAL ABSTRACTS (CONT'D)

Spiders in the grass: The effects of spiders, herbivores, and non-native grassland plants on native plant damage.

Hill, Kirsten; Mary Power

University of California, Berkeley

Biological invasions are disrupting ecosystems worldwide. In California, native bunch grasses have been displaced by non-native annual grasses throughout their former range, displacing native flora. Little is known about how interactions of grassland invertebrates have been affected. We experimentally tested the hypothesis that non-native grassland habitats weaken top-down control in comparison to native perennial and newly restored (native grasses planted in annual grassland) habitats. In June 2012, wolf spiders (*Schizocosa mccooki*) were added or removed to 1m² plots in native, non-native, and restored habitats. After four weeks, we measured invertebrate chewing damage to native and non-native leaves by, 1) the proportion of leaves damaged per plot and, 2) the amount removed per leaf. Spider presence decreased the proportion of damaged native leaves across habitats ($p < 0.0001$). Spiders had no effect on non-native leaves or removal per leaf. Overall, habitat had no effect on spider impact. Post-hoc comparisons revealed restored habitats had more damaged native leaves than non-native habitats ($p = .03$). These findings suggest 1) native vegetation suffered a disproportionate frequency dependent damage when they were a smaller component of the assemblage, especially in newly restored habitats, and 2) spiders exerted a protective effect on native plants. Our findings reveal the affects of plant assemblages on the impacts of predators that indirectly protect plants and imply that context-dependent movements, population dynamics, and interactions of invertebrates are relevant to grassland restoration.

Using mega-nourishment to adapt sandy beaches to sea level rise and storms

Hill, Kristina

University of California Berkeley

Most of the world's sandy coastlines are already coping with changes in erosion and deposition that are caused by very long-term regional changes in sediment supply, as well as local interruptions of sediment transport. As a result, many sandy coastlines are already actively replenished by dredging from deeper-water sources of sand. Sandy coastlines have different opportunities and constraints for adaptation to sea level rise than rocky shores or silty-muddy shores. The Dutch have initiated a number of full-scale experiments to find less expensive ways to use dredged sand to create multiple benefits, providing storm protection, recreation, and biodiversity. The Zandmotor is a new "feeder beach" on the coast near The Hague, which was built at 25% the normal cost. It provides an interesting example with immediate relevance to the sandy coasts of the United States, where enormous quantities of sand are being dredged for beach replenishment and maintenance of harbors, marinas and shipping channels. We tested the prototypical forms of a feeder beach using the CEM (Coastal Evolution Model), as a way to get a first approximation of how these forms might be altered by wave energy over time. We also developed a framework for evaluating multiple benefits of beach adaptation, including ecological productivity and recreational value, and interviewed local stakeholders to find out what their reactions would be to this different approach to beach design and management. Our conclusions may be applicable to a wide range of sandy coastline conditions in the US, including New York and New Jersey.

On the ground challenges for reclamation versus restoration at legacy mine sites

Hinck, Jo Ellen; Susan Finger

USGS-CERC

Reclamation of legacy uranium mines in the United States generally includes isolation, control, or removal of surface stock piles; backfilling mine openings with waste rock and low-grade ore; sealing the mine shaft; recontouring the site using pre-mining local topsoil; and revegetation of the mine site and haul roads. If performed adequately, remediation efforts can prepare a site for restoration. However, certain reclamation components as defined by U.S. federal regulations including the removal of toxic substances; the rehabilitation of fish or wildlife habitat; and the establishment of self-sustaining vegetation are not always met. Mine waste material is present at reclaimed uranium mines because of erosion, incomplete removal or coverage of waste material during reclamation, and lack of monitoring. Risk from exposure to contaminants from legacy mines has been documented for biota inhabiting these sites. With the continued risk of exposure, true restoration cannot be implemented. Successful reclamation at uranium mines has historically been defined as soil stabilization through revegetation with non-natives. Using native plants to reclaim would move one step closer to a restoration goal. This approach has faced criticism because of the cost and time required for native flora reestablishment in the desert southwest. Developing alternative remediation goals with implementation of long-term monitoring would help to reestablish functional ecosystems and reduce the risk of inorganic contaminants to wildlife receptors to acceptable levels at legacy mining sites and future mine sites. Advantages and disadvantages of different reclamation and restoration approaches used at legacy uranium mines will be presented.

Competing feedbacks as a driver for ecosystems development and restoration success

Hinz, Christoph

Brandenburg Technical University of Cottbus

Engineered landscapes represent one of the most severe disturbances, in which substrates with little biological memory are placed on the earth surface. Irrespective of the climatic region and substrate properties, the first precipitation events trigger abiotic feedbacks between fluid flow and particle transport and deposition on the surface and within the subsurface. This leads often to the formation of erosion channels by surface runoff and to particle redistribution within the soil resulting in hard setting and densification on the one hand or in tunnelling and subsurface erosion on the other hand. These abiotic feedbacks stand in direct competition with the colonisation of the substrate with organisms, which themselves are involved in abiotic-biotic feedbacks. For example root growth and associated microbial activities often increases infiltration capacity and water storage capacity by

ORAL ABSTRACTS (CONT'D)

aggregate formation, form fluid flow pathways, and affect the mechanical strength leading to a stable habitat with enhanced biological activities. During the very early stages of ecosystems development these two type of feedbacks compete in the sense that frequent flow events determine the extent to which organisms can establish themselves in the substrate. It implies that besides the substrate properties, the atmospheric conditions, in particular the statistical properties of event magnitude and frequency, determine the trajectory of the ecosystem development. Examples form semi-arid settings in Western Australia will be presented in the context of stabilising soil surfaces with rock armour by surface runoff and erosion and vegetation as well as woody root establishment in gold mine tailings.

Historical-hybrid-novel: from concepts to application

Hobbs, Richard J.

University of Western Australia

Discussing the concept of novel ecosystems seems to engender a polarized response. Some see a useful framework for considering the management options across the array of degrees of ecosystem alteration seen in our rapidly changing world. Others see a dangerous slide away from traditional restoration perspectives that ultimately threatens to erode the entire restoration enterprise. Here I discuss the concepts behind the novel ecosystems perspective, including such slippery issues as thresholds and reference systems, and then ask whether recent conceptual developments can be translated into practical guidance for policy and management. This involves considering the entire spectrum of ecosystem states from those that are relatively intact and maintain historical continuity through to those that are entirely transformed and characterized by novel biotic and abiotic combinations. In addition, consideration needs to be given to those hybrid systems in the middle of the spectrum – where novel elements are combining with the original assemblage in complex ways. We can continue to debate the utility or otherwise of the concepts, but in the meantime we also have to find ways to provide practical guidance to help steer the world's ecosystems through a period of unprecedented change.

Resilience in ecosystem management and restoration: can we make the concept more concrete?

Hobbs, Richard J.; Rachel J. Standish

University of Western Australia

Resilience is frequently encountered in policy as a desirable goal for ecosystem management, yet the demand for science-based frameworks for creating resilient systems is currently ahead of what ecologists can confidently provide. Here we consider which aspects of the multi-faceted concept of resilience can be usefully applied to ecosystem management. We highlight that resilience can maintain both desirable and undesirable states, and hence can be both helpful and unhelpful in a management context. A big hurdle in the application of the concept to management has been a lack of guidance on how to identify and measure resilience concepts, particularly ecological resilience. We explore species composition, functional diversity and landscape factors as potential measures. All three measures have a role in helping to define management goals (i.e., the desirable state), assessing ecosystem recovery after disturbance, distinguishing between 'unhelpful' and 'helpful' ecological resilience and monitoring the maintenance of helpful ecological resilience. In particular, trait-based approaches offer promise for their ability to link pattern to process across scales and so address a crucial element of the resilience concepts. Identifying what drives changes in these measures and ultimately the switch between ecosystem states would enable managers to predict the likelihood of a state change and whether intervention would be useful in maintaining or creating a desired state. Lastly, clarifying which drivers (slow and fast) can and cannot be managed to influence these shifts between states could help translate abstract resilience concepts to real-world guidance in management decision-making.

Restoration decision making: Panglossian or pragmatic?

Hobbs, Richard J.

University of Western Australia

How should we approach the pressing requirement for up-scaled and more effective restoration in a rapidly changing world? Do we continue to assert that it is possible to restore ecosystems in every situation, if only enough knowledge, resources and effort are thrown at it? Or do we alternatively recognize that it will be well-nigh impossible to do this, because of both ecological limitations and the unlikelihood that limitless resources will be available? The former approach, though promulgating the optimism inherent in the restoration enterprise, is likely to result in scattered and ineffective activities and ultimately, poor ecological and social outcomes. The latter, though apparently reeking of defeatism, may offer a more pragmatic and ultimately more effective approach to deciding what to do where. Deciding how best to allocate scarce resources and efforts in restoration can be likened to the practice of triage in medicine, in which decisions are made on priorities for urgent care in hospitals, warzones or natural disasters. Restoration triage is required to ensure that restoration efforts are targeted effectively through an effective decision-making process that considers the scale and treatability of the problems to be dealt with, the resources available, and the overall likelihood of useful outcomes across as broad a range of situations as possible.

Modeling Sea Level Rise in the NY-NJ Harbor Estuary using a Coastal Vulnerability Index

Hoelzle, Timothy; Zachary Lehmann, Kate Boicourt

Great Ecology

The impacts of climate change on global sea levels poses a particular risk to coastal communities. In response to concerns about projected sea level rise (SLR), and increasing pressures on public access, the NY-NJ Harbor & Estuary Program partnered with Great Ecology to launch Case Studies in Sea Level Rise Planning: Public Access in the NY-NJ Harbor Estuary, focusing on sites in the Raritan River in New Jersey. Great Ecology conducted a GIS

ORAL ABSTRACTS (CONT'D)

analysis of the vulnerability of public access infrastructure and natural resources (e.g., parks) to SLR at three public access sites within the harbor estuary. Great Ecology used LiDAR data, publicly-available GIS data, and information gathered during site assessments to create a geospatial composite overlay and a Coastal Vulnerability Index (CVI) model (adapted from Tallis et al. 2011) to assess SLR impacts for these three sites. The CVI model considered six main criteria: geomorphology, relief, low-lying areas, natural habitats, soil type, and projected sea level rise. By including recommendations at the site-scale, the case studies provide practical insight into techniques to minimize potential ecological and public access infrastructure damages caused by SLR. The CVI model demonstrates a relatively simple and rapid method that provides coastal communities with the information needed to plan for SLR. By focusing on vulnerability to SLR and potential resiliency options at the site scale, the project complements larger scale vulnerability assessments by providing site-specific recommendations for towns, counties, and landowners.

Multiple benefits of tallgrass prairie restoration

Holland, Jeffrey; Insu Koh, Joe Fargione, Helen I. Rowe
Purdue University

The area of tallgrass prairie has been severely reduced. In north-west Indiana, restoration work has reclaimed this habitat from crop fields surrounding the Beaver Lake tallgrass prairie remnant. Over the past five years, we have used vegetation and insect sampling in the prairie remnant and restorations, and throughout the surrounding county, to examine several different benefits stemming from the remnant–restoration complex. We found that the prairie complex contains a high diversity of leafhopper species, especially in restorations of high plant diversity. We found that prairie restorations can buffer prairie remnants against incursion by exotic plant species. Using graph- and circuit-theory approaches, we found that some native beneficial predator insect species are bolstered by prairie habitats and that this increases biological control of crop pests can extend far from the prairie if suitable networks of habitats such as conservation plantings are in place. We found that exotic *Harmonia* ladybird beetles did not show this same pattern of response to the prairie and habitat network.

Restoration and conservation planning based on carbon sequestration under current and projected future scenarios

Hooper, Michael J.; John Schmerfeld, Kristin Byrd, Susan Kennedy, Robin Tillitt, Susan Finger, Zhiliang Zhu, Matthew A. Struckhoff
U.S. Geological Survey, Columbia Environmental Research Center

The USGS Biologic Carbon Sequestration Assessment (the Land Carbon Project) is developing baseline and projected levels of carbon sequestration and greenhouse gas fluxes of ecosystems as a function of existing and projected changes in land use. Their assessments identify lands with high carbon sequestration capacity and potential for future climate change, wildfire, land use change, and land management activities that could modify that capacity. Department of Interior agencies overseeing contaminant-associated restoration and refuge conservation activities are working to provide practitioners with tools that assist in climate change adaptation and identifying lands whose restoration and protection maintain or increase biological carbon sequestration. Incorporation of biological carbon sequestration into resource planning in wetlands across the United States Great Plains ecosystems is the goal of this project, by developing and testing guidelines to identify lands with the greatest current or potential carbon stocks and/or sequestration values. Key areas of interest are National Wildlife Refuge System land protection and acquisition, and restorations associated with Natural Resource Damage Assessment settlements. Using Land Carbon datasets, spatial distributions of wetlands with high soil organic carbon and woody biomass levels and high likelihood of future conversion were identified and classified based on wetland type. We assessed future opportunities for climate change mitigation, primarily though avoided loss of high carbon wetlands, and considered suitability of land for competing uses. Locations of existing and anticipated restoration and conservation efforts were overlaid on maps of wetland carbon values to identify resource activities that could benefit from input on carbon sequestration potential.

Community-based Ecological Restoration in the Urban Commons: California Examples at Schools, Libraries, Fire Stations and Other Community Lands.

Hopkins, Arlene; Lisa Novick
Arlene Hopkins & Associates

Inspired by the work of Elinor Ostrom, Johan Rockström, Robert Costanza and others, we will look at program and project strategies emerging at the nexus of culture and nature that enhance the regeneration and resilience of community ecological and social systems. The approach integrates best ideas from multiple disciplines to the challenge of community-based climate change mitigation and adaptation, and uses ecological restoration as a keystone strategy. Thinking globally, the Stockholm Resilience Center's Nine Planetary Boundaries are used as a dynamic boundary framework. Acting locally, the presentation focuses on community-based ecological restoration at public places such as schools, libraries, fire stations, city halls, museums and urban connective places such as boulevards and alleyways. Examples will be drawn from urban environments in California, and will include the work of Lisa Novick of the Theodore Payne Foundation. Taking a social ecological systems approach, ecological restoration practice is integrated with both facilities planning and organizational culture. This includes the design and construction of the buildings and the site infrastructure and landscape improvements. The entire site becomes a focal action situation for a social ecological system process which includes ecological restoration. For schools, as one example, site planning is integrated with place-based, differentiated curriculum blended with environmental education and mobile platforms; specific school sites will be used to illustrate the use of ecological restoration as a keystone strategy for social ecological systems resilience. So, incrementally, as other community places become focal action situations, so is a network of community action situations assembled.

ORAL ABSTRACTS (CONT'D)

Field assessment and geospatial modeling for developing an ecological design for restoration in the St. Louis River Estuary

Host, George; Paul Meysembourg, Carol Reschke, Valerie Brady, Gerald Niemi, Annie Bracey, Lucinda Johnson
University of Minnesota Duluth

The 4,860 ha St. Louis River estuary, the largest U.S. tributary to Lake Superior, provides diverse and important habitat for fish, birds and wildlife, but is also an EPA Area of Concern with a long history of industrial degradation. We have developed an 'ecological design' for two restoration sites in the lower estuary. In this design process, biological variables collected in the field were integrated with geospatial data to develop a predictive model of aquatic vegetation. We sampled vegetation, substrate, benthic macroinvertebrates, and bird usage at two 'remediation-to-restoration' sites, along with reference locations at other sites. Bathymetry, wind fetch and other environmental variables were used to develop logistic regression models to predict occurrence of dominant aquatic vegetation communities. These relationships were incorporated into a GIS modeling framework to map the predicted distribution of aquatic vegetation across these restoration sites. This approach allows the assessment of ecological design scenarios, in which alternative restoration approaches can be evaluated. Scenarios include alterations to substrate or bathymetry to provide more suitable habitat for emergent, floating-leaf or submerged aquatic vegetation beds, along with the creation of islands or breakwalls to disrupt wind fetch and dissipate wave energy. Environmental endpoints are assessed in terms of the type and areas of different aquatic vegetation beds established, along with the consequent improvement for macroinvertebrate, fish, and avian habitat. This ecological design tool will provide important information to decision makers as they consider options among restoration activities that vary in cost, effort and effectiveness.

Looking to the past for a wider range of options in northern Wisconsin.

Hotchkiss, Sara C.; Elizabeth A. Lynch, Randy Calcote, Michael A. Tweiten, Gregor Schuurman
University of Wisconsin

Questions about natural range of variation and long-term responses of different vegetation communities to climate change are integral to restoration planning. Which communities are most stable? Under what conditions do sudden state changes occur? We used paleoecological records to assess the response of forest communities and fire regimes on sandy soils in northwestern Wisconsin to climate changes of the last 4000-8000 years. Transition matrices calculated using >500 transitions show that jack pine (*Pinus banksiana*) communities with strong fire feedbacks varied more at 70-year intervals than other community types but showed few large changes in state over thousands of years, despite variation in climate and fire regimes. In contrast, communities with more oak (*Quercus* spp.) and white pine (*Pinus strobus*) had larger state changes, sometimes coincident with evidence for climate change. Observations from this analysis of history include: 1. The modern vegetation includes more oak than has been present over the past 4000 years, but some communities did have abundant oak >4000 years ago. 2. The Public Land Survey records are a reasonable representation of vegetation from ~650-200 years ago in most areas, but that period is unlike any other period in our data. 3. Jack pine vegetation on coarse sand in an area with few fire breaks has been quite stable despite climate changes. 4. The more heterogeneous vegetation on soils with greater moisture-holding capacity in an area with more potential firebreaks has had more state shifts over time. Some of those sudden state shifts have coincided with climate changes.

Restoration, Narrative, and History: Unearthing Values at Former Military Sites

Hourdequin, Marion E.
Colorado College

In many landscapes, the traditional notion of historical fidelity in ecological restoration provides inadequate guidance because contemporary and future social, ecological, or climate contexts differ, or will differ, radically from the contexts that historically prevailed. What's more, setting restoration goals often requires negotiating diverse social and ecological values. In light of such changing contexts and complex values, John O'Neill, Alan Holland, and Andrew Light (2008) have recommended that we embrace a "narrative ethics" that incorporates social values and takes account of the past while allowing for change as part of a coherent, unfolding story. Drawing on case studies from two military-to-wildlife refuge conversion sites in Colorado, this presentation illustrates ways in which narratives can reveal conflicting values and meanings in restoration. At Rocky Flats, for example, there are distinct tensions between two key narratives: a government narrative which asserts that the site is cleaned up and ready for a new chapter in its history as a public wildlife refuge, and a counter-narrative embraced by activists and many members of the public which sees the site's history as a plutonium production facility as a critical consideration in planning its future. These narratives, in turn, point to different approaches to restoration and management of Rocky Flats. Although narratives cannot directly settle complex questions regarding the establishment of restoration goals for a particular site, they can illuminate the value dimensions of restoration decisions, generate creative possibilities for reconciling diverse goals in restoration, and enable more thoughtful interpretation of restored sites.

Workshop: Teaching Restoration Ecology

Howell, Evelyn
Nelson Institute for Environmental Studies

Although the field of restoration ecology has been relatively slow to take root in higher education curricula, it is now gaining wider recognition as an important area of study. One need only look at the inclusion of the topic in two mainstream introductory biology texts — Life and Biology — as well as recent and forthcoming academic textbooks dedicated to the topic for evidence of an emerging interest among educators. This workshop will explore the teaching of restoration ecology at a variety of scales from developing learning outcomes and goals for undergraduate and graduate degree programs to providing learning objectives and activities for a restoration unit within a general biology or conservation biology course to offering a survey course

ORAL ABSTRACTS (CONT'D)

for non- majors. We will also explore various expectations for restoration curricula; for example, programs designed to teach implementation and management skills, those that focus on understanding and generating restoration theory, and others that blend education in theory, research and practice.

Latitudinal population genetic differentiation in *Stylidium hispidum*: implications for restoration planning

Hufford, Kristina; Siegfried Krauss, Erik Veneklaas
University of Wyoming

To reduce the risk of inbreeding and outbreeding depression in restored plant populations, guidelines for ecological restoration recommend introductions of diverse, local genotypes that reflect the boundaries of gene flow and adaptive differentiation. Molecular genetic analyses contribute to the development of these guidelines through detection of the magnitude and extent of genetic differentiation, and initial prediction of zones for seed transfer. In this study, we compared molecular marker differentiation among populations of *Stylidium hispidum*, a species endemic to Southwestern Australia. Population genetic structure was calculated for 16 sites and 134 AFLP loci along a north-south transect of the species range, and multivariate ordination methods were used to detect significant differences among clusters of sites. Genetic differentiation among these populations is contrasted with previous studies of fitness in short- and long-distance intraspecific hybrids among four of the 16 sites. Results will be discussed in light of the consequences of mixing seeds sources for biodiversity restoration, and the efficacy of methods to determine germplasm suitable for restoration sites.

The Canadian Lower Columbia Ecosystem Management Program – A collaborative approach to assess, restore, conserve and enhance terrestrial ecosystems around a smelter site.

Hull, Ruth N.; Marlene Machmer, Steven R. Hilt, David DeRosa
Intrinsic Environmental Sciences Inc.

The Canadian Lower Columbia Ecosystem Management Program (LCEMP) is a collaborative approach to assess, restore, conserve and enhance terrestrial wildland ecosystems (including wetland and riparian areas) in the Program area. The LCEMP scope includes all lands identified as showing residual impacts to vegetation communities in an Ecological Risk Assessment completed for an area within a zone of historical smelter emissions, and also includes non-impacted lands over a broader area. A Steering Committee, that includes participation from regional and provincial governments, and local conservation programs, will oversee and direct LCEMP through the development, implementation and performance monitoring phases of the Program. LCEMP builds on work that Teck, the smelter operator, is already doing on its own lands, and also creates opportunities for additional conservation gains by encouraging collaboration with other area stakeholders and landowners to identify and implement activities that result in the greatest environmental benefit. A variety of actions could be implemented through LCEMP including: improving soil conditions; restoring, maintaining or enhancing habitat suitability; creating habitat elements; and conserving and protecting features or lands. The LCEMP Steering Committee members are consulting with a variety of stakeholders to identify opportunities for conservation partnerships with these other landowners. By adopting this landscape-scale approach, it is felt that the program can effectively address issues related to ecosystem function, biodiversity, habitat connectivity and suitability for a wider range of species.

Does native revegetation lead to the restoration of plant-herbivore interaction networks?

Hume, Ellen; Raphael Didham, Jason Tylianakis, Rosa Henderson
University of Canterbury, New Zealand

In regions that have been subject to severe habitat degradation, restoration intervention is often the only option available to mitigate or reverse biodiversity loss. Although restoration is often founded on a broad conceptual goal of improving native biodiversity, the majority of studies focus solely on revegetation and restoration of plant species composition. Reinstating overall community composition and structure is critical for the stability and functioning of ecosystems upon which we depend, but these aspects are rarely studied. By quantifying the interactions between plant species and their associated invertebrate herbivores, I aimed to determine whether native revegetation leads to the restoration of plant-herbivore interaction networks and ecosystem function. I collected herbivores from vegetation at seven restoration sites in mid-Canterbury, New Zealand, comprising a chronosequence of time since native revegetation, as well as from two ancient podocarp remnant forests that acted as reference sites of what interaction network structure might be expected to converge to in an intact natural system. The fraction of potential interactions realised in the network decreased with increasing time since revegetation, and was attributable to an increase in total species diversity, whereas the presence of exotic species did not alter the complexity of the networks. This has positive implications for restoration management techniques, as restoration practitioners may be able to actively promote the rapid return of plant-herbivore interaction network structure by simply planting a more diverse assemblage of species.

Integrating Ecological Restoration and Infrastructure in Puget Sound, Washington

Hummel, Peter C.
Anchor QEA

Large scale infrastructure such as roads, railroads, utilities, and coastal/flood protection has a limited functional life, and must be periodically repaired and replaced. Infrastructure can be viewed as hindrances or opportunities for ecological restoration in the face of sea level rise. As the realities and consequences of sea level rise become increasingly apparent, and as infrastructure ages, inevitable questions arise about how the replacement facilities will respond to these threats. In Puget Sound, Washington and elsewhere, coastal infrastructure has had significant impacts on nearshore ecosystems. As a result, replacing aging coastal infrastructure has the multiple responsibilities of considering both sea level rise, environmental consequences, and in many cases, ecological restoration that goes beyond minimizing impacts. The design and engineering solutions to these issues in rural, suburban and

ORAL ABSTRACTS (CONT'D)

urban settings are significantly different in response to differing constraints, and project objectives. In this presentation, opportunities to replace aging coastal infrastructure with new infrastructure that is along Puget Sound shorelines will be explored in the following three different settings: Rural Setting: Puget Sound Nearshore Ecosystem Restoration Project (PSNERP), Marshland Restoration, Snohomish County. Suburban Setting: Seahurst Park Ecosystem Restoration Project, City of Burien. Urban Setting: Elliott Bay Seawall Project, City of Seattle. Each example replaces different types of infrastructure and responds to sea level rise and ecosystem restoration differently based on differing settings, project objectives and constraints.

Pit and mound construction for restoring diverse plant communities on former farm fields: 10-year results

Hunt, Shelley; Cara Bulger
University of Guelph

Pit and mound construction is an ecosystem restoration technique that is becoming increasingly common in southern Ontario and other jurisdictions. However, very little quantitative information is available on the success of this technique in restoring diverse plant communities to former agricultural land. We surveyed plant communities occurring on 3 different restoration sites 10-12 years after pit and mound construction had been implemented. We hypothesized that different microenvironments (i.e. pits, mounds, and flat ground) would host different plant communities, and that overall this would result in greater plant species diversity in areas with pits and mounds versus areas without. We also hypothesized that variability in the plant communities found within a particular microenvironment would be linked to characteristics of the pit or mound (e.g. pit depth, mound height, etc.). We used univariate (t-test) and multivariate (nonmetric multidimensional scaling) statistics to analyze the data. We found that areas with pits and mounds contained more plant species overall than flat areas (53 vs 27 species on average). This could be explained by the occurrence of distinct plant communities particularly in pits, but also to some extent on mounds, compared to flat ground. Plant community composition in pits was related to pit dimensions and water-holding capacity.

Maintaining flat bug species (*Aradus* spp.) in boreal forest landscapes; an experiment mimicking natural disturbances.

Hägglund, Ruairidh; Joakim Hjältén
Swedish University of Agricultural Sciences

Industrial forest harvest and fire suppression has led to reduced structural heterogeneity with subsequent declines of biodiversity in Swedish boreal forests. In order to achieve environmental certification many forest companies implement some environmental consideration such as tree retention and leaving buffer zones against waters. In order to improve prerequisites for biodiversity it would also be desirable to practice more active restoration such as prescribed burns and creating artificial gaps, which mimic natural disturbance and recreate a more diverse forest landscape. By using replicated prescribed burns, artificial gap cuts and forest set asides as experimental controls, we tested the efficiency of restoration efforts for maintaining biodiversity. Fungivorous flat bugs, within the poorly known *Aradus* genus were positively affected by forest fire. Significantly more *Aradus* specimens were found in burned stands than in gap cuttings and controls. *Aradus corticalis*, *A. betulae* and *A. brevicollis* which previously were not considered pyrophilous, were exclusively found in burned sites. We suggest that more species of *Aradus* are strongly favored by forest fire than previously known. In contrast to the fire favored species, *Aradus depressus* was primarily found in stands with artificially created gaps. Only one single specimen of *Aradus* (*A. depressus*) was found in the control sites. In order to maintain multiple *Aradus* species in the landscape our recommendation to forest managers is the use of a diverse restoration toolbox, including prescribed forest fire and artificial gap creation, as part of their management practices.

Pollinator habitat restoration in managed lands – does it increase bees and crop yield, and can that further encourage restoration?

Isaacs, Rufus; Emily May, Brett Blaauw
Department of Entomology, Michigan State University

Government-funded programs in the last Farm Bill encouraged conversion of land into habitat to support bee populations, persuading land owners to enhance thousands of acres within agricultural landscapes with greater floral diversity. The expansion of these programs has led to a need to understand which plant species are most suitable for this use, how they perform in mixes, which bees respond to the restorations, and whether bee abundance and diversity are enhanced. Adoption of these practices is also expected to be encouraged by evidence of economic benefit to landowners, yet this information is rare or non-existent for most agricultural systems. Here, we describe studies to compare native plant mixes varying in diversity for support of bees, with our results suggesting that the added expense of plant diversity does not result in greater wild bee abundance. To evaluate the benefit of adopting pollinator habitat in commercial farms, as promoted through the CRP-SAFE program in Michigan, we have also established wildflower plantings adjacent to blueberry fields and measured crop pollination and yield compared to fields without the restorations. Establishment of pollinator habitat led to higher blueberry yield after 3 years, with the cost of planting establishment recouped one or two years later, depending on the yield benefit, subsidy, and crop price. Such information is being used to educate land owners about the benefits and potential revenue enhancement opportunity of pollinator restorations, providing further incentive to adopt these practices as a component of their farm management and crop pollination strategies.

ORAL ABSTRACTS (CONT'D)

Restoration of a wetlands complex in the Forest of Chinon (France).

Isselin-Nondedeu, Francis; Sylvain Pincebourde, Alain Pagano

Université François Rabelais

In the 1970s and 1980s, afforestation has destroyed up to 95% of the wetlands within the Forest of Chinon, Loire Valley (France). These wetlands were mainly depressionnal wetlands of various types : temporary and permanent pools, peat pools, wet heaths. They were hydrologically isolated and spatially organized to form wetlands complex. Forest industry filled the depressions, drained the wetlands to plant pine trees. In 2012, we started a restoration project to rehabilitate 35 degraded wetlands distributed on a total surface of 95 ha within the forest by recreating depressions and cutting trees. The sites to be restored were chosen in order to optimize the ecological connectivity of the wetland complex. This research investigated colonization of the restored wetlands by vegetation, populations of amphibians and dragonflies. For these latter, we identified the species (larval states and adults) and estimated their populations in every restored wetlands. Monitoring also included hydrology (chemistry, hydrological regimes). We present the results of the first year after the restoration, including summer 2013, by comparing data obtained before and after the restoration and with undisturbed neighboring wetlands. We used mark and recapture methods to follow displacements within the wetland network. The first results show a rapid colonization of the restored sites, especially by newts (both larvae and adults), including rare and protected species. However, few dragonflies' species were found the first year. We examined the relative importance of environmental parameters (such as light, vegetation, water chemistry) and the location of the sites within the complex on the colonization rates.

History of ecological history in ecological restoration

Jackson, Stephen T.

USGS

Ecologists have viewed ecological dynamics in three contrasting ways: successional steady-state, gradual long-term change, and historically contingent evolution, each with counterparts in restoration. In a steady-state world, ecological processes culminate in static or dynamic equilibrium, persisting in the absence of perturbation. Classical ecological restoration has aimed at restoring ecological entities and properties to something approximating original, historical states, by manipulating successional processes, intervening to re-create historical states, or both. Ecologists have long known that long-term environmental changes, particularly climatic changes, have occurred in the past several thousand years, affecting species distributions, community composition, and ecosystem properties. Until recently, this view has been accommodated in classical ecological restoration, with tacit understanding that restored ecosystems should be able to respond in dynamic equilibrium with gradual environmental change. This view is being reconsidered with recognition of rapid climatic change in current and coming decades. The third view, historically contingent evolution of ecological systems, has origins in Cowles' 1901 notion of vegetation and climate as 'a variable pursuing a variable' and Gleason's arguments concerning historical contingency in ecological succession, and has been expanded and enriched in the past two decades by ecological and paleoecological studies. Historical contingencies and legacies abound in many ecological systems, novel environmental and ecological realizations arise (and existing realizations disappear) through time, and many natural communities and ecosystems have shallow antiquity, arising only within recent millennia, centuries, or decades. This view poses practical and philosophical challenges for ecological restoration, but creates new opportunities and pathways in a rapidly changing world.

What's new about ecological novelty?

Jackson, Stephen T.

USGS

Ecologists are recognizing that the combination of rapid environmental change and alteration, severe disturbance, invasive species, and other factors are leading to emergence of novel ecosystems at an increasing rate. Such ecological novelty is attributed, directly or indirectly, to human activities. This recognition comes at the same time as increasing awareness from historical ecology and environmental history that human activities have influenced ecological properties and processes for millennia, at spatial scales ranging from local to global. Human-driven novel ecosystems are characteristic features of the Anthropocene. In a third, and largely independent development, paleoecologists have recognized since the 1970s that ecological communities and ecosystems are often ephemeral at timescales exceeding a few millennia, and that ecosystems lacking any modern analogues were widespread in the early Holocene. Indeed, paleoecological records indicate a continual unfolding of ecological realizations, with new ecosystems emerging and old ones vanishing, driven by continually evolving environmental realizations and combinations. Ecological novelty seems to be 'old news', from an historical perspective. From just about any point in time, the future will appear to be novel, just as the past too will appear to be alien. Though unsettling, this perspective can contribute to ecological restoration. By confronting the natural world as we find it, we are better positioned to make sound decisions, within a broader constellation of possibilities and acceptable outcomes, in a rapidly changing world. This perspective also illuminates the necessity of identifying and clarifying value choices in restoration.

A conceptual framework for restoration of threatened plants: the effective model of American chestnut (*Castaneadentata*) reintroduction

Jacobs, Douglass F.; Harmony J. Dalgleish, C. Dana Nelson

Hardwood Tree Improvement and Regeneration Center - Purdue University

We propose a conceptual framework for restoration of threatened plant species that encourages integration of technological, ecological, and social spheres. A sphere encompasses ideas relevant to and the people working within similar areas of influence or expertise. Increased capacity within a sphere and higher degree of coalescing among spheres predicts greater probability of successful restoration. We illustrate this with *Castaneadentata* (Marsh.)

ORAL ABSTRACTS (CONT'D)

Borkh., a foundation forest tree in North America that was annihilated by an introduced pathogen; the species is a model that effectively merges biotechnology, reintroduction biology, and restoration ecology. Because of *C. dentata*'s ecological and social importance, scientists have aggressively pursued blight resistance through various approaches. We summarize recent advancements in tree breeding and biotechnology that have emerged from *C. dentata* research, and describe their potential to bring new tools to bear on socio-ecological restoration problems. Successful reintroduction of *C. dentata* will also depend upon an enhanced understanding of its ecology within contemporary forests. We identify a critical need for a deeper understanding of societal influences that may affect setting and achieving realistic restoration goals. *Castaneadentata* may serve as an important model to inform reintroduction of threatened plant species in general and foundation forest trees in particular.

Optimizing seedling quality for reforestation after surface mining

Jacobs, Douglass F.

Hardwood Tree Improvement and Regeneration Center - Purdue University

Although mine reclamation sites are important targets for ecological restoration, they are generally difficult to regenerate successfully. These sites are typically planted with nursery seedlings of forest trees, and various morphological and physiological quality attributes may be quantitatively linked to restoration success. For example, root system size is positively correlated with seedling survival because large roots allow greater exploitation of soil for nutrient and water uptake. Additionally, carbohydrate content is correlated with root system size, thereby allowing seedlings to better avoid and tolerate stresses common to reclamation sites. Root:shoot biomass is another important morphological indicator because this reflects the water balance between root system uptake and plant demand – increasing root:shoot usually results in reduced drought stress, which is among the most severe stress factors on reclamation sites. Exponential nutrient loading in the nursery (whereby plants are fertilized at high rates toward the end of propagation to induce luxury consumption) has also been linked to improved growth and seedling nutrient content on mine reclamation sites, at least partly associated with translocation from stored reserves. Recently, eco-physiological models have been developed that link many of the aforementioned seedling attributes to survival on harsh restoration sites. These models suggest a feedback mechanism between plant reserves, root growth, photosynthesis, and survival that is also strongly relevant to mine reclamation sites. Understanding the key seedling quality variables that promote survival and growth under a given set of environmental conditions is essential toward achieving successful mine reclamation.

Restoring the High Desert: Volunteers, Healing the Land and Policy Change

Jacobs, Jefferson

Oregon Natural Desert Association

The Oregon Natural Desert Association (ONDA) seeks to conserve and restore large areas of Oregon's Great Basin. Their work extends directly into Idaho, Nevada and California and via cooperation with NGO's in those states. ONDA has grown significantly in influence and support over the last decade and a half, in part relying on traditional NGO tools such as lobbying and litigation. However a large part of ONDA's increased impact and reach comes from growth in its Wilderness Stewardship and Restoration program which removes extensive fencing, repairs grazing damage, re-establishes damaged habitat. Over the past decade the program has expanded to a cadre of hundreds of dedicated volunteers that return year after year. The restoration program has contributed not only to on-the-ground recovery of ecological function but to greatly enhanced public and agency support for policy changes. The growth of this program, its management and effectiveness, and plans for the future are analyzed for lessons that can be applied in the future and by other NGOs. Among the most important functions are imparting a strong sense of efficacy through visible achievements, reinforcement of love for the high desert country, providing opportunities for the development of community, and providing the opportunity to belong to an organization dedicated to an important cause.

Lessons Learned from Implementing a Variety of Watershed Restoration Projects within a Highly Urbanized Watershed located in the Great Lakes Basin.

James, Phil; Christine Zimmer

Credit Valley Conservation

The topic of this abstract is to discuss a variety of watershed restoration initiatives that have been implemented within an urban watershed located within the Greater Toronto Area. The Sheridan Creek watershed is a highly urbanized watershed that drains an area of approximately 1,035 hectares before draining to Rattray Marsh on Lake Ontario. The watershed exhibits a flashy hydrologic response and flooding and erosion is a major issue. Long term water quality monitoring indicates poor water quality and increasing trends for pollutants of concern such as metals, nutrients, chlorides and temperature. Rattray Marsh and Sheridan Creek have been heavily impacted by upstream urbanization activities such as development, road salting, nutrient loadings and forest and wetland loss. To mitigate the impacts of urbanization a variety of restoration projects were implemented ranging from Pollution Prevention (P2) to Low Impact Development (LID) demonstration projects. P2 projects included installation of secondary containment around outdoor fuelling stations, better outdoor material storage, and creation of clean water buffers and enhanced swales among others. LID projects include the creation of a raingarden within a public school, retrofitting of an existing parking lot using green infrastructure and conversion of several acres of lawn to natural landscaping. And finally, the reconnection of a portion of Sheridan Creek with its floodplain. Lessons learned will be highlighted such as partnership development, maintenance agreements, securing funding, design, construction and on-going operation and maintenance. Overview of knowledge transfer tools such as educational signage, performance monitoring and site tours to promote wide scale implementation.

ORAL ABSTRACTS (CONT'D)

Women hunters and their barriers to participation

Janiczak, Catherine

Ball State University

Ungulates can negatively impact the ecosystem structure and agriculture. Although there are methods to control ungulate populations (e.g. relocation, sterilization), hunting is accepted by wildlife managers as the most cost-effective and efficient way to control ungulate populations at the local level. In a society where fewer individuals understand conservation and restoration, hunting can help them understand the environment and ungulate overabundance. Researchers continually overlook one group of hunters: women hunters. Women hunters continue to increase according to the National Fishing, Hunting, and Wildlife-Associated Recreation Survey. It is important to understand the barriers to participation women have in hunting if wildlife managers want to rely on hunters for ecological restoration. B.O.W (Becoming an Outdoors Woman) introduces women to outdoor activities including hunting. An important factor missed by this organization is who introduces women to hunting: their male spouses. During the Indianapolis 2013 Deer, Turkey, and Waterfowl Exposition, female hunters filled out surveys. Analysis of survey data indicate women are most often introduced to hunting by a male spouse and are more likely to hunt than single or divorced women. This fall, surveys will be distributed throughout Indiana to women hunters and the results will be presented. It is important to understand women hunters and their barriers to participation because women will ultimately decide what outdoor leisure activities their family participates in. Ungulates have had negative impacts on the ecosystem, so it is important to study hunters, especially women hunters; they are and can be stewards for ecological restoration.

Does different nutrient supply affects biomass production or dry mass allocation of leguminous trees species in an ecological restoration planting in Central Amazon?

Jaquetti, Roberto; José Gonçalves, João Ferraz, Marciel Ferreira

Instituto Nacional de Pesquisas da Amazônia

The use of fast growing species that has high biomass production is a key aspect to restore forest ecosystems. For this purpose the leguminous trees are highly recommended, because of their ability of rapid nutrient accumulation improving the soil conditions. In order to understand the influence of different fertilization treatments on the biomass production of the Amazon leguminous forest species *Dipteryx odorata* (Aubl.) Willd., *Inga edulis* Mart. and *Schizobolium amazonicum* Huber ex Ducke, a field study was established to restore a degraded area near the Power Plant Balbina, AM. The species studied have been successfully used in ecological restoration plantings in the Amazon region. The following treatments were assessed: T1 = unfertilized control; T2 = chemical fertilization; and T3 = green and chemical fertilization. As we compared the species *I. edulis* showed higher biomass production in all fertilization treatments. Comparing the fertilization treatments *I. edulis* produced 56 times more total biomass in T3 than T1. T3 also favored *S. amazonicum*, with total biomass production 13 times greater than T1. In *D. odorata* the best treatments were T2 and T3. In general the fertilization treatments provided lower root mass fraction (RMF) and root/shoot ratio, which indicates a nutritional limitation in T1. Our results suggest that the combination of green and chemical fertilization is more effective in improving the biomass production of the species. Through this study we can finally recommend the need to improve the soil properties, to facilitate the development of the species in a degraded ecosystem.

City of Middleton, Wisconsin, Northern Pike Spawning Habitat and Streambank Stabilization

Jensen, Jens

Cardno JFNew

Cardno JFNew assisted the City of Middleton, Wisconsin, with their plan to create Northern Pike spawning habitat. Being a top level predator on most of our Wisconsin Lakes, northern pike are a very important to both the ecological balance of lake's ecosystem and as a sport fish. The project had dual goals to enhance the ecological aspects of the lake's ecosystem, while also enhancing sport-fishing on the Madison chain of lakes. The proposed spawning habitat is within the City's conservancy park in the floodplain of Pheasant Branch Creek, which drains into Lake Mendota. The goal of the project was to encourage natural reproduction of the Northern Pike population on Lake Mendota. The project also had the goals of vegetative restoration, habitat enhancement and streambank stabilization. The spawning habitats required excavation to create shallow seasonally flooded spawning habitat. Depth and elevation of the habitat area were determined using elevations relative to daily gauge data on Lake Mendota to achieve optimal depth during the spring spawning season. Native wetland vegetation conducive to pike reproduction was installed in the habitat areas. Preliminary monitoring has shown that pike have started to utilize the area for spawning. Further monitoring is planned in the future years to quantify success of the pike habitat areas and how it responds to changing water levels, water temperatures and other seasonal variables.

Building resilience into coral reef conservation with the reef resilience network, training and knowledge sharing for reef managers and stakeholders.

Jobe, Jordan

The Nature Conservancy

The Reef Resilience Program works to build the capacity of coral reef managers and communities as they confront a host of complex issues affecting both the reefs and the people who depend upon them. This presentation will provide an overview of the three main components of the Reef Resilience program, specifically focusing on restoration tools provided to managers and networking strategies used to strengthen cooperation among managers and increase on the ground actions to manage for resilience. Program components that will be highlighted include: The Reef Resilience Toolkit, a global online hub designed to provide information on resilience and inspire action, serves as the foundation for all program capacity building efforts.

ORAL ABSTRACTS (CONT'D)

This resource aggregates, translates, and disseminates new coral reef science and management strategies for coral reef practitioners. The Toolkit attracts approximately 15,000-18,000 unique visitors each month. Virtual capacity-building efforts include the Reef Resilience Network (an online community of practice for coral reef managers), online courses, and a webinar series. The Reef Resilience Network is designed to promote collaboration and sharing while providing inspiration and new ideas to isolated reef managers. Training of Trainers Workshops and Learning Exchanges are intensive, in-person trainings for coral reef managers. The training program empowers on-the-ground leaders to effectively communicate with and engage stakeholders in reef management and provides reef managers with information and training on the latest relevant scientific findings. The trainings are designed to connect managers and improve management techniques on the ground.

Mobilization and Community Building for Large scale Restoration

Johns, David
Wildlands Network

Very large-scale restoration (VLSR)—on the scale of large portions of entire ecosystems or biomes—is still in the process of creating a template. Like all work which seeks to conserve or restore lands and waters there are other interests which seek to use the landscape in incompatible ways. Generally the larger a project the more opposition it is likely to generate. For VLSR to succeed projects will require mobilizing substantial support. This support may come in the form of those going into the field to do restoration work. Political mobilization will also be required—the process in which people commit their time, energy and other resources to collective action for a policy goal and that involvement is sustained over time. In many respects mobilization of restoration field workers and political mobilization are complementary—action has always been recognized as an important component of gaining and strengthening commitment. Other factors are also important as similar efforts to attain broad societal goals attest: creation of a strong community, a clear and compelling vision, flexibility on means but firmness on goals, perseverance, careful targeting of groups who can bring important resources to bear, a solid understanding of the political landscape, and the creative combination of insider and outsider strategies. Creation of a strong community enables many of the other attributes and is a threshold task.

Progress toward restoration of naturally reproducing top predators and self regulation of Lake Huron's fish community, a case study

Johnson, James E.; Ji X. He, David Fielder
Michigan Department of Natural Resources

Lake Huron is a complex trophic system, where harvest has been focused on the highest, keystone-predator level. Between ca. 1920-1960, overharvest, habitat losses, water quality degradation, and depredations by the invasive sea lamprey decimated top predators leading to predator release of native and invasive mesopredators, the invasive alewife in particular. Since ca. 1968 agencies have been facilitating recovery of predators in Lake Huron, beginning with reintroduction of lake trout and walleye and introduction of nonnative Pacific salmon. For the next three decades, reproduction of the stocked predators was minimal due to continued overharvest, effects of invasive alewives and rainbow smelt on egg quality and early survival, and continued depredations from sea lampreys. More recently, core refuges and improved fishing controls in connecting corridors between spawning and feeding areas were established. Control of sea lampreys improved. In 2004, alewives collapsed under the combined pressures of top-down and bottom-up forces, which caused the introduced Pacific salmon to decline, but reproduction of native walleyes and lake trout rose sharply. Agencies sharply reduced hatchery stocking after 1998. If sustained, recent events will represent regime shift to a top-predator configuration resembling what prevailed prior to system collapse. Realization of a self-sustaining top-predator community resembling that of the pre-collapse era (though not yet fully achieved) would represent a “rewilding” of Lake Huron. The restoration of top-down controls could lead to a more resilient fish community with lower management costs to resource agencies.

A transferable campaign model for restoration communication

Johnson, Laura E.; Cristina Eisenberg
Prescott College

The success of restoration efforts depends on community support. In this study we built a communication campaign model that can be employed to increase public support for and participation in restoration efforts and easily tailored to a specific community. We conducted a case study in rural northeast Michigan where resource managers struggle to garner support for Lake Huron restoration efforts. We interviewed 30 participants from three groups—natural resource managers, communication practitioners, and citizen stakeholders—to investigate how differences between urban and rural communities affect public support and participation in resource stewardship. We found that differences in capacity (financial and human resources), land use, and culture between communities strongly affect motivations for stewardship and should inform restoration campaign design. For example, interviewees said urban and rural communities use and relate to natural resources in different ways (70.0%) and that rural connection with natural resources is often based on economics and livelihood, while urban residents connect on a social or recreational level (40.0%). As such, these community characteristics (capacity, land use, and culture) act as guiding principles in our resulting model, which steers practitioners through three phases of a resource-based communication campaign—research and development, messaging, and implementation. The model provides recommendations for executing each phase based on the targeted community's financial and human capacity level and their cultural relationship with local natural resources. This preliminary research strongly supports the need for a more integrated and community-based approach to restoration communication design.

ORAL ABSTRACTS (CONT'D)

Management effort over time affects long-term outcomes of ecological restoration in urban forest patches

Johnson, Lea R.; Steven N. Handel
Bates College

Urbanization transforms biophysical landscapes. Recognizing that some ecosystem services must be provided at the local level, municipalities are turning to ecological restoration of urban forests to provide essential ecosystem services. To test the idea that ongoing management is important to the long-term success of ecological restoration in urban forest remnants, we examined forests invaded by woody invasive plants 15-20 years after restoration. We compared restored areas with forest patches that were similarly invaded but not restored, and with a less-disturbed urban forest remnant that was not invaded at the time of the initial restoration. We examined relationships between management effort, soil surface characteristics, indicators of disturbance, adjacent land use, and plant community composition between all site types and among restored sites. Community composition differed significantly among restored, unrestored and less-disturbed sites in all forest strata, indicating that restoration treatment had significant and persistent effects. Differences between restored and unrestored plant communities were strongly associated with whether or not a site was restored, and with soil surface characteristics related to invasion and human impacts. Among restored sites, differences in plant community composition were strongly associated with restoration effort, assessed by the number of dates on which sites were treated 1988-2009, and with soil surface characteristics related to both the urban environment and invasion. These findings indicate that ongoing management effort is important to long-term outcomes of urban ecological restoration, and that urban environmental conditions should be anticipated to improve restoration effectiveness in urban forest patches.

Randall's Island Living Shore: Design for Rising Sea Level

Johnson, Marcha
NYC Parks

Softening armored urban shores to enable them to provide some of the ecosystem functions of natural shores is a restoration objective more often discussed than accomplished in NYC. In this project, a section of stone seawall is in such extreme disrepair and so frequently overtopped that the park administrators decided NOT to repair it, and try something softer and dynamic rather than stable. The intent was to come up with a concept for re-using the stones from the wall to make a habitat friendly shore capable of adapting to changing water levels. Guiding Collaboration: Just putting people together and assigning them a joint problem does not necessarily lead to collaboration. In this project, we attempted to guide the collaborative effort. In my experience "collaborative teams" are rarely truly collaborative in the sense of equal partners sharing fluidly across professional boundaries.... the term is often a euphemism for separate responsibilities and inputs to a project blended together by the project leadership. Brainstorming: The most collaborative moments in this project occurred in a workshop format, in which each participant did some work in advance and brought a short presentation, then went outside together, followed by a guided discussion focused on specific questions.

Shifting the Paradigm from Stabilized Shores to more Flexible, Living Systems

Johnson, Marcha; Kristina Hill, Peter Hummel, Shimrit Perkol-Finkel, Orrin Pilkey, Ido Sella
NYC Parks

Since storms Katrina in 2005 and Sandy in 2012, much more attention is being paid to the dynamic, fluid and mobile nature of shores, even those which have long been thought to be "stable." The idea of releasing hardened shores so that they can move more naturally is complicated, structurally, legally and emotionally. What if this idea could be explored in an urban context in which there was no emergency, no one's life, livelihood or property was at stake...what would a city shore be like if we disassembled the seawalls, let it adjust to water, wind and storms and made adaptation a park feature? The Randall's Is. Living Shore project, located in the tidal waters of NY Harbor, involves dismantling a stone seawall, carving a cusp-shaped pocket beach anchored by headwalls made from the old wall stone, and creating a terraced and sloped shore which allows plants to migrate inward and upward in response to water level rise. As we watch such shoreline dynamics in a non-threatening situation, we may find that there is much to learn about ways WE can adapt our behavior and expectations.

The dammed Missouri River: A forty-year remeasurement shows that time for restoration is running out

Johnson, W. Carter; Michael L. Scott, Mark D. Dixon
South Dakota State University

River ecologists have known about the decline of early-successional cottonwood forests on dammed western U. S. rivers for about 4 decades. The problem was first laid out in Ecological Monographs in the mid-1970's based on studies of riparian forests downstream of a massive storage dam on the upper Missouri River in North Dakota. Since then, hundreds of studies have been published on numerous western rivers discovering similar consequences of flood control for pioneer trees, especially cottonwood. The North Dakota forests first studied in 1969-70 were remeasured in 2008, some 40 years later. The results measured over real time show that, as predicted, cottonwood regeneration has declined sharply, producing a strong compositional shift toward floodplain dominance by green ash. However, all native ashes, including green ash, are predicted to be annihilated by the emerald ash borer in a few decades. Other changes discovered were the explosive increases in invasive understory species such as reed canary grass, Canada thistle, and smooth brome. All in all, these changes documented by re-measurement, were caused by a complex of factors, some related to damming as predicted and others were unexpected and related to disease and the spread of invasive plants. The prospects for restoration of this valuable ecosystem, rich in history and in goods and services provided to the public, are daunting. Time has not improved the chances that restoration can be achieved.

ORAL ABSTRACTS (CONT'D)

A Restoration Evaluation Program for Minnesota, USA

Johnson, Wade A.; Susan M. Galatowitsch
Minnesota Department of Natural Resources

A legislative requirement to evaluate habitat restoration projects funded by the State of Minnesota's Clean Water, Land and Legacy Amendment was enacted in 2011. The State Agencies charged with implementing this evaluation program, the Minnesota Board of Water and Soil Resources and Department of Natural Resources, have seated a panel of restoration experts with broad backgrounds to review selected project plans and field assessment reports. The Panel determines if projects apply current science based practices, meet planned goals, what issues exist in implementation and what modifications may improve outcomes. Project evaluations are conducted throughout the State of Minnesota in a variety of habitat types, including wetlands, prairies, forests, rivers, streams and lakeshores. Of nine projects evaluated in 2012 all were considered to be on trajectories that have the potential to meet the project's overall goals. However, deficiencies in planning, documentation and/or implementation were noted for all projects. Common shortcomings were insufficient detail regarding outcome based goals, inadequate planning for vegetation management and the need for long-term protection from land conversion. Four of the nine projects were determined to need follow up site visits to track continued restoration establishment in light of specific threats to project success. The evaluation process has shown that an effective evaluation protocol requires meaningful and equitable assessment techniques and a high degree of collaboration between evaluators and project managers to facilitate improvements in restoration practice.

Assessing forested wetland restoration success in North Carolina using ecohydrological patterns from reference sites

Johnson, Yari; Ted Shear, April James
North Carolina State University

Restoring jurisdictional wetland hydrology does not ensure that the hydrologic conditions of any specific natural forested wetland community are recreated. This is especially problematic for a state like North Carolina, which has roughly two dozen different forested wetland communities. Since forested wetland communities align themselves across edaphic and hydrologic gradients, we suggest exploiting these relationships to guide restoration design and set performance standards. However, methods to compare hydrology between multiple reference sites and restored wetlands are lacking. To address this, we studied three different forested wetlands across thirteen reference sites to determine which measures of water table levels based on correlation with plant community composition would be useful to distinguish these three communities. We then used the best measures of water table levels to assess two restoration sites and compare them to the reference sites. Our results showed that monthly median water table levels encompassing the start of the growing season had the strongest correlation with plant community composition, while roughly five other measures also had strong correlations. Based on the best measures, both of the restoration sites had water table levels that generally fell within the natural range of the reference sites. Since there was variation in water table levels across each restoration site, the different measures were useful to identify which areas were least similar to the reference sites and might need further monitoring in the future. Based on our results, we recommend using community-specific measures of hydrology to guide and assess forested wetland restoration.

Native early seral plant species improve restoration success

Jonas-Bratten, Jayne; Brett Wolk, Mark Paschke
Colorado State University

Efforts to restore degraded habitats often utilize late seral plant species (e.g. shrubs and bunch grasses), non-native species, or both. However, such approaches often fail to meet restoration goals. Native early seral species are seldom used in ecological restoration although they may be more competitive against non-native species due to similarities in life history characteristics and resource use. In addition, they may also promote important soil processes that facilitate development of a persistent and resilient late seral native community. Much of our recent work examines the hypothesis that including native early seral species in restoration seed mixes will help limit establishment of non-native invasive species and promote long-term native community development. In particular, we conducted a field experiment to compare the effects of seeding cheatgrass (*Bromus tectorum* L.), an aggressive invasive non-native annual in the western United States, with and without native early seral species on cheatgrass establishment and soil mycorrhizal abundance in Colorado shortgrass prairie. After two years, native early seral plants inhibited cheatgrass and increased mycorrhizal abundance in soils. These results support findings of previous experiments and suggest including native early seral plant species in seed mixes may improve restoration outcomes.

Session 1: Mississippi River Basin: Working toward Integrated River Basin Management

Jordahl, Harald "Jordy"
America's Watershed Initiative, Great Rivers Partnership - The Nature Conservancy

The natural systems, economies and communities throughout the entire Mississippi River Basin – stretching from Wyoming to West Virginia and from Minnesota to Louisiana – are intertwined and connected in many ways. Yet, management decisions for the river basin are often made in isolation. Leaders from different interests and regions all recognize that geographic, institutional and issue-based silos have become barriers to achieving the economic, social and ecological potential of this vital watershed. Global opportunities will be missed and costs will increase if we let state borders or single issues divide up this interconnected river system. Meeting this challenge, a diverse group of leaders representing public and private organizations, agencies and corporations have come together since 2009 to bring greater emphasis to the complex issues facing long term sustainability of North

ORAL ABSTRACTS (CONT'D)

America's largest river system. This work is now called America's Watershed Initiative. The foundation of a movement toward Integrated River Basin Management will be broad agreements for a vision of sustainability and improved governance structure. The Initiative is working to advance three main objectives: 1) Unite the Watershed -- Unite the diverse stakeholders, sectors, and sub basin geographies behind a shared vision for America's Watershed Initiative that builds local, national and global recognition. 2) Improve Policy & Governance -- Advance a sustainable management approach within the Mississippi River Watershed through improved decision making, policy and practice. 3) Measure Results -- Use sound science and best practices to inform policy alternatives and measure progress toward a healthier Mississippi River Watershed that is economically, socially, and ecologically sustainable.

Brave the Distinctions: Thoughts on the meaning and history of “ecological restoration”

Jordan III, William R.

The New Academy for Nature and Culture

Both the history and the ongoing practice and development of ecological restoration have been marked, as Dave Egan points out, by a many-dimensional ambiguity (or, less politely, confusion) about what “ecological restoration” means. The problem is that the discussion of what this form of land management is—that is, what distinguishes it from, say, habitat improvement or, more generally, conservation—has consistently reflected a desire to apply the word “restoration” in as broad a way as possible. This is reflected in language that seems designed to take advantage of the powerful positive connotations of the word “restoration” even when this results in oxymoronic constructions such as “restore to the future” and “restoration” of novel ecosystems. The aim of this kind of talk seems to be to sell the idea of restoration to as broad a market as possible. But its effect is to preclude clear thinking about what we are really up to or talking about, and to deprive efforts to restore some particular thing, process or quality of their distinctive value. This not only makes a muddle of attempts to develop a history of “restoration”, it also precludes full development of the attempt to restore any particular thing as a performing art—that is, an occasion for the creation and expression of meaning—which is arguably the most important thing about “restoration” or, for that matter, any intentional act.

Response, synthesis and discussion

Jordan III, William R.

The New Academy for Nature and Culture & the Institute for Nature and Culture, DePaul University

Since my job is to respond to the other speakers, I can't outline my comments in advance. But I regard the work of non-professionals and the opportunities for “intimate restoration” it offers as a very important component of restoration culture, and I'm looking forward to presentations that offer insights in a number of relevant areas. A few of the things I'd like to hear about: Accounts and reflections on the role amateurs play and have played in the development of restoration and the realization of its distinctive value as a form of land management, an experience, a way of doing ecology and a context for exploring our relationship with nature in the form of the classic ecosystems that are typically models for restoration efforts. Thoughts on how amateur practitioners, freed (as, say Aldo Leopold was at his Sauk County property) of the constraints of research, regulations or politics, think about what they are doing. Exactly what do they think they are doing? Why are they doing it? And what good is it? Given the advantages of this situation, what do they have to say about the long-term value and their value for the public of projects carried out on privately-owned land?

Thoreau Wildlife Sanctuary: Ecological Restoration in the Historic Great Black Swamp (NW Ohio)

Kane, Douglas D.

Defiance College

The Thoreau Wildlife Sanctuary (TWS) was established in NW Ohio in 1989 by Defiance College, in partnership with the Diehl Family Foundation. At TWS students get extensive practical experience in the practice of ecological restoration. 250 acres of former farmland have been restored to prairie, meadow, wetland, deciduous and white pine (*Pinus strobus*) forest habitats with ongoing management. Restoration Ecology students have planted more than 40,000 trees on the TWS property, as well as planting herbaceous terrestrial and wetland plants. Research dealing with invasive garlic mustard (*Alliaria petiolata*) and surveys of mosses and lichens of TWS have been conducted by scientists. Further, students have conducted research involving removal of invasive teasel (*Dipsacus sylvestris*), population estimates of deer (*Odocoileus virginianus*), water quality of stream, wetland, and lake habitats, and surveys to determine distributions of amphibians, reptiles, birds, and mammals. The Thoreau Wildlife Sanctuary is also used for service learning and internship programs and many different courses (i.e. Field Botany and Zoology; Restoration Ecology) at Defiance College, with plans for additional teacher and community education in the future. Geographic Information System (GIS) and Global Positioning System (GPS) techniques are also taught using data collected at TWS. I submit the examples of the Thoreau Wildlife Sanctuary and the Restoration Ecology major at Defiance College as models for both a successful partnership between a private landowner and an academic institution and of integrating restoration ecology into the collegiate curriculum and providing training for future restoration ecologists while restoring degraded/ modified habitats.

Restoring protected areas provides climate change adaptation benefits for wildlife and local communities in Kenya

Kanga, Erustus; Edwin Wanyonyi

Kenya Wildlife Service

A one year project which underscores the importance of protected areas as a natural solution of coping with adverse effects of climate change, is being implemented in six national parks in Kenya. The parks are Amboseli, Lake Nakuru, Mt. Kenya, Aberdare, Tsavo East and Tsavo West. The

ORAL ABSTRACTS (CONT'D)

project aims at enhancing the ecological integrity and resilience of protected areas and wildlife populations to climate change and reduction of human wildlife conflict among local communities living around these national parks. The project expected results include riparian vegetation maintenance and improvements, with resultant maintenance or increase in water retention in wetland ecosystem; forest vegetation cover maintenance and improvement to provide habitat for wildlife and enhance water catchment attributes of the forested ecosystem; savannah and bushlands rehabilitation and restoration to provide adequate seasonal biomass/vegetation to wildlife and community livestock; and general public educated on importance of protected areas for climate change adaptation while increasing visitor experience. Some of the results from this project are the four modern greenhouses have been installed to boost tree seedling production; over 12,000 seedlings have been produced and planted. One forest rehabilitation enclosure covering 100ha has been constructed to enhance forest regeneration and protection. 438ha that were invaded with invasive species have been mechanically controlled and various wildlife species have been recorded using these areas. One community water dam has been desilted and community members have access to water throughout the dry season hence reduction of influx of wildlife to the parks.

Beaver (*Castor fiber*) recovery triggers peatland restoration in southern Germany

Kaphegyi, Thomas A.M.; Yvonne Christoffers, Stefan Bürschgens, Andreas Böhme, Claus-Peter Gross, Ursula Kaphegyi, Werner Konold
University of Freiburg, Institute for Earth and Environmental Sciences

As well as in many other regions in Europe, in the alpine upland of Southern Germany peatlands mostly are degraded by peat exploitation in former times. In accord to the ecological value of those habitats, considerable working efforts and financial resources have been invested during the last 20 years in order to restore moor habitats. Based on re-introductions in Bavaria, currently the beaver more and more colonizes the German alpine upland. The return of the rodent is accompanied with conflicts e.g. damage to agricultural land. On the other hand, the rewetting effects coming along with the beaver assumedly can provide significant potentials for wetland restoration. Our research aims on quantifying the restoration effects resulting from the return of the formerly extirpated species by comparing the impact of beaver activities with anthropogenic rewetting measures in a peatland preserve extending over about 20 km². We combined hydrological modeling and aerial infrared photography assessments in order to analyse beaver activities according to rewetting effects and in respect to changes in vegetation composition. Our analyses suggest that the dam building activities of beavers considerably support restoration of formerly drained wetlands and peats. Anthropogenic induced measures can be restricted to situations when targeted damming on the spot is required or to locations that are unsuitable for the beavers. Against the background of our results, including the beaver as a factor into restoration schemes is recommended.

Heterogeneous restoration outcome as a result of heterogeneous disturbance

Kareksela, Santtu; Tuomas Haapalehto, Hilja Vuori, Janne Kotiaho
University of Jyväskylä

Anthropogenic ecosystem disturbances and resulting habitat degradation are often heterogeneous over the disturbed area. Consequently the effects of restoration also vary within and between the restored sites, making the interpretation of the restoration outcome complicated. Recognizing the within and between sites variation is of increasing importance as we are shifting from evaluating single restoration cases to estimating how to reach global restoration goals. Here we investigate how distance to ditch lines (disturbance) in drained peatlands creates heterogeneity in drainage induced ecosystem degradation on one hand and heterogeneity in restoration induced ecosystem recovery on the other. We use data from an experimental set up with 38 independent pristine, drained and 5 and 10 years ago restored peatland areas. Within these sites we analyze vegetation composition at 0, 5, 10 and 15 m from the ditch line with altogether 20 1m² vegetation plots at each site. Our results show that restoration is successful in returning the vegetation composition towards the pristine sites. However, as the effect of restoration is not uniform relative to the ditch the heterogeneity of the within site vegetation composition increases. Although the increased ecosystem heterogeneity is not exactly in line with the ecosystem type specific restoration targets it is none the less increasing habitat diversity that can benefit the persistence of peatland species especially as these relatively recently restored areas are still undergoing changes.

Piedmont forest restoration at Fernbank Museum of Natural History in metropolitan Atlanta

Kaunzinger, Christina M. K.; Steven N. Handel, Susan Stainback, John A. Kett
Rutgers University

Urban old growth forests provide an extraordinary opportunity for urban dwellers to experience and develop a conservation ethic for the vegetation that once covered the land where they live and work. Fernbank Forest in metropolitan Atlanta is a 26-hectare (65-acre) remnant of the great Piedmont pine-oak-hickory forests of the southeastern United States. In 2012, aligned with their 20th anniversary and the expiration of a long-term lease to the county school system, Fernbank Museum of Natural History reclaimed management and programming of Fernbank Forest. Non-native horticultural species, escapees from the original homesteads and surrounding landscaped yards, currently endanger the health of the forest and its ability to regenerate. English ivy carpets the bluffs in lieu of ferns, privet and heavenly bamboo dominate the shrub layer, and liriope and Japanese stilt grass are increasingly prevalent. The museum, in investigating how to incorporate the forest into its educational mission, charged an interdisciplinary team of Landscape Architects and Ecologists to develop a phased plan that addressed issues of arrival, circulation, ecological health, and educational opportunities and situated this important resource within a larger geographical and ecological context. The Forest and the museum campus are envisioned as a single narrative, expressing the diversity of the Piedmont ecology from meadow to mature forest, and incorporating sustainable strategies for engaging the forest and providing universal access throughout the site. These changes will broaden the museum's visitor base, and energize people of all ages to understand and protect the ecosystem services that healthy natural areas provide.

ORAL ABSTRACTS (CONT'D)

Transitioning from invader dominated to native dominated wet meadows: Comparing long-term, multi-site response to herbicide treatments for the invasive species *Phalaris arundinacea*

Kauth, Philip; Carrie Reinhardt Adams
University of Southern Mississippi

Transition from invader dominated to native dominated state is highly variable, and determining the efficacy of any management approach attempting this transition requires multiple sites over multiple years. Additionally, developing large-scale restoration practices that can be implemented in varying landscapes is critical for controlling widespread invasive species and determining site-level factors that influence treatment outcomes. Through the Reed Canary Grass Adaptive Management Project, we compared efficacy of herbicide treatments selected for *P. arundinacea* control applied to 32 sites in ten US Fish and Wildlife refuges over a four year period. Sites were either treated with a broad spectrum herbicide (glyphosate) alone and in combination with seeding native species or a grass specific herbicide (fluazifop). Decreases in *P. arundinacea* and increases in native perennials were more likely with glyphosate (80.0% likely for both) compared to fluazifop (16.7% likely and 58.3% likely, respectively). *Phalaris arundinacea* was more difficult to control with both glyphosate ($p < 0.0001$) and fluazifop ($p = 0.02$) when soil nitrogen levels were high. When initial *P. arundinacea* cover was high (over 40%), only glyphosate and seeding led to a decrease in *P. arundinacea* ($p < 0.0001$) and increase in native perennials ($p = 0.003$). We determined that using glyphosate was more efficient at transitioning *P. arundinacea* dominated meadows to native wet meadow vegetation. Considerable gain in our understanding of herbicide treatment outcomes has been facilitated by studying multiple sites over multiple growing seasons. We encourage that evaluation of restoration activities account for contingencies associated with variation in long-term landscape-scale ecosystem processes to provide maximal learning.

The local economic impact of the Emiquon Preserve

Kay, David; Mallory Rahe, Rebecca Burgstahler, K. Douglas Blodgett
Minnesota IMPLAN Group

In 2000, The Nature Conservancy purchased land along the Illinois River in Fulton County, Illinois. Approximately 6,600 acres of this has become what is now known as the Emiquon Preserve, a wetland/floodplain restoration project of The Nature Conservancy. At the time of the purchase, much of the land was agricultural and had been used for row crops, livestock, and grazing. The proposed land use change attracted attention from neighbors, local officials, sportsmen, and conservationists who were interested in how the land use change would affect the local economy. In this study we try to answer this question. Specifically, we determine how the local economic impact of the Emiquon Preserve compares to that of a reasonable alternative land use, row-crop farming. We develop two scenarios for the use of the property – a preserve scenario and a farm scenario. Our study finds that agricultural production generates higher economic impacts than current Conservancy operations and visitor use on the Emiquon property. Input-output analysis is a limited modeling tool as it does not value the nonmarket benefits that recreation and conservation provide, including scenic beauty, biodiversity, nitrogen filtering, and flood protection. It is possible that different methods could be used to place dollar amounts on those benefits, but this is beyond the scope of our current study.

Protected area restoration as a natural solution for climate change (overview)

Keenleyside, Karen A.; Marie-Josée Laberge
Parks Canada

National parks and other protected areas are increasingly seen as playing important positive roles as “natural solutions” to climate change. Ecological restoration in and around protected areas is often essential for maintaining or restoring important climate change adaptation and mitigation functions that these areas play. Current evidence suggests that negative feedbacks exist among climate change, ecosystem degradation, disaster risk, and carbon sequestration. Ecological restoration in and around protected areas can play a key role in climate change adaptation strategies by limiting or reversing ecosystem degradation and increasing the resilience of natural systems and human communities to climate change impacts, including climate-related disasters. It also enhances biological carbon sequestration, thus also contributing to climate change mitigation. Protected areas agencies in Canada and internationally are identifying ecological restoration in and around national parks and other protected areas as a key element of their approaches to helping ecosystems and neighbouring communities adapt to climate change. Parks Canada has a long history of ecological restoration success that has been achieved through the implementation of an integrated approach to the delivery of its mandate for protection, public awareness and visitor experience. This approach is being adopted by other countries as part of their climate change adaptation strategies. This presentation introduces the symposium by providing the context for subsequent presentations and a group discussion.

Long-term impacts of restoration activities in the semi-arid Savannas of South Africa assisted by Government and Non-Government organisations

Kellner, Klaus; Dieter Jordaan, Seppie Esterhuysen, Franci Jordaan
North West University

Restoration actions are financially assisted by Government and Non-Government organisations in the North-West and Northern Cape Provinces. The projects are monitored and assessed by research and academic institutions. Farmers, land managers and communities are asked to implement and sustain the projects over the long-term. Several active and passive restoration actions are implemented to mitigate or prevent land degradation, i.e. better management strategies by rotational grazing and implementation of water reticulation schemes; control of woody shrub and tree invasion

ORAL ABSTRACTS (CONT'D)

(bush encroachment); and re-vegetation of bare, denuded areas with climax, palatable grasses for increased fodder and vegetation cover. Most projects funded by Government over the last 10 years through LandCare and CASP programmes (Comprehensive Agricultural Support Programme) in the communal and subsistence managed rangelands (ca US\$ 5.5 million) have failed, are non-existent or mismanaged. Projects financed by farmers in the commercial, privately owned sector who invested similar budgets over the same period are however still maintained with positive results. Causes for these discrepancies are multiple but are mostly related to a lack in ownership and responsibility in communally managed land, lack in motivation and awareness, no proper technical support, and no direct economic benefit from the restoration, which are often only financially supported over the short-term. Subsistence farmers are not in the financial position to contribute to the maintenance of restoration activities. Some case studies of restoration applications, their long-term impacts and sustainability in the different land tenure types and possible reasons of failure and successes will be discussed during the presentation.

Quantifying oyster reef ecosystem services: Denitrification, nutrient assimilation and food web support

Kellogg, M. Lisa; Jeffrey C. Cornwell, Michael S. Owens, Mark W. Luckenbach
Virginia Institute of Marine Science, College of William & Mary

Quantifying the ecosystem services provided by benthic habitats helps justify their conservation and restoration. Recent and ongoing studies seek to quantify the ability of restored oyster reefs to: 1) convert the nitrogen contained in phytoplankton into nitrogen gas via denitrification, 2) assimilate nitrogen and phosphorus into the tissues and shells of macrofaunal species, and 3) provide food web support for commercially important species. Studies of a restored oyster reef in Maryland demonstrate that deep (below the euphotic zone) subtidal reefs can have very high rates of denitrification, assimilate substantial amounts of nutrients and provide habitat for over 24,000 other macrofaunal organisms per square meter. Subsequent studies of shallow experimental reefs indicate that subtidal reefs lying within the euphotic zone may have comparably high rates of denitrification. These studies also demonstrate that there is a positive relationship between oyster biomass and denitrification rates but that this relationship is non-linear. Ongoing studies of intertidal oyster reefs suggest that denitrification rates on these reefs are generally lower, have greater variability and do not increase as rapidly with increases in oyster biomass. The implications of these studies for optimizing oyster reef restoration efforts, choosing success criteria and improving water quality via oyster reef restoration will be discussed.

Landscape Architects' Approach to Ecological Restoration

Kemper, Patricia C.
Temple University

Landscape architects play a pivotal role in implementing and promoting ecological restoration in a variety of projects, from corporate and academic campuses to city, county, and national parks. This presentation looks at several award winning projects in which landscape architects create sustainable designs that manage stormwater, restore hydrological functions, create wildlife habitats and re-establish ecosystems and will also review the training of ecological restoration in landscape architecture graduate programs.

The different faces of history in post-industrial landscapes

Keulartz, Jozef
Wageningen University, Netherlands

Measured by expenditure and scale, reclamation of industrial brownfields and industrial ruins is currently one of the largest infrastructure undertakings in Europe and America. The legacy of the Industrial Era, from 1850 to 1950, saddles landscape planners and designers with multiple problems. Should they aim for demolition, preservation or transformation of decommissioned military sites, derelict factories and decayed piers? How should they treat former industrial sites as sites of public memory – as 'memoryscapes'? What role should history play in the regeneration and revitalization of postindustrial landscapes? To answer this question, I will make use of Friedrich Nietzsche's work "On the Use and Abuse of History for Life". Nietzsche questions the belief that historical knowledge is intrinsically valuable. He argues that history is valuable only insofar as it serves life, and he identifies three different forms of history, each with a unique ability to help or hinder life: antiquarian history, monumental history, and critical history. Each of these forms can be put in the service of life, but each may also degenerate into a threat to life. This happens when one form of history gains supremacy at the expense of the other two. Nietzsche's ideal is that of a balance, where the different forms of history may complement and correct each other. I will first provide an overview over these forms of history and then apply them to the different forms of design and management of postindustrial landscapes, using examples from England, Germany, the Netherlands and the USA.

Comparative analysis of assisted regeneration in four dry forest vegetation types in Pakistan's Punjab province

Khan, Amin; Joachim Gratzfeld, Faiza Sharif, Zafar Siddiq, Umar Hayyat
Sustainable Development Study Centre GC University Lahore Pakistan

The extent of Pakistan's subtropical to tropical, natural dry forests has diminished by some 90% over the century, mainly as a result of habitat loss, indiscriminate exploitation and invasion by exotics species. National reforestation strategies still favouring uniform plantations of fast growing non-native trees, are not offering the diverse range of vital ecosystem goods and services provided by the original dry forests. To promote natural regeneration with local communities and governmental authorities, GCU and BGCI are piloting a restoration scheme in four dry forest vegetation types in Punjab province. Between 2010 and 2013, to examine population reinforcement effects using plant material of local provenance, over 6,100 saplings of eight woody climax species were raised and planted in 10 trial plots, covering a total area of 6.68 ha. With an overall 46% seedlings' survival rate,

ORAL ABSTRACTS (CONT'D)

reinforcement plantings accompanied by other conservation measures including fencing, elimination of invasive species and soil remediation, have also facilitated natural regeneration via seed, root budding and suckers. Close collaboration and regular interaction with representatives from local communities and the provincial forestry department generally helped consolidate ownership of the conservation measures and engagement in the restoration trials. However setbacks, resulting from natural as well as human-induced causes including wild rodents' grazing, fire or fencing removal, were also experienced. Further research on the socio-economic potential of the restoration action to revive traditional or develop new value chains based on dry forests' natural resources is required, to address conservation and livelihoods improvement as two complementary objectives.

Environmental filters during the restoration of species-rich grasslands and field margins

Kiehl, Kathrin; Anita Kirmer

Osnabrück University of Applied Sciences

Numerous studies have shown that seed limitation is a key factor for the successful restoration of natural and semi-natural grasslands. Seed limitation can be overcome successfully by measures of species introduction like seeding or transfer of seed-containing plant material. The establishment of introduced target species, however, often depends on environmental filters in relation to species adaptations. While regeneration niches for germination and seedling establishment can be easily created by soil disturbance before species transfer, it is much more difficult to reach lower soil nutrient levels for species-rich plant communities, e.g. on formerly fertilized arable fields without topsoil removal. As topsoil removal is expensive and often questioned in respect to soil protection it is also necessary to develop restoration measures, which are suitable for sites with high nutrient levels. Examples from southern Germany show that it is possible to restore species rich low-productive grasslands on sites with high nutrient contents if nutrient availability is limited by drought on soils with low water-holding capacity. During the restoration of species-rich field margins in Northern Germany nitrogen availability and biomass production on ex-arable fields was effectively reduced by carbon addition but had also a negative effect on the establishment of sown target species. Soil pH and the availability of basic cations are additional environmental filters, especially in Central Europe with a large species pool of vascular plants restricted to base-rich and calcareous soils. Establishment rates in species introduction experiments can be influenced by the response of basiphytic species to small changes in pH.

Articulating the Convention on Biological Diversity global protected area targets: A design example from Australia

Kilbane, Simon; Richard Weller

University of Western Australia

The OECD projects 7.2 billion people living in urban areas by 2050 and an accompanying increase in agricultural land to meet this growth. Meanwhile the Convention on Biological Diversity (CBD) targets aim to augment the protected area share of the Earth's surface from a current 13% to 17%. Where therefore should the urban and agricultural land-uses be distributed at the continental and at local scales and where do protected areas and ecological restoration fit? This paper outlines a research methodology that has created the National Green Network, an Australian example that offers potential solutions to this much broader global polemic. This is a design project that responds by providing accurate, measurable and visual plans. These identify conservation candidates across landscapes already replete with human use and explore potential restoration configurations through large scale ecological restoration designs. A flexible and iterative process involving multiple scales and community stakeholders then ground-truthed the potential for their implementation. This revealed that leverage to ecological restoration was dependent upon a holistic understanding of landscapes, inclusive of cultural intent. Further exploration of 'synergistic' restoration trajectories, those providing complementary ecological and cultural benefits ultimately augmented the potential for meeting CBD targets and providing structural connectivity across a highly fragmented 25km x 25km vignette. These included recreational greenways, carbon and agro-forestry, creating a design for an ecologically robust and interconnected protected area network across the Australian continent to assure a minimum life-supporting ecological infrastructure.

Rangeland restoration and livelihood diversification: Considerations of social-ecological vulnerability in emerging mixed land use systems.

King, Elizabeth G.; Ryan R. Unks

University of Georgia

Semi-arid rangelands are an archetypal ecosystem for studying the mechanisms and emergent dynamics of vegetation degradation and restoration, enabling the formulation of effective ecological restoration strategies. But in African communal pastoralist systems, rangelands are part of tightly linked social-ecological systems. Restoration efforts must consider both ecological dynamics and social factors, in order to promote land use practices that offer both ecological and livelihood benefits. Today many community-based restoration strategies also focus on alternative livelihood strategies as a way decrease reliance on livestock and pressure on grazing resources, while increasing livelihood resilience. We examine two pastoralist communities in Kenya, which began small-scale river-irrigated maize agriculture in 2011, to ask how this transition may affect: human vulnerability, pressure on grazing resources, and the prospects for ecological restoration in the surrounding degraded rangelands. We interviewed 60 households; 70% began farming to cope with food and livestock shortages, but 83% of those had to sell livestock to afford initial investments. Farmers' initial sources of information indicated that very few had any training for dryland agriculture. While food from farming may reduce reliance on livestock, the cost of investment and crop failure potential may instead increase household risk exposure. Most (64%) reported that farming detracted attention or changed labor allocation from tending livestock. Based on monthly dung counts along 26 100-m transects, it appears grazing pressure is increasing near farming areas. We discuss the implication of these trends for devising strategies to restore ecological integrity and social resilience in this emerging mixed land use system.

ORAL ABSTRACTS (CONT'D)

How to overcome limitations in grassland and field margin restoration in high intensity farming systems

Kirmer, Anita; Sabine Tischew

Anhalt University of Applied Sciences, Germany

In many parts of Germany, land consolidation resulted in huge arable fields at the expense of grasslands and field margins. Especially in Saxony-Anhalt, an intensively used agricultural region with chernozem as predominant soil type, species-rich lowland hay meadows and field margins are scarce, the remaining ones mostly species-poor, with dense grass swards. Our restoration efforts aim at the conversion of arable land to species-rich grasslands as well as on the diversification of species-poor field margins. Dispersal limitation caused by the depletion of the regional species-pool can be overcome by species introduction but environmental filters, especially nutrient contents, are influencing restoration success. In our grassland restoration trial, seed material was harvested directly on a species-rich remnant nearby and the nutrient content of the receptor site was decreased by repeated cultivation without fertilization. But for the field margin restoration trial, there are no species-rich donor sites left in the region. Therefore, we composed a seed mixture of 49 perennial native species typical for dry and mesic grasslands as well as fringe communities that are most likely to cope with the given site conditions (e.g. high nutrient content, summer drought). Before sowing, the dense grass sward was destroyed by a combination of tilling and grubbing. In both trials, establishment rates of introduced species were rather high but target species considerably differed in frequency and coverage depending on nutrient content and mowing regime. Establishment success will also be related to species traits and their role in restoring ecosystem services.

Lessons Learned through the Grassland Restoration Network; 2003-2013

Kleiman, Bill; Chris Helzer

The Nature Conservancy

The Grassland Restoration Network was formed in 2003 by The Nature Conservancy, along with many other partners. The original goals were to share expertise and experiences between prairie restoration sites across the country, and to work together on shared challenges. Staff from those project sites, along with many other participants, have worked toward those goals through annual workshops and targeted peer review sessions. Considerable time has been spent defining the role of prairie restoration as a tool for restoring ecological function, and exploring ways to evaluate success in that regard. In addition, many discussions have focused on the kinds of techniques used by the diverse group of participants to establish prairie communities. Those techniques include harvesting, cleaning, storing, and planting seeds, propagating plants in nurseries, and both short- and long-term management of restored prairies. In some cases, participants have found that methods such as dormant-season broadcast seeding are universally successful across all or most sites. In contrast, seeding rates that lead to successful prairie community establishment seem to be driven largely by unique local conditions. After ten years of existence, the Grassland Restoration Network has successfully built collaboration, shared experiences and expertise among project sites, and is investing in research projects to further build our shared knowledge about prairie restoration.

Applying the past to the present: Assessing reconstruction of Karner Blue Butterfly habitat on conservation reserve program lands in Wisconsin

Kleintjes Neff, Paula; Eric Mader

University of Wisconsin-Eau Claire

The State Acres for Wildlife Enhancement (SAFE) for the Karner Blue butterfly (*Lycaeides melissa samuelis*) was created by the USDA Farm Service Agency and Natural Resource Conservation Service to construct suitable habitat for the federally endangered butterfly on Conservation Reserve Program lands in Eau Claire County, Wisconsin. Since 2009, we have assessed the effectiveness of the program in order to assist landowners and agency staff with future management practices. Of 48 participating landowners, 11 are located within the Wisconsin DNR "High Potential Range" for Karner blue butterfly recovery and 7 of the CRP-SAFE sites are located *Bombus terricola*). Results have been used to publish management guidelines for CRP-SAFE landowners.

Growing the ungrowable - Australian keystone species for revegetation through plant tissue culture

Kodym, Andrea; Shane Turner, Eva Tensch, Laurie Krauss, Alex Arnold, Eric Bunn, Ary Hoffmann, John Delpratt

University of Melbourne

Many Australian native plant species are not available for revegetation because of the lack of efficient propagation methods. Among this group of plants are Austral bracken fern (Dennstaedtiaceae) and many sedge species (Cyperaceae), which are widespread and significant understorey species of various native plant communities. In vitro techniques are being researched to produce large quantities of planting material for revegetation programs, while maintaining appropriate genetic diversity. In vitro cultures of *Pteridium esculentum* were initiated from spores. A system of transferring gametophytes directly to the greenhouse is being developed to allow for early integration into standard nursery practices. In the sedge genus *Lepidosperma* a propagation system based on somatic embryogenesis was developed using in vitro-grown seedlings as starting material. The genetic stability of regenerated plants was analysed using flow cytometry. Plants showed a stable ploidy level and stable C-values. In another sedge, *Gahnia radula*, dormancy was successfully overcome through in vitro seed culture and micropropagation rates of seven-fold could be achieved in five weeks. A study using microsatellites has been undertaken to determine levels of genetic diversity within and between four populations. Female trees of the dioecious *Allocasuarina luehmannii* (Casuarinaceae) are in high demand for revegetation as they provide a valuable food source for the endangered south-eastern red-tailed black cockatoo. Shoot tips collected from female sucker material developed readily in vitro on medium containing maltose but not sucrose. Through the use of plant tissue culture, some keystone species are now becoming available for the first time for revegetation projects.

ORAL ABSTRACTS (CONT'D)

Restoration of Tribal Ecosystems through Permacultural for Sustainable Development and Poverty Alleviation in Underdeveloped and developing countries

Koppula, Narsanna; Deepthi Vangala

Aranya Agricultural Alternatives

Permaculture/Permanent culture has globally proved workability in ecosystem restoration and sustainability. In the present scenario of ecosocial crisis, forest communities have a focal role to play in addressing the related concerns. The tribal areas of the underdeveloped and developing world provide a unique opportunity to apply the permaculture principles in ecosystem restoration, alleviation of poverty, efficient natural resource management and for the sustainable development from the grass root levels with community participation. Success at smaller-scale locally suggests a potential replication at global scale. The Tribal Permaculture case study has been implemented by the local NGO Aranya in Nirmal, Tribal area in AP. Activities and methods: 1) Permaculture farm development and practices; 2) Capacity building of the personnel/primary and secondary stakeholders; 3) Promotion of alternative energies; 4) Community food plant nursery; 5) Ensuring sustainability; 6) Disseminating knowledge and awareness on sustainability. Monitoring and Evaluation of project (both internal and external) are conducted. Sustainability and systematisation of experiences is ensured phasewise. The project results conclude the importance of creating incentives for conservation of Tribal ecosystems through Promotion of Permacultural practices, agro biodiversity for sustained food security, promotion of horticulture for nutrition security, efficient water resource management, alternative energies, supporting poverty alleviation through different Permacultural practices in integration with local technologies and prevent welfare losses among vulnerable Communities.

A test of potential seed transfer zones for restoration in the Great Basin: examples from Penstemon and Eriogonum

Kramer, Andrea T.; Jeremie Fant, Kayri Havens-Young

Chicago Botanic Garden

To identify potential seed transfer zones for five common forb species in the Great Basin region of the United States (*Penstemon deustus*, *P. pachyphyllus*, *P. rostriflorus*, *Eriogonum microthecum* and *E. ovalifolium*), ecological genetics research was carried out utilizing a combination of microsatellite DNA analysis, common garden studies, and experimental crosses. Results revealed significant genetic diversity and divergence among populations in both neutral and potentially adaptive genetic traits for all species, but among the *Penstemon* species there were striking differences in results depending upon the primary pollinator of each species. The hummingbird-pollinated species had much greater gene flow among populations than the two bee-pollinated species, but this greater gene flow did not translate to lower divergence in potentially adaptive traits. However, the first generation of experimental crosses spanning different geographic and genetic distances revealed both inbreeding and outbreeding depression in progeny of the bee-pollinated species (which also had the highest degree of population divergence). No negative fitness effects were identified in first generation crosses of the hummingbird-pollinated species. Results are discussed in the context of potential seed transfer zones (including the US Forest Service's provisional seed zones and different ecoregional zones developed by other agencies). Results provide insight into the feasibility of using universal seed zones for species that are not well-researched, and can help guide the movement and mixing of seeds for different forb species being used in ecological restoration efforts.

Developing a local development strategy: Preservation and revitalization of Louroujina village in Cyprus

Kurt, Sevinc; Yasemin Mesda, Marko Kiesel

Cyprus International University

This research aims to develop attitudes on the protection and preservation of the natural and built environment; preservation and revitalization of cultural and historical heritage, and sustenance of significant architectural inheritance and sense of place of Louroujina, the largest Turkish village in Cyprus until 1974. In need to goal for a sustainable approach, the project does not only seek to document historical and cultural heritage of the village but to develop awareness and interest with the participation of local stakeholders so that a local development strategy specific to the area can be produced. Louroujina, as a Turkish Cypriot village, was the largest rural settlement of the country before 1974 conflict. Yet, following the post-war years - the last 39 years-, there has been a 1:15 decrease in the population of the village mainly due to the ill-effects of the War. Although most of the buildings were neglected and some of these were abandoned or destroyed over the years, there are still many adobe and stone buildings of historical and cultural importance. Together with the preservation of natural environment and the rehabilitation of the rich architectural heritage of the village, the local values of the area shall come to the fore whilst helping the village regain its significance by creating sustainable solutions to the existing problems. The strategy for the rehabilitation of the village should consider the restoration, maintenance and protection of the natural and built environment.

Integrated Evaluation Model of Biodiversity Conservation for Planning Protected Area in Korea

Kwon, Hyuksoo; Changwan Seo, Chonghwa Park, Jiyeon Kim

National Institute of Ecological Research, Korea

Conservation biologists have recommended on designing or enlarging protected areas as the most effective method to maintain biodiversity. Korean government plans to expand protected areas from 8.9% to 15% of national land until 2015, and designs or redesigns regularly national park's boundary by natural park act. However, there are few of studies for criteria and methods of designing protected areas. The purpose of this study is to suggest an integrated evaluation model of biodiversity conservation to provide criteria and methods of planning protected area. The methods of this study are as

ORAL ABSTRACTS (CONT'D)

follows. Firstly, we set five evaluation criteria (species richness, key species habitat, representativeness, rarity and connectivity) to assess the suitability of biodiversity conservation. Secondly, we developed species distribution models for mammals, birds, plants, key species and endangered species, and then did a connectivity analysis to make five criteria index. Finally, hotspots were detected and protected areas were designated from conservation priority using Marxan. Species richness and rarity analyses showed that potential biodiversity areas of mammal and plant were distributed largely on and around existing protected areas, whereas those of bird were distributed near river and mainly on coastal wetlands. Some hotspots were located far from existing protected areas and were isolated due to fragmentation. The distributions of key and endangered species were mostly inside and near potential biodiversity areas of each taxonomic group. We could find biodiversity hotspots and prioritize new alternative protected areas. Therefore, it was useful to apply this approach for planning protected areas in Korea.

Rebuilding resilient boreal forest ecosystems after oil sands mining

Landhausser, Simon; Ellen Macdonald

Dept. of Renewable Resources, University of Alberta

Oil sands mining results in severe disturbance to landscapes representing a range of boreal forest ecosystems. Operators are legislatively obligated to “revegetate the disturbed land to... a self-sustaining, locally common boreal forest, integrated with the surrounding area...” The structure and function of boreal forest ecosystems are characterized by complex interactions and feedbacks between landform and topography, soil conditions, vegetation, and a range of natural disturbances - to which these forests are well-adapted. An understanding of natural processes, relationships, and dynamics in these forest ecosystems is key to rebuilding resilient boreal forests. In this context resilience can encompass both recovering from the mining disturbance and the capacity to recover from future natural disturbances and stresses. We will discuss approaches to restoring diverse and productive boreal forest ecosystems, which therefore possess properties that are likely to confer resilience. These approaches include: 1) re-establishing a diversity of tree species in concordance with landform and soils; 2) use of planting stock that will confer stress tolerance; 3) use of surface soil and forest floor material to encourage development of a diverse, natural understory plant community; and 4) the use of coarse woody material to kick-start key ecological processes. Inherent to these approaches is using natural boreal forest ecosystems as models for process and pattern in restored ecosystems. We will also discuss the issue of defining appropriate targets for the outcome of restoration and whether success might appropriately be defined by a range of alternate stable states incorporating the context of changing climate.

Past and future national symbols: Sugar Maple or Norway Maple for Canada?

Larson, Brendon MH

University of Waterloo

For several decades, Canada's national symbol has been a stylized maple leaf modeled after the Sugar Maple. Recently, however, botanists and conservationists across the country were upset when the leaf of a Norway Maple appeared on our new \$20 bills. Not only is Norway Maple a European introduction, it is also invasive in some natural areas in eastern Canada. In this paper, I consider how this debate parallels the past and future of restoration ecology: Sugar Maple as synecdoche of wilderness and “nature” and Norway Maple as symbol of despoliation of wilderness and “culture.” Although this is a caricature, I argue that there are several reasons to consider whether Norway Maple may be just as adequate a representation as Sugar Maple for a multicultural Canada in the Anthropocene. Not least, it provides important ecosystem services as well as a connection to nature for many people—and especially new immigrants—living in urban regions. This raises critical questions about how to maintain and restore urban parks and ecosystem services in the context of climate change and invasive species in the coming decades.

Legacies of invasive plants: A different kind of soil contaminant

Larson, Diane L.; Nicholas R. Jordan, Dustin F. Haines, Linda L. Kinkel, Sheri C. Huerd

U.S. Geological Survey

Invasive plants have been shown to change soil biotic properties. These changes may outlast the presence of the plants on a given site, and thus present challenges to site restoration. We have examined soil legacies that result from occupancy by leafy spurge (*Euphorbia esula*), smooth brome grass (*Bromus inermis*), and crested wheatgrass (*Agropyron cristatum*). In varying degrees, each produced changes in living soils that either facilitated invasion by other invasive species or suppressed growth of some native species; these effects were abolished in sterilized soils. Subsequent research has revealed changes in both infection levels and taxon composition of arbuscular mycorrhizal fungi on roots growing in soils the invasives previously occupied. Of particular interest for restoration is the considerable variation in effects on growth of native species, from facilitation of some species to suppression of others. It has also been suggested that invasive plants may accumulate soil pathogens in the vicinity of their roots to which they themselves are insensitive. Such dense populations of pathogens are thought to reduce recruitment of native plants after invasives are controlled. We examined effects of root exudates from leafy spurge and a variety of native grasses and forbs on *Rhizoctonia* and *Fusarium* species isolated from Great Plains soils and found substantial variation in effects of exudates, again from positive to negative. Bioremediation is commonly used to remove specific contaminants; the variation we have found in soil conditioning by different species suggests a form of bioremediation for previously invaded sites that resist recolonization by native plants.

ORAL ABSTRACTS (CONT'D)

Acropora cervicornis (Staghorn Coral) restoration: An evaluation of nursery and outplanting success in Broward County, Florida

Larson, Elizabeth A.; David S. Gilliam

Nova Southeastern University Oceanographic Center

Acropora cervicornis was listed as a threatened species under the US Endangered Species Act in 2006. This prompted the initiation of restoration efforts throughout much of the species range. Efforts include the establishment of *A. cervicornis* nurseries and the associated evaluation of techniques for nursery propagation and outplanting to natural reefs. Since 2007, offshore Broward County, the northern most extent of the species range, three *A. cervicornis* nurseries have been established. Initial nursery material was collected from 30 genetically distinct donor colonies, removing 30cm per colony. This produced a total of 270-3cm nursery colonies. Nursery expansion occurred throughout the project and in 2008 and 2012 fragments from nursery colonies were outplanted to three and eight natural reef sites, respectively. In just over 2.5 years the total tissue within the nursery increased by over 10,000%. From the initial 270 nursery colonies over 2,500 fragments were produced for nursery expansion and over 1,500 were outplanted to the natural reef. In addition, the fate of each donor, nursery and outplant colony was monitored, at least quarterly, for survival, growth, and condition, for a minimum of one year. Survival of nursery colonies was 66% two years post establishment. Survival of outplanted fragments after one year was 59% (2008 outplants) and 50% (2012). This project illustrates that in a short period of time and with a small impact on a natural population, thousands of corals can be successfully raised and subsequently outplanted back to the natural community aiding species recovery.

Converting invasive plants to bioenergy: an innovative approach to restoring Great Lakes coastal wetlands

Lawrence, Beth; Shane Lishawa, Nancy Tuchman, Dennis Albert

DePaul University

Great Lakes coastal wetlands are increasingly dominated by invasive macrophytes such as hybrid cattail (*Typha X glauca*) that reduce plant diversity and alter nutrient cycling, largely through the accumulation of biomass. Using invasive species biomass to produce bioenergy has the potential to simultaneously increase biodiversity, remove nutrients from eutrophic habitats, and create a low input biofuel that could offset the cost of restoration. To investigate the feasibility of this approach during coastal wetland restoration, we tested how the mechanical removal of *Typha* (mow, above-harvest, total-harvest) affected plant community structure and composition in four Michigan coastal wetlands. One year after manipulations, biomass removal significantly increased light penetration to the soil surface, promoted native species recruitment from the seed bank, and tended to increase plant diversity relative to controls, though treatment effects varied by site. A companion seed bank experiment suggests that water level strongly effects seed recruitment, with greater seedling density and diversity from soils exposed to surface or sub-surface (-5 cm) hydroperiods than inundation (+5 cm). Relatively young invasions (25 yr). Combining invasive species biomass estimates (*Typha*, *Phragmites*, *Lythrum*, *Phalaris*, *Myriophyllum*) with results from our methane production potential assays suggests that there is great potential to promote both biodiversity and bioenergy by combining invasive species harvest with anaerobic digestion in Great Lakes coastal wetlands.

Restoration of the campos rupestres, Neotropical mountain grasslands (Brazil).

Le Stradic, Soizig; Elise Buisson, G. Wilson Fernandes

Université de Liège, Gembloux Agro-Bio Tech

While numerous techniques have already been tested in temperate zones, restoration experiments in tropical ecosystems, especially in open ecosystems, such as grasslands or savannas, are rare at best. This work aimed to test different methods to restore campos rupestres, which are Neotropical altitude grasslands found in the Cerrado biome in Brazil. This ecosystem hosts a huge biodiversity and high levels of endemism. Three ecological restoration techniques were tested to restore areas degraded by quarrying: 1) hay transfer; 2) species translocation; and 3) vegetation turf translocation. One year after the hay was spread, few seedlings were observed and they all belonged to ruderal species already present on the degraded areas. This technique thus did not allow the establishment of target species on degraded areas, although seeds were found in the hay. The second technique also failed: only one species, *Paspalum erianthum*, survived translocation from pristine to both degraded and pristine areas, whereas for the seven other species, root damages which occurred during the translocation probably limited their survival. The third technique, turf translocation, was the most efficient technique since many species, including some endemics, were reintroduced to degraded areas. However, due to the low resilience of the campos rupestres where turfs were taken, this method can only be considered to save habitats where destruction is inevitable. In face with the difficulty to restore these grasslands, their protection and their conservation must be a priority.

The Ecological Engineering and Large Scale Restoration of the Pennsylvania Avenue and Fountain Avenue Landfills, Brooklyn, NY

Leahy, George; John McLaughlin

URS Corporation

The New York City Department of Environmental Protection and URS Corporation performed the remediation and ecological restoration design and construction management for the 110-acre Pennsylvania Avenue Landfill and the 300-acre Fountain Avenue Landfill in Brooklyn, NY. These sites were listed by the New York State Department of Environmental Conservation as Inactive Hazardous Waste Sites (IHWS). The goal of this project was to apply ecological principles to restore these IHWS for an ultimate end use as part of the National Park Service's Gateway National Park System, for wildlife ecosystem communities and public usage. A highly innovative alternative approach to ecological engineering and sustainable large scale restoration was

ORAL ABSTRACTS (CONT'D)

incorporated into the design of the closure vegetative cover that had not been used previously for projects of this nature and scale. The design included indigenous warm-season grasses, such as Switchgrass, Little and Big Blue Stem, and Indian Grass, representative of prairie grasses originally native to New York City. The end use plan included the planting of over 35,000 native coastal trees and shrubs, many extirpated or uncommon species for New York City, with a focus on restoring plant community habitat types. The plantings included over forty species of trees and shrubs, and twenty-eight species of native grasses and wildflowers. The species for this project were selected based on their ecological plant community associations and the environmental setting of the landfills (maritime ecosystem) to provide a much greater ecological value, long term sustainability and biodiversity. An innovative contract growing program was also developed.

Innovative solutions/tools for coastal fish nursery restoration

Lecaillon, Gilles; Fabien Dubas

ECOCEAN

The post-larvae stage is the final stage of the pelagic larval phase of reef-dwelling coastal marine animals. Those post-larvae fishes and invertebrates settle in shallow, sandy or rocky onshore habitats to protect themselves from catastrophic predation. In an intact onshore habitat, more than 90% will die within the first week of their return, but without adequate natural habitats, the survival rate can decline to zero! Young of the Year (YOY) gathered in these shallow habitats are seeking nurseries, defined as possessing 3 mandatory attributes: 1- presence of suitable food, 2- presence of calm water and 3- a refuge which limits predation (represented by a “persistent rate”). Onshore constructions are increasingly prevalent, directly affecting the essential habitats of the YOY. A dedicated mitigation for the impacts occurring during these lifestyle stages is crucial to restoring the connectivity and life cycles of marine populations. Various types of patented Biohut micro-habitats have been introduced to disturbed areas to substitute the role played by rocky sea bottoms and shorelines in protecting wild post larvae marine fish. They work by providing larvae and young recruits with the opportunity to hide and feed. A double cage system creates a predator-free habitat with adapted feed. Therefore the BioHut system helps to restore the marine ecosystem by protecting YOY from predation, thereby allowing them to reach “refuge size”. The presentation will show the difference between Biohut habitats versus artificial reef, present on-going projects in Europe, then outline our objectives for marine restoration program in US.

The Nappex project: initial results of a marine harbor restoration study

Lecaillon, Gilles; Philippe Lenfant

ECOCEAN

The EU strategy of the marine framework directive is now achieving its first milestones. The French government, in accordance with that directive, has defined a National Strategy for Biodiversity that seeks to reduce biodiversity losses, improve knowledge and propose solutions for mitigation of environmental damage. In this context, the Ministry of Environment, by means of its Water Agency, has funded the “Nappex” project, to develop tools for restoring marine ecosystems in practical ways. Calm and nutrient-rich harbor waters would appear to provide good nursery areas for fish larvae and new recruits. However, such harbors present a fatal trap for many species; port construction and operations destroy shallow water habitats essential for early life cycle stages. By introducing a uniquely designed habitat (called BioHut) into harbors areas, Nappex intends to substitute the role played by rocky sea bottoms and shorelines in helping wild post larval marine fish get established and complete their life cycles. The BioHut habitat is intended to improve the survival rate of new recruits. An underwater visual census is being used to monitor this survivorship. Seawall zone with Biohut are compared with regular seawall zone. The presentation will outline the Biohut principle and the first encouraging results. The early recruits of seabream *Diplodus puntazzo* appreciate the Biohut habitat when they settle at 10-15mm and are capable to leave it when they reach a 50-60 mm size. Since, the weather conditions are improving; the juveniles of many more species are using the Biohut such as *S. Sarpa*, *D. vulgaris*.

Principles of restoration ecology included in construction of the National Institute of Ecology in Korea

Lee, Chang Seok

Seoul Women's University

National Institute of Ecology was created as a wise alternative choice instead of constructing the Industrial Complex by reclaiming the tidal flat in the central western Korea. In this significant project, we practiced several restoration programs. First, we created several types of forest vegetation based on the reference information obtained from various regions where the nature is conserved well including several national parks. The forest vegetation will function as the models of restoration projects, which will be carried out in the future in Korea. Second, we realized a passive restoration that the rice paddy returns to natural wetland and the result appears in increasing biodiversity. Third, we created several ecosystems with different climate such as tropical rain forest, desert, Mediterranean vegetation, and warm temperate forest within several greenhouses based on plot based data obtained from the natural vegetation of each climate zone. Their establishing process as well as field site where the reference information was collected will be monitored together. We will carry out adaptive management by comparing data got from both sites. Fourth, we managed a reservoir by applying the restorative treatment such as introduction of riparian vegetation buffer, perch, and bar. The treatment contributed to attracting two endangered species and consequently increased biodiversity of the reservoir. Finally, we recovered connectivity by transforming the road, which fragmented cross the NIE into the underpass and restoring ecotone between wetland and mountain foot, which disappeared in most areas except DMZ due to excessive use such as rice paddy and residential area.

ORAL ABSTRACTS (CONT'D)

Exploring the intersection of urban forestry and ecological restoration

Leff, Michael

Davey Institute / USFS

Urban forestry must be viewed and pursued as a form of ecological restoration. In addition to its direct ecosystem benefits to the urban environment itself, the urban forest – including canopy, understory, shrub, and herbaceous vegetation layers, as well as the unseen dimension of soil – plays a critical role in the health and function of surrounding natural areas, especially where urbanization is dense and likely to increase. And it is a linchpin to the integrity and resilience of the environment at the broadest regional and even global level. This presentation will explore some of the most challenging issues and promising opportunities facing urban forest managers and restoration practitioners. Stressors can include invasive plants and pests, dysfunctional urban hydrology, degraded urban soils, unnatural successional patterns, and contaminated sites, as well as rampant development and incompatible land use patterns – not to mention inadequate funding for long-term care. Plus, of course, there's the all-encompassing stress of climate change. How to deal? On the positive side, what are some of the emerging "Best Practices" that ecologically minded urban forestry practitioners might consider? Some of the opportunities being explored include agroforestry, green infrastructure solutions, utilizing recycled woody debris, making community connections, promoting desirable succession, installing highly urbanized riparian buffers, and even enhanced street tree plantings. During this presentation, we'll look at some inspiring – and cautionary – tales of today's pioneers on the leading edge of the urban forest.

Response of zooplankton communities to restoration of a shallow floodplain lake at Emiquon Preserve, Illinois

Lemke, A. Maria; Michael J. Lemke, John R. Beaver

The Nature Conservancy

The 6,400-acre floodplain area of The Nature Conservancy's Emiquon Preserve encompasses two shallow alluvial lakes, Thompson Lake and Flag Lake. The Illinois River was separated from much of its floodplain by levees in 1919 as floodplain areas were converted into farmland. Systems were installed to drain the land that consisted of underground pipes to transport water from fields into a series of drainage ditches and excess water was pumped into the Illinois River. Emiquon pumps were turned off in 2007 and the historic backwater lakes were re-inundated over the next several years. Our objective was to quantify pre- and post-restoration zooplankton diversity, biomass and secondary production in the larger of the two lakes, Thompson Lake. Monthly zooplankton samples were collected from 15 pre-restoration agricultural ditch sites (2004) and post-restoration transect sites (2008, 2011). Preliminary analyses indicate that the pre-restoration zooplankton community displayed overall lower biomass with dominance by small-bodied microcrustaceans (*Diaphanosoma*, *Sida*, nauplii, rotifers) while the post-restoration zooplankton communities had significantly higher biomass with increased importance of large-bodied microcrustaceans (*Daphnia* spp.). Pre-restoration copepod communities were modest but post-restoration copepod communities displayed larger-bodied species (*Acanthocyclops robustus*, *Leptodiatomus siciloides*). This shift from community structure dominated small-bodied zooplankton in the pre-restoration period to one dominated by larger-bodied suspension filter-feeders in the post restoration period should be reflected in higher secondary production in Thompson Lake after re-inundation compared to that of pre-restoration conditions. Further analyses will include 2011 data and relate community structure changes to water quality.

Water Quality and Bacteria Community Changes in Newly Restored Thompson Lake, Emiquon Preserve, IL

Lemke, Michael J.; Keenan Dungey, Angela Kent, Felipe Vehlo, Luzia C. Rodrigues, Doyn Kellerhals, Sara Paver

Therkildsen Field Station at Emiquon

Early restoration of Thompson Lake on the Emiquon Preserve, Lewistown, IL after decades of agriculture, represents an altered natural ecosystem going through rapid stages of change in structure and function. Just as monitoring water quality tracks rapid changes in the abiotic environment, bacterial communities serve as a responsive indicator of biotic change. The objectives of this study were to measure and relate water quality characteristics and change in bacterial community composition over five years of early restoration of a floodplain lake not yet connected to its flood pulse river source. Lake water was sampled weekly ($n=3$; 2008-2012) and physical (e.g., light, temperature) and chemical (TN, TP, pH) parameters were measured. ARISA community fingerprinting characterized bacterial community composition. In 2008, Thompson Lake had remarkable water clarity with Secchi disk readings reaching the bottom (~200 cm). These readings soon decreased to 1/5 of the lake depth (2010-2011) as dissolved phosphate (SRP) rapidly increased to 0.7 mg/L in 2008 then fell to below detection limits. The observed increase in SRP was likely triggered by low dissolved oxygen (late June, 2008) near the lake bottom. These events, coupled with low dissolved nitrogen led to an extensive cyanobacterial bloom of the heterocystous cyanobacteria, *Aphanizomenon flos-aque* that dominated in 2008 and 2009. Microbial community change was directional with time throughout the five-year study. During this early stage of restoration, analysis of these data indicates that the lake has gone through an early, transitional and late phase of change.

Post-larvae capture and culture evaluation of fish biodiversity and potential capacity to restore fish population

Lenfant, Philippe; Laure-Hélène Garsi, Gilles Lecaillon, Sylvia Agostini, Romain Crec'Hriou, Gilles Saragoni

CEFREM-University of Perpignan / CNRS

According to the most recent assessments of the Census of Marine Life (PlosOne 2010), the decrease of marine biodiversity is dramatic in the Mediterranean Sea. Habitat degradation, overexploitation of natural resources, climate change, invasive species and pollution are recognized as the most important. The urgent need to stop the biodiversity decrease is addressed by EU (Marine Strategy Framework Directive). We propose a new approach to monitor and to reduce the loss of marine biodiversity. Specific aim is to analyse the biodiversity at the post-larval stage. In the fish life cycle, the arrival and settlement of pelagic post-larvae in their permanent habitat is a critical phase with more than 90% mortality. The innovative technique proposed is

ORAL ABSTRACTS (CONT'D)

to catch live post-larvae prior to the mortality event by CARE light trap. They are reared-on in aquaria to confirm identification. We present first results about Mediterranean post-larvae sampled in the European Life SUBLIMO project (www.life-sublimo.fr). In only 4 month of survey, we caught 2891 post-larvae (more than 60 taxa) on French Mediterranean Coasts (including Corsica Island). Fish assemblages allow to separate rocky vs sandy coast and continental vs island sites. A few month later, the tank-reared juveniles returned to the sea using micro-habitats (such as small artificial reefs). The survey of White seabream juvenile (*Diplodus sargus*) on three micro-habitats (three square-meter) shown the same capacity over several thousand meter of natural rocky nursery. This method can restore fish population size reduced (i) by several very low level of juvenile recruitment or (ii) by overfishing.

Prioritization of stream restoration strategies at the watershed scale for reduction of sediment and phosphorus load

Lenhart, Christian; Ben Underhill, Jason Ullrich, Laura Triplett, John Nieber
University of Minnesota

Stream bank erosion is a major contributor of sediment and phosphorus to many streams in agricultural regions of the Midwestern U.S. There is a need to reduce channel erosion to achieve water quality goals, yet tools for prioritizing stream restoration actions are limited. We investigated soil and riparian vegetation properties along three different rivers, representing different upper Midwestern ecoregions. Riparian vegetation composition, plant root depth and density, soil properties, and Bank Erosion Hazard Index (BEHI) data were collected at 30 sites, with more detailed analyses of erosion processes done at 2 sites. A modified BEHI model was developed to predict sediment loading from stream banks in GIS and to examine restoration scenarios. Hydrologic and geomorphic investigations were also done to assess mechanisms of bank erosion. 85% of riparian vegetation root mass is in the top 60 cm across all sites. BEHI - BANCS calculations showed that the most stream bank-derived sediment from the Whitewater River and Elm Creek was from the lower 20km, while the middle Buffalo River had the highest loads. While grasses have greater root density, trees have more large roots below 90 cm. Grass provides the most benefit for stream banks < 1m high while trees provide greater large deep roots for stream banks 2-3 m high. On banks > 3 m, vegetation has less benefit where mass-wasting processes dominate. The tools developed here will help to optimize placement of riparian vegetation management practices, important in the restoration of water quality in large river basins.

Regional strategy provides tools for conservation and restoration in Portland, Oregon

Lev, Deborah
Portland Parks & Recreation

Portland, Oregon's metropolitan region is rich in natural resources. Threatened salmon still migrate through the Columbia and Willamette rivers and spawn in urban streams. Rare species still populate our remaining natural areas. Local government and non-profit organizations have been active in conservation planning and restoration but we lacked a regional comprehensive strategy. The 2012 Regional Conservation Strategy for The Greater Portland-Vancouver Metropolitan Area (RCS), will guide future conservation measures. The product of more than two years with contributions from over 100 individuals and dozens of organizations, the RCS comprehensively assesses the strategies needed to protect our natural systems. The RCS contains an overview of the region's current condition, threats and desired future conditions; addresses issues such as climate change and biodiversity corridors; equity and environmental education; conservation in natural areas, working lands and urban landscapes; ecosystems services and green infrastructure; and current species specific initiatives. The supplemental Regional Biodiversity Guide provides a comprehensive assessment of the flora, fauna, natural habitats and natural processes that represent and support our region's biodiversity, a watershed level perspective of priorities, and species lists by habitat type. A third element is a set of high resolution (five meter) land cover maps and data driven habitat prioritization models that cover the entire region, useable at any geographic scale, designed for use by government and community groups. The City of Portland will use these science-based tools to refine our conservation priorities, enhance public dialogue, and seek funding for conservation and restoration efforts.

An ecohydrological approach to guiding riparian restoration, Part 1: understanding hydrogeomorphic processes on the ecologically sensitive Virgin River

Leverich, Glen; Bruce Orr, Tom Dudley, Sebastian Araya, Karley Rodriguez
Stillwater Sciences

Achieving long-term success of much-needed river restoration and floodplain management projects across the US demands informed, science based approaches during the planning phases. To this end, we have developed a planning tool for riparian restoration in these systems that integrates the key physical attributes of a river and its watershed—typically climate, hydrology, and geomorphology—with the ecological responses of vegetation, fish, and other wildlife to those conditions. We present an ongoing case study from the Virgin River, where two successive floods have destroyed recent tamarisk removal and riparian restoration efforts, and where our ecohydrological approach will aid habitat restoration efforts for the endangered Southwestern Willow Flycatcher. Our focus here is upon the initial step in our ecohydrological approach: to understand the active hydrogeomorphic processes along the entire 210-km river corridor to predict likely future trends in channel evolution which will help to inform on suitable site selection. Using a series of historical aerial photographs taken after large flood events, we mapped flood-disturbance probability in each reach to highlight those channel areas most frequently disturbed by repeat flood events. We also considered the vertical adjustments and variability of the river bed (varying naturally over several meters) through comparing a series of pre- and post-flood LiDAR datasets: an equally vital component in assessing local channel behavior, and understanding restoration planting surface elevations relative to the low-flow channel and shallow water table. Subsequent steps in our approach entail incorporation of other vital data layers, including vegetation, soils, groundwater, land-use, and wildlife information.

ORAL ABSTRACTS (CONT'D)

Restoring Acroporid coral reefs in the US Virgin Islands

Lewis, Kemit-Amon

The Nature Conservancy

Acroporid coral populations throughout the Caribbean and western Atlantic have drastically declined since the 1980's due to temperature induced bleaching, diseases, and hurricanes. The ability of Caribbean reefs to cope and recover from these natural disturbances and more localized, direct and indirect anthropogenic impacts has significantly been reduced over time. In an effort to enhance the resilience and structural complexity of U.S. Virgin Island (USVI) reefs, The Nature Conservancy's USVI program has established coral nurseries using American Recovery and Reinvestment Act funds. The nurseries house elkhorn (*Acropora palmata*) and staghorn (*A. cervicornis*) coral fragments detached during storm events and vessel groundings. The fragments are used to enhance genetic diversity, reverse population decline, and maintain ecosystem services at outplanting sites throughout the territory. Colony survivorship (resistance to natural and anthropogenic stressors) and the re-colonization of reef-dwelling organisms at outplanting sites are monitored and location-based variations in responses of individual transplanted corals to environmental factors will help determine the optimum habitat requirements for future coral enhancement and recovery projects. The nursery program has also increased local community awareness of the importance of coral reefs and also benefits the scientific and habitat restoration communities. More importantly, the outreach and education through the coral nursery project along with the establishment of the Virgin Islands Reef Resilience Program should create stewardship, behavioral and policy changes, and a reduction in the incidence of anthropogenic stressors impacting coral reefs in the US Virgin Islands.

Effects of cascading hydropower dams on the biological integrity of aquatic plankton assemblages in the middle Lancang-Mekong River

Li, Jimpeng; Shikui Dong

School of Environment, Beijing Normal University

Lancang-Mekong River, as an important transboundary river in Southeast Asia, has been attracted and argued on international levels in recent years due to extensive cascading hydropower dams exploitation planning. The middle reach of Lancang-Mekong River, located at the Yunnan Province, China, as typical region for cascading hydropower dams exploitation, was selected as study area to explore the variation of phytoplankton and zooplankton assemblages before and after cascading dams. In this study, along the longitudinal gradient of this river, the plankton assemblages were investigated in 3 periods, including 1988 (pristine state), 1997 (completion of the first dam), and 2011 (cascading dams). The composition and abundance of plankton assemblages were sensitive indicators in the assessment of aquatic ecosystem health degradation associated with the cascading dams operation. The comprehensive plankton index of biotic integrity (CP-IBI) was developed as a synthetical and quantitative index that integrated composition, structure, diversity index, trophic status index, and biomass of phytoplankton and zooplankton assemblages before and after cascading dams. This index can well demonstrate biological integrity and aquatic ecosystem degradation before and after the operation of cascading dams. As an aggregative indicator, the selected multi-metrics (CP-IBI) can provide a quantitative tool to identify the specific cause of aquatic ecosystem degradation. In addition, to mitigate the impact of cascading hydropower dams on the aquatic ecosystem, this index can provide exact indicators for the aquatic ecosystem restoration processing and the operation planning of cascading dams.

Birds and ecosystem processes in tropical forest restoration efforts

Lindell, Catherine; Emily Morrison

Michigan State University

Birds are critical to a number of ecosystem processes in tropical forests including seed dispersal, pollination, and the consumption of arthropods that damage leaves. Thus, birds play important roles in tropical forest restoration efforts and practitioners should consider how to manipulate restoration design to attract them. However, aspects of restoration design may influence birds involved in these different ecosystem processes differentially. We worked in a large-scale restoration experiment in Costa Rica that is testing the influence of planted patch size on restoration trajectories. When planted, patches ranged from tens of square meters in size to 2500 square meters. Our work showed that, in seasons when many tree species were fruiting, seed-dispersing birds more commonly used larger patches than smaller patches, potentially producing greater seed rain in larger patches. Similarly, an exclusion experiment showed that insectivorous birds and bats significantly reduced leaf damage from herbivorous arthropods in larger patches but not in smaller patches. In contrast, planted patch size did not influence bird pollinator visits to one of the planted species, *Inga edulis*, although visits by bats and insects, also potential pollinators, were not measured. These results indicate that planting in larger patches is more likely to attract birds involved in some, but not all, important ecosystem processes. Thus, restoration ecologists should prioritize the ecosystem processes they seek to restore, consider how various animal groups contribute to these processes, and incorporate design elements most likely to attract those groups carrying out the processes.

Biodiversity restoration in production landscapes through planting of a key species

Lindig-Cisneros, Roberto; Arnulfo Blanco-García, Berenice Díaz-Rodríguez, Rubén Ortega-Alvarez, Mariela Gómez-Romero

Centro Investigaciones en Ecosistemas, UNAM

The role of key species in restoration has been studied, for example the role of nurse plants in the establishment of tree species. But the effects of these species in multiple taxa and in biodiversity restoration has not been fully addressed. Results from a restoration established in 2004 allowed to explore the effects of *Lupinus elegans* in three conifer species, the establishment of understory vegetation and in the use of the site by birds. Lupines had a significant effect in the conifers because they increased survival of *Pinus pseudostrobus* and *Abies religiosa* and had no effect on *P. montezumae*. When comparing forest remnants, plantations and the restoration experiment, a total of 133 plant species were found: 63 species in the restoration experiment while

ORAL ABSTRACTS (CONT'D)

adjacent plantations contained 38 species, and the closest forest remnant 65 species. The restoration clustered with adjacent plantations when comparing sites over time and at a small scale (1.15 ha), while the forest remnant remained distinct. However, the restoration site more closely resembled the forest remnant when compared with plantations at the landscape level. We assessed differences in avian community responses among the restoration, reforestation sites, cropfields, and forest remnants. Bird communities vary among habitats, as a consequence of both their disturbance history and current use. The restoration, where lupines were planted, promote a more diverse, even, and heterogeneous bird community that resemble those of natural habitats. These results suggest that some species can act as restoration key species playing different roles at different spatial scales.

Restoration in light of ecological changes: Complex consequences for wildlife populations and communities

Litt, Andrea R.; Robert J. Steidl

Montana State University

Anticipated changes in climate will interact with other anthropogenic stressors in ways that could create significant challenges for conservation and restoration. Changes in climate will alter distributions of many native and nonnative organisms, which in turn will influence species-level interactions. For example, as summer precipitation decreases, the distribution of cheatgrass (*Bromus tectorum*) in the western US could expand greatly, altering vegetation communities in ways that are likely to affect the composition of animal communities. As changes in climate create novel states, ecologists will need to determine whether historical conditions continue to provide suitable reference targets for evaluating the efficacy of restoration efforts or if alternative targets are more appropriate. For example, hydrologic regimes in the southwestern US will change substantially in response to altered precipitation patterns and increased withdrawal for human uses, which may make it impossible to restore historical processes. Finally, ecologists and managers often seek to reestablish natural ecological processes to restore structure and function in altered ecosystems, yet restoring these processes in areas altered by anthropogenic stressors may yield unanticipated or undesired effects on native organisms. When fire is restored to semi-desert grasslands invaded by Lehmann lovegrass (*Eragrostis lehmanniana*), for example, fire functions differently than in native-plant dominated grasslands, altering the effects on animals. Because most ecosystems will continue to change in response to climate and other anthropogenic stressors, reestablishing key ecological processes may trigger a set of complex and novel interactions that require us to increase our understanding to create effective solutions for restoration and conservation.

Understanding historical trend of ecosystem services for river restoration: a case study of the Yongding river in Beijing, China

Liu, Junguo

Beijing Forestry University

Freshwater ecosystems are changing rapidly worldwide, raising sustainability concern for rivers' health and for communities relying on their ecosystem services. Knowledge on historical trend of ecosystem services is a key to formulating river management and restoration policies; however, it is still lacking for many rivers in China. We evaluate the ecosystem services of the Yongding River (it was once called the Mother River of Beijing, but is suffering from serious dry-ups and water quality problems) through an intensive effort involving the local stakeholders. The assessment shows that the total values of the river ecosystem services have decreased by 40% over 1978-2009. Among all the services, water supply and cultural services have suffered from the sharpest declines. They have decreased by 94% and 54%, respectively. We conclude that restoring culture-related services may be the most effective way to enhance the Yongding river ecosystems in the short run, but setting up monitoring measurements is also a priority to trace long-term changes of the river ecosystem services after restoration.

Spatio-temporal variability of grassland associated with climate change and human disturbance in Altun Nature Reserve in past 15 years

Liu, Shiliang; Haidi Zhao, Shikui Dong, Xukun Su, Qi Liu, Li Deng, Xiang Zhang

School of Environment, Beijing Normal University

One of the focuses of global change research is the impact of climate change on terrestrial ecosystem, especially on alpine vegetation on Qinghai-Tibet Plateau with high elevations. Altun Nature Reserve is the biggest comprehensive reserve nowadays in China to protect wild animals such as Tibetan wild donkey, Tibetan antelope, and wild yak. This paper aims to detect change trends in grassland activity in this region. Temporal change of Normalized Difference Vegetation Index (NDVI) for the grasslands in Altun Nature Reserve and its correlation with climatic variables was studied over the period of 1998–2012. Based on the SPOT-VGT NDVI vegetation index and using ArcGIS spatial analyst, we located the vegetation degradation and improvement distribution using linear regression analysis. The results showed that there existed distinct monthly changes in NDVI and the values were relatively low varying from 0.032 to 0.112. The the highest value exhibited in September. Generally, the NDVI values were increasing trend with a average value about 0.06 while dropped drastically in 2001 and 2002. From the spatial distribution, the high values of NDVI mainly located in the core area in the nature reserve. Trend analysis showed that vegetations near rivers, lakes degraded, but the vegetation conditions got better within the protected area overall. Precipitation and temperature had a linear significant correlation with NDVI. But the vegetation at the edge of the protected areas degraded due to human activities such as mining and collecting *Artemia*.

ORAL ABSTRACTS (CONT'D)

Native Seed Farming: Vacancy as a Laboratory

Lokman, Kees Lokman

Washington University in St. Louis

This paper explores the opportunities of restoration ecology as a transdisciplinary model to foster healthy relationships between humanity and the environment. Restoration ecology not only acknowledges society's dependence on nature, but also suggests that nature depends on deliberate human actions to maintain biodiversity. Strengthening this relationship becomes increasingly important in urban areas where many people have lost daily connections with the natural environment. Within this context, the Chicago Botanic Garden launched the Native Seed Farming Project: a platform that grows Midwest prairie plants by converting vacant parcels into seed farms. The goal is to test the viability of generating native seed stock as a marketable crop for urban farmers. Moreover, the project trains underemployed and at-risk young adults to become urban farmers. In contrast to urban agriculture, which requires clean soils (high remediation costs), prairie plants have the ability grow in compacted soils, store carbon underground, prevent stormwater runoff and provide habitat for pollinators and other wildlife. Human intervention benefits prairie plants by mitigating declining habitats, generating their seed stocks, and enhancing the possibility of plant diversity for future generations. Urban seed farms, in turn, allow restorationists to gain access to first-generation seed stock of known origin while enabling urban farmers to diversify their markets. As an alternative approach to restoration ecology, the Native Seed Farming Project allows for the coproduction of knowledge through various means, techniques and actors, in search of new ways to convert marginal lands to productive landscapes.

Prioritizing wetlands for *Phragmites australis* control and wetland restoration around the Great Salt Lake, UT

Long, A. Lexine; Karin M. Kettenring, Christopher M. U. Neale, Charles P. Hawkings, Richard E. Toth

Utah State University, Watershed Sciences

Invasive species negatively affect the structure, function, and services of the ecosystems they invade. One of the most problematic invasive plants in North America and within Great Salt Lake (GSL), UT wetlands is *Phragmites australis* (hereafter *Phragmites*). *Phragmites* creates dense monocultures, displaces native wetland vegetation, and reduces the quality of ecosystem services provided by wetlands. Significant resources are spent on controlling *Phragmites* on public and private lands around the GSL, but there has been little coordination of efforts, based in-part on insufficient baseline *Phragmites* distribution maps. Limited mapping efforts of *Phragmites* around the GSL have occurred, but these have failed to capture the species' full extent. We undertook a tiered investigation using high resolution (1m) multispectral imagery to determine the current distribution of *Phragmites* and other wetland vegetation around the GSL. We used species distribution modeling to identify environmental and anthropogenic factors important to *Phragmites* presence. We then used these predictors to identify areas potentially vulnerable to *Phragmites* invasion. We paired this information with disturbance, environmental conditions, and land management data to create a spatial model to prioritize areas for *Phragmites* control and wetland restoration around the GSL. Based on these data and our prioritization framework, we identify areas that may have the greatest potential for effective *Phragmites* control and successful wetland restoration. Wetland restoration is often conducted on a site by site basis, and less often at the watershed scale. Our findings and prioritization framework demonstrate how larger scale restoration planning can be one component of effective wetland restoration.

Restoring a lost ecotone: Reintroduction of the endangered Pyne's ground plum (*Astragalus bibullatus*)

Long, Quinn; Matthew Albrecht

Missouri Botanical Garden

Identifying suitable habitat is an essential component of rare plant recovery programs, yet the habitat needs for many rare plants are difficult to distinguish in degraded ecosystems. In the southeastern US, encroachment by native and exotic woody species around calcareous glades, which are openings of shallow soil and exposed bedrock within a woodland/forest matrix, has created an abrupt ecotone between glade openings and surrounding forests that may threaten the persistence of sensitive plant populations. One example is *Astragalus bibullatus*, a federally endangered legume endemic to the Stone's River watershed in the Tennessee Central Basin. Previously unsuccessful reintroductions of *A. bibullatus* to unoccupied glades edges suggest that current conditions of glade-forest ecotones are suboptimal for the species' long-term persistence. In this study, we quantified microenvironmental variation in wild populations and conducted experimental reintroductions at three sites to determine optimal habitat for *A. bibullatus*. Two reintroduction sites were mechanically thinned prior to reintroduction whereas prescribed fire was used to manage woody encroachment at the third site. In wild populations, fecundity significantly decreased with increasing canopy cover and seedling densities tended to be greatest in microsites with low forb cover. Initial (<1 year) survival and growth of transplants was significantly greater at the reintroduction site with less canopy cover and a history of prescribed fire. Our results suggest that natural and reintroduced populations will benefit from active glade restoration practices (e.g., prescribed fire), that create spatially heterogeneous microenvironments capable of supporting recruitment and reproductive niches.

Wildfire and native bees in the Great Basin

Love, Byron; Jim Cane

Utah State University

Wildfires in the Great Basin have increased both in frequency and intensity within the past century. Livestock grazing, exotic grasses and a changing climate are perpetuating a downward spiral of destructive fire and weeds. As part of a landscape-level approach to post-wildfire restoration, land managers have been working to include native forbs in reseeding mixtures, many of which require the pollination services of bees. Fire ecologists recognize three phases of fire--acute, shock, and recovery--which can influence bees directly by exposing them to lethal temperatures, or indirectly by removing nesting and foraging resources. In this study, we investigate the response of bee communities to these stages using a 10-year chronosequence

ORAL ABSTRACTS (CONT'D)

of large historic wildfires in sage-steppe habitat. Paired plots were established far into the burn (>100 meters) and outside the burn to test for differences in the following characteristics: bee density in patches of target flowering hosts; similarity of bee communities (with a focus on nesting and diet strategies); and the diversity, and density, of forbs and shrubs. Our results suggest that all bee life stages can survive wildfire, but certain nesting strategies may be negatively influenced. Furthermore, in relatively mild burns of intact sage-steppe plant communities, entire bee communities exhibit excellent prospects for survival. However, where forbs do not bloom in the year following fire (especially in previously depauperate communities or hotter fires), surviving bee communities will need supplemental forage that blooms reliably the year after seeding.

The past history of vegetation stabilisation of mine tailings on the Witwatersrand Gold Mine Fields and its influence on the restoration processes in South Africa

Lubke, Roy A.; Brian L. Dawson
Dept of Botany, Rhodes University

Restoration of degraded lands in South Africa has had a different perspective compared with many other countries. Here the first large scale programmes of establishing vegetation on derelict land were carried out using grasses and herbs to stabilise mine tailings after gold mining on the Witwatersrand. Pollution of the air and water of the region necessitated action which was taken up by mine managers and horticulturalists resulting in a mechanistic process for vegetation establishment on existing mine tailings that followed this formula: The tailings were treated to allow for a "cocktail" of seeds to germinate and become established as a grass/herbaceous cover of the exposed fine rock tailings. Thus, although a stable landscape or ecosystem appeared to become established, an experimental approach, as used in other countries, to determine the best techniques, as well as the appropriate land use or land reclamation potential, was overlooked. Moreover this stabilisation process was not a permanent solution and degradation of the "grasslands" required further action. This process on the mine dumps unfortunately set a precedent in South Africa for the restoration of degraded land on other mining projects. Only now, in the 21st century, has a large scale experimental reclamation programme been instigated on the Witwatersrand. Moreover, the need for a restoration strategy been seen as essential by mining companies. The most appropriate research techniques need to be studied in order to establish long term environment restoration that has an appropriate land use for the local people.

Using life cycle models for planning, design, and prioritization of landscape restoration actions for migratory species, such as Pacific salmon

Luiting, Victoria T.; Greg Blair
ICF International

Effective restoration requires planning and design tools to evaluate landscape-scale issues, prioritize restoration actions, determine project design elements, and monitor outcomes. Life cycle models are useful tools to answer questions such as: what landscape-scale factors are affecting the species; which life history stages are limiting recovery; what design elements are most effective; which restoration projects should be implemented? Restoration focused on recovery of migratory species such as Pacific salmon is also particularly challenging. Salmon use habitats ranging from headwater streams to estuaries, nearshore, and ocean habitats across their life history stages. Salmon are central to Pacific Northwest ecosystems and the focus of millions of dollars of watershed and site-specific restoration. They are also of critical cultural and commercial concern to Native American Tribes, and are worth millions of dollars to the US and Canadian economies. The Ecosystem Diagnosis and Treatment (EDT) life cycle model is used to integrate the experiences of multiple life history stages across the landscape and parse the importance of multiple factors to different life history stages. EDT is being used to evaluate limiting factors for life history stages of several species of salmon in rivers in Washington State, including the Yakima River, a major tributary of the Columbia River. We present how EDT was used to evaluate and prioritize the benefits of different types of restoration actions, the cumulative benefits of multiple projects in a watershed, and how results are being used by a Yakima basin working group to support restoration funding and plan project implementation.

Landscape change under ecological restoration in the loess hilly area of China: spatial heterogeneity

Lv, Yihe; Jianglei Wang, Bojie Fu
Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences

Ecological restoration policy can be an important driver for landscape change and landscapes can respond to ecological restoration policy differently owing to different biophysical and socioeconomic settings. This paper analyzed the spatial heterogeneous responses of landscape change to ecological restoration policies including soil and water conservation and reforestation on sloping croplands in Baota District of the loess hilly area in China. Landscape changes were detected based on Landsat imagery interpretation and GIS analysis. Then, k-means clustering was used to find similarity and differences among the 20 township landscapes on their changes under ecological restoration policy based on 17 clustering indicators comprised by landscape metrics, population, and grain production characteristics. Results indicated that landscape changes at the district scale during 1990-2010 were represented by 3.2%, 18.6%, and 262.4% increase in forestland, grassland, and residential area, respectively. While, cropland and water body decreased by 21.6% and 0.3%. The interspersion and juxtaposition index, mean patch size index increased, and edge density decreased to show the overall land restoration trend at the district level. The landscape change at the township level can be classified at most into five categories composed of two to six township areas accounting for 7.6% to 32.7% of the whole district. For further landscape and ecological restoration planning and implementation, these five categories can be considered to improve management performance on both land use and ecological restoration facilitated by the more spatial explicit heterogeneity on landscape pattern and related socioeconomic characteristics.

ORAL ABSTRACTS (CONT'D)

Using video technology to communicate remediation and restoration design to multiple stakeholders

Lyndall, Jennifer; Kyle Konechne, Victor Magar
ENVIRON International Corporation

The remediation and restoration of complex contaminated sediment sites often involves the collaboration of numerous stakeholders and concurrence from public and private landowners and the local community. Conveying information to such a diverse group of interested parties is a challenge due to the wide range of perspectives and technical backgrounds. Under the Great Lakes Legacy Act (GLLA), the Buffalo River Area of Concern is expected to be remediated in the near future. We prepared a brief video for the Buffalo River GLLA Project Coordination Team to present the project details to the various stakeholders and general public. The video was created using Adobe Photoshop, Illustrator, and After Effects by editing and developing various graphics, photos, and satellite imagery into a sequence of consecutive images that, when viewed in rapid succession, give the illusion of motion. The Buffalo River video is a 2.5D animation, meaning that the flat two-dimensional images are rotated in a three-dimensional environment, creating a sense of space and depth within the animation. The video was targeted for a wide audience, providing a general overview for individuals with no technical background as well as detailed information for stakeholders who wanted to visualize the implementation details. It was presented at a public meeting and then distributed via the New York State Department of Environmental Concerns website. Initial feedback indicated that the video was a valuable tool for stakeholder and public outreach.

Framing the Cross-Continent Dialogue on Limitations to Grassland Restoration

Lyons, Kelly
Trinity University

Cross-continental dialogues on biotic and abiotic determinants of grassland restoration and species establishment have a long history. Nonetheless, these dialogues are constrained by differences among ecosystems in land-use and resource extraction histories, soil types, species compositions, management practices, and temporal proximity to novel species introductions. This talk will be the first in a symposium of eleven talks designed to facilitate an intercontinental discussion on and elucidate the principle limitations to grassland restoration. Symposium invitees were asked to consider foundational papers on limitations to grassland restoration and identify the principle determinants for success of restoration in their respective ecosystems. In the first portion of this talk, I will provide an overview to build a foundation for discussion following the symposium. I will then highlight the limitations to grassland restoration in South Texas, USA. In this region of the world, as in many others, restoration is primarily limited by homogenizing invasive species and to a lesser extent depleted soil seed banks. While research into the mechanisms of the competitive dynamics of native and invasive species often focuses on nutrient cycling and resource availability recent evidence points to a historic shift in soil microbial species composition that may mediate inter-specific competition, favoring non-indigenous, invasive species. In addition, future restoration in this region will be conducted in a “novel ecosystem”, particularly in light of anticipated long-term changes in precipitation. Consideration of soil processes and plant species selection in the context of climate change will be critical to the success of restoration in South Texas.

The Assessment of Coastal Wetland Restoration: A Case Study in Wuyuan Bay, Xiamen, China

Ma, Zhiyuan; Weiei Yu, Bin Chen
The Third Institute of Oceanography, State Oceanic Administration

Serious loss and degradation of coastal wetland along China's vast coastline has aroused a series of restoration projects in recent years. However, most of these projects terminated as soon as engineering completed, thus they can't provide useful experience and instructive lessons for future restoration efforts due to lack of effective monitoring and assessment. Restoration project in Wuyuan Bay, Xiamen, is a pioneer practice of urban coastal wetland restoration in China. Wuyuan Bay was once a typical bay with little disturbance, while it had been destroyed as a result of intensive exploitation and urbanization since 1950s. Local government initiated restoration project in Wuyuan Bay in 2005. In this paper, some indicators were selected to evaluate the restoration process and effectiveness in Wuyuan Bay, in terms of landscape, hydrology, environmental quality, biology, and social and economic considerations. The results indicated that after 5-year restoration, some aspects were processing toward planned objectives, including restoration of tidal hydrodynamic condition, improvement of environmental quality, promotion of public access and economic development. However, it also indicated that there was not obviously trend toward goals for some biological communities. Some lessons of Wuyuan bay restoration were summarized, which will be useful for future associated restoration programs. It's found that 5-years restoration is not enough to restore biological communities completely. In the early stage of restoration, it's important to evaluate ecosystem's recovery process, providing significant information to look for contributive factors for trend or opposite toward objectives and determine the modifications as needed.

Chain of Lakes: green infrastructure and eco services in Minneapolis parks

MacDonagh, Peter
Kestrel Design Group

Minneapolis, Minnesota is bordered by the Mississippi River, dotted with lakes and bisected by streams. It is a City intertwined with water. Seeing the important role that water played in the fabric of Minneapolis, Horace W. S. Cleveland created forward-thinking park plans that preserved significant open space around Minneapolis' water bodies. Cleveland's park plans, developed in the late 1800s, have resulted in a modern-day Minneapolis with plentiful open space and access to water, fondly called the Chain of Lakes. After years of public use and direct stormwater deposition, the water and adjacent open space that Cleveland set aside deteriorated. Streambanks were eroding along Minnehaha Creek and phosphorous-laden stormwater, leaf detritus and sediment plumes flowed directly into the Lakes. The pollutants that entered the surface water resulted in hazardous swimming conditions

ORAL ABSTRACTS (CONT'D)

and unsafe fishing. Clarity readings in Cedar Lake, Lake Nokomis and Lake Calhoun dropped below four inches in the mid 1980's. Minneapolis was facing critical water quality problems. Nine separate projects were commissioned to drive a watershed-wide approach to water quality improvements throughout the City's parks system. We spearheaded a collaborative, coordinated effort that brought together local watershed districts, neighborhood groups, agencies, counties, and universities to re-think the existing paradigm of gray infrastructure to control and manage stormwater and protect our natural resources. Treatment wetlands, soil bioengineering using native plants were the solution. Water quality in the lakes has returned to pre-1970 levels.

A Preliminary Survey and Assessment of U.S. Municipal Regulations Governing the Use of Prescribed Grazing as an Ecological Restoration Technique in Urban Settings

MacDonald, Eric A.; Michael E. Salter, Zachary A. Richardson
University of Georgia, College of Environment and Design

This paper provides an overview of how municipal level regulations affect the practice of prescribed grazing as an ecological restoration technique in urban environments. In cities throughout the U.S., land management professionals are experimenting with the use of goats and sheep as biological agents for controlling invasive plants and assisting in the restoration of ecological function in woodland and riparian environments. To assess how municipal ordinances impede or facilitate the use of prescribed grazing as a method for managing invasive vegetation, the authors conducted a literature review and a review of land-use codes and other regulations in ten U.S. cities where prescribed grazing activities are underway. To better understand how these regulations currently impact prescribed grazing projects the authors also conducted semi-structured interviews with individuals who are directly engaged in these practices. The study suggests that few, if any, U.S. cities have regulations in place to allow and adequately govern prescribed grazing on privately-owned urban lands. Consequently, prescribed grazing efforts in these cities have a legally ambiguous status, or are constrained by municipal ordinances and policies that govern the use of domestic livestock in urban settings only as pets. This situation limits further testing of prescribed grazing methods, and potentially places animals, humans, and the environment in jeopardy. The paper concludes with suggestions for how public policy-makers, scientists, and environmental contractors may collaborate on research and environmental remediation via prescribed grazing, and alter existing municipal codes to support this emerging frontier of urban land management.

Regeneration of mangroves: A case study

Madav, Ramesh P.; Deepak M. Mhatre
Terracon Ecotech Private Limited

Mangroves as an ecosystem are capable of performing certain functions like shoreline protection, reducing erosion, flood attenuation etc. Mangrove forests continue to disappear all over the world. About 90% of the global mangroves grow in developing countries and they are critically endangered and nearing extinction in 26 of these countries. There are cases of successful mangrove re-vegetation and our present study at Jessel Park, north of Mumbai, India was an attempt to regenerate a patch of mangroves degraded by anthropogenic activities. In this paper we would like to report the successful pilot study of transplantation of seedlings of three mangrove species in a 600 sq m patch degraded by the presence of a jetty. Seedlings of *Avicennia marina*, *Sonneratia alba* and *Rhizophora mucronata* were collected from Dharamtar creek (Pen-Raigad district), a location 90 km south of the project area and transplanted at this patch. Mangrove associated flora species were also planted along with the mangrove seedlings. These were planted closer to the high tide mark. Initially, the mangrove seedlings suffered from high mortality rates due to disturbance from dumping of garbage by locals. A second planting phase was carried out with stricter protection measures against anthropogenic disturbance. There was 80% success rate after the second plantation. A healthy growth in the mangroves has been seen in this area instead of the limitation that the area is highly polluted and has high human interference.

Documenting lessons and refining the wetland restoration field of practice in South Africa: The response of two wetlands to Working for Wetlands restoration.

Madikizela, Bonani; Craig Cowden, Donovan Kotze, William Ellery
Water Research Commission

The objectives of the Working for Wetlands programme in South Africa include the restoration of wetland ecosystems, guided by the Water Research Commission's Wetland Management Series guidelines. The programme acknowledges that there has been inadequate assessment and reporting on the outcomes of its rehabilitation activities. Towards this, the restored Killarney and Kruisfontein wetlands in KwaZulu-Natal were assessed, including an evaluation of changes in ecological integrity, the supply of ecosystem services, and vegetation composition. Improvements in hydrological and geomorphic integrity were recorded in both wetlands, but vegetation integrity response varied. Improved levels of delivery were recorded for ecosystem services aligned with improved hydrological conditions in the systems. Investigation of changes in vegetation composition, using the Wetland Index Value and Floristic Quality Assessment Index indices, highlighted that after seven years of restoration, the Killarney vegetation composition was improving, but the Kruisfontein wetland was still largely dominated by pioneer species, notably the hydric alien invasive grass *Paspalum dilatatum*, and appeared to be stable in a severely transformed state such that a threshold needs to be crossed before the vegetation returns to its former state. The response of these wetlands has shown that sites for restoration should be screened in terms of the intensity of management of vegetation recovery, taking into account the objectives and the anticipated benefits of the project, and that multiple measures of system response are required to reliably assess restoration success. The incorporation of these research findings into the Wetland Management Series was identified as important for future wetland restoration.

ORAL ABSTRACTS (CONT'D)

Restoration of native fish communities through the eradication of alien fish in a South African river

Madikizela, Bonani; Darragh Woodford, Olaf Weyl, Dean Impson

Water Research Commission

South Africa is ranked one of the top three countries with the highest biodiversity in the world. However, the on-going decline of ecosystems through impacts such as habitat degradation and the effects of invasive species, which are worsened by climate change, puts tremendous pressure on this heritage. Tragically, aquatic ecosystems are the worst affected. Of the 27 fish taxa in the Cape Floristic Region, 24 are endemic to this biodiversity hot spot, 19 of them are IUCN red-listed. Rehabilitation was initiated in 2011 through collaboration between CapeNature, Working for water, the South African Institute for Aquatic Biodiversity and the Water Research Commission. This project investigated the feasibility of using the piscicide rotenone to eradicate invasive alien smallmouth bass from a selected 4km reach of the Rondegat river, north-east of Cape Town. The study was preceded by environmental impact assessment (EIA) and public consultation because rotenone is lethal in sensitive environments and can kill non-target fauna such as aquatic invertebrates. The EIA found the project to be justified, and recommended a comprehensive environmental monitoring programme be set up to assess the impacts of fish eradication operations on the river ecosystem. The river was then treated with rotenone in 2012. Monitoring indicates that the Rondegat river rehabilitation was a success. All bass appeared to have been killed in the river without significant long-term damage to non-target faunas. Further research and policy on use of rotenone is underway. This will inform conservation of threatened fish species as a pioneer in South Africa.

Bet-hedging across the conservation network: how diverse adaptation strategies can increase regional resilience

Magness, Dawn R.; John Morton

Kenai NWR, USFWS

Natural resource managers have traditionally used the concept of historical condition or naturalness to develop and assess management goals. Climate change is a rapid directional driver that may make maintaining historical condition and extant species assemblages a costly strategy. Adaptation goals can focus on historical condition (retrospective adaptation) or likely future conditions (prospective adaptation). We conducted a vulnerability assessment of 501 refuges in the U. S. National Wildlife Refuge System. We use the geography of vulnerability to suggest alternative adaptation strategies based on climate change exposure and landscape integrity (a landscape measure of adaptive capacity and sensitivity). We suggest that some conservation units may be more likely to maintain historic condition, while others may be better suited to prospective adaptation. A diverse, but coordinated management response would reduce climate change risk for the entire conservation network. In areas where ecological transition is likely, managers could experiment with prospective adaptation. Managers in more stable areas could use retrospective strategies to maintain and enhance current ecological conditions. In a rapidly changing climate, retrospective adaptation may be as risky as prospective adaptation.

Common ground in a heated debate: A role for restoration in facilitating plant species' responses to climate change

Mahaney, Wendy M.; Jennifer L. Lyndall, Katrina B. Leigh, Timothy R. Barber

ENVIRON International Corporation

Assisted migration is a controversial topic with often polarized views on facilitating species' movement in response to climate change. Assisted migration may be appropriate when barriers to natural migration exist (e.g., landscape fragmentation). However, the importance of preventing extinction is widely acknowledged and must be weighed against the risks of creating invasive species and novel ecosystems. Planning assisted migration is complicated by uncertainty associated with location-specific climate changes and effects on species survival and competitive interactions. Facilitating the establishment of forest types from adjacent climate zones into their predicted new ranges is a low-risk approach to assisted migration. For example, northern Ohio's climate might soon reflect those currently experienced in southern Ohio, causing a shift from maple-beech-birch forests to the oak-hickory forests common in southern Ohio. However, if rates of environmental change or migration barriers are expected to prevent successful natural migration, this type of regionally-focused assisted migration may be a valuable, low-risk tool to facilitate species/community movement. Restoration represents an important opportunity to create climate-adapted plant communities and scientifically evaluate the efficacy of assisted migration. Using predictive models of plant community change, a conservative assisted migration approach can be incorporated into restoration design. For example, a northern Ohio forest restoration project could be designed using species common to southern Ohio oak-hickory forests. Restoration could function as a long-range dispersal mechanism to overcome migration barriers. Moreover, pairing scientific study with restoration/mitigation monitoring requirements would benefit both restoration practitioners and restoration science.

Habitat restoration over 24 years on a Central Texas ranch: Methods and results on heavily browsed and over grazed land invaded with exotic species

Mahler, David

Environmental Survey Consulting

Restoration work on this 450 hectare ranch in Spicewood, Texas has resulted in significant increases in the diversity and quantity of grasses, forbs and woody species which had been nearly or totally eliminated through previous management. When restoration started in 1989, the vegetation was typical of most of the present day Texas Hill Country, with most of the palatable native grass species gone or greatly reduced, and the surviving forb and woody component reduced to extremely low browse value species. Management and restoration techniques are being developed and modified to be practical for use on the large areas of prairie, savanna, woodland and riparian habitats of this ranch. These include controlled burns, selected removal of juniper

ORAL ABSTRACTS (CONT'D)

(*Juniperus ashei*), reduction of white-tailed deer (*Odocoileus virginianus*), limited cattle grazing, high fencing, seeding, exotic species control, and propagation research. For successful reestablishment of woody species and perennial forbs we have developed a process of simultaneously reducing the deer population while increasing the available browse through a sequence of species reintroductions. We start with plants that are only somewhat palatable to the reduced deer population then gradually introduce additional species as the increase in available browse allows their survival. The locally harvested seed required for these reintroductions is often started within exclosures to increase available seed quantities for wider use on the ranch. This project is demonstrating that even though restoration of the high value browse species of this habitat is a much slower process than grass restoration, it is possible.

Saving tropical copper grasslands: a comparison of vegetation and top soil translocation.

Mahy, Gregory; Julie Lebrun, Edouard Ilunga wa Ilunga, Michel Pierre Faucon, Pierre Meerts, Mylor Ngoy Schutcha, Soizig LeStradic, Maxime Seleck

Gembloux Agro-Bio Tech, Université de Liège

The Katangan copper-cobalt deposits (Democratic Republic of Congo) are one of the world's greatest metallogenic province unique to biodiversity. The ore comes to the surface in a series of hills covered by highly original swards and steppic savanna, isolated in a miombo woodland. Of the world's copper ores, the Katangan outcrops are the only ones known to host primary vegetation presenting strict endemic species. Due to a recent revival of mining activities, copper biodiversity will irreversibly be damaged in the coming decades and methods for ecological restoration urgently need to be tested. In this study we compare the initial ecological trajectory (3 yrs.) among two restoration methods applied at large scale: 1) translocation of full vegetation blocks with their soil mat on an adequate mineral substrate (3 sites), 2) top soil translocation (1 site and a small scale experiments). Initial ecological trajectory was similar to reference ecosystems only for vegetation with the highest concentration in copper (sward) both in translocated ecosystem and top soils. In steppic savannah, clonal grasses extended to a higher cover than in reference ecosystems. Development of steppic savannah vegetation was low in top soil highlighting that a lack of seed bank may be a major filter to restoration, a hypothesis partly verified with sowing experiments. Structuring and endemic species with large woody underground systems (xylopod) were absent from reconstructed ecosystem and top soil. Specific methods of sowing and transplantation need to be developed for those species.

Cows in the Prairie, Prairies in the Fields—A House in the Wild

Maier, Craig M.; Randall D. Jackson

Wisconsin Department of Natural Resources

We view agroecology as grafting new branches of research and application to the deep roots of ecological restoration, with hopes of bearing new fruit that complements the original variety. In the prairie-forest border region of central North America, conserving biological diversity of highly endangered grasslands and savannas requires expanding the scale of ecological restoration. In this region, leaders of the restoration movement have primarily championed the exacting replication of plant community composition found in remnant prairies and savannas. However, these methods may be inherently limited to small scale projects due to the expense of land protection, restoration methods, and continued management, as well as conflicting with the values and goals of other community members in a landscape dominated by agriculture. Ultimately, the restoration movement must expand in scope in order to increase in scale, which means substantively engaging food systems in our practice, science, and rhetoric. We will present results from the first experiment in Wisconsin examining the effects of managed grazing on composition of reconstructed tallgrass prairie and discuss how this and related projects can engage farmers, land trusts, public lands managers, and other stakeholders. The resulting interdisciplinary research and demonstration projects can produce results relevant to biodiversity conservation, ecosystem services, and economic viability of working lands. The road to the typical Wisconsin farmhouse may one day wind through a wilder landscape than the one we inhabit today, if we are willing to engage in the complexities, and admitted ambiguities, of the deeper integration of restoration and agriculture.

Wetland and Stream Restoration Techniques Following Emergency Response Actions to the Line 6B Oil Leak in Marshall, Michigan

Majka, Brian; Stu Kogge

Cardno JFNew

On July 26, 2010, Enbridge Energy, Limited Partnership (Enbridge) responded to a leak on the Line 6B pipeline, part of its Lakehead System, near its Marshall, Michigan pump station. An estimated 20,082 barrels (843,444 gallons) of crude oil was released from Line 6B. Of that, an estimated 8,033 barrels (337,386 gallons) reached Talmadge Creek and the Kalamazoo River. Within a day of being contacted by Enbridge, Cardno JFNew conducted ecological assessments of existing biota and resources of the wetland and floodplain areas affected along Talmadge Creek. Draft restoration plans were developed and Cardno JFNew commenced implementation of stream and wetland restoration efforts along the creek and floodplain within days, utilizing standard and unique restoration techniques given technical challenges associated with the site. To date, Cardno JFNew has been responsible design and implementation of ecological restoration measures in affected streambanks and floodplains throughout Talmadge Creek and the Kalamazoo River.

ORAL ABSTRACTS (CONT'D)

Valuing the mangrove wetlands of north Kerala for ecological restoration

Manha, Khaleel K.

Sir Syed College

Three sample sites of tidal difference in North Kerala were selected for study viz. Valapatanam, Vellikkeel and Kavvayi. The study aims to generate baseline data on the mangroves and wetlands of North Kerala and to review the pattern of resource use in the wetlands in terms of sustainable utilization of resources. This demands an inter-disciplinary approach with components of socio-economic, biodiversity and cartographic appraisal of the landscape units in different localities. Owing to this, the methods of investigation adopted in the present study range from household surveys, a review of the literature, foot surveys of biodiversity studies, and ecosystem value analysis. Data was collected through questionnaires and interviews with people from different walks of life – aged people, fisherman and other stakeholders. A detailed survey was conducted to obtain data regarding products, cost of labor, etc. Samples were collected for taxonomical studies. The method of Costanza et al. was followed to determine the ecosystem service value (ESV). Summary: The present study analyzed the ecosystem service value of mangrove wetlands of north Kerala with special reference to the socio-economic influence on local people and found that mangrove wetlands of North Kerala provide an Ecosystem Service value of US Dollar 10960 /ha / year. The result envisages to create awareness on the value of wetland ecosystems among local people and to make a political intervention in controlling the anthropogenic intervention for the ecological restoration of mangrove wetlands.

Developing Fluvial Erosion Hazard Maps to identify River Restoration Priorities: A fluvial geomorphic approach to restoration after flood events

Marcus, Mickey; Christin McDonough, Stephen Mabee

New England Environmental, Inc.

Fluvial Erosion Hazard Maps (FEH) were developed on four rivers in Massachusetts to document the degree of potential hazard to infrastructure based on the stability of the river, and size of the floodplain. This paper advocates the use of rapid fluvial geomorphic assessments for the restoration of rivers and the stabilization following major storms and flooding events. As a demonstration project, twenty nine miles along four rivers were surveyed and mapped to create FEH maps. These included the Green River in Greenfield, MA; Clesson Brook, in Buckland, MA, Pelham Brook in Rowe, MA, and the North River in Colrain, MA. Each of these communities sustained significant damage during the Tropical Storm Irene in 2011 due to river flooding and erosion. Examples are provided of river restoration following the 2011 tropical storms. Rivers with intact floodplains sustained less damage than river sections which were cut off from their floodplain, and showed greater resiliency in maintaining vegetation and stability. A set of maps for each of the four rivers was developed showing areas of high hazard to property and infrastructure based on fluvial geomorphic features. The FEH maps are intended to be used as a demonstration to evaluate potential use of this technique in evaluating flood prone, and high erosion hazard areas.

Challenges measuring and predicting above and belowground carbon stocks in post-agricultural Caribbean forests

Marin-Spiotta, Erika; Emily Atkinson, John Souther, A. Peyton Smith

University of Wisconsin-Madison

Reforestation of former agricultural lands in the tropics provides opportunities for biodiversity conservation and for carbon sequestration in regrowing biomass and in soils. The type and intensity of former human land use can influence the successional trajectories of post-agricultural secondary forests, with unpredictable consequences for species composition and for ecosystem carbon storage. Here we explore challenges in measuring and predicting the response of above and belowground carbon pools to changes in land use in the tropics, with a focus on forest reestablishment. We present our work in secondary forests ranging in age from 10-90 years old on former pastures and sugar cane in Puerto Rico and in St. Croix. We have found that land use legacies can have long-lasting effects on tree composition with significant implications for carbon accumulation rates in forest biomass. Soil carbon dynamics recovered much more quickly from agricultural use than did forest structure. Using data from a literature synthesis and a meta-analysis, we evaluate the importance of environmental variables in determining carbon pools and fluxes across the tropics. At the global scale, climatic variables were most important in predicting standing soil carbon stocks in successional forests and tree plantations in the tropics, but type of land use change was the most important factor in determining the magnitude and direction of soil carbon change with land use transitions. Predictor variables on soil carbon stocks and fluxes varied with soil depth, highlighting the importance of understanding interactions between vegetation inputs, disturbance, and soils.

Utilizing adaptive management for operations and maintenance of a large urban river restoration project to balance flood conveyance, ecological functions, recreational uses and budgetary constraints

Marlowe, Lee

San Antonio River Authority

The Mission Reach Ecosystem Restoration and Recreation Project covers over 500 acres and 8 river miles near the urban core of the nation's 7th largest city. Portions of the San Antonio River were previously channelized and the project will replace the conventional channel conditions with a quality riverine and riparian woodland ecosystem while maintaining flood capacity. Ecological function will be significantly improved through construction of habitat features, reconfiguration of the channel to replicate natural river conditions, and installation of plants appropriate for the site based on historical records and specific site conditions. The ecosystem restoration process will be accomplished over many years as over 100 native plant species are installed and established including over 23,000 trees and shrubs. An expansion of the well-known River Walk, the project contains

ORAL ABSTRACTS (CONT'D)

numerous recreational features including paddling amenities and over 15 miles of hike and bike trails. The San Antonio River Authority (SARA) completes operations and maintenance (O&M) of the project following an adaptive management strategy that balances the important functions of flood conveyance, ecosystem restoration and recreation. Though portions of the project are still under construction, SARA has accepted various levels of O&M as phases of the project are opened to the public and the construction contractor meets vegetation performance criteria. Significantly improved habitat conditions have already been achieved and are expected to improve over time as the ecosystem matures. An overview of the project, description of SARA's adaptive management strategy for O&M and lessons learned will be presented.

Constraints to the success of passive and active restoration of the Atlantic Forest in Brazil

Marques, Márcia C. M.; Fernanda C. G. Cardoso

Universidade Federal do Paraná

Passive (natural regeneration) and active (planting seedlings) restoration are two non-excludent technics for restore tropical areas, that involve very different management efforts and magnitude of costs. Experiments testing for vantages and disadvantages of using one or other technic, are important to guide large restoration projects and , additionally, are a opportunity for testing ecological theories in natural and artificial systems. The southern Atlantic Forest is characterized by a forested landscape, but where large areas were logged for cattle pastures and abandoned. In this region, we leaded several experiments, by almost ten years, looking for the possible constraints of using passive or active restoration technics. Our main findings are: 1) seed arrival do not limit the passive restoration; 2) seedling establishment is the bottleneck for the passive restoration; 3) soil conditions (water excess) is the most significant factor influencing the seedling performance in active and passive restoration; 4) the grass competition has a secondary role in the seedling growth, and 5) active and passive restoration do not differ in species richness, but biomass accumulation can be excessive in active rectoration. We will discuss our results in order to support future restoration projects of abandoned pastures in regions dominated by secondary forests.

The potential of biomass accumulation in restored tropical forest: estimates from Atlantic Forest of Brazil

Marques, Márcia C. M.; Carolina Yumi Shimamoto, Paulo Botosso

Universidade Federal do Paraná

Estimating biomass accumulation in restoration projects is one important challenge for ecologists, because tree biomass is possibly affected by differences among species, by individual ontogenetic changes, and by habitat variation during the successional trajectory. We analyzed the accumulation of aboveground biomass (AGB) in 10 tree species (fast-growing and slow-growing species), aiming to verify possible factors (tree age, tree size, and woody specific gravity) that influence estimates of carbon sequestration in restored forests. Additionally, we simulated the carbon sequestration in restoration projects. There were large differences in AGB among species and between years in the 10 tree species. Slow-growing species accumulated almost twice AGB (410.13 kg) than did fast-growing species (225.32 kg). For both groups, AGB was positively affected by tree age, and size variables (DBH and h), but was not affected by woody specific gravity. Simulating the carbon accumulation in restored forests using a initial density of 2,500 individuals ha⁻¹, we found that planting only slow-growing species, the carbon accumulation is 150 times lower (346 Kg C ha⁻¹) compared to planting 100% of fast-growing species (4.546 Kg C ha⁻¹) in the first years of the planting; after 60 years, differences are not so contrasting. We concluded that tree age and tree size are possible proxy for estimating AGB, and that balancing the use of fast-growing and slow-growing species in restoration programs, carbon sequestration can be more efficient.

Workshop: Ecocultural Restoration and Ecosystem-Based Adaptation to Climate Disruption: Fire, Water, Salmon and Indigenous Kincentric Ecology in Pacific North America

Martinez, Dennis

Indigenous Peoples' Restoration Network (IPRN) a Working Group of the Society for Ecological Restoration International (SERI)

This 2-hour workshop offers a window into a rich cultural and spiritual world little known by outsiders, accompanied by rare historical photos compliments of the Royal British Columbia Museum Archives. We begin with Pacific salmon and the traditional kinds of cultural practices—including transplanting of salmon when rivers were blocked by ice at the end of the last Ice Age—that contributed to the relative stability and ecological richness of Pacific North America. We show how local control of resource use enabled Indians to avoid the “tragedy of the commons” while caring for the needs of all members of society. We explain the conservative nature of traditional Indigenous landcare that maintained surplus biodiversity with limits always in mind and people and resources in balance; and how the regular use of Rx fire constantly created new and diverse habitats and niches for surplus biodiversity. Contrasting Western and Indigenous economic models, we argue that the industrial goals of “maximum productivity”, e.g. pushing plant and animal growth with GMOs, or fertilization, can lead to unintended negative cascading ecological consequences, with examples from salmon, wild rice, fire suppression, and marsh restoration; while the conservative risk-averse Indigenous model keeps productivity in line with the unhurried tempo of natural processes and Natural Law with minimum necessary yields trumping so-called maximum “sustained” yields. Throughout the workshop we will discuss the relationships between ecocultural restoration, kincentric ecology, TEK/Western science, and adaptation/mitigation of climate instability and weirdness with the intent to show the value of traditional Indigenous ways of knowing for modern restoration, conservation, and agriculture.

ORAL ABSTRACTS (CONT'D)

The Changing Maya Milpa and the Larger Issues of Ecological and Cultural Survival: Some Questions by a Discussant

Martinez, Dennis

Indigenous Peoples' Restoration Network (IPRN) a Working Group of the Society for Ecological Restoration International (SERI)

Important issues related to the survival of traditional Maya culture, agriculture, agroecology, and horticulture (milpa) are in need of clarification by symposium participants. These issues center around the rapid Mayan transition from ancient subsistence cultural practices to a modern global economy that emphasizes export-centered cash monocultures. Some of the areas of concern include: the loss of ancient intensive forest management techniques like tree cropping, terracing, and raised fields; current trends in maintaining home gardens and semi-wild orchards—including plant and medicinal knowledge; cooperation between Mexican federal or state governments and local Maya (co-management); and relationships with big environmental organizations. An area of great concern is the rural environmental crisis, including loss of biodiversity and loss of germ plasm of cultural crops; quality and quantity of water resources; soil erosion and fertility loss; food security and sovereignty; community decline; the current status of swidden (milpa) agriculture, such as lengths of fallow periods and cropping times; transmission of knowledge between elders and youth and the loss of youth to jobs in Cancun and other urban areas, including emigration to U.S.A. and other countries; the state of authority and persuasion of elders and spiritual leaders'; and the status of women.

Disentangling the impacts of former cultivation from stress removal to restore Mediterranean steppe plant communities colonized by brambles (*Rubus ulmifolius* Schott.)

Masson, Solène; Matthieu Gauvain, François Mesléard, Thierry Dutoit

University of Avignon - Mediterranean Institute of Biodiversity and Ecology

Since several decades, the Mediterranean steppe La Crau in southeastern France is undergone to many land-use changes such as cultivation phases and removal of stress by water infiltration from irrigated hay meadows. Impacts of these changes have been studied on the structure of the typical steppe plant community and on its successional dynamic through the proliferation of *Rubus ulmifolius* Schott, the elm-leaved bramble. We compared the species and functional richness, the diversity and similarities between the original steppe vegetation, the steppe impacted by a former phase of cultivation and/or current water infiltration to prioritize restoration treatments such as shrub-clearing and grazing. Our results showed that the steppe community had a significantly higher species-richness than the communities subjected to disturbance or stress removal and showed a low similarity with them. Although, cultivation induced a dominance of ruderal type species, the removal of water stress caused a stronger impact, favouring competitor species at the expense of steppe vegetation. We confirmed here the very low resilience of the steppe after a former phase, but mostly we evidenced for the first time that the stress removal had a stronger impact on the decrease of plant species-richness and diversity. In order to maintain or to realize an ecological restoration of this steppe, the controls of water infiltration and the dynamic of *R. ulmifolius* seem to be necessary before any other conservation management treatments.

The restoration of the mouth of the Housatonic River, CT: From gun club to coastal estuary

Mattei, Jennifer H.; Mark Beekey, Jennifer Gazerro

Sacred Heart University

Coastal regions, at the mouths of major rivers, in areas with high human population densities become polluted, compacted, invaded, degraded and lose their primary ecosystem functions. At Stratford Point, Connecticut we have begun coastal dune upland and salt marsh restoration after intensive clean-up efforts of tons of lead shot deposited at the site over a 50 year period. The Connecticut Audubon Society, The Nature Conservancy, DuPont Corporation, Sacred Heart University, and local community members have all participated in this project. The National Fish and Wildlife Foundation funded part of this project and will use the procedure as a model for other coastal areas. Instead of boulders and rip-rap, we have utilized Geotubes to abate wave energy, prevent erosion and enhance sand deposition at the site. We have restored dunes to the site and stabilized them with native grasses, perennials, woody trees and shrubs. A controlled burn was conducted to control invasive plant species and to rid the area of a build-up of thatch that could potentially cause a devastating wildfire. The invertebrate community sampled changed from dominance by isopods to ants after the burn. Success will be measured by examining the number of native plant species that become established and by the number of bird and insect species that utilize the area compared to pre-restoration activities. Significant differences were observed between our reference and restoration site in plant and terrestrial invertebrate community structure. Plans for installation of green infrastructure will be presented.

Developing Science-based Strategies for Restoration of Oak Woodland Communities in Northeast Illinois Using Five Canopy Thinning Regimes

Maurer, Debbie; Robert Fahey

Lake County Forest Preserves

Oak (*Quercus* sp.) woodlands are of significant ecological and cultural value in Lake County Illinois and within the much broader prairie peninsula region; however, changes in the canopy structure due in part to suppression of fire and historic human land use have resulted in a lack of native shrubs, little to no oak regeneration and an understory sapling layer that is transitioning to more shade tolerant, mesic species. Even with 20 years of deer management, reintroduction of low-intensity fire, and removal of invasive woody species, these communities are showing few signs of recovery. Current understanding of oak regeneration suggests that light is a limiting factor in many historically oak-dominated systems. Where absence of fire has allowed

ORAL ABSTRACTS (CONT'D)

these systems to develop a closed canopy, reintroduction of prescribed surface fire alone has not led to the restoration of more open canopy conditions. Management that emulates mixed-severity fire regimes through a combination of gap creation, canopy thinning, and prescribed surface fire is likely to be most successful at maintaining canopy structure, promoting oak regeneration and restoring the shrub, herbaceous and wildlife assemblages characteristic of historic woodland communities. The Lake County Forest Preserve District in partnership with the Morton Arboretum is implementing a science-based, adaptive restoration plan integrating five overstory thinning regimes across three sites and 175 acres in suburban Illinois nature preserves to restore oak woodland communities. This presentation will provide an overview of the thinning strategies, monitoring protocol, public outreach and lessons learned during the first winter of on-the-ground implementation of tree removal.

The total package: Mapping, prioritizing, treating, and monitoring large-scale Phragmites invasions

May, Christopher A.

The Nature Conservancy

The management of non-native Phragmites across large landscapes requires coordinated planning, treatment, and monitoring. A collaborative effort in western Lake Erie is addressing this issue using a combination of current technology and traditional techniques. Work began with a remote sensing effort to map the historical and existing extent of Phragmites along 50 miles of the western Lake Erie shoreline. A group of partners has formed a Cooperative Weed Management Area to prioritize, treat, and monitor Phragmites in coastal wetlands. We prioritized sites in conservation ownership with capacity for long-term management and, ideally, water level control. Since 2011 the CWMA has treated over 2,000 acres of Phragmites using a combination of herbicide, mowing, flooding, and controlled burns. All treatment data are being managed with GIS to allow evaluation of the success of different treatment regimens over time. We established a set of vegetation monitoring transects to track restoration effectiveness. In addition, we are using modeling to identify areas that may be susceptible to future Phragmites invasion, and we conduct early detection monitoring in these areas. Ultimately, this work will restore wetlands that support a variety of native plant and animal species, and provide ecosystem services such as flood control, improved water quality, and shoreline protection for human communities.

Restoration of earthen borrow sites in an arid coastal setting: Initial findings from the Shark Bay World Heritage Area, Western Australia.

Mayence, C. Ellery; Dale Van Beem

The University of Western Australia and Botanic Gardens and Parks Authority

Shark Bay Resources is an evaporative (solar) salt facility in the Shark Bay region of Western Australia. Maintenance of seawalls, salt pond levees and haul roads require that earthen materials be borrowed from one location for use in another. Natural recruitment of desirable plant species into these borrow sites after decommissioning does occur, but very slowly and with many of the functionally important framework species absent. Research undertaken over the past two years has investigated a variety of approaches aimed at facilitating establishment by these and other important species. Initial efforts focused on identifying chemical, mechanical, and physical differences between borrow site subsoil and reference habitat topsoil. This was vital because there is a significant shortfall or deficit of topsoil available on site for use in restoration. Site characterisation was followed by a large-scale field trial investigating the individual and interactive roles of substrate type and quality (subsoil vs. topsoil), seed condition (pre-treated vs. un-treated), and microcosm enclosures designed to protect recently emerged seedlings from blowing sand abrasion and wind desiccation. More recently, and on a scale equal to that required for restoration, different direct seeding approaches have been tested, in conjunction with a phased approach that includes planting greenstock of species from which seed is difficult to obtain or whose seed exhibits low germination and emergence. This project, employing an iterative, step-wise approach has increased the restoration capability of Shark Bay Resources and will lead to improved ecological continuity between the salt facility and the surrounding World Heritage Area.

Non-chemical adaptive management of resprouting shrubs in a grassland restoration

McCaw, Matt; Kevin Thuesen

City of Austin

Management of resprouting woody plants is a common challenge in prairie and savanna restorations. On large scales, herbicide can be cost-prohibitive or undesirable. Prescribed fire alone is often impractical due to suppressed fine fuels and shredding alone only encourages resprouting. In 2007, the Water Quality Protection Lands program in Austin, Texas designed an adaptive management approach to reducing the dominance of three native, resprouting shrubs - yaupon (*Ilex vomitoria*), Texas persimmon (*Diospyros texana*), and mountain laurel (*Sophora secundiflora*) - within a ~1,000 ha grassland restoration. Plants were cut and allowed to resprout. Following cutting, herbaceous fuel loading increased in the absence of shrub competition, thus facilitating follow-up prescribed fire. After three growing seasons, resprouts were treated with prescribed fire in either the dormant season (winter) or growing season (summer). The fire return interval was determined by 1) the growth rate of resprouts and 2) the recovery of fine fuels, which together determine the potential for fire to top-kill resprouts. Yaupon mortality in the summer and winter burn units was 90% and 60%, three years after treatment. Neither Texas persimmon nor mountain laurel was killed by winter fire, whereas summer fire resulted in 30% and 10% mortality. Growth rates of surviving resprouts in the winter and summer burn units were not significantly different. Implications of this work are that mixed resprouting shrub complexes may be adaptively managed on large-scale sites with short-rotation mechanical and fire treatments, although interspecies variability in the response to treatment should be expected.

ORAL ABSTRACTS (CONT'D)

Help Wanted: a call for trans-disciplinary collaboration in the urban environment

McCoy, Emily

Andropogon Associates

Enacting strategies to improve urban life can no longer be encapsulated into one discipline's goals, one realm of implementation or viewed at from one standard scale. To facilitate sustainable development within the urban form, design and planning strategies must address social, environmental, economic and aesthetic considerations in unison. Collaboration between scientists and designers is just one of many, but critical pathways to an ecologically healthier future. Discovering how collaboration among different disciplines can benefit one another and a critical evaluation of these relationships in order to strengthen them will become increasingly imperative. This discussion is a call to the disciplines of the natural sciences and urban design to engage in research and outreach together to support "evidence-based" design. As Johnson et al. (2001) recommend, there are 2 critical concepts they believe designers and ecologists need to pursue together-- defining landscape health and integrity and developing quantitative metrics to assess landscape health and integrity-- in order to improve the health of our urbanizing world. The conversation will focus on how designers and scientists can pursue Johnson et al.'s (2001) imperatives as collaborators through the perspective of a landscape architect who works regularly with scientists on landscape design projects. Emily McCoy, RLA, ASLA has been involved in the creation of a research division at Andropogon Associates, which enables the landscape design firm to rigorously review 40 years of past work in order to inform future projects and the design community. Emily will discuss possible pathways for successful collaboration from her experiences.

Resilience, transformation and restoration: How prejudging the impossibility of restoration can function as a self-fulfilling prophecy in social-ecological systems.

McDonald, Tein; Jane Gye

Australian Association of Bush Regenerators (NSW) Inc

Ecological restoration is a critical component of modern social-ecological systems, and is most effective when it harnesses extant biological resilience. Making an assumption that a biological threshold of irreversibility has been passed when (amendable) social factors are actually the drivers, serves only to exacerbate impacts, driving a nail into the coffin of declining world ecosystems. A rich literature has emerged in recent decades relating to resilience (and its limits) in social-ecological systems. But misinterpreting the degree social and ecological components are melded can lead to premature despair in the face of runaway global development and looming climate change; often prompting unjustified 'adaptation' to the idea that restoration is an outdated, backward-looking concept for much of the world's ecosystems. In this paper we draw on social-ecological resilience theory and over 30 years' on-ground experience to argue that predictions of post-threshold states at restoration sites are often overstatements, underestimating the contribution of social dysfunction to the condition of sites and underestimating the extent to which social transformation and restoration interventions could overcome that dysfunction, harness extant resilience and restore health to ecological communities. Societies have choices and need sound information that casts restoration in a fresh light. Greater potential may exist than we imagine to transform our social attitudes and institutions so that we take our own role within ecosystems more seriously; prioritise ecosystem protection and restoration; and restoratively transform all possible landscapes to reinstate ecosystem structure and function to the highest practicable extent.

Sample size and sampling method affect floristic quality estimates for a young tallgrass prairie restoration

McEuen, Amy B.; Emily Staley, Christy Troxell-Thomas, Dylan McIntosh, Kyle Peecher

University of Illinois Springfield

Given widespread conversion of tallgrass prairies to agriculture, restoration is critical for biodiversity conservation in states such as Illinois. In 2007, The Nature Conservancy began restoring tallgrass prairie across 5 different management sites at their Emiquon preserve. To gauge the success of the early stages of restoration, we have been sampling vascular plants across these sites. One index we have been using to determine each site's quality is the FQI (Floristic Quality Index), which has shown an increase in value for sites from 2008 to 2012. This index increases as the average C value (Coefficient of Conservatism) of plants at a site increases and as native species richness at a site increases. Given species-area relationships, this index should be highly sensitive to sampling effort. In 2012, we tested this sensitivity by calculated FQI for bootstrapped samples ranging in size from 15 to 30 1m² plots. As expected, FQI estimates showed strong increases with sample size ($p < 0.01$). In 2012, we also conducted full site surveys for all sites. This was done by spending one man-hour surveying each site biweekly for a total of 6 surveys from early June through early September. These site-scale surveys gave the very highest estimates of FQI. Our results suggest that FQI estimates are highly sensitive to sampling effort. This suggests care must be taken to standardize for effort when using these indices to monitor floristic quality of a site or compare quality across sites.

Does conversion from continuous to rotational cattle grazing improve the vegetation abundance and diversity in sagebrush ecosystems?

McGlone, Christopher M.; James H. Cane

USDA-ARS

In the western United States, land management agencies and ranchers are increasingly adopting alternative livestock grazing strategies in an attempt to improve forage availability and overall ecosystem health of their rangelands. Historically, livestock management practices have incorporated a single-pasture, low-intensity, long-duration (continuous) grazing strategy. A common alternative grazing strategy is a multi-pasture, high-intensity, short-duration (rotational) grazing strategy. There has been substantial debate concerning the realized benefits of adopting a rotational grazing regime.

ORAL ABSTRACTS (CONT'D)

Research into ecosystem response to rotational grazing has detected increased grass cover, reduced exposed mineral soil, improved riparian integrity and improved wildlife habitat. Meaningful assessment of the efficacy of rotational grazing management has, however, been compromised by a lack of large-scale studies, inappropriate matching of study sites, and a focus on short-term responses to changes in grazing strategies. Sagebrush (*Artemisia* sp.) communities comprise approximately 67 million hectares of the western United States, most of which is grazed by livestock. Continuous grazing has been the dominant livestock management strategy in most sagebrush communities, including our study areas in central Wyoming and northern Utah. In 2012 and 2013, we compared the plant community on two ranches that switched to rotational grazing more than 20 years ago to comparable ranches using continuous grazing. Initial results show that rotationally grazed pastures have greater grass cover, reduced bare soil, and altered wildflower diversity compared to continuously grazed pastures.

Native bee diversity and pollination function in restored wet meadows

McLeod, Kylie; Stephen Murphy

University of Waterloo

Native bees are the primary pollinators of flowering plants in most terrestrial ecosystems and the services they provide are essential for establishing and maintaining flowering plant diversity. These services are particularly important in the context of restoration, where establishing plant communities rely on pollinators to create the conditions for community resilience. Despite this critical role, little is known about how native bees respond to restoration and whether different restoration techniques result in different outcomes for establishing bee communities. The purpose of this study was to survey bee communities in a series of wet meadows 5-6 years after restoration to (1) provide a baseline for monitoring communities throughout the restoration trajectory, and (2) compare the effects of pit and mound with planting into weedy ground on the structure and function of the establishing bee communities. Native bees were surveyed using a combination of pan traps and sweep nets in six sites within Dunnville Marsh, a recently restored southern Ontario wet meadow. Collected bee specimens represent 27 genera from five families, and exhibit a range of phenology, sociality, and nesting habits. Comparisons of pit and mound and planted sites indicate that pit and mound restoration may enhance bee diversity and pollination function compared to planted sites.

Increasing atmospheric nitrogen deposition: Implications for tallgrass prairie restoration

McPhee, Jennifer M.; Hugh Henry, Jane Bowles

Western University, Canada

Agricultural activity and the combustion of fossil fuels will continue to increase rates of atmospheric nitrogen deposition over the next century. Nitrogen is typically a limiting resource for terrestrial plants, and many native species are well adapted to low-nitrogen conditions. As the rate atmospheric deposition increases, elevated nitrogen can affect both plant biomass and species composition. These effects may be especially important in the context of ecological restoration projects, where the end product relies on achieving and/or maintaining a particular community composition. Increased atmospheric nitrogen deposition might increase competition from highly productive, nitrogen-demanding, non-native species, decreasing the success of native species chosen for restoration projects. We used a field experiment in Norfolk County, Ontario, to examine how nitrogen addition affects the success of tallgrass prairie restoration. We predicted that nitrogen addition would increase the abundance of plant species not included in the original seeding. In the first year following seeding, there was an abundance of the weedy species *Erigeron canadensis* L. in the nitrogen addition plots. However, the abundance of this species was greatly reduced by the second year. Contrary to our original prediction, there was an increase in the relative biomass and cover of native species with nitrogen addition, but not a significant increase in non-native, highly competitive species. The latter species were scarce at the site. Dispersal limitation may potentially delay the invasion of non-native species into tallgrass prairie restoration sites with increased nitrogen deposition.

Interactions of garlic mustard (*Alliaria petiolata*) with the common nightcrawler earthworm (*Lumbricus terrestris*): Predicting the susceptibility of forest ecosystems to invasion

McTavish, Michael JM; Stephen D. Murphy

University of Waterloo

The invasion patterns of exotic species can be altered by interactions with co-occurring invaders. It has been suggested that two of North America's most prominent invasive species – garlic mustard (*Alliaria petiolata*) and the common nightcrawler (*Lumbricus terrestris*) – facilitate each other's invasions. This hypothesis has received limited experimental validation and has only considered effects of the two species on mycorrhizae. The purpose of this study was to provide field data on the co-occurrence of garlic mustard and earthworms and to explore an understudied interaction: effects of earthworms on garlic mustard seeds. Field surveys in Ontario were paired with mesocosm-based studies of earthworm-seed interactions. Preliminary results indicate high rates of garlic mustard-earthworm co-occurrence and spatial associations between garlic mustard and earthworm burrows. Although *L. terrestris* consumes large numbers of garlic mustard seeds, a considerable proportion of these survive gut passage. Egested seeds show damage to the external seed coat which may help to break seed dormancy and boost germination rates. Additionally, *L. terrestris* buries surface-collected seeds, with some buried below their maximum emergence depth. Although the net effect of *L. terrestris* on garlic mustard populations remains unclear, field observations and enhanced germination rates support the facilitation hypothesis. Many urban and rural forests in eastern North America susceptible to garlic mustard invasion have already been colonized by exotic earthworms. Understanding whether these forests have a unique resistance or an increased susceptibility to garlic mustard invasion will be useful to guide more effective management efforts against this ecologically-destructive plant invader.

ORAL ABSTRACTS (CONT'D)

Connecting the dots: Restoration and renewal in the Midwestern United States

Meine, Curt

Center for Humans and Nature

The practice of ecological restoration has deep roots in the American Midwest, dating to the earliest prairie restoration experiments at the University of Wisconsin in the mid-1930s. Over the decades, grassland restoration projects have been undertaken across the region, at various scales, and with varied goals. Although the region's historic grasslands have been widely converted to intensive agriculture, and the remaining prairie remnants are isolated and fragmented, the restoration movement provides important foundations for the further evolution of Aldo Leopold's land ethic. This presentation will provide an overview (especially for the benefit of conference attendees new to the region) of grassland restoration work across the Midwest, and will explore themes that emerge when we "connect the dots" across the region. Those "dots" exist in time as well as space: restoration projects, and our approaches to restoration, have evolved over time, and we can find patterns of development in those changes. Leopold envisioned the early efforts to restore Wisconsin's native landscape as "a starting point in the long and laborious job of building a permanent and mutually beneficial relationship" between people and land. Three generations later, ongoing restoration work can and must contribute to a broad vision of sustainability and resilience in the region.

Harvesting native tallgrass prairie seed for large-scale restorations: Are we changing our remnant plant communities through overharvest?

Meissen, Justin; Meredith Cornett, Susan Galatowitsch

University of Minnesota

Seed supply often limits the size and scope of restoration projects that require active revegetation. To meet demand from more and larger tallgrass prairie restoration projects in the Eastern Great Plains (US), seed is collected from intact remnant prairies using agricultural combine harvesters. We hypothesized that frequency of wild harvest would shift community composition to disfavor plant species with functional traits associated with reliance on seed for persistence and reproduction. To investigate the extent to which species composition and functional diversity differed in harvested communities, we conducted a retrospective study of 17 native tallgrass prairie remnants that varied in past harvest frequency but were otherwise similar. In the last ten years, prairie remnants had been harvested for seed with combine harvesters frequently (annually/biennially), infrequently (2-3 times), or not at all. We compared functional diversity using community weighted trait means (CWMs) among sites and used Mantel tests to determine if community composition was related to seed harvest frequency. We then used ANOVA contrasts to identify species less abundant on frequently harvested sites. CWMs of lifespan and clonality were lower in frequently harvested communities. Seed harvest was associated with community differences and 13 species were less abundant in frequently harvested sites. These results suggest that frequent seed harvest may be shifting composition to favor long-lived clonal plants, and that overharvesting remnant plant communities may change them over the long-term.

The impact of climate change on river restoration design in the Great Lakes

Melchior, Martin; Beth Wentzel

Inter-Fluve

River restoration design involves an understanding of the complex interaction of geology, geomorphology, hydraulics, hydrology and ecology. Hydrologic variability due to climate change may come in the form of more frequent and high intensity rainfall events, changing snowmelt runoff timing, and extended periods of summer drought. Designers face major challenges in designing restoration projects that can meet performance criteria and not fail due to changes in hydrology, water temperature and ecological community change. It is critically important that designers help project owners and funders understand the potential risks associated with design in the coming century. We present examples of restoration projects in the Lake Superior and Lake Michigan basins, and walk through the development of performance criteria and design criteria while considering climate change impacts.

Hydrological challenges and opportunities for reconstructing ecosystems after oil-sand mining

Mendoza, Carl; Kevin Devito

University of Alberta

Oil-sand deposits in north-eastern Alberta, Canada comprise some of the world's largest oil reserves. Open-pit mining of these resources leads to waste-rock piles, tailings ponds and open pits that must be reclaimed to "equivalent landscape capability", with viable forests and wetlands, using only native vegetation. A challenge is the cold, sub-humid climate, with highly variable precipitation. Furthermore, there are competing demands, needs or uses for water, in both quantity and quality, for reclamation and sustainability of forestlands, wetlands and end-pit lakes. On average there is a potential water deficit, yet wetlands cover half of the undisturbed environment. Water budget analyses demonstrate that, although somewhat unpredictable and uncontrollable, magnitude and timing of water delivery affects water storage and conservation within the landscape. The opportunity is to design and manipulate these reconstructed landscapes so that water is stored and conserved, and water quality is naturally managed. Heterogeneous geologic materials can be arranged and layered, and landforms sculpted, to minimize runoff, enhance infiltration, and promote surface and subsurface storage. Similarly, discharge of poor quality water can be minimized or focussed. Appropriate vegetation may help to conserve water. To achieve these ends, careful attention must be paid to the entire water budget, the variability in its components, and interconnections between hydrologic units, in space and time. To date our knowledge is guided primarily by natural analogues. To move forward, it is apparent that numerous constraints must be addressed and compromises made. Issues include geotechnical and operational requirements, material limitations or excesses, time, and money.

ORAL ABSTRACTS (CONT'D)

Initially successful introduction of an endangered Florida scrub herb to a new, protected site

Menges, Eric S.; Stacy A. Smith, Valerie C. Pence, Cheryl Peterson

Archbold Biological Station

We describe initial results of an introduction of the federally endangered legume *Crotalaria avonensis* to a protected Florida scrub site. Our experimental introduction (August 2012) used plant materials propagated through tissue culture, stem cuttings (from tissue cultured and wild plants) and scarified and control seeds collected from a nearby unprotected population. Plants were enclosed in devices that provided plant roots with consistent irrigation. We planted seeds individually and watered frequently. We report results for the first seven months, through March 2013. Field seed germination (28%) was lower than in greenhouse trials (42%) but higher than past experiments. Scarified seeds germinated more rapidly and had 4X higher (45% vs. 11%) germination percentages. Seed weight and habitat (rosemary scrub vs. scrubby flatwoods) did not affect field germination. Through March 2013, 42% of field seedlings survived. Nonscarified seeds had higher survival than scarified seeds, a pattern related to higher rainfall at germination times. Seedling survival in rosemary scrub increased with measured light levels. Transplant survival was highest for cuttings from tissue cultured plants and lowest for tissue cultured plants; it was intermediate for cuttings from wild plants (which tended to be smaller in size). For all types, survival was greater than 45%. Insect damage did not negatively affect subsequent survival. So far, this project achieved our goal of introducing material from multiple plants genotypes from an unprotected population into a protected site. If this introduction remains successful, it will increase the number of protected populations of *Crotalaria avonensis* from two to three.

Understanding soil and vegetation interactions at different life stages to restore a threatened plant community in a semi-arid environment

Merino-Martín, Luis; Lucy Commander, C. Ellery Mayence, Ben Miller, Jason Stevens, Kingsley Dixon

University of Western Australia/Kings Park and Botanic Gardens

Restoring post-mining landscapes is a complex activity that requires a holistic approach combining soil and plant sciences. Ideally in the restoration process, landform restoration is followed by soil or growth media reposition providing the basis for establishing the plant community and finally, the revegetation is undertaken. Landform restoration is not always possible due to time and budget limitations. Therefore, soil and plant optimization, taking into account the different plant life stages, are the key common processes where science based decisions need to be made to restore a resilient vegetation community. Scarcity of topsoil resources, a common problem in post-mining restoration, encourages research aimed not only at improving topsoil striping and stockpiling, but also at identifying alternative growth media, as well as direct seeding approaches. Moreover, failures in revegetation marked by poor results at some plant life stages calls for the incorporation of research on the biology of the different life stages of vegetation: seeds, seedlings and mature plants. A framework of four well defined logical steps, combining soil and vegetation sciences, has been implemented as part of this research: 1) plant community and substrate definition, followed by optimizing 2) topsoil, 3) seeds and 4) plants. In this work we present preliminary findings from an ongoing research in post-mining restoration in the Midwest of Western Australia within this logical framework.

Lakeshore Development Results in Habitat Degradation and Wildlife Impacts on Glacial Lakes in Northern Wisconsin

Meyer, Michael W.; Daniel Haskell

Wisconsin DNR, Science Services

The Northern Highlands Ecological Landscape (NHLE) of Wisconsin contains one of the densest clusters of glacial lakes in the world. While the shorelands of some lakes are in public ownership and ecologically intact, many lakeshores in private ownership have been developed for housing and recreation. Vegetation and wildlife surveys conducted over the past decade have shown significant differences at developed vs. undeveloped lakes within the NHLE. Development typically results in reduced numbers of shrubs and saplings as well as coarse woody material in the near-shore areas; non-native forbs and grasses are more common. Impacts on aquatic vegetation and reductions in coarse wood in the littoral zone have also been measured. Wildlife population impacts associated with habitat changes have been quantified. The breeding bird guild composition has been altered at developed lakes as detected during point-count surveys. Nocturnal surveys detected fewer calling green frogs (*Rana clamitans*) and shoreline surveys documented reduced green frog habitat quality at developed vs. undeveloped lakes. Snow-track and camera surveys show reduced mammalian carnivore abundance and diversity on developed lakes, but increased white-tailed deer (*Odocoileus virginianus*) numbers in winter. The Wisconsin Department of Natural Resources and partners have initiated a long-term study to evaluate whether habitat restoration in the near-shore area of developed lakes in the Northern Highlands Ecological Landscape can mitigate some of the negative impacts of shoreland development – preliminary findings will be presented during this symposium.

Freshwater restoration of tidal swamps: lessons from remediation during the Deepwater Horizon Incident

Middleton, Beth

National Wetlands Research Center

Coastal freshwater wetlands can be impacted by elevated salinity because of upstream hydrologic alteration, sea level rise and tidal inundation. In particular, decreased freshwater supply along coastal rivers and streams is becoming a key conservation and restoration issue. In Big Thicket National Preserve (BTNP) in Texas, trees in coastal freshwater forests began to die in the high salinity environments related to the drought of 2012. At the same time, hydrological remediation to push oil offshore during the Deepwater Horizon Incident in Louisiana gave some insight into how salinity stress in

ORAL ABSTRACTS (CONT'D)

coastal forests might be reduced along altered streams and rivers. We have documented long-term production processes in coastal baldcypress swamps in Jean Lafitte National Historical Park and Preserve (JLNHP&P) in Louisiana and BTNP. From 2010-2012, tree growth increased after the freshwater flow rate was increased for several months through the Davis Pond Diversion structure north of JLNHP&P during the oil spill emergency in 2010. The study suggests that freshwater releases may be essential to the restoration and management of tidal baldcypress swamps. This project was funded by National Science Foundation RAPID award and the U.S. Geological Survey Ecosystems program.

Stochasm as a factor in endangered species habitat restoration design

Mierzwa, Ken
GHD Inc.

Restoration design sometimes focuses on a goal of steady-state optimal conditions for a given habitat type, with limited attention to temporal and spatial variation. However studies of endangered or rare species including Hine's emerald dragonfly, Oregon silverspot butterfly, Indiana crayfish, California red-legged frog, Blanding's turtle, and San Francisco garter snake have suggested that it is important to restore a range of conditions to buffer against atypical weather years and long-term successional change. Restoration concepts recently designed and built in the Chicago region and in northern coastal California and including a continuum of habitat structure and variable conditions have shown promising results thus far for listed species as well as for assemblages of more common animals associated with them. Larger sites with complex structure and habitat interspersions or clusters of smaller restoration sites in proximity have been especially promising. For some species and habitat types building early seral stages into the design and re-establishing lost functions which encourage yet are resilient to natural disturbances may be a crucial component.

The interface of ecology, society and technology and the importance of "different ways of knowing" in urban wastewater design

Miller, James D.
University of Guelph

Our urban-ecological crisis is a design crisis that is rooted in our inadequate or missed ecological knowledge in action. Urban wastewater design - as a subsystem of engineering - depends on a paradigm of deterministic causation; a need for predictable, measurable results in order to satisfy social-ecological needs. In this research, we employ alternative participatory approaches in an urban wastewater design in an effort to assess the degree to which the current paradigm of wastewater engineering design diverges from current post-normal science, and ecosystem (ecological engineering) principles. Through these methods (scenario analysis, biomimicry design thinking, emancipation stakeholder participation), we identified leverage points to support transformation towards more discursive design solutions and "different ways of knowing", which better aligned with complex, dynamic social-ecological contexts and current principles of ecology.

Beyond protection: Reconsidering the role of nature reserves in grassland restoration

Miller, James R.; Lois Wright Morton, David M. Engle, Diane M. Debinski
University of Illinois

Ecological restoration is often conducted on nature reserves and other set-asides. Yet in many cases these restoration sites exist in isolation from the landscapes in which they are embedded, limiting their usefulness in meeting goals associated with biodiversity conservation. The fundamental challenge, then, is to devise effective strategies for achieving restoration and conservation objectives on private lands. Although this realization has been recognized for decades, solutions have proven elusive. Over the last few years, we (the Conservation in Working Landscapes Research Group) have been engaged in the implementation of a conceptual model aimed at the integration of restoration activities on reserves and the management of private lands in the North American tallgrass prairie ecoregion. The overall goal of this model is to blur the distinction between land reserves and surrounding lands in ways that benefit grassland biodiversity. Reserves assume a new role as natural laboratories where alternative land-use practices designed to achieve conservation objectives can be explored, and economic and conservation goals are seen as intertwined and mutually reinforcing. To date we have conducted several landowner surveys to gauge factors that influence decision-making. We have also organized numerous field tours of our restoration sites involving landowners and natural resource agency personnel, we have conducted a workshop for landowners on the use of prescribed fire, and we have helped a number of landowners implement conservation practices on their properties. Here, we discuss our overall approach and ways that our perceptions of the challenge have changed over the course of this project.

The Fall of the Wild? The Ecological Ethics of Preservation, Restoration, and Design in the Anthropocene

Minteer, Ben A.
Arizona State University

None of Nature's landscapes are ugly so long as they are wild," wrote the great wilderness advocate John Muir at the dawn of the 20th century (Muir 1901). Clearly, much has changed since Muir penned these words; indeed, according to some assessments, by the second half of the 20th century the terrestrial biosphere transitioned from a system shaped primarily by processes that lacked a major human influence to one driven mainly by human activities (Ellis 2011). Fueled in part by this acknowledgment (and reinforced by the emergence of the controversial "Anthropocene" construct), self-styled environmental "pragmatists" in conservation and environmentalist circles have argued that the venerable preservationist ideal should be jettisoned. They contend that we should support a more anthropocentric and interventionist effort, one in which ecological intervention, design, and invention are the norm. But will this abandonment of long-held notions of the wild and the loss of historical baselines for restoration act to undercut the strong moral

ORAL ABSTRACTS (CONT'D)

regard for nature that Muir wrote about so powerfully a century ago? Might we need to somehow retain a meaningful sense of the wild and of human limits within nature even as we manage, design, and change ecological systems for a range of conservation and human purposes? Is this even possible? The development of an authentically pragmatic ecological ethics that carries a sense of environmental humility and precaution in the face of urgent calls for ecological intervention will be just as important as tackling the scientific and technological challenges of constructing future nature.

Restoring Coral Reefs through Invasive Species Control in Hawai'i

Minton, Dwayne; Alan Friedlander, Russell Sparks

The Nature Conservancy

For over a decade, The Nature Conservancy and partners have worked to restore coral reefs in the Hawaiian Islands, but unlike many other ecosystems, standard “off-the-shelf” techniques are not readily available. Instead, we have collaboratively developed, tested and implemented a variety of invasive species control techniques aimed at restoring impaired ecosystem function. At Maunalua Bay, Oahu, we worked with the local community and other partners to successfully restore sediment transport processes to 11-hectares of reef by hand-removing over 1.3 million kilograms of invasive algae. While recovery has been slow, native algae and seagrass have gradually increased in dominance and diversity. At Puakū, Hawai'i Island, a partnership has removed invasive fish to test the efficacy of this action as a viable restoration technique. For 3-years to-date, an invasive grouper, known locally as roi, was removed from a 1.2-hectare patch reef to determine if the fish could effectively be removed without significant recolonization and examine if the native fish assemblage would increase in abundance and diversity. Following removal, biomass of native roi-competitors increased, but otherwise few changes were observed in the native fish assemblage. These preliminary results suggest removing roi may not be a practical ecological restoration action at this time. At Kahekili, Maui, the state instituted a ban on the harvest of herbivorous fish and invertebrate species in 2009 to increase herbivory and reduce overgrowth of corals by invasive algae. Herbivore biomass has significantly increased since the closure, accompanied by a decrease in invasive algae cover.

From adaptation planning to action: Spring ecosystem inventory, assessment and restoration in the Sky Island region

Misztal, Louise; Nicholas S. Deyo, Carianne Campbell, Christopher Morris

Sky Island Alliance

Springs in arid ecosystems occupy a small fraction of the landscape yet support disproportionately high levels of productivity, endemism and biodiversity. Although the vast majority of springs in the Southwest have been altered by human influence, many can be restored to improve the ecological function of these critical habitats. In 2011 Sky Island Alliance (SIA) began a project to inventory, assess and restore springs in southeastern Arizona. The need to develop critical baseline information on springs and to actively address their management was raised at two climate change adaptation workshops convened by SIA. At these workshops natural resource managers noted a lack of resources for the systematic inventory of springs, yet were motivated to restore and protect priority springs once identified. SIA worked with trained volunteers to collect key biologic, hydrologic and geomorphologic data at springs. This data, combined with qualitative condition and risk assessments, was used to document the ecological health of springs at a landscape-level and identify priority sites for restoration. This talk covers the benefits and shortcomings of assessment techniques, discusses approaches to restoring spring ecosystems and provides a case study for a current spring restoration project. SIA's work is a model for moving from climate change adaptation planning to implementation using novel approaches, including volunteer engagement and building NGO- agency partnerships to overcome resource constraints. Scientific literature on spring restoration remains limited and this project will provide new insights into approaches for spring ecosystem restoration.

Landscape-scale conservation: Bridging the gaps between public, private, professional and volunteer conservation efforts

Mittendorf, Erin E.

The Stewardship Network

For years, the land preservation community acted on the premise that land protection ensured long term viability of lands. Today, the conservation community as a whole realizes that active conservation, restoration, and stewardship are required to maintain the integrity of native habitat and to preserve healthy ecological functions. The Stewardship Network (TSN) has built upon that premise, and has developed a model that supports collaborative approaches to conservation of public and private lands at the community level through education and volunteer engagement in hands-on restoration projects. The Stewardship Network started its “Cluster” model in 2003. Clusters are geographically defined communities within which environmental organizations, landowners, and individuals work together to identify and address locally significant needs in environmental education and conservation action. Cluster activities range from education on early invasives, to shared professional trainings on BMPs, to promoting and aiding restoration of prairies and wetlands on private lands through partnership between landowners, and more. We have launched seven successful Clusters, which are collectively working with over 100 partners in southern Lower Michigan to increase outreach and on-the-ground stewardship. In the process, we have learned how to align and collaborate with multiple stakeholders, and how to provide structure with flexibility. The Cluster model is highly sustainable because it is made up of community volunteers focusing on local issues. TSN is working with groups in Wisconsin, Indiana, Ohio, New Hampshire and Ontario to expand strategically within the Great Lakes region and beyond. This talk will focus on the delivery of TSN's model.

ORAL ABSTRACTS (CONT'D)

Variable fire regimes and interactions in Lake States forest types

Mladenoff, David

University of Wisconsin

Fire regimes of the northern portions of the U.S. Lake States (MN, MI, WI) varied historically based on forest and substrate type. These factors were also constrained by spatial and temporal climatic gradients, and variable ignition sources, both by weather and Native Americans. Another layer of complexity is due to significant disturbance by windthrow in the region, which also interacts and influences fire susceptibility. There are surprisingly notable climatic gradients across the region, resulting in differential seasonal constraints on fire conditions. Within this larger gradient, glacially derived soil substrates form the template for sub-regions. These soil and climate combinations yielded a range of disturbance regimes and resulted in sorting of dominance by pine species (jack, red, white), as well as oak and aspen. Such information can be useful in understanding drivers and possible restoration techniques for increasing these pine systems on the landscape. At the same time, legacies of past land use and abuse, and changed and changing climate, yield challenges for the traditional model of range of natural variability and restoration goals.

From seedlings to trees: evaluating restoration success using structural and functional attributes in a mangrove ecosystem in the Amazonian Coast, Maranhão, Brazil.

Mochel, Flavia Rebelo; Ivanilson Luis A. Fonseca, Clovis L. Rocha Jr.

Universidade Federal do Maranhão

Mangrove restoration was carried out from 2009 to 2012 in a mangrove area damaged by dredging activities. Nursery grown seedlings of *Rhizophora mangle*, *Avicennia germinans* and *Laguncularia racemosa* were planted and structural and functional attributes were registered in monitoring plots along 3 years. Plant height, diameter at the base (DBH), phenology, leaf herbivory and plant mortality were measured and quantified. From October 2009 to April 2012 the mean plant height for *L. racemosa* increased 18.5 times from 11 to 203.5cm and mean DAB increased 6.5 times. The mean plant height for *A. germinans* increased 5.6 times from 32.3 to 181.6cm and mean DAB increased 2.7 times. For *R. mangle* the mean plant height increased 3.7 times from 36.25 to 136.44 cm and mean DAB increased 2.2 times. *A. germinans* first flowers appeared in September 2010 while *L. racemosa* flourished in November 2010 and *R. mangle* in February 2011. Herbivory was very low and when occurred was more intense on *R. mangle* leaves (mean of 1.56%) than on *L. racemosa* (0.63%) or *A. germinans* (0.12%). Results showed low mortality values: *A. germinans* presented the lowest losses (11.1%) followed by *R. mangle* (12.5%). *L. racemosa* showed the highest mortality (14.8%) as well the highest structural gain as a function of reducing density. The data show that the mangrove restoration plots have reached a reference ecosystem state after 3 years of planted seedlings.

Restoration Trajectory for Loktak Wetland, Manipur, India

Mohanty, Braja Narayan; Th. Ibobi Singh

Government of Manipur, India

The Loktak Wetland - a Ramsar site, perched on the central valley of hilly state Manipur (India), is unique in many respects namely its phumdis -floating vegetal land masses, the endangered Sangai Deers (*Rucervus eldi eldi*) surviving with phumdis as their habitat and the surrounding ethnic human communities barely eking out a livelihood. Fraught with innumerable encumbrances the ecosystem has undergone degradation overtime to be included in Montreux Record. Loktak Development Authority has been engaged in holistic conservation of the wetland with emphasis on Phumdi, Water, Catchment, Biodiversity, Livelihood, etc. A study was carried out to ascertain the overall improvement of the ecosystem due to multi-pronged actions taken. The data, collected on various ecological parameters over the period 2007-11, have been analyzed using ArcGIS 10 software. Based on the spatial distribution maps for the important water quality parameters such as Dissolved Oxygen (DO), pH and Hardness, it is brought out that there is increase in the level of DO in eastern and central parts of Loktak lake as opposed to overall decline in concentration of Hardness. Phumdi restoration activity has improved the water quality due to increased uptake of nutrients. This has resulted in the rise of DO level and clarity of water, which may trigger enrichment of species. Census figures over recent years have shown rise in the population and diversity of water fowls. The encouraging findings will be integrated in to a feasible restoration trajectory with the aim of putting the lake out of Montreux Record.

Rio Duero, an integral restoration program in a Mexican sub-basin

Moncayo-Estrada, Rodrigo; José Teodoro Silva-García, Carlos Escalera-Gallardo

CIIDIR-IPN-MICHOACAN

Rio Duero sub-basin belongs to the Lerma-Chapala watershed, which represents one of the most contaminated basins in Mexico. We started our study with a detailed diagnosis and defined 16 "hot spots" or "red dots" using six criteria related to the hydrography (vulnerability, water use and overexploitation), topography (soil erosion), environmental parameters and biological communities (vegetation management, deforestation, IWQ and IBI), urban and agricultural development (land use change, solids residues, technological efficiency) and socio-cultural elements. We described as red dot those sites critically impacted and strategically located, to implement restoration measures on water, land and forest. Then, we established general control strategies at municipal and regional levels resulting from the defined red dots, which were mutually agreed with producers, authorities, NGO's and residents through the implementation of participatory strategic planning workshops. These key-players helped to prioritize the actions and to establish the commitments as these were the principal actors directly involved in the integral restoration at different local productive systems. As a result, the program structure included seven main guidelines related to Information (research and monitoring), Institutional Training and Management, Infrastructure, Conservation and Restoration (environmental and water culture), Technological Innovation, Credit promotion, Ecological Territorial Planning and Land Use. A detailed action program incorporated 116 initiatives with a succinct description of the action goals and expectations, location

ORAL ABSTRACTS (CONT'D)

(municipality or region), organization responsible, resources (human and material), action cost, real and potential financial funds and a timeline for the implementation.

Food-web approaches in landscape-scale restoration

Montoya, Daniel
University of Bristol

Ecological restoration, as many other disciplines in Biological Sciences, has traditionally been implemented at small spatial scales. While the ecological knowledge at this spatial scale has improved enormously over the last decades in both quality and quantity, the focus primarily on single species (rather than networks of species interactions), and single guilds in single habitats means that there is a real possibility that we are missing the bigger picture – a classic case of not seeing the wood for the trees. From a food-web approach, this suggests that we may be wrong about a number of key network properties and how these translate into ecosystem services simply because network ecologists mostly work at the small scale in single habitats. Recently, however, it has been realised that understanding the relations between restoration trajectories and the spatial scale of restoration is fundamental, and a landscape perspective in ecological restoration is increasingly embedded in restoration projects. In this oral presentation I will show some empirical evidence from food-web theory supporting the shift in focus from single, isolated habitats to a larger landscape-scale perspective in ecological restoration. The second goal of this talk will focus on the challenges and open questions that remain unclear in landscape-scale restoration, and how food-web approaches can be used to contribute in the answer.

Workshop: Resolving Environmental Conflicts: A Mediator shares Lessons for Resource Managers, Scientists and Stakeholders

Moore, Lucy
Lucy Moore Associates, Inc.

In our increasingly polarized society, working collaboratively to protect and restore ecological systems is more and more difficult. Clearly, a greater impact can be made if agencies, scientists, non- profits and stakeholders pool their resources and expertise. And yet, this is easier said than done. There are political, economic, historic and cultural factors that keep us in a competitive, or even hostile, posture with each other. Without a way to bridge these differences and resolve these conflicts in an equitable and sustainable way, battles will continue, hostility will escalate, and ecological restoration efforts will suffer. This workshop will provide an opportunity for an honest and thought- provoking discussion of the challenges facing those who work collaboratively – or would like to – in the field of ecological restoration. A nationally recognized mediator for the last 25 years, Lucy Moore has been in the middle of highly controversial natural resource conflicts dealing with endangered species, traditional agriculture, toxic waste, federal Indian policy, and more. She has learned that a case can turn not on data, legal merits or the moral justness of the cause, but on the human dimensions of participants. She has seen the power of a personality make or break a process and the impact of cultural differences – from corporate to ethnic – keep a good solution from moving forward. She knows the value of anecdotal knowledge in a sea of technical data and how to deal with historical trauma when it threatens resolution. In this workshop, Moore will share insights from her experience in the trenches of environmental conflict resolution and lead discussions to help participants understand the dynamics of conflict, approaches to resolution, and their own particular strengths and weaknesses in the conflict arena.

Using scenario building to assess the needs for ecological restoration in protected areas under a changing climate: A case study at Bruce Peninsula National Park

Moore, Kelly D.; Stephen D. Murphy
University of Waterloo

The global climate is changing; there are many predictions about the ecological impacts, and even more uncertainty. Predicted ecological impacts include northward shifting biomes, invasive species, decoupling of biotic interactions, all of which are threats to the already challenged ecological integrity (EI) of Canada's National Parks System. To maintain and restore EI, parks must be managed with climate change in mind. A scenario building tool was developed to explore management and restoration options because of its minimal resource requirements and its ability to address uncertainty. Scenarios were built to assess various management and restoration techniques under mild and dramatic climate change conditions based on an existing research program for forest health. Bruce Peninsula National Park in Ontario, Canada was used as the case study for this pilot set of scenarios. Scenarios allow managers to explore the potential impacts of a wide array of management and restoration regimes, allowing them to make more informed decisions about the most effective and efficient ways to spend their minimal available funds for restoration activity. The scenarios indicate that in the case of Bruce Peninsula National Park, restoring to the historical forest type of White Pine and Hemlock forests is unreasonable under dramatic climate change and possible but challenging and expensive under mild climate change. With the current forest composition however, it is very possible to use management to maintain and restore EI to the system structure and function in both mild and dramatic climate change regimes.

Are fencing and pest controls enough? Perspectives on long term forest management

Morales, Narkis S.; George Perry, Bruce Burns
Presenter: Narkis S. Morales

The negative impacts of unsustainable human activities have reduced many natural ecosystems to patches surrounded by productive land threatening their long-term survival. In New Zealand, approximately three-quarters of the original forests have been destroyed. *Beilschmiedia tawa* is an endemic

ORAL ABSTRACTS (CONT'D)

evergreen canopy tree, one of the two members of *Beilschmiedia* in New Zealand, and one of the main species of the the podocarp-tawa type forest. The main threat to these forests are the pressure by exotic mammalian herbivores and the reduction of seed dispersal by keystone dispersers such as the native pigeon (*Hemiphaga novaeseelandiae*). The podocarp-tawa type forest in New Zealand, especially *B. tawa* (tawa) dominated fragments, have suffered from recruitment problems that are affecting its long term survival. The aim of this study is to determine if the combination of fences and exotic herbivore control has an impact on forest fragment species composition, abundance, number and survivorship of natural seedlings. We compared areas with long term management (fencing and pest control) with smaller fragments under less rigorous controls to determine which type of management could lead to higher survivorship and abundance of natural seedlings over time. Also, we are developing an ecological model to assess the factors that affect recruitment of *B. tawa* forest fragments and the fragments potential for self sustainability. The results of this study could help in the design of conservation and restoration strategies of remnant ecosystems by improving our understanding of forest dynamics and by providing an assessment of the possible outcome(s) of management actions.

Physical interventions determine wetland ecosystem recovery

Moreno Mateos, David; James Aronson, Maria Isabel Vara Rodriguez

Stanford University

Ecosystem restoration is becoming a global priority even if there are known ecological and technological limitations. Scientific understanding of how interventions affect the recovery process of biodiversity and ecosystem functioning is vital to overcome those limitations. We collected measurements of biological structure (richness and abundance of plants, macroinvertebrates and vertebrates) and ecosystem functionality (storage of carbon, nitrogen, phosphorus and organic matter in soils) from published literature in restored and created wetlands where specific human interventions were identified, and compared them with equivalent “undisturbed” reference ecosystems. Using these parameters, we used response ratios to estimate the recovery trajectories of 409 restored and created wetlands where physical manipulations were used alone, 251 restored and created wetlands, where physical and biological manipulations were combined, and also 70 other wetlands where biogeochemical manipulations were used in addition to other manipulations as well, either physical, biological or both. During the first 30 years after ecosystem restoration or creation was initiated, significant differences between the recovery trajectories of restored and created wetlands where physical interventions were used alone and those where physical and biological intervention were combined were not found. Biogeochemical interventions significantly increased (over 10-15 years) the recovery of the biological structure and biogeochemical functionality to reference levels. Our results were consistent across contrasted wetland hydrogeomorphic types, climatic conditions, target ecosystems (restored versus created), and size of restored and created wetlands. Our results suggest that physical interventions should be given priority unless there is prior knowledge that supports the use of biological interventions.

Moving towards a strategic approach to on-the-ground adaptation to rapid climate change on the Kenai National Wildlife Refuge, Alaska

Morton, John M.; Dawn R. Magness, Elizabeth Bella

US Fish and Wildlife Service

In response to a warming and drying climate since 1968, the Kenai Peninsula in southcentral Alaska has experienced rising treeline, drying wetlands, receding glaciers, warming streams, increasing spruce bark beetle outbreaks, and changing fire regime. Magness et al. proposed that response to climate change could be prospective (managing towards future conditions) or retrospective (restoring towards historic conditions). The Kenai National Wildlife Refuge is particularly well-poised to respond prospectively because we have a rich understanding of natural processes and changes imposed by recent warming. We also “see ourselves” in the larger landscapes of the Kenai Peninsula, Alaska, and even the National Wildlife Refuge System through climate envelope and other spatial models. We are in various stages of several promising initiatives to promote a strategic approach to reducing the uncertainty that hampers on-the-ground adaptation: development of a collaborative climate vulnerability assessment with Chugach National Forest, Kenai Fjords National Park and the University of Alaska; development of a regional geospatial data-sharing hub; seeking congruence in hierarchal models and competing spatial models; validation of model forecasts through existing data; and a common garden study. We show how adaptation can be retrospective initially but gradually more prospective as we modify our goals for fire management, invasive species management, game management, and ecological monitoring, while moving towards serious consideration of translocating new species. Perhaps the most important message is that different agency missions are not an obstacle but an opportunity to build resilience in our collective responses to rapid climate change.

The good farmer and the group effect

Morton, Lois Wright; Jean McGuire

Iowa State University

The unintended consequences on ecological conditions of production-oriented agricultural systems often challenge farmers to reconcile competing identities characterized by conservation and productivist goals. All farmers have their own version of what it means to be a good farmer. Many have conservationist identities within their good farmer identity, however their conservation goals often need to be activated to rebalance the production-conservation meanings they give to their roles in society. One way to do this is to use a performance-based environmental management process that uses social context and group expectations to shift farmers identity toward stronger conservation standards and actions.

ORAL ABSTRACTS (CONT'D)

Understanding tree regeneration following restoration with native tree plantations in degraded montane forests of Kenya

Mullah, Collins; Joram Mbiga, W. Omondi
KEFRI

Restoration of degraded montane forests using native tree plantations is a promising innovation for facilitation of native tree species. We postulated that type of tree species and distance to adjacent natural forest could influence the diversity of native tree species recruits under these plantations. The study aimed to assess abundance and composition of understory tree species assemblages across five plantations of *Juniperus procera*, *Prunus africana*, *Olea europea* ssp. *africana*, *Podocarpus falcatus*, and *Polyscias kikuyensis*. Ages of native plantations ranged between 14 and 84 years. A total of 42 tree species representing 27 families were recorded beneath the plantations with density ranging from 1630 to 8260 individuals per hectare. Generally, seedlings populations were the most abundant components of regeneration in most of the plantations forming 85% of the total regeneration count. Multivariate analysis of plots based on tree species composition showed that plantations isolated from natural forests were associated with lower total tree species diversity. Similarity between the soil seed bank and aboveground flora was very low implying that the role of soil bank in the regeneration was low and dispersal of seeds from the adjacent natural forests played an important role in the process. These results support the concept that native tree plantations can foster regeneration of native tree species. Restoring degraded montane forests using native tree species should be encouraged to enhance species recovery and increase biodiversity of these important watershed ecosystems.

Evolution of the designer / practitioner model within the genre of applied ecological restoration

Munro, John W.
Munro Ecological Services, Inc.

SERI started as a group in search of something new; scientists, naturalists, and others wanting to find a way to bring back the health of degraded and lost ecosystems. The organization was created and had practitioner beginnings and has gradually shifted to global and academic primary perspectives. Concurrently the need for the applied planner / designer to configure and work out the appropriate details for larger and complicated projects has grown. Professional ecological restoration practitioners have done this work along with others from landscape architecture and other professions. The growing practitioner / designer needs and training are addressed and suggestions are given for meeting the needs.

Symposium Wrap Up: Best Practices for Using Resilience Theory in Restoration.

Murphy, Stephen D.; Cara R. Nelson
University of Waterloo

As management goals shift from re-establishing historic ecosystems to a focus on ecological functions, there is a need for critical examination of “ecological resilience” as a suitable management goal, for analytical innovations to define resilience thresholds, and for management practices that effectively apply this concept to restoration. We will use the last 40 minutes of the symposium to synthesize concepts and to hold a moderated question and answer session with symposium speakers and all members of the audience.

The management framework in practice: Making decisions in Atlantic Canadian Meadows

Murphy, Stephen D.
University of Waterloo

In 1984, planning began to test approaches for restoration of abandoned farms in to a coastal meadow ecosystem starting with the area around the Bay of Fundy in New Brunswick and Nova Scotia in eastern Canada these habitats. Four sites that are best described as wet, mildly saline meadows were chosen. The restoration approach used involved spraying three times with glyphosate in spring 1985 to remove weeds. A list of plants was generated by the then-expert consensus and research, and a variety of plants from regional seed sources were planted in spring 1986 at a density of 1 kg seeds of each species per hectare. The sites have been resurveyed every spring and late summer through 2012, and surveying will continue every alternate year for the foreseeable future. Because of the long history of land use changes, lack of historical data, and some errors in choosing species in restoration, the outcome has been at least a hybrid ecosystem where there has been improved the ecological structure and function. It would be technically feasible to restore this area further but the expense and marginal ecological benefit (especially as new exotic species often migrate into the region) likely make this option too risky and expensive to undertake. If one accepts the hybrid-novel ecosystem framework, then the project has succeeded. Pragmatically, given land use and other regime changes, this framework is most appropriate for managers.

About time: developing a professional landscape architecture program with a concentration in ecological restoration

Myers, Mary
School of Environmental Design, Temple University

In 2013, the Temple University Master of Landscape Architecture (MLA) became the first professionally accredited landscape architecture program in the USA with a concentration in ecological restoration. This presentation describes the process of visioning, developing and implementing the program. The process began in 2007 and culminated with a successful accreditation in 2013. The Temple MLA responds to the “growing realization that we will

ORAL ABSTRACTS (CONT'D)

not be able to conserve the earth's biological diversity through protection of critical areas alone (Gann and Lamb, p.1)." It aims to educate landscape architects to understand, value and apply ecological restoration science in their designs as a means of restoring biodiversity. Program objectives are to: 1) Prepare graduates for professional licensure in landscape architecture with the basic skills required of professional landscape architects including: design; computer graphics; horticultural knowledge; and technical competence; as well as, knowledge of ecological restoration. 2) Educate students who are trained to think critically and creatively about each ecological situation. 3) Develop a body of knowledge through research, long-term monitoring of restored landscapes and comparison of methods upon which current and future professionals can draw. Regional and national programs in landscape architecture were assessed during the development investigation. It was learned that there is a dearth of accredited professional programs with this special concentration. The challenges of developing Temple MLA will be discussed, along with the reason for seeking professional accreditation as a means of assuring its longterm institutional commitment and stability.

Climate change adaptation in the context of ecological restoration through urban forestry

Nagel, Linda; Chris Swanston, Maria Janowiak, Matthew Powers

University of Minnesota, Department of Forest Resources

Climate change is a pervasive driver of ecosystem change and uncertainty regarding future conditions, and represents a significant threat to many critical ecosystem functions. The uncertain nature of climate change adds an additional dimension to developing sustainable management plans, including finer-scale urban settings. There is a dire need for conceptual tools that incorporate adaptation into urban forest planning and management. This process begins with reframing objectives and the notion of desired future conditions, which can be especially important where restoration treatments are a priority. Decision-making processes built on principles of adaptive management can help urban foresters and ecological restoration practitioners assess potential climate-related challenges to their goals and objectives, evaluate the feasibility of existing objectives in the context of climate change, diagnose the need for climate change adaptation efforts, prescribe appropriate treatments, and use monitoring efforts to evaluate treatment effectiveness and gauge the need to adjust management over time. A common emerging adaptation theme is to manage ecosystems for resistance and resilience, which can often be achieved by maintaining and enhancing complexity. A case study using species of the Great Lakes region will be discussed in the context of these tools. Additionally, an adaptive silviculture project will be highlighted that is building science-management partnerships to guide managers through the process of developing site-specific, objectives-driven climate change adaptation treatments in a variety of forest types across the United States.

Comparing seed drill effects on post-fire soil erosion in the Great Basin

Newingham, Beth A.; Amy C. Ganguli

University of Idaho

Post-fire rehabilitation focuses on stabilizing and rehabilitating ecosystems after fire. In the Great Basin, seed drills are used to stabilize soil and re-establish perennial vegetation in these desert ecosystems. While seed drilling is intended to stabilize soils via vegetation recovery, it is possible tilling directly destabilizes soil and creates erosion problems. We examined the effects of two different seed drills (rangeland and minimum-till drill) on soil erosion. We measured soil microtopography, stability, and dust flux in unburned and burned plus treated plots. Treatments included the two seed drills and different seeding rates. Microtopography was significantly higher in the rangeland plots compared to unburned and burned + minimum-tilled plots. This variation in surface relief decreased over time but only in the rangeland drill plots. Soil stability was significantly lower in burned areas but was not affected by different seed drills or seeding rates. Dust flux rates were up to 1,000 times higher in burned than unburned plots but were not significantly different among seed drills or seeding rates. Dust flux substantially decreased one year after fire with peak dust flux rates approximately 4,000-8,000 g/m²/day. Our results indicate that fire dramatically increases wind erosion in these dryland ecosystems during the first year post-fire. While seed drills differentially affected microtopography, there was no detectable effect on soil stability or dust flux. Further studies are needed to tease out effects of seed drills on wind erosion on different soil types.

Maya restoration agriculture: Carbon sequestration and habitat conservation in traditional milpa landscapes

Nigh, Ronald

CIESAS Sureste

For millennia the milpa, a perennial, multi-cropping system centered on maize (*Zea mays* L.), has been the axis of resource management in the tropical lowland woodlands of the Maya cultural and natural area, and has played a role in shaping and conserving these ecosystems. The 'high-performance milpa', a sophisticated, intensive agroforestry swidden, was widely practiced by Mayan farmers in the past. Contemporary, de-intensified milpa of marginalized smallholder families is little more than a rear-guard action to conserve seed and provide fresh corn and other products for domestic consumption. Preliminary research has shown that the Maya milpa swidden, under traditional management, results in a significant cumulative input of black carbon to the soil and the enhancement of other characteristics of anthropogenic dark earths. Soil is the largest pool of terrestrial organic carbon and interacts strongly with vegetation cover and climate. In its high-performance mode, the Maya milpa is a form of 'restoration agriculture' as defined by Shepard (2013): each cycle of production results in abundant products for family subsistence and trade, increased soil fertility, long-term carbon sequestration in the soil and the regeneration of enriched woodland vegetation. The dialogue of scientific and traditional agricultural knowledge can contribute to the creation of future productive conservation landscapes in the tropics.

Process-based riparian restoration on boreal rivers: success or failure?

Nilsson, Christer; Lina Polvi

Umeå University

ORAL ABSTRACTS (CONT'D)

Riparian landscapes in boreal regions are shaped by streams with permanent, although seasonally widely varying, flows. Many boreal riparian areas have been the subject of anthropogenic alterations, including fragmentation and flow regulation by dams, channelization for timber-floating, surface mining, pollution, forestry, agriculture, and human settlement. During the last two decades, restoration of boreal streams and their riparian zones has become increasingly common. In Fennoscandia, where the majority of streams were heavily channelized for timber-floating, many of the still free-flowing streams are now restored to more closely resemble preindustrial conditions. Although restoration is primarily motivated by the enhancement of sport fisheries, it has also had profound effects on riparian ecosystems. In general, restoration entails increasing overall instream complexity and channel-floodplain connectivity by returning coarse sediment (cobbles and boulders) to the channel from the margins, opening side channels, and removing dams. Although similar restoration techniques have been used in projects throughout Fennoscandia, results have varied widely. Hydrological responses are consistent in that current velocities have decreased and become more varied, wetted areas have widened, and ice conditions have become more heterogeneous. However, biological responses vary: some authors report positive responses, whereas others fail to see any biological effects of restoration. We discuss the potential factors that cause reported outcomes of similar restoration projects to differ, including ill-defined objectives, poor restoration design, lack of well tested follow-up methods, different choices for indicator organisms, lack of populations for recolonization, and short recovery periods.

The effects of ecological restoration on drained pine bog arthropods in Eastern Finland

Noreika, Norbertas; Janne S. Kotiaho, Jouni Penttinen, Pekka Punttila, Anna Uusitalo, Timo Pajunen, Olli Autio, Olli J. Loukola, D. Johan Kotze
University of Helsinki

Drainage is a major threat to wetland wildlife. Finland has performed the world's most extensive program of mire draining for silvicultural purposes during the 1960s and 1970s. Mire restoration activities were started relatively recently. Still very little is known about the responses of fauna to the rewetting of bogs by complete ditch filling, which results in the regrowth of bog vegetation. Therefore, it is essential to evaluate the effectiveness of rewetting for the re-establishment of individual bog specialist species and their communities. We investigated nine raised ombrotrophic bogs with ditched, restored (4 years after restoration) and pristine (control) sites in Eastern Finland by evaluating the successional changes in invertebrate (carabid beetle, spider, ant, microlepidoptera, crane fly) communities. We also recorded vegetation changes and the water table level of these sites to determine how they influence the structure of arthropod communities and individual species. Results indicate that drainage has a negative effect on bog arthropods, while restoration has a positive effect on bog specialist species. Furthermore, vegetation structure and water table level play important roles in predicting the responses of bog species and communities. It appears that ditch filling, as a bog restoration option, is successful in also restoring the bog arthropod community.

Scaling up? Difficulties in the prioritization, selection, and evaluation of restoration sites for Oregon's ecosystem services market

Nost, Eric
University of Wisconsin-Madison

I argue that efforts to orient restoration for ecosystem service markets towards landscape and watershed scales are not easily accomplished. Around the world, environmental regulators, conservationist groups, and eco-entrepreneurs are increasingly interested in restoring the services, like flood abatement, that wetland and other ecosystems provide to society. The idea behind "mitigation markets" in ecosystem services is that private entrepreneurs speculatively invest in restoration and sell the ecological improvement as offset credits to development projects in other parts of the watershed. But entrepreneurs' choice of where to do restoration may be less responsive to watershed needs than it is to their ability to find willing landowner partners and their need to make a return on their investment. I show how efforts to strategize restoration siting have played out in the US state of Oregon. Combining social and ecological analysis, I draw upon recent interviews with key market actors there to understand the financial, legal, and ecological opportunities and limitations to accounting for the spatial context of aquatic ecosystem services. Regulators and conservationists have sought to make the prioritization, selection, and evaluation of sites more considerate of watershed and landscape context. As a consequence, however, entrepreneurs have found their ability to continue to do restoration for the market constrained. The Oregon case suggests that emerging efforts towards scaling up market-based conservation are likely to be contested and variegated. The broader implication is that mitigation markets may not prove to be the best way of promoting more spatially holistic ecological restoration.

Oak, fire and mesophication: Past, current and future trends of oak in the eastern United States.

Nowacki, Gregory
US Forest Service

Fire has been a preeminent force over much of the eastern United States for multi-millennia. As such, pyrogenic vegetation types dominated this region in pre-European times, including oak, oak-pine, and pine savannas/woodlands/forests and tallgrass prairies. Nation-wide fire suppression efforts began in earnest after particularly destructive fires in the early 1900s. Although subsequent structural and compositional changes were similar between the dry West and the humid East (increases in stand density and shade-tolerant species), the ecological consequences differed profoundly. While the conifer-dominated West experienced a precipitous rise in fire risk, the hardwood-dominated East generally did not. Instead, vegetation shifts from open lands to closed-canopy forests promoted cool and moist understory conditions and a concurrent shift in leaf litter from fire-promoting xerophytic species (oak, pine) to fire-suppressing mesophytic species (maple, beech, basswood). This caused fuel beds to be less receptive to fire. Mesophication refers to this positive feedback cycle, whereby microenvironmental conditions (cool, damp, and shaded conditions; less flammable fuel beds) continually improve for

ORAL ABSTRACTS (CONT'D)

shade-tolerant, fire-sensitive competitors and deteriorate for shade-intolerant, fire-adapted species. This phenomenon unfolds most quickly and is most steadfast on rich mesic sites vs. more infertile drier sites.

Monitoring tree cover to manage sustainable forests in the changing urban landscape

Nowak, David J.

USDA Forest Service - Northern Research Station

The urban landscape is changing. Not only do the processes of urbanization alter surrounding rural landscapes, but within already established urban areas the amount of tree cover and types of trees are shifting – and with that, the ecosystem services that the urban forest provides. This presentation will explore the various factors influencing change, present data on changing tree cover and species composition, and discuss steps to sustainability. Data from several cities across the U.S. will be presented to assess the state of the urban forest. Drivers of urban forest change will be examined – including an array of both human-driven and nature-driven change agents. The interaction of these factors results in surprising trends involving such things as tree planting activities versus natural regeneration in cities, as well as the impact of population density, regional variation, and land use decisions. The net result is a striking difference in tree species and sizes in human-dominated versus nature-dominated landscapes. Having considered these trends and influences, the presentation will conclude with a series of recommended “steps to sustainability” – involving data collection, assorted management goals, and the need for a specific management plan to guide future change in the desired direction. In short, understanding the ongoing changes in the urban forest is the first step toward guiding future change in the desired direction.

What drives the use of scientific evidence in invasive alien plant management? A case of the South African Working for Water program

Ntshotsho, Phumza; Karen J. Esler, Heidi Prozesky, Belinda Reyers

Council for Scientific and Industrial Research (CSIR)

Scientists often criticize natural resource managers for not using scientific evidence when making decisions in their day-to-day operations. This criticism is likely driven by the assumption that where empirical, scientific evidence of the effectiveness of alternative interventions exists, such evidence should be used easily to inform decisions in practice. Little regard is given to the practical constraints faced by managers to using research findings in their work environments. To explore these constraints, we conducted a case study of the Working for Water program (WfW), a public-funded invasive alien plant (IAP) management program that has been operational in South Africa for nearly two decades. We investigated the extent to which decision makers in WfW use scientific evidence to inform their decisions pertaining to the clearing of IAPs and also identified opportunities for, and constraints to, the ideal of evidence-based practice. Our results indicate that the use of scientific evidence is limited by the fact that the management of natural resources involves much more than just science. The social context within which decisions are made, which includes organizational structure, priorities and capacity, plays an important part in the extent to which science informs practice. On the basis of our findings, we highlight the importance of generating evidence internally through proper planning, implementation and monitoring of projects.

Performance of saplings implanted and natural regeneration development in different restoration models in a riparian forest in Southeastern Brazil

Nunes, Yule Roberta Ferreira; Lílian de Lima Braga, Graciene da Silva Mota

Universidade Estadual de Montes Claros

This work aimed to evaluate the survival and growth of saplings of indigenous species and the performance of natural regeneration in a riparian forest degraded by cattle in plots of 1 ha, including open areas (AA), fenced areas (C) and dunged areas (E), including even models with direct sowing (S) and the sapling planting in spaces of 2 or 4 m (T2 and T4), and with the presence and absence of direct sowing (T2S and T4S). The saplings growth and survival were monitored and were register the natural regeneration during 12 months. The greater growth (in height and diameter) of saplings was associated to the plots T4 and T4S, located in soil that showed greater amounts of phosphorus, greater proportion of clay and minor proportion of sand. The survival of sapling was high in all models, however was greater in the T2S (78.49%) model. The initial height of the saplings influenced their survival, once that saplings with greater initial height had less mortality rates. Were registered 145 species, being 106 herbaceous and 39 wood species in the natural regeneration. It can not be concluded which is the best restoration model at the moment, but it can be concluded that the soil has an impact on the saplings growth and the treatments that had been done in the area, and the initial height of sapling can determine its survival. Besides, despite the changes that the pasture caused on the area, it is in a natural restoration process.

Topsoil substitutes for mine rehabilitation - 10 years later

Nussbaumer, Yvonne; Carmen Castor, Mike Cole

The University of Newcastle, Australia

Topsoil substitutes have been trialled with the aim of reconstructing functioning, sustainable, forest ecosystems on mine spoil. Mount Owen open-cut coal mine in NSW Australia has passed through 50% of Ravensworth State Forest, the largest forest remnant left on the Hunter Valley floor. While forest topsoil has been spread on to the spoil as a growing medium and source of provenance seed, alternatives need to be found for this limited resource. Several bulk materials were trialled and compared in terms of native species richness, exotic weed and grass infestation, plant growth and ability to restore important microbial associations such as rhizobia bacteria. Over the first five years, forest topsoil produced the best outcomes in terms of plant

ORAL ABSTRACTS (CONT'D)

density and species richness, while pasture topsoil performed worse than bare soil due to high exotic weed and grass competition. Overall, pasture subsoil was the best of the forest topsoil substitutes in terms of native species richness, native plant density, plant growth, second generation seedling establishment and low exotic weed and grass cover. However, long term monitoring of experiments is needed to demonstrate the resilience of newly established systems to environmental stresses and therefore the likelihood for long-term sustainability. This experiment is now 10 years old and data will be presented on the changes in the vegetation community and soil properties over that period.

Floodplain Restoration in the Pend Oreille River Valley in NW USA: A Kalispel Tribal Perspective

O'Connell, Margaret A.; Ray D. Entz
Eastern Washington University

Since 1992, the Kalispel Tribe has engaged in multiple projects to protect and restore floodplain habitats in the 29,000-acre Pend Oreille River Valley. This area encompasses the Kalispel Indian Reservation, two small municipalities, and a large grass hay farming and ranching community. In collaboration with other stakeholders, the Tribe has protected nearly 2,800 floodplain acres, and restored over 1,200 acres of hydrologic, ephemeral wetland, and riparian habitats to date. We strive to restore habitat to its natural condition using 1930 series ortho-photographs, LiDAR, high resolution photography, and site specific data. Three diking districts covering over 50% of the floodplain pose the most significant restoration hurdle in the valley. To minimize their effect, we focus on local hydrologic restoration behind them to benefit prior converted wetlands. Site specific restoration actions are used to increase connectivity with existing protected lands while providing added value for wildlife and habitat. We also recently contracted with Ducks Unlimited, Inc. to implement a stakeholder wetland restoration planning process covering all 29,000 acres. Along with resident stakeholders and agencies, we completed this plan to identify the highest priority restoration sites remaining in the valley. We then implemented a second contract with Ducks Unlimited to complete a feasibility analysis and draft restoration plan on two additional areas covering over 500 acres. The future implementation of these actions along with other ongoing efforts will continue to balance the restoration of the floodplain with associated multiple compatible uses and resident stakeholder values.

Assessing ecosystem health, stressors and opportunities for restoration along a 1.2 mile stretch of dune and beach along southern Lake Michigan

O'Leary, Mark J.
SmithGroupJJR

Sand dunes along the coast of Lake Michigan provide unique and rare habitat to a variety of rare and globally significant species and communities. Much of this habitat is under threat through development, sand mining, invasive weeds, fire suppression, and erosion caused by volunteer paths and beach grooming. The inherent dynamic nature of sand dunes is further exacerbated by historically low lake levels which create opportunities for exposed and blowing sand. Michigan City owns more public beach on Lake Michigan than any municipality. Partners working in and around Michigan City dunes must recognize the multi-functionality of these municipally-owned dunes when considering ecological restoration, controlled public access, management of invasive species, and how dunes are perceived and understood by the public. A 2012 Ecological Assessment of Sheridan Beach and the Esplanade concludes: 1) More than half of the plant species encountered were non-native and the most abundant species were non-native; 2) Invasive species were more abundant closer to homes and access points; 3) Consolidating volunteer trails would reduce blowing sand, and create more comfortable trails to the beach; 4) Controlling weeds and restoring the historic fire regime could improve views for neighbors and park users. In general, dune health, as measured by the abundance of invasive plants, decreases moving landward. Fore dunes were nearly weed free. Secondary dunes abutting homes and access areas were the weediest. The potential to restore diverse and stable ecological communities is high based on the persistence of the matrix of characteristic dune species.

Imperatives of resolving the Niger Delta conflicts for growth and development.

Obasi, Mgbore N.; Uwazie I. Uwazie
Alvan Ikoku Federal College Of Education, Nigeira

This paper calls for a change in the current policy and increase in the derivation based revenue allocation to states. Apart from the positive extent the change will help in ending the conflict going on in the region, it will bring about uninterrupted supply of gas to the country's gas turbine power stations. The very high economic stakes involved in control over natural resources are a key driver of conflict in the Niger Delta. Failure to deliver basic developmental needs have left the population polarized and disenfranchised, whilst corruption and violence are becoming accepted as valid means to achieve political and social aims. The failure to address root causes is pushing the area towards sustained conflict, which will seriously affect the revenue accruing from oil and, political arrangement in the region particularly and Nigeria at large.

Grassland plant establishment in post-extraction sandpits: Plant response to arbuscular mycorrhizal inoculum, municipal compost, and biochar

Ohsowski, Brian M.; John N. Klironomos, Kari E. Dunfield, Miranda M. Hart
University of British Columbia

Prairie plant species, adapted to disturbance, are excellent candidates for post-mine sand pit re-vegetation. Plant reestablishment in sand pit substrate is hampered by reduced soil fertility and extirpated soil biota. This research tests industrially feasible land management techniques to facilitate native plant

ORAL ABSTRACTS (CONT'D)

growth in sand pits. In May 2010, I established a large-scale plant plug field trial in a 0.5 hectare sand pit near Simcoe, Ontario, Canada. Using a fully-crossed factorial design, 10.2 m² plots were amended with the following treatments: municipal compost (20 tons / hectare [T/ha]), biochar (10T/ha), and arbuscular mycorrhizal fungal (AMF) commercial inoculum [*Rhizophagus intraradices*]. Plant plug locations were mapped and aboveground biomass was estimated for two growing seasons. Plant biomass was non-destructively predicted via partial least squares regression, a multivariate statistical technique adapted from chemometrics literature. AMF colonization in roots was assessed by staining and microscopic scoring for two growing seasons. Using linear mixed effect modeling, results indicate that treatments adding municipal compost significantly increases total plant biomass compared to control. Treatments adding biochar resulted in no significant difference in total plant biomass from control. AMF colonization rates of roots significantly differ from non-inoculated treatments. No significant plant biomass effects were detected due to AMF inoculum. These preliminary results will inform industry and restoration practitioners regarding the most cost-effective strategy to establish grassland plants in disturbed substrates. To elucidate long-term plant growth patterns and AMF colonization in a restoration scenario, plant growth will continue to be tracked over ten growing seasons.

An ecohydrological approach to guiding riparian restoration, Part 2: riparian vegetation dynamics and informed restoration planning on the Virgin River

Orr, Bruce K.; Glen Leverich, Tom Dudley, Kevin Hultine, Matt Johnson
Stillwater Sciences

While it is widely acknowledged that biological control (biocontrol) of tamarisk will ultimately yield long-term benefits for wildlife and ecosystem services in the Southwest, there is currently elevated concern over the need for riparian restoration measures to mitigate possible short-term negative impacts of biocontrol, particularly on nesting habitat for the endangered southwestern willow flycatcher. Thus, there is a crucial need for immediate, yet strategic riparian restoration along the ecologically sensitive, flood-prone Virgin River—the first location where the tamarisk leaf beetle and southwestern willow flycatcher coincide. We recently initiated a restoration action feasibility assessment of the ecohydrological conditions of the entire river corridor to determine where and how restoration efforts should be focused in order to facilitate sustainable habitat enhancement for avian and other wildlife species. Classification and mapping of vegetation types along the Virgin River is a key component of our ecohydrological approach that allows us to identify which areas are currently dominated by native species versus those supporting dense stands of non-native, invasive species, (e.g., tamarisk, Russian olive). We used a combination of remote sensing and extensive rapid field surveys to characterize vegetation along the entire 210-km river corridor. The field assessment and vegetation map, combined with our flood-scour and topographic mapping (discussed in the previous talk) and additional data to be obtained for each potential restoration site (e.g., soil texture and salinity, relative elevation, depth to groundwater, land use and ownership), provide valuable tools for conservation and restoration planning and prioritization in the focal areas.

Integrating traditional ecological knowledge and restoration ecology: a few obstacles, multiple stakeholders and long term mutual benefits.

Ostergren, David
Goshen College, Institute for Ecological Regeneration

A growing number of restoration ecologists in public and private organizations are working with First Nations, Tribes and indigenous people to incorporate traditional ecological knowledge (TEK) into natural resources management. Of all government agencies, national parks tend to be most active in working with TEK. Both ecologists and First Nations benefit from increased communication, increased knowledge about the habitat, and by developing allies in a time of biodiversity extinction. This investigation utilizes survey results and recent qualitative research in the US and to illustrate both advantages and obstacles of incorporating TEK into restoration projects. It has been a slow process for the western scientific community to accept TEK just as indigenous people are careful to allow access to long held information. One surprising insight is that restoration ecologists and the leaders in indigenous communities seek a very similar end point – completeness, balance or wholeness. The spiritual aspect to TEK often plays a key part in either obstructing or facilitating the interaction between groups who, in the end, are allies in restoring ecological systems.

Degradation in subtropical grasslands in southern Brazil - lessons for restoration

Overbeck, Gerhard E.; Mariana S. Vieira, Fábio P. Torchelsen
Universidade Federal do Rio Grande do Sul

Grasslands are the characteristic vegetation type in the Brazilian Pampa biome, but are increasingly being transformed to crop and tree plantations. Restoration of these grassland is becoming an important topic in science and politics, but a scientific basis for grassland restoration is still lacking and no experiences with grassland restoration exist. Based on two case studies, this contribution aims at characterizing the potential of spontaneous recovery of grassland vegetation after severe land use change. We present data from a seed bank study of two grassland areas in a rotational system with crops (rice; soy bean) as well as data on vegetation composition from areas that had been used for eucalypt plantation for decades and returned to be grazed grasslands ten years ago. Seed bank composition of degraded areas differs markedly from both vegetation and seed bank of undisturbed grasslands. While areas with a history of agricultural use have a dense seedbank of ruderal and exotic species, the seed bank of undisturbed areas, without ruderals and exotics, seems to have only a limited role for vegetation regeneration, indicating a low resilience of grasslands to severe disturbances. Vegetation recovery after use of areas for eucalypt plantation followed contrasting pathways. We conclude that unassisted recovery will allow for establishment of some grassland-type vegetation, but that these communities will not present the same diversity as natural grasslands and that characteristic species of natural grasslands found in the region are mostly missing. Implications for restoration aims and methods are discussed.

ORAL ABSTRACTS (CONT'D)

Limitations to Grassland Restoration – a view from Southern Brazil

Overbeck, Gerhard E.; Sandra C. Müller

Universidade Federal do Rio Grande do Sul

At present, few experiences with grassland restoration exist in Southern Brazil and methods established elsewhere may not be applicable there. Both ecological constraints and practical issues require research in order to surpass challenges of restoration. Based on recent studies and an evaluation of the ecological and socio-cultural context of restoration in southern Brazil, we can make some predictions regarding grassland restoration: 1) Nutrient availability should not be a limiting factor; on the contrary, in some cases, nutrient loads after degradation will be much higher than in natural grassland communities, which may be a problem. 2) The seed bank likely has a limited role in recovery of natural vegetation after agricultural use, and no native seed material is commercially available. Introduction of species thus likely is the principal challenge. No data from experiments is currently available on this. 3) Risk of invasion by exotic species is high in some regions of the state, i.e. control is necessary during (and sometimes before) restoration processes. 4) Areas that need to be restored usually are of considerable spatial extent, which may cause severe practical constraints and which results in a different perspective on restoration than e.g. in Central Europe. Considering these issues, a rather pragmatic focus of restoration on principal functions of a grassland ecosystem seems to be helpful at present, while restoration of full diversity will require more time and a better understanding of community assembly processes. Inclusion of management is of high importance to guarantee long-term restoration success and acceptance.

Encouraging a Watershed-Based Approach to Mitigation Planning in the Etowah River Watershed

Owens, Katie; Sara Gottlieb

The Nature Conservancy

The Etowah Watershed, located in Northwest Georgia on the north side of the Atlanta Metro Area, is one of the most biologically rich temperate river systems in the world. Some of the fastest-growing counties in the United States are in the Etowah, causing rapid development and water supply pressure on the watershed. The Nature Conservancy and Environmental Law Institute developed a stakeholder-driven watershed approach for prioritizing future mitigation sites to maximize the conservation of ecosystem function throughout the Etowah. The pilot project, which is intended to be replicable in other similar watersheds, uses a straightforward analysis of existing datasets to prioritize sites for Preservation or Restoration. Stakeholders identified the key system functions and needs, which were subsequently used to drive the analysis. The Preservation analysis focuses on identifying areas that are currently in the best ecological condition and are currently supporting system function and would result in significant impacts if converted to other land uses. The Restoration analysis identifies a set of sites with a low level of degradation which, if restored, could support system function over the long term based on surrounding current and future land use. The model results provide a screening tool for mitigation bankers and the agencies tasked with approving mitigation credits to ensure that future banks will meet the requirements of the 2008 Compensatory Mitigation Rule.

Un-farming in western Wisconsin - restoring prairie and savanna habitat on an old farm

O'Connor, Marcie

We bought 450 acres of land in the driftless area of western Wisconsin in 2000. Historical records show that before settlement, the area was mostly prairie and savanna and we decided to try to restore our land back to those habitats. We've planted prairie in the crop fields, worked on controlling invasive species, and cleared invading trees and brush from prairie and savanna remnants. I'm also learning all I can about the plants and animals that share the land with us, and keeping a record of what I see. I try to inspire others by sharing my enthusiasm and experiences on a Facebook page, my web site www.APrairieHaven.com and blog, and by giving tours and talks about our project. After hearing the debates about burning and its effects on insect populations, I avoid burning, and have been experimenting with other restoration techniques. Doing this project as a private landowner allows me to experiment on a small scale, and tailor my projects to what I enjoy and can do successfully. I know my land better than anyone else, and I spend most of my time there, so if there are interesting animals or plants, I'm likely to find them. When we eventually sell the land, I hope to be able to pass along a wild, diverse community of plants and animals to someone else who will enjoy its beauty and richness.

Rescuing nature from neglect, weeds, and bureaucracy.

Packard, Stephen

National Audubon Society

Quick lessons from long experiments – conclusions from 37 years of restoring tallgrass woodlands, savannas and prairies: Ecological surprises, politics, fire, deer, and measures of success. Tidbits of seeding techniques, endangered plant restoration, rare bird and butterfly habitat. Ending with brief thoughts on ecosystem conservation and “the structure of scientific revolutions.”

Challenges and perspectives for large-scale restoration in Atlantic Forest, Brazil

Padovezi, Aurélio; Miguel Calmon, Rubens Benini, Letica Couto Garcia, Marcelo Matsumoto, Marina Merlo Campos

The Nature Conservancy

The Atlantic Forest (AF) is one of the world's most biodiverse biomes, with more than 20,000 species, of which 8,000 are endemic. AF is home of 120 million people and its natural habitats are reduced to 12% of its original size; most of the remnants are smaller than 50 hectares. Policies aimed to large-scale restoration are essential to reduce species extinctions, maintain and provide critical ecosystem services, mitigate climate change, and improve

ORAL ABSTRACTS (CONT'D)

livelihoods. In order to enlarge AF restoration, 247 institutions established the Atlantic Forest Restoration Pact (AFRP) in 2009 with the goal to restore 15 million hectares by 2050. Because 92% of AF is found in Brazil and more than 70% of the Brazilian territory is privately owned, the goals of the AFRP is highly dependent on the enforcement and compliance of the Brazilian Forest Code (BFC). Recent changes in the BFC (2012), however, reduced the required area to be restored by more than 50%. BFA also created new incentives for a nationwide restoration program. The actions needed is to strengthen local and regional supply of seeds and seedlings, build the capacity of labor and technicians; develop and apply new techniques to reduce the cost and increase the effectiveness of restoration, develop a market for forestry products from native species, and mobilize public and private funding. The result of this effort has the potential to mobilize US\$ 25 billion through the restoration supply chain, generate more than 40,000 jobs, and establish a new green economy in AF.

Role of forest fringe communities in regenerating degraded forest in thiruvannamalai district : a study of tamil nadu afforestation programmes, India.

Pandiyan, Maduraiveeran
Presidency College, Chennai

Tamil nadu, one of the southern states of India has a forest cover of 17.19 per cent of the geographical area as against desired forest cover of 33.3 percent under the national forest policy, India (1988). Hence, earnest efforts are undertaken by the government of tamilnadu to increase the forest area with the assistance from international co-operation agency funded by Japan under the tamilnadu afforestation project since 1997. The primary objective of this empirical research is to analyze the benefits shared by the forest fringe communities through joint forest management in thiruvannamalai district of Tamil nadu. Another objective is to critically assess the effectiveness of tools, and techniques used forest regeneration processes, such as a) community mobilization b) formation of self help group for income generation. c) capacity building and strengthening the local institutions d) buffer zone activities to rehabilitate the forest department This study is based on primary data collected from 180 respondents from forest fringe communities. Through an interview schedule. Descriptive and analytical methods along with percentage variation are used to interpret the data. Major Findings 73 percent respondents acknowledge that joint forest management has benefited them. 61 percent respondent confirmed that the rehabilitation measures undertaken by the government towards fringe communities are satisfactory. As a whole, different strategies used such as community mobilization and capacity building for income generation activities have positive correlation with forest regeneration activities and has increased forest cover in the area by planting more than 1,00,000 varieties of trees.

Functional flows to support restoration of cottonwoods on the Kootenai River, Idaho, U.S.A

Parker, Thomas G.; Norm Merz
Geum Environmental Consulting, Inc.

The Kootenai Tribe of Idaho, working with a diverse group of agencies and stakeholders, is implementing habitat restoration along a 55-mile reach of the Kootenai River that extends from the confluence of the Moyie and Kootenai Rivers, downstream to the border with Canada. Because this section of the Kootenai River has controlled flows due to Libby Dam operations, restoration requires understanding functional flows that support aquatic species such as the endangered Kootenai River white sturgeon (*Acipenser transmontanus*) and native riparian vegetation such as black cottonwood (*Populus balsamifera*). To understand how flows relate to river morphology and riparian response, information from hydrologic models, land cover mapping and high-resolution topography data (LiDAR) were combined to develop detailed stage/discharge relationships. These data were then used to evaluate the relationship between existing hydrologic conditions and floodplain areas where successful cottonwood recruitment has been observed. The result is a suitability model that combines metrics from existing successful cottonwood establishment sites with the stage/discharge/floodplain elevation models, and also factors in substrate and risk of invasion by reed canarygrass (*Phalaris arundinacea*). Using the analysis results as working hypotheses about site suitability for cottonwoods, floodplains are being reconstructed at targeted elevations using coarse, alluvial substrate and surface roughness in the form of woody debris to promote natural cottonwood establishment as part of planned restoration actions. Information from two years of effectiveness monitoring provides a means to test the working hypotheses and refine designs for future projects that will be implemented over the next several years.

Vegetation restoration at a high-elevation surface mine in the San Juan Mountains, Colorado

Paschke, Mark W.
Colorado State University, Department of Forest & Rangeland Stewardship

The Summitville gold mine in southwestern Colorado, USA was the site of a heap leach operation beginning in 1985. By 1994, the site was declared a Superfund Site by the United States Environmental Protection Agency. In 1995, a project aimed at restoring 200 ha of highly disturbed and unvegetated land was initiated. A prescription for restoration was developed that included the identification of constraints to plant establishment and growth. The major constraint identified in this stage of the project was phytotoxic acid-bearing waste rock and lack of suitable topsoil for revegetation. A greenhouse experiment was used to screen 36 potential soil amendmentsto overcome this constraint followed by a field experiment to test a subset of the best performing amendments from the greenhouse study. Ultimately a single best approach was identified that consisted of constructing topsoil with 30 cm of waste rock amended with lime and mushroom compost and covered with 15 cm of limed, fertilized stockpiled topsoil. From 1999 to 2001, the site was re-contoured, amended, and seeded accordingly. From 2002 to 2009, an increase in uniformity of vegetation cover site-wide was documented, as well as an increase in species richness, and a significant shift from a plant community dominated by seeded and short-lived species, to one more similar to the neighboring, subalpine meadow plant community. The approach for identifying constraints and solutions eventually led to successful revegetation of the Summitville site, which was a major step in the overall restoration of this challenging project.

ORAL ABSTRACTS (CONT'D)

Grassland bird conservation areas: taking a partner-driven landscape-scale approach to grassland conservation in an agro-ecosystem

Paulios, Andy; David Sample

Wisconsin Department of Natural Resources

Grassland bird conservation in the Upper Midwest will require working at large scales within privately owned agro-ecosystems. Within the bird conservation community there is growing recognition that species densities and reproductive performance are sensitive to habitat variables at the stand, patch, and landscape scales. Traditionally, conservation delivery has taken place opportunistically at the smaller or more local scales and has ignored the importance of the landscape context in which that work is placed. In addition, most planning and delivery efforts have not been undertaken with spatially explicit population and habitat goals that allow for periodic evaluation and adaptive management. Partners within the Wisconsin Bird Conservation Initiative (WBCI) have incorporated this recent research into an adaptive management plan for focal grassland birds. This plan sets bird population goals and habitat goals within Grassland Bird Conservation Areas (GBCAs) and includes an active evaluation effort to allow for adaptation during the life of the plan. Conservation delivery efforts are now facilitated through a landscape-scale partner-driven model. These local partnerships have gradually shifted the focus away from “refuge” approaches to “working-lands” models that include agricultural partners.

Social factors drive decisions that influence restoration and conservation outcomes in Australian urban grassland reserves

Pearce, Lilian M.; Dave Kendal, Ian D. Lunt, John W. Morgan, Joslin L. Moore, Mark J. McDonnell

Australian Research Centre for Urban Ecology, Royal Botanic Gardens Melbourne

Australia's temperate grasslands are among the world's most threatened ecosystems, with less than 1% of their pre-European extent remaining. Their ecology is now reasonably well understood, and a number of important grasslands are protected in reserves, many within metropolitan boundaries. However, the biological quality of these grasslands continues to decline. This is likely in part the result of management actions (or lack thereof) rather than a paucity of scientific knowledge or restoration techniques. This project aims to understand the social drivers of grassland quality by exploring the factors that influence decision making by managers of urban grassland reserves. A conceptual framework was developed identifying key factors (e.g. policy, community, science) influencing decisions. To test the framework, we interviewed 45 grassland managers working in a range of roles (on-ground management, policy and planning, and conservation science) across a range of organisations (government, contractors and consultants, nursery industry, community groups and traditional owners). Results showed that a variety of values were being managed in urban grasslands, including biological (e.g. native plant diversity, rare or threatened and invasive species) and social (e.g. aesthetic values and fire risk). Both ecological science and the personal experiences of managers were important influences on decision making, while current and historic policy both aided and limited management capacity. Social factors clearly influence decisions about critical management actions (e.g. biomass removal or direct seeding) in diverse ways in different management agencies. These social factors may greatly affect outcomes of initiatives that aim to conserve and restore these endangered ecosystems.

40 years of oak savanna restoration: species ecology in the context of evolutionary history

Pearse, William D.; Peter B. Reich, Jeannine Cavender-Bares

University of Minnesota

Prior to European settlement, fire-dominated oak savannas were a major North American ecosystem throughout the midwest from Canada to Mexico. With land-use change and fire suppression, this once widespread ecosystem is largely gone, converted to agricultural landscapes and closed forest. We use data from a 40-year burning experiment at Cedar Creek (Minnesota, USA) initiated in 1964 to examine the role of fire frequency in restoration of an oak savanna. We show that evolutionary transitions that took place over 80 million years ago impact present-day community assembly and composition. Using a novel plant phylogeny and novel statistical approaches, we are able to identify phylogenetic clades whose ecological structure differ among communities exposed to contrasting fire regimes. We discuss how these insights can help improve ecological predictions for community response to environmental change and restoration efforts. We also test alternative hypotheses of limiting similarity and ecological filtering by examining patterns of non-native species assembly that have entered the oak savanna system over four decades. We test patterns in the phylogenetic and functional trait structure of non-native species relative to the communities they invade. Our findings provide novel insights for harnessing information about the evolutionary history of species to better understand, and ultimately restore, degraded ecosystems.

Spotties vs. Bullies: Assessing differential habitat selection by endangered and invasive amphibians to inform wetland restoration targets.

Pearson, Monica M.; Purnima Govindarajulu, Judith Toms, Patrick Mooney

Balance Ecological

The Oregon spotted frog (*Rana pretiosa*) is a critically endangered species in the Pacific Northwest, primarily due to habitat loss. Re-introduction into restored habitats is essential for the survival and recovery of this species. However, invasive American bullfrogs (*Lithobates catesbeianus*) are now present throughout most of the historic range and are suspected to be responsible for local extinctions in remnant habitats. As both species prefer shallow warm slow-moving wetlands, we proposed that habitat restoration efforts should consider the species' microhabitat feature selection to attempt to target Oregon spotted frogs while deterring colonization by bullfrogs. We used radio-telemetry to identify and differentiate habitat selection of both Oregon spotted frogs and bullfrogs in a shared habitat, and developed criteria for habitat modification and creation. Adults of the two species used different

ORAL ABSTRACTS (CONT'D)

habitat types, with endangered Oregon spotted frogs using shallower and more structurally complex sites than the bullfrogs. Adult bullfrogs almost exclusively used deeper water with a low density of emergent islands or hummocks and dominated by rooted floating vegetation. This research informed our design for a shallow marsh restoration in south-western British Columbia, implemented in Summer 2013. The restoration design and adaptive management plan allows for multiple potential biological outcomes that will guide the future monitoring and management of the site, and provide a framework for the eventual re-introduction of an endangered species deep in enemy territory.

Retrofitting coastal and marine infrastructures in order to increase their ecological value and sustain diverse marine life.

Perkol-Finkel, Shimrit; Ido Sella

SeArc - Ecological Marine Consulting LTD

With over 60% of the human population living along the coastlines, the proliferation of coastal and marine infrastructure (CMI) is inevitable. As most marine flora and fauna reside in coastal areas, anthropogenic changes to coastlines are a key driver for coastal habitat loss and reduced biodiversity. Current design of most CMI consists of inclined homogeneous surfaces, compressing the intertidal zone to a narrow belt which supports low biodiversity. Moreover, over 50% of CMI are made of Portland cement, which is known as a poor substrate for biological recruitment. To date, CMI have been designed and built with little or no consideration to marine life developing on them. As a result, the ability of CMI to provide ecosystem services similar to those offered by natural habitats is severely compromised. We propose an innovative approach, of retrofitting CMI using ecologically sensitive design and construction technologies that enhance their ability to provide valuable ecosystem services, while also elevating their structural integrity and longevity. We present results from a pilot project evaluating the biological performance of new concrete matrices, designed to enhance marine growth, in comparison to standard Portland cement. This was examined simultaneously in tropical, temperate, estuary and freshwater environments. Results indicate that innovative concrete matrices with a complex surface texture recruit a more diverse and dense benthic assemblage. Apart from the biological and ecological significance, the observed enhancement of benthic communities, especially of species forming hard calcitic skeletons, add stability and weight to the concrete, thus contributing to its longevity and strength.

Quantifying the extent of novel ecosystems

Perring, Michael P.; Erle C. Ellis

The University of Western Australia

Much ecological restoration has been targeted towards a goal of restoring ecosystems back to some pre-anthropogenic disturbance state. The continuing presence of multiple drivers of ecological change questions this goal. More broadly, such drivers have led to the emergence of more and more ecological novelty. Quantifying the extent of this novelty may allow an informed judgement as to the necessity of considering novel ecosystems in restoration planning and practice. In this presentation, we provide an estimate of the terrestrial extent of novel ecosystems through time using current and historic land-use and human population estimates. We also extend our analysis by considering ecological change in the marine sphere. Our results highlight that novel ecosystems currently occupy more ice-free land surface than purported 'wildlands', and show their widespread presence in the marine sphere. In addition, we emphasize the long-term presence of novel ecosystems, particularly in long-inhabited and well-used areas of the terrestrial biosphere. Novelty's widespread presence, its rapid increase and its likely persistence suggests that restoration planning and practice needs to broaden its approach. Although we provide a first estimate of novel ecosystems' importance in anthropogenic land and sea-scapes, we highlight challenges to their quantification and discuss avenues to improve identification. To achieve effective planetary stewardship we must consider how to effectively intervene in anthropogenic land- and sea-scapes. Understanding, quantifying, and assessing how to respond to drivers of ecological change offers one such avenue.

The impact of large-scale rangeland restoration programme on participants attitude and behavior towards ecological restoration and sustainable land management.

Peturdottir, Thorunn; Asa L. Aradottir, Gudmundur Halldorsson

Soil Conservation Service Iceland

Substantial parts of the world's degraded ecosystems are rangelands, grazed by livestock. The utilization of these systems underpins the livelihood within large numbers of rural societies. The systems' natural capital can be amended through ecological restoration and improved land management but to ensure sustainable outcome, the activities needs to be managed on a large-scale via supportive agri-environmental policies. Such policies should create incentives to change the behavior of the involved actors and result in the desired changes within the social-ecological system (SES) of livestock grazing. The ecological progress of restoration programmes is highly connected to their social acceptance. Thus, it is critical to monitor their progress and evaluate whether related policies are triggering the expected paradigm shift and changes in behavior within the related stakeholder groups. We estimated the impact of a large-scale rangeland restoration programme on the participating farmers' attitude and behavior toward restoration and sustainable land use in comparison to a control group of non-participating farmers. The study was made in Iceland where large-scale rangeland restoration has been practiced by farmers since the 1990s. The results reveal an insignificant difference between these two groups; both favored the use of ecological restoration to increase the natural capital of degraded systems and both shared the same opinions related to rangeland management. The outcome indicates that the restoration programme per se did not trigger the expected attitude or behavior changes amongst its participants with regard to improved rangeland utilization.

ORAL ABSTRACTS (CONT'D)

Past, Present, and Future Objectives of Stream Restoration: A Practitioner's Perspective

Peyton, Scott D.; J. George Athanasakes, Greg Jennings, W. Cody Fleece, David Bidelsbach, Michael Adams

Stantec

Streams provide a number of important physical, biological, and physiochemical functions including water conveyance, sediment transport, aquatic habitat, and nutrient cycling among many others. Managers of this important water resource often present practicing engineers and biologists with a wide range of problems associated with our nation's streams that require practical and timely solutions. It is incumbent upon us to provide holistic and sustainable solutions that work within both the human and natural environment. The concept of stream restoration has evolved substantially over that last 20 years both nationally and in the Great Lakes Region. One of the biggest shifts is in our understanding and setting of project goals and objectives; they have shifted from simple (i.e. geomorphic stability, vegetative cover) to more complex (i.e. nitrogen cycling, endangered species habitat improvement) and are often set in such a way to target a wider array of stream functions. The shift in project objectives, increased demand for stream restoration, and added scrutiny of projects have also influenced the way projects are implemented. Practitioners have expanded their toolbox to include multiple stream restoration design approaches and are working with larger, multi-disciplined teams. In the past 10 years practitioners are becoming increasingly more experienced and are working within a more regimented body of knowledge. During this presentation, the author will discuss these and other shifts in the practice of stream restoration and provide examples of historical approaches and future directions for the practice.

Mosaic burning: applying fire across ownership boundaries

Pfeiffer, Kent E.

Northern Prairies Land Trust/Nebraska Game and Parks Commission

In 2003, the state of Nebraska developed the Nebraska Natural Legacy Program, a plan for conserving Nebraska's native habitats. Under this program, 40 "Biologically Unique Landscapes" (BULs) were designated as high priorities for conservation action. One of these regions is the Sandstone Prairies BUL, an area of 250,000 acres of relatively intact tallgrass prairies, almost entirely privately owned. In many ways, the Sandstone Prairies are a miniature version of the Kansas Flint Hills, with one important exception. There is no local culture of prescribed fire. Consequently, invasion of the prairies by woody species has become an increasingly severe problem. To address this, we initiated a program to assist landowners with the removal of invasive trees. We have completed tree clearing projects on over 40,000 acres, but these projects are viewed as merely a means to an end. Development of a fire culture is the ultimate objective. Within a decade, private landowners had increased prescribed fire on the landscape from near zero to around 10,000 acres per year, an impressive achievement. However, that equates to an average fire return interval of once every 25 years. It's not adequate. Landowners are developing ideas to get a greater proportion of the landscape burned each year. The most promising is a concept called "Mosaic Burning". Rather than burning individual pastures, landowners are cooperating to create multi-pasture, multi-owner burns off "hard" firebreaks. Due to differences in grazing management across property lines, these fires are highly variable in intensity and coverage.

Developing a qualitative state-transition model for restoration planning at the landscape scale

Phillips-Mao, Laura; Susan Galatowitsch, Jodi Refsland

University of Minnesota

Landscape-scale restoration planning is challenging due to the site-specific nature of restoration decision-making and implementation. Budgeting for landscape-scale projects requires a method for anticipating restoration prescriptions and costs that is sensitive to site and project variability, but can also be rapidly applied across large landscapes. To address this need, we developed a qualitative state-transition model as a coarse-resolution tool for landscape-scale restoration planning and applied it to two landscapes to guide implementation of restoration goals set forth in the 2011 Minnesota Prairie Plan. We specified common "start states" based on vegetation, and restoration "end states" distinguished by plant community, soil moisture, and project goals. We assessed which transitions from start to end states could be achieved through restoration, and for a subset, we developed generalized restoration plans based on best practices; created seed mixes reflecting commercial availability and regional differences; and surveyed restoration practitioners to estimate the costs of achieving each transition. Cost estimates ranged widely based on starting conditions, project goals and restoration targets. The per-acre cost difference between the cheapest transition—crop to moderate-diversity prairie—and the most expensive—restoring high-diversity wet meadow on a site invaded by reed canary grass (*Phalaris arundinacea*)—was greater than threefold (\$800-\$2700). Start states were mapped for each landscape, and the transition costs will be used to inform prioritization models for conservation planning. Restoration plans, seed mixes and cost estimates will also be distributed to conservation implementation teams to guide regional restoration planning and inform private landowners about restoration options.

Are allometric models developed to natural forests an accurate biomass predictor for restoration plantations?

Assessing aboveground biomass to different functional groups

Piña-Rodrigues, Fatima C.M.; Luís Eduardo G. D. Nogueira, José Mauro S. da Silva, Ivonir P. Santos

UFSCar- Sorocaba

Restoration programs allow conciliating ecological and economic interests. Nowadays, carbon assimilation is a special issue because ecological and economic approaches are put together. An accurate evaluation of carbon stock and assimilation in restoration and monitoring programs need to be developed to ensure a trusted carbon trade. In response, allometric models developed to natural tropical forest are also applied to estimate carbon stock in restoration areas. The research was carried out in a one year dense restored area with eighty species and 3 plants/m² (49% of pioneers ; 51% non-pioneers). Nine species of 3 functional groups were evaluated. The biomass was directly determinate to 25 plants/species by dry mass ("real

ORAL ABSTRACTS (CONT'D)

biomass”) and estimated using an allometric model proposed by S. Brown for tropical wet forests: $y = \exp[-1.996 + 2.32 \cdot \ln(\text{DBH})]$. Biomass was $1232.25 \pm 72.60\text{g}$ ($1.15 \pm 0.06\text{g/month}$) to pioneers, $158.53 \pm 12.83\text{g}$ ($13.21 \pm 1.07\text{g/month}$) to partial-shade-tolerant and $13.85 \pm 0.70\text{g}$ ($1.15 \pm 0.06\text{g/month}$) to shade-tolerant. Estimated biomass proportionally overestimated all functional groups in relation to real biomass: pioneers $-333.01 \pm 20.63\%$; partial-shade-tolerant $-822.44 \pm 59.66\%$; shade-tolerant $-619.23 \pm 39.61\%$. So, there was a high variation among estimated and real biomass using the proposed model. Based on this, and the precautionary principle, the current allometric models need to be revised and avoided in populations with diameter distribution distinct from a mature natural forest. Furthermore, tropical allometric models should be developed based on a functional approach.

The Juçara palm (*Euterpe oleracea* Mart.) as an alternative for restoration of ciliary forest in the wetlands of Maranhão State, northeastern Brazil.

Pinheiro, Claudio Urbano B.

Federal University of Maranhão

In the region of the Baixada Maranhense, State of Maranhão, Brazil, the *Aterrados* are a very little known and peculiar type of vegetation, formed in swampy areas. In these environments the substrate that sustains the vegetation is the result of the continued accumulation of organic matter. The *Aterrados* constitute barriers that sustains the waters of lakes, and are important areas for the reproduction of many fish species. The Juçara palm (*Euterpe oleracea* Mart.) is a species of great environmental, social and economic value for the region. The revegetation of these environments with the Juçara palm has contributed for recomposing the ciliary function, also generating significant income by extraction of the fruits, in addition to producing an increase in fishing. In this sense, this research project was carried out to develop a program of revegetation of native *Jucara* in the lacustrine region of Penalva, Baixada Maranhense, and in particular, in the *Aterrados*, that would result in restoring the vegetation of these environments, contributing, in the short term, to the generation of income, by means of the fruits and, in the medium and long term, for the environmental conservation. Actions of this project included: mapping, characterization, and quantification of the areas of *Aterrados* in the region of lake Formoso with the use of LANDSAT images; botanical sampling to survey the species composition of the *Aterrados*; and, as the main action, a program for the production of seedlings of Juçara, planting and monitoring of the seedlings in their growth, in the *Aterrados* region.

Initial plant community development on a reclaimed oil sands mine in northern Alberta, Canada

Pinno, Brad; Ruth Errington, Benjamin Sey, Stephen Tuttle

Natural Resources Canada, Canadian Forest Service

Oil sands mines in northern Alberta, Canada have currently disturbed around 70,000 ha of boreal forest with the potential to disturb many times this area over the next 60 years. The re-establishment of native boreal plant communities on reclaimed sites is a key priority but there has been relatively little research on the impact of different reclamation treatments on plant community development. We examined the initial vascular plant community on a reclaimed site with six different reclamation treatments and compared this to nearby natural forest stands. The reclamation treatments included two soil prescriptions (peat based and forest floor based soils), two fertilizer treatments and two levels of woody debris application. All of the reclaimed sites were dominated by non-native plant species, in particular agronomic weeds such as *Sonchus arvensis* and *Melilotus alba*. Species richness was higher on the forest floor soils compared to the peat soils but only 62% of the species present on the reclaimed site were native and these natives only covered 16% of the ground area. In contrast, no non-natives plant species were found in the natural stands. Fertilization tended to decrease species richness but increase total cover while woody debris had no consistent impact on plant diversity. Overall, the initial plant community on the forest floor treatment more closely resembled the natural forest stands but it is not yet clear what the long-term successional trends will be on the reclaimed areas.

Site evaluation, limiting factors, and mitigating measures: understanding your outplanting site to maximize outplanting success

Pinto, Jeremiah R.

USDA Forest Service

Seedlings face a myriad of challenges after outplanting before they can become established and grow. These challenges are realized by land managers after a thorough site evaluation that includes spatial and temporal factors. Only then can the primary limitations to establishment be understood and consequently overcome. In most cases, the primary limitation to seedling establishment is moisture availability, but other limiting factors might include: other plants, animals, extreme temperatures, lack of microorganisms, and even social/cultural issues. A model of seedling establishment furthers our understanding of how seedlings engage their surroundings and begin to survive and grow on a site. This model characterizes the physiologic, atmospheric, and edaphic process that factor into a target seedling's design and the supplemental appropriate mitigating measures that need to be employed. In this session, site evaluation, limiting factors, and mitigating measures (including target plant material and site preparation) will be discussed and supported using research and case study information.

ORAL ABSTRACTS (CONT'D)

Effects of species diversity and drought on community composition in restored tallgrass prairie plots

Piper, Jon K.

Bethel College

A series of experimental plots was established in 2007 to examine relationships between initial seeding diversity and establishment success. Native grass and wildflower seed mixtures were sown at five levels of richness--4, 8, 12, 16, and 20 species--in 25 30 m X 30 m randomized plots, five replicates per treatment. Plots with 16 or 20 species achieved or exceeded 100% native cover by the second year; plots seeded with 12 species reached 100% native cover by the fourth year. Plots seeded with 8 or more species had less weedy cover relative to 4-species plots by the second year, a pattern that persisted for the remaining five years. The last two years, 2011 and 2012, were drought years (precipitation 57.7% and 86.2% of 30-year mean, respectively), and treatments responded differently. Cover by weedy and invasive species increased in 2012 in all treatments, but to the greatest extent in the 4-species treatment. The results demonstrate that sowing mixtures with as few as 12 native species can produce prairie-like communities within a reasonable time frame. Moreover, moderately high diversity seed mixtures may exhibit some resistance to drought. The results have implications for grassland restoration efforts within an increasingly drier and warmer Great Plains climate.

Institutional and landscape resilience in central Oregon

Platt, Emily K.; John Bailey, Susan Charnley

Oregon State University

Restoration of federal lands in fire prone landscapes has become an important issue in the United States from rural towns like Chiloquin, Oregon to the nation's capitol. This research is part of a coupled natural-human systems project called Forests People Fire (FPF). FPF includes ecologists, sociologists, economists, programmers, and others. FPF is building an agent-based model to explore how social and ecological systems interact to shape fire-prone landscapes over time in central Oregon. Roughly 50% of the project area is managed by the Forest Service, and this research focuses on restoration of these federal lands. A range of issues from local social dynamics to congressional politics influence the Forest Service's ability to address restoration needs and challenges. The Forest Service's institutional resilience is assessed by considering both its ability to adapt to changing social and ecological conditions and its ability to meet goals and objectives outlined in the Forest Service's strategic plan, the national fire plan, and management plans for the local forests – the Deschutes and Fremont-Winema National Forests. Qualitative analysis of interview data is paired with ecological modeling to explore obstacles to restoration of federal lands and landscape outcomes of select management strategies. Findings to date reveal significant opportunities for improving the institutional resilience of the US Forest Service in the areas of landscape planning, budgeting, and organizational structure. Preliminary results of ecological modeling will also be presented.

Adaptive management in restored forest: is the removal of an exotic tree species beneficial for the recruitment of native species?

Podadera, Diego Sotto; Deivid Lopes Machado, Luciane Missae Sato, Vera Lex Engel

São Paulo State University-UNESP

Using exotic species as facilitator during the restoration process can be opportune as they can improve soil fertility and help weed suppression. Otherwise they may compete with native species during a later phase, delaying the successional process or even deviating the successional trajectory expected. In these cases, adaptive management practices (i.e. species removal) might be necessary to ensure the achievement of restoration goals. We looked at the effect of elimination of the nitrogen-fixing exotic species *Mimosa caesalpinifolia* in two sites with contrasting soil fertility after 14 years of the establishment of two plantation models to restore the tropical semideciduous moist forest in Brazil, namely: AS- Agroforestry System; and MIX-mixed commercial timber and firewood tree species plantation. The natural regeneration of woody species (height ≥ 0.2 m) was compared between managed (*M. caesalpinifolia* removed) and unmanaged (control) plots, soon after and one year after the thinning. The natural regeneration in the most fertile site (S1) had higher density, species richness and diversity than the less fertile one (S2). The MIX model showed higher density than the AS model in both sites. Although the basal area and the density of regenerating community decreased in all managed plots, due to tree felling damage, and the weed infestation increased slightly after management, the removal of *M. caesalpinifolia* trees resulted in increased species richness and diversity of the natural regeneration in both sites and plantation models. Our results suggest a suppressive effect of *M. caesalpinifolia* on the recruitment of native vegetation.

Natural processes for the restoration of landslides, steep and unstable slopes

Polster, David F.

Polster Environmental Services Ltd.

Natural processes have been 'restoring' landslides and unstable slopes since the advent of terrestrial vegetation about 400 million years ago. Identifying the natural recovery processes and understanding how these operate allows us to apply them to contemporary sites. The first step in developing treatments is to determine the filters or constraints that are preventing or delaying the recovery of these sites. Instability and/or rapid erosion are key filters that prevent vegetation establishment on landslides and steep or unstable slopes. Methods that drain saturated soils (e.g. live pole drains) or that reduce slope length and steepness (e.g. wattle fences or modified brush layers) can be used to address these filters. In some cases, compaction coupled with surface erosion prevents the establishment of vegetation. Treatments that capture weathered fine textured materials can be used to initiate the recovery processes. The lack of plant propagules can slow recovery. Direct seeding of pioneering woody species (e.g. *Alnus* spp.) can be used to overcome this problem. Similarly, live staking using Balsam Poplar (*Populus balsamifera*) and Willows (*Salix* spp.) can be used to establish pioneering

ORAL ABSTRACTS (CONT'D)

woody species that will help in the stabilization of slides. This paper explores the use of natural processes as a model for the development of strategies to address difficult sites. The use of soil bioengineering and other specialized techniques such as 'Rough and Loose' to initiate these processes will be presented. Examples will be drawn from over 35 years of experience by the author.

Restoring Garry oak (*Quercus garryana*) ecosystems in southwestern British Columbia, Canada – historic, hybrid or novel targets?

Polster, David F.; Donald S. Eastman, Eric S. Higgs

Polster Environmental Services Ltd.

Garry oak (*Quercus garryana*) ecosystems occur along the west coast of North America from California to southwestern British Columbia. Historically, these ecosystems have been impacted by invasive species, loss (conversion) and fragmentation. These factors continue to operate with the addition of newer factors such as climate change and nitrogen deposition. In Canada, the net result of these impacts is that less than 5% of the former Garry oak range currently exists, mostly as small, scattered and degraded remnants. These ecosystems are rated as one of Canada's most endangered, and considerable individual and organizational efforts are underway to preserve and restore these ecosystems. To date, restorationists have emphasized using historic records of Garry oak ecosystems to develop benchmarks to guide restoration activities and to assess success, that is, returning systems to something that approximates presumed historic conditions. However, the emergence of the novel ecosystem concept provides an impetus and opportunity to re-assess this emphasis and ask if targets based on historic benchmarks are broadly applicable, realistic and appropriate. In this paper, we review current approaches to restoration of Garry oak ecosystems and assess the relevance and applicability of the novel ecosystem concept to Garry oak ecosystem restoration in Canada. Based on this assessment, we offer suggestions regarding future restoration, with particular emphasis on future targets.

From pre-disturbance planning to restoration - Wetland restoration in three years

Polzin, Mary Louise

Vast Resource Solutions Inc.

Pre-disturbance planning and a combination of restoration planting techniques were used for the restoration of vegetation along a small stream (Palmer Bar Creek, East Kootenay, BC, Canada) and surrounding wetlands during a culvert replacement. The goals of the project were to restore vegetation quickly, to prevent the dispersal of noxious weeds into the disturbed area, and prevent soil erosion and bank widening along the creek. Revegetation of three zones (wetland, riparian, upland) involved a combination of restoration techniques including i) transplanting clumps of wetland species into the wetland zone; ii) planting plugs of native riparian shrub species; and iii) planting agronomic grasses and legumes on a temporary access road with poor soil nutrients. Stockpiled wetland soil was used for restoration and provided an excellent growth medium that preserved the natural seed bank. Initial results revealed very high establishment success of vegetation the following spring. Initial wetland mean cover, riparian mean cover, and planted riparian shrub height were 8.7%, 5.2%, and 10 cm, respectively. After three years, wetland mean cover, riparian mean cover, and planted riparian shrub height were 97%, 83%, and 70 cm, respectively. Grass seeding of the access road successfully prevented weeds establishing from the dense noxious weed cover bordering the planted area. Pre-field planning and on-site monitoring reduced the impact of construction on the sensitive wetland while transplantation of wetland vegetation clumps and utilization of the original stockpiled soil accelerated the time for successful restoration over a three year period.

Comparison of habitat conditions and soil carbon in restored and unrestored montane meadows of California

Pope, Karen; Diane Montoya, Jessie Brownlee, Janina Dierks, Thomas Lisle

USFS Pacific Southwest Research Station

Efforts are increasing to restore the hydrologic connectivity of stream channels and meadow floodplains of degraded montane meadows in the western USA. Re-watering projects such as pond-and-plug quickly raise the water table by blocking the existing incised stream channel and can result in meadow habitats with greater vegetative productivity, increased ability to sequester carbon, and greater habitat stability compared to pre-project conditions. Based on the existing literature, however, it is difficult to determine realistic expectations for outcomes of projects across a range of geologic and hydrologic conditions. We compared easily measurable wetland, vegetation, soil carbon, and channel stability variables between 10 randomly selected restored and 10 unrestored montane meadows in California to provide an unbiased comparison of habitat conditions. We found that unrestored meadows had a higher proportion of wetland habitat, fewer indicators of channel instability, and greater soil carbon stores compared to restored meadows. Restored meadows had more herbaceous biomass within their wetland habitats compared to unrestored meadows but this finding is likely related to livestock exclusion from project areas. Among restoration projects, newer projects scored better than older projects in all measured variables. Other than restoration status, meadow slope and elevation were important predictors of percent wetland and channel stability. Our findings place meadow re-watering projects within the range of existing meadow conditions in California. Realistic expectations of outcomes are necessary for managers to make appropriate decisions about whether or not to implement restoration projects that permanently alter meadow landscapes.

From plantations to forests: Restocking carbon

Potvin, Catherine; Jurgis Sapijanskas, Maria del Carmen Ruiz-Jaen

McGill University

The stocking of forest carbon plays a key role in climate regulation. As tropical forests regrow, it is therefore important to identify factors that determine forest carbon stocking rates. To do so we worked in a native tree species plantation and a permanent forest plot both located in central Panama. The Sardinilla plantation, established in 2001, counts > 5000 trees planted in plots of 1, 3 or 6 species. Our analysis disentangled the effect of tree diversity

ORAL ABSTRACTS (CONT'D)

on carbon stocking and showed that the effect of diversity became more important with time. After 10 years, 10 out of 12 mixture plots exhibited significant over yielding for biomass production. Carbon stocking was 30% higher than expected from species-specific monoculture performance. To further understand the relation between diversity and carbon stocks we also used data from the 50-ha Forest Dynamic Plot of nearby Barro Colorado Island. Using path analysis we showed that the Gini Coefficient, used to measure inequality in tree basal area at the sub-plot level, was the best predictor of biomass. While above ground biomass correlated with the presence of large DBH trees, high species richness was correlated with the presence of a large number of small trees. Our results therefore show that there is a decoupling in the mechanisms behind species richness and carbon stocks. They suggest that, if forest carbon is an objective of restoration, attention should therefore be paid to the size inequality among stems with tree diversity playing a minor role.

Improving Wollemi pine recovery outcomes: is success determined by soil microbes?

Powell, Jeff R.; Jessica L. Mowle, Steve Clarke, Ian C. Anderson, Brajesh K. Singh, Cathy A. Offord

University of Western Sydney

The iconic and endangered Wollemi pine (*Wollemia nobilis*; WP) is only known to occur in very small numbers within Wollemi National Park in the Greater Blue Mountains Heritage Area, a one million hectare reserve bordering Sydney, Australia. The species was thought to be extinct until one population was discovered in 1994. The WP Recovery Team identified the ecological interactions with other organisms as a priority area of research to contribute to the protection of wild stands and their habitat as well as cultivation to establish off-site populations through translocation. With many tree species, one of the most important factors limiting their introduction or reintroduction is the presence of microbial partners that enhance nutrient acquisition and tolerance to devastating pathogens as well as change their ability to compete with neighbouring species. We found that microbial communities associated with soils under WP in the wild differed from those under neighbouring species. We also found that WP seedlings performed better when interacting with their own microbes than with microbes associated with these neighbours, suggesting that generalist pathogens and/or a lack of host-specific beneficial associations may be an important factor limiting WP recruitment. Given the limited distribution of WP and, by extension, their microbial partners, strategies for inoculating WP may be necessary to enhance outcomes of translocation efforts that are currently underway.

Assessing above- and belowground carbon stocks in regenerating tropical dry forests

Powers, Jennifer; Justin Becknell

University of Minnesota

Throughout history tropical dry forests (TDF) have been converted to other land uses such as grazing. Over the past few decades, some lands have been taken out of production, and secondary forests are regenerating. The objective of our work is to understand the temporal trajectories of carbon and community dynamics in regenerating TDF, and how these processes vary across the landscape. To accomplish this goal we have conducted: i) large-scale surveys of species composition, aboveground biomass, and soils in 84 forest inventory plots distributed across the landscape (chronosequences), and ii) repeated measurements of forest growth and ecosystem processes in 18 permanent plots that vary in soils and stand age (longitudinal studies). Soil parent materials differ widely in this region in Northwestern Costa Rica, and the concentrations of total phosphorus and other elements vary by orders of magnitude among sites. Tree species and functional traits clearly sort over these edaphic gradients, providing strong evidence for environmental filtering. Aboveground biomass ranged from 10 to 473 Mg ha⁻¹ among sites between 5 and >100 years old. Stand age was the only variable that explained significant variation in aboveground biomass among sites ($R^2=0.46$). By contrast, edaphic factors explained more variation in fine root stocks and soil carbon than did stand age, suggesting that the drivers of above- and belowground C stocks differ across the landscape. Data from our permanent plots are broadly consistent with results from the landscape chronosequences. These studies suggest that a landscape perspective is essential for understanding patterns and their controls.

Spontaneous succession as a way of restoration of human-disturbed habitats: a multi-site analysis

Prach, Karel; Klara Rehounkova, Kamila Lencova, Alena Jirova

Faculty of Science USB and Inst. Botany CAS

Spontaneous vegetation successions were compared running in various stone quarries, spoil heaps from mining, sand pits, extracted peatlands, sedimentary basins, road banks, ruderal urban sites, abandoned arable fields, forest clearings and clearcuts, an emerged bottom of a water reservoir, artificial fishpond islets and barriers, and bulldozed sites, located in various parts of the Czech Republic in central Europe. Vegetation records were performed in representative successional stages aged from 1 to 100 years. In total, 2,451 vegetation samples containing 955 species were analyzed by multivariate statistics. The following results were obtained: The successional seres studied were more similar in their species composition in the initial and early stages, in which synanthropic species prevailed, than in the later stages when the vegetation differentiated, and this depended mainly on local site moisture conditions. Successional development thus diverged across the seres. The total number of species and the number of target species increased in majority of seres with successional age. Participation of invasive alien species was generally unimportant. We can conclude, the vegetation in the sites studied formed a continuum along the moisture gradient and successional age. The particular seres largely overlapped in their species composition. Spontaneous succession usually proceeded towards a woodland, except very dry or wet sites, which appeared to be highly valuable from the restoration and conservation point of view. Spontaneous succession appeared to be an ecologically suitable way of ecosystem restoration in the majority of the disturbed sites.

ORAL ABSTRACTS (CONT'D)

Using an individual-based model to foresee possible restoration outcomes in transplanted *Acropora* (Order Scleractinia) communities

Punongbayan, Andalus T.; Caryl S. Benjamin, Dexter W. dela Cruz, Ronald D. Villanueva, Helen T. Yap
The Marine Science Institute

Various approaches to coral transplantation are being developed in the attempt to increase rate of reef recovery from perturbations. Success is often evaluated based on short-term observations that capture only the initial phase of space colonization by transplants. Here we develop an individual-based model to quantify uncertainty in future trajectories in experimental restoration plots given past observations. Data from a previous study were used to estimate the posterior probability distributions for growth, survival, and partial mortality rates in *Acropora pulchra* and *A. intermedia* (Order Scleractinia) colonies in a sandy reef flat (Bolinao, Philippines). Simulations were initialized with different densities (25 or 50 transplants per species per 16m²) to forecast possible coral cover trajectories over a 5-yr period. Given current conditions there is risk of local or within-replicate plot extinction which is higher in low-density plots for both species, and higher for *A. intermedia* compared to *A. pulchra* regardless of density. While the significant increase in projected total coral cover lends support to the feasibility of re-establishing coral populations with the given approach, species composition in the future is more likely to be highly uneven, and at worst, monospecific. We extended the use of the model to address the implications of (1) protecting the site from severe anthropogenic disturbance and (2) conducting additional transplantation activities. When monitoring data are limited in time, stochastic models may be used to assess whether the restoration trajectory is heading towards the desired state and at what rate, and foresee system response to various adaptive interventions.

Wildfire rehabilitation with changing climates: What can we learn from meta-analyses?

Pyke, David A.; Troy A. Wirth, Jan L. Beyers
US Geological Survey

Rangelands cover a diversity of ecosystems with one general characteristic; they are normally devoid of closed-canopy forests. Wildfires, when historically common on rangelands, often stimulate fire tolerant or resistant species to dominate those ecosystems. When fire intervals are long, their ecosystems may not be dominated by species that can withstand fires, but may contain mixtures of fire resistant/tolerant and fire sensitive species. In addition, wildfire rehabilitation has become a common practice in the western USA to meet one of three post-fire objectives: (1) stabilize soils; (2) control the spread of weedy species; and (3) to restore critical habitat for wildlife. However, a recent meta-analysis indicated that success of meeting the objective of controlling invasive species is climate related, but the type of rehabilitation project may influence the project's success. Successful establishment of aerial seedings are dependent on precipitation and elevation whereas drill seedings appear to be less dependent. Climate change scenarios in the western US where wildfire rehabilitation projects are often instituted indicate warmer drier environments in the future. More detailed metadata on rehabilitation success should aid in providing better predictive models not only of locations where rehabilitation will succeed, but also provide better predictions of species to use for success.

Rocking the boat of biodiversity offsets: how ecological restoration in civil engineering and landscape planning is getting sussed out

Pöll, Constantin Eduardo; Thomas Wrbka, Wolfgang Willner
University of Vienna

Biodiversity offsets (BDO) summarize ecological compensation measures (ECM) and planting areas of technical construction measures (TEC) that serve as mitigation toll for destructions or deterioration elsewhere. They are an integral component of large-scale construction projects. This case study targeted evaluation of BDO based on empirical methods of nature conservation, vegetation- and landscape ecology. Five criteria were chosen to assess restoration success by a representative vegetation inventory of different BDO types and a region-wide habitat mapping: a) connectivity of landscape elements; b) diversity of habitat types; c) characteristic species assemblages of vascular plant communities; d) occurrence of endangered plant species according to Red Lists; and e) distribution of current and potential future habitat endangerments and impairing. Additionally, we developed an enhanced biotope value calculation that includes further data from habitat mapping and vegetation inventory relevant for nature conservation. Results showed valuable insights into the restoration capacity of TEC, having had far more Red List species than ECM and reference sites. ECM proofed well implemented in terms of the habitat network improvement and habitat diversity, but bad in community diversity. Best performance in community structure was shown by BDO types related to free succession and water bodies (river renaturation). The latter had also the highest biotope value. Methods for assessing restoration success should operate at different scales to account for effects at the landscape, habitat and community level. Ecological compensation should include the protection and/or the enhancement of remnant biotopes with relatively high natural value within a biotope network system.

Remote mapping of habitat suitability for at-risk plant species and its implications for restoration and reintroduction

Questad, Erin J.; James R. Kellner, Kealoha Kinney, Susan Cordell, Gregory P. Asner, Amanda Uowolo, Sam Brooks
California State Polytechnic University, Pomona

Finding suitable habitats in fragmented and degraded landscapes is a major challenge to restoration and reintroduction programs for plant species at risk of extinction. Desiccation and water stress are significant barriers to survival for over 40% of at-risk plant species that occur in dry or rocky habitats.

ORAL ABSTRACTS (CONT'D)

We examine how microtopographic features that reduce water stress and increase resource availability can be modeled for landscape planning that can increase the success of restoration efforts in drylands. We developed a topographic habitat suitability model (HSM) from airborne Light Detecting and Ranging (LiDAR) data as a tool to enhance landscape planning for at-risk plant species reintroduction for a dryland landscape in Hawaii. The HSM identifies topographic depressions that are protected from prevailing winds (high suitability sites) and contrasts them with ridges and other exposed areas (low suitability sites). In our field tests of the HSM microclimatic conditions and plant-response traits indicated better growing conditions in high suitability sites compared to low suitability sites. The locations of six at-risk plant species showed associations with high suitability areas, and the survival of planted individuals of *Dodonaea viscosa* was less variable among high suitability plots. These results suggest that the HSM can improve plant establishment and survival, reduce the cost of restoration and reintroduction programs through targeted management activities in high suitability areas, and expand landscape-scale restoration planning capabilities.

Comparing soil biogeochemical processes in novel and natural boreal forest ecosystems

Quideau, Sylvie

University of Alberta

Soil organic matter- the result of in situ decomposition processes- plays a central role in the overall functioning of forest ecosystems. Its composition and rate of decomposition directly affects the diversity and activity of the biota that is responsible for the recycling of nutrients. In the boreal forest of northern Alberta, thick forest floor horizons may contain as much carbon as the entire aboveground vegetation, representing a storehouse of nutrients and a major determinant of biogeochemical fluxes at the ecosystem level. In this study, we aimed to assess soil quality through organic matter attributes in novel ecosystems covering different reclamation treatments following open-cast mining for oil extraction. We compared the attributes to those present in a range of natural soils representative of mature boreal forest ecosystems in the same area of northern Alberta. Due to its presence in large portions of the mining footprint, peat is the main source of organic amendment used for reclamation in the Oil Sands region. However, there is uncertainty about how peat materials exposed to drier, nutrient-rich upland environments influence eventual soil functioning. When analyzed together, all novel ecosystems differed significantly from the natural boreal forests, in particular with respect to soil organic matter composition, characterized using nuclear magnetic resonance spectroscopy. Some organic matter attributes showed an evolution with time since restoration towards conditions observed at the undisturbed forest soils. Further, our results document how canopy cover and stand type are both important factors for forest floor development and plant-soil relationships at these sites.

Stream and river restoration in the Waikato, New Zealand: Where theory meets practice

Quinn, John M.; Paul Franklin, Cindy F. Baker, Bruno O. David, Aslan E. Wright-Stow, Erica Williams, Cheri Van Schravendijk-Goodman, Bruce Williamson, Brian J. Smith, Jacques A.T. Boubee, Glenys Croker

National Institute for Water and Atmospheric Research

Ecological values and services of many streams in the Waikato Region have been degraded by pressures from deforestation, land use for intensive agriculture and urbanisation, invasions by exotic species, and loss of longitudinal and lateral connectivity due to engineering. Restoration efforts have increased recently, driven by the dairy industry, government and indigenous Māori, and boosted recently by a Treaty Settlement negotiation for a 30 year, \$210M, clean-up fund to restore the health and wellbeing of Waikato River. Restoration science has identified a range of opportunities and constraints for restoring community river values (e.g., cultural fisheries and practices, indigenous biodiversity, safe swimming, aesthetics) depending on the ecological, social and economic context and available resources. Some aspects of headwater pastoral streams (shade, temperature, pathogens and macroinvertebrates) have shown “rubber-band” responses to integrated farm and riparian management. Others show strong hysteresis due to legacies (e.g., soil and groundwater nutrients), poor connectivity between restored habitat and potential colonists, and the time required to regenerate some ecological functions (e.g., large wood in streams). Some hysteresis drivers can be overcome by simple, low-cost, actions, like tree-log additions that boost habitat complexity and simple retrofits to artificial barriers to fish migration. Engineered infrastructure, such as hydro-electric dams, produce conflicts between historic and novel instream values and between in-river and out-of-river values for which partial mitigations have been developed (e.g., trap and transfer of elvers above dams). Restoration science is helping develop cost-effective restoration plans that recognise and manage value conflicts and synergies.

Re-Naturalization and Industrial Heritage in America's Largest Superfund Site: The Case of the Warm Springs Ponds in Montana's Clark Fork Superfund Site

Quivik, Fredric L.

Michigan Technological University

The Clark Fork Superfund site in Montana is the largest Superfund site in the United States. It overlaps with the Butte - Anaconda National Historic Landmark, one of the largest National Historic Landmark districts in the U.S. Superfund remediation in the Clark Fork site has engendered tension between segments in the community, one of which has long been working to preserve and interpret the cultural landscapes of the area, and one of which wants to see hazardous materials removed and natural resources restored. Superfund remediation has also led to the enhancement of features where culture and the environment intersected, enhancements that allow a closer examination of what ecological restoration can mean in a setting so profoundly damaged by industrial activity. This presentation will explore the Warm Springs Ponds, an artificial wetland facility built by the Anaconda Copper Mining Company in 1918 to prevent tailings from migrating further downstream, and a facility that has been enhanced under Superfund remediation. The facility now also serves as a wildlife refuge for migratory waterfowl, while it also serves a number of other ecological functions in a rehabilitated landscape. The Upper Clark Fork has been so intensely altered by the mining activity that it is questionable whether it could ever be

ORAL ABSTRACTS (CONT'D)

restored, if that is understood to mean returning it to some condition before mining. Many of the ecological functions once provided in the area, however, can be restored, even as cultural features are preserved which interpret mining's impact on the environment.

Phytosociological study of Miandasht Wildlife refuge, Iran.

Rahimi, Alieh; Morteza Atri, Ramazanali Khavarinejad
Islamic Azad University

Miandasht Wildlife Refuge with 84435 Ha area and 912-1082 a.s.l altitude range, is located in Khorassan province, Iran. Climate of this region is semiarid. It is located in Irano-Turanian area. In this survey eco - phytosociological study of the region was carried out. Eco-phytosociological methodology was used. In this method, physiognomical, floristical and ecological criteria are important for determining the endogenous environments. Minimal area method by nested plots and species - area curves was used for the delimitation of the area of relevés. The number of relevés became more than 600. Ecological factors (i.e. altitude, slope degree, exposition and soil features) were measured in every relevé. Braun-Blanquet criteria (abundance-dominance and sociability) were determined. Phytosociological data were analysed by Factorial Correspondence Analysis and Hierarchical Ascendant Classification methods, using Anaphyto software. In the Northern part of the region, were distinguished 9 endogenous groups, 10 plant formation, 33 plant association and 2 subassociation. Altitude, soil pH and soil OC are effective on the distribution of the phytosociological units in the North. 19 endogenous groups, 8 original formation, 16 secondary formation and 20 plant association were distinguished in the south. Soil OC is effective in distribution of phytosociological units in the south. Ecological conditions were determined for every plant association. Following maps were drawn: original and secondary endogenous groups, original and secondary formations, endogenous environments, plant association, soil pH, EC, OC and texture. Table for autecological characters of all plants was prepared. These results will help to the management of the region.

Trigger point theory; an idea model for large landscape restoration in the anthropocene

Rahmani, Aviva; Eugene Turner, James White
Aviva Rahmani

Can transdisciplinarity design better models for bioregional restoration? This paper proposes that integrating transdisciplinary methodology into cultural and engineering plans may enhance resiliency by identifying coastal catalyst "trigger points." This idea model combines systems analysis, Geographic Information Systems science (GISc) and ecological art. Forty per cent of humans are affected by habitat fragmentation and loss of coastal (littoral) zone integrity. This model proposes scaling up small (nuclear) sites for bioregional remediation. Two case studies will be presented from the Gulf of Maine and the Mississippi basin. In the Gulf of Maine, the Ghost Nets case study bioengineered and restored a coastal town dump to flourishing wetlands from 1990-2000. Point of view for planning and adaptive management drew on metaphors from physics, theatre, sound and visual representations. GISc modeling to identify additional littoral zone "trigger points" from that work will be presented demonstrating relationships between eelgrass, finfish survival and invasive (*Carcinus maenas*) European green crabs. Baseline data is from Michele Dionne from the Wells National Estuarine Research Reserve (Wells NERR). The second case study is Fish Story (2012- present) launched in Memphis, TN., to remediate dead zones in the Gulf of Mexico. Conceptualization developed with Jim White of INSTAAR, UCB and Eugene Turner, LSU as part of Gulf to Gulf webcasts (2009- present). Rules for agent based modeling will be suggested. Recommendations include formally engaging ecological artists as equal partners on restoration teams.

Adaptive framework for Puget Sound ecosystem recovery: Supporting collective impact through evolutionary problem solving

Redman, Scott; Kari Stiles, Ken Currens, Tracy Collier
Puget Sound Partnership

Concerted efforts are being made to recover the Puget Sound ecosystem, a large coastal ecosystem on the Pacific Northwest of the United States. The Puget Sound Partnership, an agency of the State of Washington, has adopted an adaptive approach to Puget Sound ecosystem recovery. This approach builds from the Open Standards for the Practice of Conservation, a science-informed process in which ultimate goals are defined and prioritized, solutions are designed, actions are planned and implemented, and their effects are monitored. The Partnership's approach fits some definitions of adaptive management but falls short of more rigorous definitions in that it does not typically view or analyze management interventions as tests of recovery hypotheses. Puget Sound ecosystem recovery occurs through iterative decisions, by the Partnership and others, to develop and prioritize solutions. Iterative decision making by many entities is a defining feature of an adaptive approach referred to as evolutionary problem solving, which emphasizes capturing and sharing learning to facilitate adaptations. Evolutionary problem solving also depends on explicitly structured interactions among decision-makers, implementers, scientists and stakeholders. For the Partnership these interactions occur across science-policy interfaces related to conceptualizing and planning recovery and evaluating progress toward recovery. Evolutionary problem solving occurs as iterative decisions and science-policy interactions combine to encourage innovation, diffusion, and adaptation among the myriad entities implementing recovery and protection actions in the Puget Sound basin. Specific examples will be given, showing how we have used our shared experiences and learning to adapt our approach, including revision of our Action Agenda.

ORAL ABSTRACTS (CONT'D)

Consequences of climate change for vegetation and restoration opportunities

Reeves, Matt C.; Adam Moreno

USFS

Climate change presents great challenges for society, especially stewards of natural resources. Though we do not know precisely what the future holds, there are some indicators and hypothesized climate change scenarios that can be used to make educated guesses. These future climate scenarios have significant implication for restoration because they will dictate the types and abundances of vegetation that can be used for restoration purposes. To understand the possible influence on the distribution and abundance of vegetation, we evaluated the A1B, A2 and B2 climate change scenarios in tandem with projected changes in bioclimatic regimes to understand the effects on the productive capacity and nutrient cycling of both cool season and warm season species assemblages. In addition, we examined the implications of climate change for fire on rangeland landscapes. The research presented here resulted in projections of vegetation conditions from 2001 to 2100 across the extent of all US rangelands. Results indicate that the southwestern US will become significantly drier and less productive, potentially eliminating herbaceous growth. This suggests fewer opportunities for successful restoration in the southwestern US. In contrast, higher elevations and northern latitudes exhibit enhanced production through CO₂ fertilization and longer growing seasons. Increased fuelbed continuity and changes in lifeforms alter severity and prevalence of wildland fire.

The restoration of different post-mining sites using spontaneous succession: a comparison across seres on Central European scale

Rehounkova, Klára; Karel Prach, Kamila Lencová, Alena Jírová

Faculty of Science, University of South Bohemia

Spontaneous vegetation development was studied in successional seres running in all main types of mining sites within the Czech Republic, i.e. in stone quarries, coal mining spoil heaps, sand and gravel-sand pits, and extracted peatlands. Altogether 1 187 vegetation samples containing 705 species were analysed. Vegetation records were performed in 16-25 square-meter plots located in the centre of representative successional stages aged from 1 to 100 years. The DCA was carried out to analyse the post-mining seres. The results show that the course of vegetation development depends mainly on local moisture conditions. The seres run from stages composed predominantly of synanthropic species towards semi-natural woodland, which usually established after approximately 20 years. The only exceptions are extreme sites (very dry or wet), where woody species were limited. The open habitats can serve as refuges for many heliophilous species and species of nutrient-poor habitat decreasing in the landscape and therefore are highly valuable from the point of view of nature conservation. Except the peatlands, the total number of species and the number of target species increased as succession progressed. The proportion of alien species was negligible. The only alien which may seriously invade the mining sites is the black locust (*Robinia pseudacacia*). We can conclude that the establishment of semi-natural vegetation is rather fast in mining sites. Spontaneous vegetation succession in post-mining sites appears to be very effective way of ecological restoration reaching in reasonable time target vegetation and also support rare and threatened species of open nutrient-poor sites.

Bat communities in a tropical forest restoration experiment in southern Costa Rica

Reid, J. Leighton; Chase D. Mendenhall, Rakan A. Zahawi, Karen D. Holl

University of California Santa Cruz

Animals are key beneficiaries and benefactors of forest restoration. In tropical ecosystems, birds and bats assist forest regeneration by dispersing seeds, improving seed germination through gut passage, increasing seedling growth by consuming herbivorous arthropods, and ultimately maintaining gene flow via pollination. Birds and bats are not, however, functionally redundant. Differences in behavior, diet, and predation risk suggest that ecosystem functions provided by these taxa should differ spatially and temporally, yet most restoration studies have focused only on birds. To evaluate the impacts of local restoration treatments and landscape context on bat communities, we captured bats over two seasons in ten restoration sites established on degraded cattle pastures in southern Costa Rica. Restoration sites spanned a gradient of landscape tree cover from ~10-90% within a 500-m radius. Each site contained three 50 × 50 m treatments: control (no seedlings planted), islands (six patches of trees planted), and plantations (seedlings planted in rows throughout). We found that bat community attributes including abundance, species composition, and range of body sizes were similar across the different local restoration treatments and across landscapes with varying amounts of forest. These results strongly contrast with bird observations from the same sites but support measurements of day- and night-time zoochorous seed rain. Differences between birds and bats may be explained in part by the nocturnality and species survival hypothesis. High site-to-site variation in bat captures could reflect differences in food resources or roost availability in surrounding areas.

An overview of the Staying Connected Initiative: successes, challenges and prospects for a new phase of work.

Reining, Conrad

Wildlands Network

In 2008, Wildlands Network, Two Countries One Forest (2C1Forest), The Nature Conservancy, Wildlife Conservation Society and other organizations identified a set of landscape linkages that are essential for regional-scale movement of multiple species and to maintain ecological processes between large blocks of habitat in the Northern Appalachian/Acadian region of northeast North America. In 2009, the Staying Connected Initiative (SCI), a partnership of non-profit organizations and state and provincial agencies from Vermont, New Hampshire, Maine, New York, Québec, New Brunswick and Nova Scotia, was established. The mission of SCI is to safeguard and restore habitat connectivity in the Northern Appalachians for the benefit of wide-ranging, forest-dwelling wildlife. SCI works in eight linkages in the Northern Appalachians. During its first four years, the partnership successfully

ORAL ABSTRACTS (CONT'D)

deployed a wide range of tools in each place, including: 1) identifying the highest priority habitat for connecting blocks of forests together; 2) conserving these high priority habitats through land protection and restoration work; 3) mitigating the effects of transportation networks on wildlife populations; 4) supporting land-use planning practices that protect habitat and connectivity; and 5) galvanizing public awareness and support for all of the above. This presentation will discuss the origins of the Staying Connected Initiative, how the partnership was organized, the results of the first phase of work from 2009 to 2013, strategies for the next phase, and how SCI can increase its engagement with the restoration community.

Quantifying ecological memory during forest succession: a case study from the lower subtropical forest ecosystems in South China

Ren, Hai; Zhongyu Sun, Valentin Schaefer

South China Botanical Garden, CAS

Ecological memory is the information assemblage that can reflect the historical disturbance, current situation and future trajectory of the community or ecosystem. It provides a new perspective for forest succession research. We selected nine proxy indicators (i.e. plant species, soil seed banks, soil microbes, soil animals, birds, soil age, soil pollen, soil mineral distribution and light environment) and developed a quantitative method to quantify the states of a successional series of subtropical forests in South China. Taking the climax, monsoon-evergreen-broad-leaved-forest as the reference ecosystem, we found that ecological memory increased nonlinearly and accumulated following a specific assembly rule during succession. The major soil microbes and soil animals mainly accumulated from the initial stage to early stage, contributing to improved soil substrate and ecosystems' resistance to physical obstacles. The number of bird species and the availability of light, which ensured the regenerative seed sources and the understory seedling survival rates, primarily accumulated from the early- to medium- stages. Vegetation and soil seed banks accumulated significantly from the late- to climax-stages, guaranteeing the ecosystem would reach the regional climax. The retrospective memory was larger than prospective memory in every successional stage except the late stage, which indicated that all stages but the late stage were undergoing progressive succession. Our study demonstrated that the ecological memory and the proposed evaluation framework could be a useful tool for guiding succession and restoration research, especially for assessing how "far" the restored ecosystem was from the reference ecosystem or deviated from the natural succession trajectory.

Burning effect on seedling emergence in Fescue Prairie

Ren, Lei; J.T. Romo, Yuguang Bai

University of Saskatchewan

Fire may regulate species composition in Fescue Prairie through its effects on seedling recruitment. The number and rate of seedlings emerging in the field and from soil seedbanks incubated in a greenhouse were examined after burning and mowing in the spring. Soil seedbank samples were taken from top 5 cm of the soil profile, separated into litter and the 0-1 cm, and 1-5 cm layers, and incubated in a greenhouse. In the field study, more than 1,800 seedlings emerged, representing 11 plant families with 1 graminoid and 18 non-graminoid species. Burning significantly increased ($P < 0.05$) the number of *Androsace septentrionalis*, *Artemisia frigida*, *Artemisia ludoviciana*, *Campanula rotundifolia*, and *Cirsium arvense* seedlings emerging as well as total seedlings emerging. More than 7,000 seedlings emerged from the soil seedbanks incubated in the greenhouse with 12 plant families present. Seedlings of 10 graminoid species and 19 non-graminoid species emerged. More seedlings of *Artemisia ludoviciana*, *Cirsium arvense* and *Conyza canadensis* emerged after burning as compared with the mowing treatment ($P < 0.05$). Burning significantly increased ($P < 0.05$) the rate of emergence for *Androsace septentrionalis* and *Artemisia frigida*, but it decreased the emergence rate of *Conyza canadensis* ($P < 0.05$). Fire appears to stimulate recruitment of some species, especially early seral species, contributing to potential changes in species composition of the Fescue Prairie.

Transformation of an Industrial Brownfield into an Ecological Buffer for Michigan's Only Ramsar Wetland of International Importance

Rice, Kelly N.; Dr. John Hartig, Allison Krueger

Cardno JFNew

A key unit of the Detroit River International Wildlife Refuge is the 410-acre Humbug Marsh that represents the last mile of natural shoreline on the U.S. mainland of the river and Michigan's only "Wetland of International Importance" designated under the 1971 International Ramsar Convention. Adjacent to Humbug Marsh is a 44-acre former industrial manufacturing site (called the Refuge Gateway) that is being remediated and restored as an ecological buffer for Humbug Marsh and the future home of the refuge's visitor center. Restoration and redevelopment activities have included: cleanup and capping of contaminated lands; daylighting a creek that had been historically placed in a culvert; constructing a retention pond and emergent wetland to treat stormwater prior to discharge to the Detroit River; restoring coastal wetland, riparian buffer, and upland habitats; and providing public access that allows visitors to experience this internationally-recognized natural resource. This project has been described as transformational for the region by restoring the industrial brownfield site into beneficial wildlife habitat. Specific restoration targets for the site include: achieving a net gain of 15 acres of wetlands in a river that has lost 97% of its coastal wetlands to development; restoring 27 acres of upland buffer habitat; treating invasive *Phragmites* along 2 miles of shoreline; and treating invasive plant species in 50 acres of upland habitats in Humbug Marsh. Further, the Refuge Gateway is being restored as a model of environmental sustainability for nearly seven million residents within a 45-minute drive.

ORAL ABSTRACTS (CONT'D)

Utilizing genetic information to mitigate impacts of climate change: an example in desert shrubs

Richardson, Bryce

USDA Forest Service, RMRS

Plant genetic information provides critical knowledge necessary to mitigate the impacts of climate change through ecological restoration. The first step in restoration is recognizing and delineating genetic boundaries at different taxonomic and spatial hierarchies (e.g., species, subspecies and populations). For many of the native grasses, forbs and shrubs that occupy western North American, little population genetic information is available, making restoration a virtual guesswork for restorations. This information is also essential to perform further genetic research. The second step is an assessment of the genetic diversity found within and among populations of a species. This data provides guidance on the health and evolutionary potential of species and populations. Finally, an evaluation of adaptive traits in common garden trials provides the information needed to infer climatic adaptation and delineate seed transfer zones. Because of the relationships between climate and adaptive trait responses within a species, researchers are able to assess how plant populations could be affected by future climates. Examples of two western North American shrub species, big sagebrush (*Artemisia tridentata*) and blackbrush (*Coleogyne ramosissima*), will highlight this research approach and its benefits to restoration under climate change.

Will warm or cold adapted ecotypes prevail in the future? A look at blackbrush (*Coleogyne ramosissima*) genecological models under climate change scenarios

Richardson, Bryce A.; Stanley G. Kitchen, Rosemary L. Pendleton, Burton K. Pendleton, Matthew J. Germino, Gerald E. Rehfeldt, Susan E. Meyer

USDA Forest Service, RMRS

Climate change has the potential to affect numerous ecosystem processes and fundamentally alter plant communities. Mitigating impacts to natural ecosystems will require an understanding of how climate change affects populations, the basic units of evolution. This knowledge can guide restoration efforts to ensure the most appropriate plant materials are used given current and future climates. In this study, we focused on the adaptive genetic variation in blackbrush, a widespread shrub distributed across the warm and cold desert ecotone. Two common gardens served to evaluate plant responses from a range-wide sample of 26 populations encompassing two ecoregions, the Colorado Plateau (CP) and the Mojave Desert (MD). Preliminary results show that plant responses, including growth, carbon isotope ratios and mortality, support strong adaptive genetic differences. These differences were primarily found to exist between ecoregions. For example, at the cold common garden, average mortality among CP populations was 15% versus 75% for MD populations. Growth and carbon isotope measurements were highly correlated with mortality. The rise in mortality for MD populations followed the 2010-11 winter where minimum temperatures reached -17°C (1°F). Modeling the plant responses with climate of origin also supports variation in cold tolerance between ecoregions. Based on this model, blackbrush can be defined as having two ecotypes, warm and cold, that principally follow ecoregions. Future projections of the species distribution and ecotypes support the prevalence of the cold ecotype. This change in ecotype distribution could be a result of higher elevations and latitudes that would support colder winter temperatures.

Assessment of ecosystem service values of Everglades restoration

Richardson, Leslie; Laila Racevskis, Kelly Keefe, Chris Huber, Larisa Serbina

U.S. Geological Survey

Calculating the monetary value of ecosystem services is a means of expressing the value of a natural or restored ecosystem. These values can play a critical role in decision-making processes that affect ecosystem service quality and quantity, and can be incorporated into both public and private decision-making to better inform management of natural capital and ecosystems. The Central Everglades Planning Project team, led by the U.S. Army Corps of Engineers and the South Florida Water Management District, has partnered with the U.S. Geological Survey and the University of Florida to conduct an assessment of the economic value of ecosystem services associated with restoration activities in Florida's Everglades. Comprised of an interdisciplinary team of economists, biologists, and other scientists, this assessment monetizes and compares the economic value of ecosystem services associated with two Everglades conditions: the future without the restoration project conditions and the conditions associated with the planned restoration. The team has monetized the value of select ecosystem services using existing data and benefit transfer methods, and provided a qualitative description of those services that will not be significantly impacted by restoration activities or cannot be valued monetarily due to a lack of existing data. The results of this effort highlight the iterative process and lessons learned in conducting a complex assessment requiring the involvement of many different agencies, scientists, and stakeholders. Preliminary findings suggest that there are a range of ecosystem services that could be affected by Everglades restoration and these services have significant economic value.

Limber pine (*Pinus flexilis*) seed harvest timing and ex situ cone maturation for restoration and biodiversity conservation in Alberta, Canada

Robb, Lindsay

Government of Alberta

Limber pine (*Pinus flexilis*) is an integral component of the Rocky Mountains ecosystem in the USA and Canada. It is endangered in Alberta, mainly due to white pine blister rust (*Cronartium ribicola*), mountain pine beetle (*Dendroctonus ponderosae*) and limited natural regeneration. As climate change is expected to intensify the species decline, Alberta is initiating a limber pine conservation program with current efforts including the collection and storage of seed for resistance screening and outplanting. Successful seed storage and seedling propagation requires high quality mature seed. In practice, pine seeds with embryos occupying >90% of the corrosion cavity have been considered mature but this is difficult to achieve in limber pine due to short

ORAL ABSTRACTS (CONT'D)

growing seasons and the need to collect early to avoid seed predation and imminent early snowfall at high elevations. For this study, limber pine seed collections were made every two weeks from mid-August to mid-October. Embryo lengths, dormancy, desiccation tolerance and longevity were tested initially and subsequently every two weeks while cones were 'matured' in a high humidity chamber. Ex situ cone maturation increased germination and desiccation tolerance of early harvested seeds. Embryo lengths were found to be unreliable for field maturation assessment, as some seed collections with >90% embryos had not yet gained desiccation tolerance or maximum longevity. Limber pine seeds were found overall to be very short-lived, which may exacerbate restoration difficulties. Successful restoration of limber pine in Alberta depends on overcoming these issues, as recovery is unlikely without blister rust resistance screening and reforestation.

Stacking ecosystem services: Controversies in selling multiple credit types from single restoration sites

Robertson, Morgan; Todd BenDor, Rebecca Lave, Adam Riggsbee, JB Ruhl, Martin Doyle

University of Wisconsin - Madison

Ecosystem services are increasingly used as frame for understanding not only the goals of ecological restoration, the objects that are transacted in regulatory markets addressing environmental problems ranging from endangered species to wetlands loss to climate change. In these markets, entrepreneurs restore ecosystems to create ecosystem credits, which are then purchased to compensate for regulated environmental impacts. "Credit stacking" is a novel and significant development in these markets whereby multiple, spatially-overlapping credits representing different ecosystem services are sold separately to compensate for different impacts. Interest in stacking has grown rapidly in the past year, and will continue to expand in the multibillion-dollar international market in carbon, habitat, and water quality credits. Environmental entrepreneurs see that stacking provides the possibility of new revenue from environmental credit sites, and regulators are encouraged by stacking's capacity to recognize multiple environmental benefits (as with REDD+ policies for carbon). However, scientists are concerned that because ecosystem functions are interdependent and integrated, stacking may result in unaccounted net environmental changes. Asymmetry in the treatment of stacked compensation sites and impact sites may make functional gains more visible and easily-counted than functional losses. The regulatory challenges of overseeing multiple interrelated markets may be overwhelming. We discuss examples of credit stacking and outline the two major concerns that will challenge policymakers and restorationists alike. We recommend that stacking should be approached with great caution until ecological assessment techniques can be developed which account for the functional integration of distinct ecosystem credits present on a conservation site.

The lawyer in the triage ward: Economic and social forces in the prioritization of restoration.

Robertson, Morgan

University of Wisconsin - Madison

When regulators or investors dedicate their resources toward ecosystem restoration, there are inevitably many social forces at work beyond the desire to achieve ecosystem integrity. Regulators are often constrained by the Congressional directives and agency missions within which they are authorized to operate; investors in restoration sites are often constrained by the economics of site selection and the social context within which land-use choices are made. However, it would be a mistake to conceive of any of these actors as completely bound by their institutional or economic settings; both creativity and constraint are hallmarks of the complicated social settings within which real restoration projects are implemented. Non-scientific influence on scientific practice is often figured as an unwelcome invasion, analogous to lawyers and insurance companies influencing medical doctors' diagnosis. However, social and cultural forces are not extraneous or additional to restoration science, they are the context within which restoration problems and solutions appear in the first place. Appropriate prioritization of ecological concerns depends not on making other interests "come to" ecology, but rather on becoming literate in the inherent limits and imperfect translations that must occur with the many other disciplines and interests that invest in, regulate, and give social sanction to the performance of ecological restoration.

Unexpected Herbivory on a Rare Plant and the Need for Landscape Restoration

Roels, Steve

Michigan State University

Efforts to conserve and restore populations of rare plants are sometimes frustrated by high rates of herbivore damage. Even when herbivory is frequent, the herbivores themselves are rarely observed and particular herbivore species responsible are often presumed, based on observations of closely related plant species that are more common and better known. I present the case of Mead's Milkweed (*Asclepias meadii*), a federally threatened prairie species. Milkweeds are well-known for their plant defenses including sticky latex and toxic secondary compounds. These defenses are usually effective at suppressing damage by herbivores, except for a handful of highly co-evolved insect specialists. However, when I compared the herbivore communities feeding on the rare Mead's Milkweed and two other abundant milkweed species, I found that deer frequently damaged Mead's, but not the other milkweeds. Furthermore, there was a striking contrast in rates of deer damage between two field sites, which were in different landscape contexts. This example illustrates several important principles for rare plant restoration: first, important aspects of natural history cannot be assumed from knowledge of related species; second, habitat restoration for rare plant species encompasses the herbivore community; and third, suitable conditions for restoration extend to the landscape scale.

ORAL ABSTRACTS (CONT'D)

Translocation of listed species: A landowner's perspective on risk and benefit

Rogers, Deborah L.

Center for Natural Lands Management

The Center for Natural Lands Management (CNLM), a public benefit organization, has specialized for close to 25 years in conservation of sensitive habitats and listed species as its primary mission. CNLM does, from time to time, receive requests to accept individuals from a particular listed species onto their preserves. These individuals could be: those rescued from other habitats that are no longer suitable because of gradual or abrupt (e.g., land conversion) changes; the result of a captive breeding program; or part of a restoration or recovery program for the species. Under those conditions, at issue is whether CNLM should allow its preserve(s) to serve as recipient sites for the translocated listed species. Based on its business model that considers not only conservation value but risk, CNLM reviews each translocation request. This decision-making process will be presented, describing the criteria that relate to the risk to the species, translocated individuals or populations, recipient population, and the organization. Financial, legal, and biological criteria are considered. Different criteria are invoked for plant and animal species, in part because of differences in management practices and federal and state regulations as regards to listed plant and animal species.

Functional flows: A practical strategy for healthy rivers

Rood, Stewart; John Mahoney, Chad Gourley, Joseph Rasmussen

University of Lethbridge

While it is recognized that aquatic (instream) and riparian (streamside) ecosystems are adapted to natural flow regimes, it is not practical to restore natural flows along most regulated rivers. As an alternative, we propose functional flows, deliberately managed artificial flow patterns that support fluvial geomorphic processes and satisfy the life history requirements of the aquatic and riparian plants and animals. The functional flow strategy provides different objectives across years, with managed flows in high-flow years attempting to rejuvenate the riverine ecosystems, while flows in low-flow years provide artificial patterns with aspects such as priority flow in the hot and dry period of mid-summer, to avoid thermal stress on fish and drought stress on riparian shrubs and trees. The functional flow strategy mimics components of the natural hydrograph pattern in many years but there may be down-scaling to support smaller systems, such as with narrower riparian woodlands. The functional flows are not intended to entirely recover natural ecosystems but instead seek to sustain healthy ecosystems, which are regarded as those that provide a full range of trophic interactions and elemental cycling, and support ecosystem services including fish and wildlife habitats, bank stability, and water quality. The presentation will outline the concept of functional flows and describe the implementation and outcomes along a number of rivers in western North America.

Initial results from a sand prairie restoration experiment: Species establishment and community responses

Roos, Robb; Todd Aschenbach

Grand Valley State University

Sand prairie, a historic component of the tallgrass prairie mosaic in Michigan, has been all but eliminated from the state's landscape. Few attempts at restoring this ecosystem have been conducted at the state and national levels. Our attempt at creating a successful restoration approach involves varying the seeding rates of native plant functional groups (warm-season grasses, early season forbs, late season forbs, legumes) in an effort to dictate plant community development in a sand prairie restoration experiment at the Chittenden Nursery in the Manistee Huron National Forest. After two full growing seasons following seeding, results show that (include specific community variables here i.e. native species richness, diversity, productivity) were significantly greater compared to the non-seeded control plots. Among treatments, those that contained a high concentration of warm-season grasses yielded significantly greater (include specific community variables here i.e. native species richness, diversity, productivity, non-native species suppression) compared to other treatments. Our results also highlight the role that facilitation, competition (with non-native species), and succession have on the initial development of a sand prairie community.

The Ecological Science Data Set of the RESTORE project: How Biodiversity Patterns Help Answer the Core Question of the Research Project

Ross, Kristen; Basil Iannone III, David H. Wise, Liam Heneghan

UIC Biological Sciences

Basic biodiversity data were collected over a 2-year period from 14 sites managed by 10 Chicago Wilderness (CW) organizations. Each site was an oak-dominated woodland or savanna to which the public had access, that had been undergoing restoration for at least five years, and that was within ~ 1km of residential areas. One to four 1000-m² (0.1ha) circular plots were located within each of 1-5 management units on each site, yielding a total of 74 plots across the 14 sites. Basic vegetation biodiversity patterns were determined by (1) measuring the basal area and abundances of canopy species in each 0.1-ha plot; (2) measuring percent cover and abundance of wood understory species in five 4-m² subplots within each 0.1-ha plot; (3) determining the abundance of the invasive shrub *Rhamnus cathartica* in 10 additional 1-m² subplots; (4) determining frequency of occurrence of herbaceous species in twelve 4-m² subplots along transects placed in each cardinal direction in the 0.1-ha plots. We also measured soil moisture, organic matter, pH, cations/anions, and heavy metals in three of the 12 4-m² subplots. To answer the core research question ("How do different organizational structures and decision-making processes in the ecological restoration arena influence on-the-ground biodiversity results?"), we used a variety of multivariate techniques to examine how patterns of variation in measures of organization structure and the decision-making process (the social-science data matrix) correlated with patterns of biodiversity (the ecology data matrix). The patterns that emerged from these analyses will be evaluated and discussed.

ORAL ABSTRACTS (CONT'D)

Volunteer Restoration: Building a Culture of Caring and Involvement

Ross, Laurel

Field Museum; formerly IllinoisTNC

In the Chicago metro and in Illinois there is a decades-long culture of volunteer participation in protecting and restoring habitat. Restoration of prairie remnants across the state and implementing the Chicago Wilderness Biodiversity Recovery Plan both depended largely on volunteers. Both efforts were organized around mobilizing volunteers not just to “build public support” but as an essential feature of getting work done over the long haul. The plan to involve large numbers of non-professional conservationists was new and presented many challenges as well as opportunities. Recruiting or mobilizing large numbers was perhaps the easiest task. Training them, sustaining their involvement over the long haul, and creating the organizational structure to coordinate the work called for innovation. This volunteer force numbers in the thousands and is deployed by many conservation organizations. The decentralized approach makes precise metrics difficult to obtain. Many volunteers have become skilled “citizen scientists” who monitor a range of organisms from rare plants to dragonflies. Their work extends to invasive species removal, planting seeds of native shrubs and flowers, and assisting with controlled burns. Forest preserve and grasslands are being restored and managed in significant part by non-professional conservationists. Restoration volunteers now come from a variety of Chicago’s culturally diverse neighborhoods as well as tradition constituencies, creating a community of support for restoration which is broad as well as deep. Children are now engaged by the thousands through programs such as Mighty Acorns, which introduces 4th-6th graders to nature and conservation stewardship, ensuring a new generation of support.

Maintaining mud: Examples from Southern Africa of the role sediment plays in riverine habitat preservation and restoration

Rountree, Mark W.

Fluvius Environmental Consultants

Ecosystem preservation and rehabilitation efforts can be detrimentally impacted at both large (catchment) and small (site) spatial scales by a focus on narrowly defined objectives, such as species biodiversity, without cognizance of the underlying biophysical processes. Examples are provided of widespread catchment revegetation proposals to reduce instream sedimentation, regional scale dams seeking to limit downstream social and environmental impacts on riparian systems and small scale site rehabilitation efforts to protect wetlands that have been developed in the absence of an understanding of the underlying biophysical processes responsible for physical habitat creation and maintenance. In riverine systems it is critical to examine the relationship between flow and sediment at spatially and temporally appropriate scales. When this relationship is decoupled, through catchment development, dams or even rehabilitation interventions, unanticipated downstream impacts can be severe, and rehabilitation efforts can unintentionally exacerbate these impacts if they are not explicitly recognized and considered upfront. A focus on functional, rather than solely biodiversity, objectives for habitat preservation is recommended to achieve better outcomes for ecological preservation and restoration actions.

Interstate 294 bio-swales acting as pre-treatment systems and soil pH regulators

Rowley, Susan

ENCAP, Inc.

The purpose of the bio-swale creation along Interstate 294 (along the Illinois Tollway) is to provide water quality benefits for the surrounding areas compared to typical vegetative conditions. Bio-swale Types 1 and 2 act as long and linear wetland cells, relying on the plantings in a shallow surface water volume to filter the runoff. Pre-treatment furrows act as level spreaders to collect sheet flows from fore-slopes. Bio-swale Types 3 and 4 act as filtration Best Management Practices to filter the first flush flows from the roadway. These bio-swales rely on the filtering action of the soil/stone planting medium as well as biological action of the vegetation to clean the runoff. The bio-swales were restored with native wetland vegetation and slope conservation vegetation in order to provide sediment and erosion control, along with stormwater filtration functions to improve the quality of stormwater entering the downstream waterways. This study contains data inspecting the planted vegetation, non-native weeds, furrows, and pH soil levels in the bio-swales. This study will outline the steps taken to provide a pre-treatment system along a heavily traveled roadway, will document the pH level changes in the soil, and will provide observations/conclusions based upon the field findings. This preliminary data suggests that during 2011 the bio-swale vegetation may have had some effect on the overall pH levels in the soil. It appears that the pH levels increased dramatically from 2010 to 2011; however, throughout the 2011 growing season the pH levels were observed stabilizing back to neutral.

Restoring Fish Passage for Migrating Aquatic Species at the Henry Ford Estate Dam

Rozumalski, Laura; Caroline Ubing

Baird and Associates

A common cause of habitat loss for migratory fish is hydropower projects restricting accessibility. As the industry has become more ecologically vigilant, many restoration studies have been conducted on existing hydropower facilities. Baird & Associates was retained by the U.S. Army Corps of Engineers to perform a hydrologic and hydraulic analysis determining natural channel design features and alignment of a fish passage channel to restore aquatic access to habitat upstream of the Henry Ford Estate Dam while still providing enough main channel flow for hydropower operations. The Henry Ford Estate Dam blocks fish migration into the lower reaches of the Rouge River as well as movement of Great Lakes fish from the Detroit River upstream into potential spawning and foraging habitat throughout the watershed. The Henry Ford Estate Dam was designed by Jens Jensen and is a National Historic Landmark; therefore, the integrity of the dam and the viewshed from the Estate must also be maintained. A hydraulic model was developed to design a channel profile that will maintain sufficient water depth and not surpass a maximum average water velocity to not only provide upstream passage, but

ORAL ABSTRACTS (CONT'D)

also create suitable habitat and produce flows that attract targeted fish to the passage channel. This presentation will summarize the initial design of a channel which fulfills passage design criteria, allows for operation of the historical hydropower plant, and maintains the historic integrity of the Henry Ford Estate.

Contextual Ecological Realities: An Evolutionary Framework Suggests a Minimally Invasive Restoration Ecology

Ruggiero, Daniel A.

University of Wisconsin - Madison

The extent to which restorationists pursue historic fidelity during an era of environmental change raises philosophical and pragmatic issues for ecological restoration and environmental policy. The concept corresponds with a widespread norm of protecting 'native ecosystems' and biodiversity from non-native invasive species and the attempted eradication or perpetual control of invasives amid diverse landscape contexts. There is significant overlap in the landscape between areas considered a high priority for restoration, and areas hosting 'invasive' species. Questions about restoration norms are paralleled by emerging arguments in invasion biology that question the extinction threat posed through competition from invasive plants and note positive ecosystem-service attributes of invasive populations, as well as questioning the relevant scales targeted by policy decisions. The issue is further complicated by case studies demonstrating potential long-term ecosystem recovery roles of invasive populations, describing where their value likely overshadows the prospects of potentially counterproductive management. Restoring 'back to' a pre-invasion state is especially challenging due to the irreversibility of community change and anthropogenic drivers. The importance of relatively unimpeded successional processes in facilitating ecosystem resilience amid unstable environments is an especially significant consideration for the pragmatic scope of human-intervention in ecological restoration. I provide a synthesis of recent and interrelated conceptual shifts to reconsider the pragmatic significance of less intensive approaches to restoration, such as assisted recovery, and related emphases on re-establishing successional and evolutionary processes to enable 'adaptive' ecosystem services relative to irreversible environmental stress, as a higher priority goal than restoring toward an a priori reference community.

Temperature control of germination in Eucalyptus: implications for restoration

Ruiz Talonia, Lorena; Nick Reid, David Carr

University of New England

Direct seeding with precision planters is an attractive option to restore large areas of cleared arable land due to time and economic efficiency, compared with other methods. However before planning any restoration program, seed germination requirements need to be understood. Eucalyptus species are keystone species and a priority in many restoration projects in Australia. The objective of this study was to clarify the germination response of 11 Eucalyptus species in relation to temperature, to determine suitable sowing seasons for seedling emergence in direct seeding restoration programs. Seasonal temperature regimes of the natural habitat of *E. albens*, *E. blakelyi*, *E. camaldulensis*, *E. chloroclada*, *E. coolabah*, *E. dealbata*, *E. melanophloia*, *E. melliodora*, *E. pilligaensis*, *E. populnea* and *E. sideroxylon* were investigated in north-western New South Wales and matched in germination experiments. These temperatures were simulated in growth cabinets set at 15/5°C, 15/25°C and 25/35°C (12/12 hour day/night regimes) to match winter, summer and autumn/spring temperature regimes, respectively. All species exhibited germination percentages >90% at the 15/25°C, except *E. coolabah* and *E. melliodora* which had poor viability. Ungerminated seeds at the other temperatures were recovered and placed in cabinets set at 15/25°C to test viability. *E. dealbata* and *E. chloroclada* germinated under all temperature regimes; other species performed less well at both extremes. Timing of germination plays a significant role as rate of germination in all species was proportional to temperature.

Climate-induced changes in plant-herbivore interactions: potential impacts on biocontrol of invasive plants

Runyon, Justin

Rocky Mountain Research Station

Biological control—one of few tools capable of controlling widespread invasive plants—could be affected by climate change in important ways. A primary route is by fundamentally altering interactions between plants and herbivores, which could alter broader population-level outcomes and the success of biocontrol. For example, climate change is predicted to affect herbivory by modifying plant chemistry—the central factor regulating plant-herbivore interactions. The most straightforward way climate change can affect interactions between plants and insects is by altering the basic nutritional value of plants. Elevated CO₂ generally increases plant growth (the "fertilizer effect") and the ratio of C:N in plant tissues, which reduces the nutritional quality for N-limited insects: studies show that herbivores consistently respond to CO₂-induced changes in their host plants by consuming more foliage. How such changes will affect biocontrol is not known. Climate change can also impact plant nutritional value by altering chemical defenses against herbivores. Elevated CO₂, temperature, ozone (O₃), and ultra-violet light are each reported to affect levels of plant secondary chemicals, including plant volatiles. However, available information is limited and dependent on the plant and insect species involved as well as the class of chemicals examined. If we are to keep pace with and effectively limit the spread and damage caused by invasive species, it is critical to understand and predict how climate change will affect species invasions and the efficacy of the tools used to combat these invasions.

RiverSmart Washington: Sewershed scale ecological restoration in an urban environment

Saari, Steven A.; Meredith Upchurch

District of Columbia Department of the Environment

Many ecologists are familiar with the Hubbard Brook Ecosystem experiment where two forested watersheds of similar size were compared by clear cutting one and monitoring both to examine the changes in hydrology. The District Department of the Environment (DDOE) and its partners are

ORAL ABSTRACTS (CONT'D)

reverse engineering this famous experiment. We are examining the hydrologic response when two urban sewersheds with impervious covers from 30% to 60% are “re-greened.” This project is quantifying volumetric reductions in stormwater runoff when these sewersheds totaling 28 acres are widely retrofit with Low Impact Development (LID). To date the project has completed pre-restoration monitoring and most LID retrofits have been installed on private property. Construction on retrofits to control stormwater from the public right-of-way will begin in June 2013. Design calculations currently predict stormwater volume reductions 2.5 times higher than the originally projected 6,000,000 gallons annually. Post-restoration monitoring will commence in March 2014. This project has aided the District of Columbia in 1) developing guidelines for installing LID retrofits in the right-of-way and around utilities; 2) examining the potential for LID retrofits to eliminate or reduce the size of planned combined sewer storage tunnels; 3) targeting future retrofits through ground-truthing model projections of LID stormwater benefits; and 4) providing invaluable lessons on marketing LID to District residents. Scaled-up city-wide, LID has the potential to provide numerous ecological benefits, such as reduced local air pollution and urban heat island effects, and increased green space and habitat – all while improving the water quality of local streams.

Analysing learning at the interface of scientific and traditional ecological knowledge in a mangrove ecosystem restoration scenario in the eastern coast of Tanzania

Sabai, Daniel

Environmental Learning Research Centre (ELRC), Rhodes University

From community-based development initiatives indicate that local communities who are key actors in activities that aim at safeguarding the health status of terrestrial and marine ecosystems face a lot of challenges associated with adapting and using indicators that are scientifically abstracted and methodologically developed, given varying existing social and technical conditions amongst them. This paper brings into view possible challenges of adapting and applying scientific indicators in community-based monitoring of mangrove ecosystem and suggests a new approach that may lead to development of a framework of indicators which are less reified, more congruent to users (coastal communities) and likely to attract a wider context-based learning and allow epistemological access between scientific institutions (universities inclusive) and local communities. It thus attempts to establish an interface between knowledge that scientific institutions produce and the potential knowledge that exist in local context (traditional ecological knowledge) for purposes of widening and improving knowledge sharing and safeguarding the health status of mangrove species and fisheries that use mangrove as key habitats. The paper stems from an on-going PhD study which employed processes of abstraction and experiential learning techniques to unlock knowledge that local communities have, as an input for underlabouring existing scientific indicators in the Eastern coast of Tanzania. Keywords: Scientific knowledge, scientific indicators, mangrove ecosystem, context-based learning, traditional ecological knowledge, traditional ecological indicators, community-based monitoring, and underlaboring.

Factors affecting shifts in forest understory communities after deer exclusion

Sabo, Autumn E. ; Katie Frerker, Eric Kruger, Donald M. Waller

University of Wisconsin-Madison

In many forest understories in the eastern United States, comparatively lush plant communities develop within white-tailed deer (*Odocoileus virginianus*) exclosures. However, with respect to structure and composition, the level of divergence between fenced and surrounding unfenced vegetation varies among sites. Our objective is to explore why forest understory communities differ in their degree of divergence following the removal of deer foraging pressure. To address this question, we sampled 17 deer exclosures and adjacent, unfenced controls in upland hardwood forests of northern Wisconsin and the Upper Peninsula of Michigan. We measured woody and herbaceous vegetation, browse damage on plants, coarse woody debris, soil chemistry and compaction, canopy openness, and earthworm invasion levels and also collected historic information on deer densities and canopy conditions. We then calculated divergence metrics for each exclosure as the difference in vegetation composition and structure inside versus outside the fence, and regressed these metrics against associated environmental and community variables. Disturbances including earthworm invasion and soil compaction played an important role in community divergence. We will discuss which variables correlate to the most dramatic exclosure-mediated shifts in understory vegetation and explore how restoration professionals might take advantage of this information to guide forest management.

Cultural and Aesthetic Relevancy: The Design of Novel Ecosystems

Sack, Catharina

University of Western Australia

This paper addresses the relevance of cultural and aesthetic consideration in the design of novel ecosystems. It argues that novel ecosystems, both by happenstance and purpose, are human-derived landscapes and therefore cultural. Within highly modified landscapes, in particular those impacted by urbanisation and mining, design can address cultural and aesthetic qualities while also increasing biological and systems relevance. Through case studies, the paper relates how the design of abiotic and biotic infrastructure can engage human participation in the design, construction and management of landscapes, subsequently inculcating them with greater long term value, both human and ecological. In this, how can designed landscapes and ecosystems facilitate ecological targets? Additionally the paper argues that sustaining ecological and landscape systems is no longer enough; in seeking to increase the footprint of ecological utility, highly modified landscapes can become strategic sites for the purposeful regeneration of ecological function.

ORAL ABSTRACTS (CONT'D)

The restoration trajectory and effects of typhoon on vegetation, soil and macrofauna in restored mangroves

Salmo III, Severino; Ian Tibbetts, Catherine Lovelock, Norman Duke

Ateneo de Manila University

Using a space-for-time (SFT) substitution approach, we evaluated the rate and pattern at which the restored mangroves may match the vegetation, soil characteristics and macrofaunal communities (composed of mollusc assemblage and nekton community) of mature mangroves. We also investigated the effects of Typhoon Chan-hom in the restoration trajectory of the stands. Pre-typhoon values were measured and were then compared with 0.5-mo, 2.5-mo, 7-mo, and 9-mo post-typhoon. Prior to the occurrence of typhoon, there were clear developments in vegetation, soil and mollusc assemblage (but not with nekton community) with mangrove stand age. The change in mollusc assemblage is significantly correlated with the vegetation and soil characteristics. This development trajectory was however interrupted by the occurrence of Typhoon Chan-hom on 9 May 2009. Severe damages were more apparent in older mangrove stands (11- and 18- yr stands) but practically low to none in younger stands. There were reductions in tree density and forest biomass by 70 % and 80 %, respectively. In terms of soils, nutrient contents increased by 40-60 %, temperature increased by 6 – 100C, and redox decreased by 40 %. Mollusc species richness, abundance and biomass were reduced by at least 50 %. The post-typhoon changes in vegetation and soil characteristics were significantly correlated with the shift in mollusc assemblage. In summary, the occurrence of the typhoon derailed the restoration trajectory by five to ten years. Cumulative tree mortality, compounded by lack of seedling recruits and unfavorable soil condition, may possibly limit long-term recovery.

Natural regeneration in restored forest: the role of canopy structure and landscape context.

Sato, Luciane Missae; Vera Engel, Diego Podadera, Deivid Machado, Danielle Almeida

São Paulo State University - UNESP

Different models of mixed-species forest plantations have been widely used to restore diversity, suppressing weeds and promoting the recruitment of native species in degraded ecosystems. However, there is still little empirical evidence on the role of different techniques to catalyze the ecological processes. We assessed natural regeneration in two 15-year-old plantation models with contrasting initial species number and silvicultural techniques (M1 = direct seeding of 5 species M2 = seedlings plantation of 41 species) and sites conditions (S1 and S2) in Southeastern Brazil. We surveyed all woody regenerating plants in twelve 900m² plots (six per site), and their dispersal syndromes were recorded. Both the floristic complexity and the density of individuals in the smaller size class (0.20 m < height < 1.30 m) were higher in M2 in both sites, whereas M1 held higher sapling density and species richness in the size class of ≥ 1.3 m in height and < 4.9 cm in diameter at breast height. Abundance of zoochorous species was higher for S2 in M1 whereas M2 comprised 44% of zoochorous community in S1 suggesting that not only the attractiveness of the species to the wildlife but also the distance from native fragments are determinants of seed dispersal success. Our results show that not only the initial species richness of planted trees matters, but the interaction of stand structure (canopy richness, basal area and stratification), the wildlife attractiveness of the species introduced and the landscape context (distance from seed sources) interact in to determine restoration trajectories.

Enrichment of a young restored semideciduous forest with secondary and climax trees species by direct seeding – Sao Paulo / Brazil.

Schiavon Machado, Manoela; Sergius Gandolfi

Esalq - USP

Direct seeding has great potential to improve tropical forest restoration. In highly fragmented landscape one possible strategy to use is the direct seeding of pioneer species first and then enrich the young forest by seeding secondary and climax species. To obtain success it is essential to know the appropriate amount of seeds to be used and also to use high species diversity since seed dispersal tends to be low and slow. The present study performed the enrichment of a 6 year old forest composed only by pioneer species. To obtain the desired density of seedlings, seed density was a priori defined assuming a single germination and seedling survival rate for all secondary and other single different rate for all climax species. Seeds of 17 secondary and 15 climax species were placed in rows between the already existent pioneer trees rows (40 seeds of each secondary and 140 seeds of each climax species). In the lab, 100 seeds of each species were subjected to controlled conditions in order to test their viability. The seedling emergency, establishment and survival are being accompanied during 5 months. Composition and structure of the obtained community will be described. This will be compared with the seeded community and with the rates a priori defined. The direct seeding of this study was conducted in April and the first results are being obtained. If achieved success there will be over 35 tree species in only 7 years. This study will allow pointing out improvements for the method.

Reef restoration and coral propagation of the threatened genus *Acropora* in the Caribbean: Time to scale up!!

Schopmeyer, Stephanie A.; Diego Lirman, Chelsey Young

University of Miami/RSMAS

There is growing agreement among reef scientists that management and conservation efforts to enhance the recovery of depleted Caribbean *Acropora* populations include active restoration. To synthesize collective knowledge about reef restoration and to identify effective restoration methods and major obstacles hindering restoration success, we conducted a literature review, personal communications with restoration practitioners, and an online questionnaire in 2009. Participants strongly believe that *Acropora* populations are severely degraded, continue to decline, and may not recover without human intervention. Coral gardening and fragment stabilization were ranked as the most effective restoration activities for *Acropora*. In-situ coral nurseries have provided a productive, sustainable source of corals for restoration and contribute to the preservation and enhancement of local genetic

ORAL ABSTRACTS (CONT'D)

diversity. Nursery colonies exhibit high growth rates due to pruning vigor while outplanted corals display high survivorship and contribute significantly to coral abundance. Additionally, nurseries protect essential genetic material during thermal anomalies and other acute disturbances. High financial costs, the small footprint of restoration activities, and damage to wild populations were identified as major concerns, while increased public awareness and education were ranked highest as benefits of coral restoration. Restoration efforts will always pale in comparison with the potential scale of natural recovery, but propagation and restoration activities utilizing productive coral nurseries have been expanded to ecologically meaningful levels in the past 5 years and are beginning to have a considerable impact on the localized recovery of coral reefs.

Swidden (milpa) farming of Petén, Guatemala: Present practices and implications for the past.

Schwartz, Norman B.; Amilcar R. Corzo

Emeritus-Univ of Delaware

By 1970 archaeologists, geographers and others had rejected the “myth of the milpa” --that the ancient lowland Maya had sustained themselves by swidden cultivation. Rather, by the Classic Period, long-fallow milpa could not meet the needs of a growing population (150 + persons/km²). Maya began to deploy more efficient and intensified food production systems, but they also cleared more forest for short-fallow milpa, thus depleting soil fertility and eventually reducing food production. Environmental mismanagement fed into a complex set of interacting factors leading to the so-called “collapse” of lowland Maya civilization. By the late 1990s several archaeologists, ethnographers and others began to raise doubts about the post-1970s model. There were questions about whether earlier scholars had over-estimated ancient Maya population densities; the spatial and temporal dimensions of the “collapse;” inconsistencies between paleo-nutritional diets and what one would expect had nutritional standard declined; the how much deforestation had really occurred; and, finally, questions about the carrying capacity of milpa. This paper suggests that milpa (plus kitchen gardens) is productive enough to support denser populations than previously thought and to do so without depleting forest and soil resources to the point of seriously diminishing returns. Indigenous petenero farmers know how to manage their resources to feed relatively large numbers of people over long, sustained periods of time

The tortoise and the hare effect: From incremental steps to giant leaps, earning a passport for creative conservation and ecological restoration.

Scott, Richard

Landlife

Landlife is a small conservation organisation that has consistently believed in punching above its weight, looking for creative opportunities to bring the benefit of nature directly to people. Landlife celebrates nature's cultural possibility, in what many would consider unlikely locations. Such experience is now informing major landscape scale techniques. Opportunities can't be mapped easily, it needs inspiration. Action demands practical solutions often from simple approaches, and careful use of resources. Nature knows no boundaries, and sometimes it is the lost spaces in between the valued ones that can teach us as much as the cherished “pristine” environments. In this way urban ecology practice in its origins and ingenuity at being a playful ecology can teach very much. We are all urban now. The journey begins with one step, and it is said we should walk a mile in another's shoes. Our goal in creative conservation or ecological restoration is to make the world a better place. The impact of what we do in society depends on the conversations and time taken to create a rolling stone that does in fact gather moss, and picks up allies and converts along the way. It is about the inspirational starting points that motivate our interest and actions, and being able to pass on this intent and purpose. Lessons picked up from past conference events (SER and otherwise) which poked this creative spark in conference goers will be presented, and perhaps a new one will be invented, or discovered. Wait and see?

Is there enough water in waste-rock substrates to restore a functional tropical savanna to mined lands in northern Australia?

Segura, Jillianne; Lindsay B. Hutley, Sean B. Bellairs, Ping Lu

Research Institute for the Environment and Livelihoods, Charles Darwin University

Ecohydrology of mine-site rehabilitation is not extensively studied but critical for successful revegetation of mined lands in the seasonally wet-dry tropical climate of northern Australia. Vegetation survival is dependent on accessing stored soil moisture during the 6-month-long dry season. Successful mine restoration is dependent upon understanding mechanistic ecohydrological processes of natural and mine restoration sites. This is important as mining occurs across north Australia and this study's mine-site is surrounded by, but not part of, the World Heritage listed Kakadu National Park. Ecohydrological properties of adjacent tropical savanna (TS) were investigated and compared to a waste-rock constructed landform (CL) using a calibrated Soil-Vegetation-Atmosphere-Transfer model. Modelling focused on simulation of below-ground soil moisture dynamics, redistribution and seasonal vegetation water use. Accurate modelling of the soil Plant Available Water (PAW) was paramount to determine water required for vegetation maintenance in the dry season. Particle Size Analysis data were used with a pedotransfer calculator to attain parameters for the van Genuchten equation to determine PAW. Preliminary results show that the simulated CL has 180mm of PAW in four metres 'soil' profile, approximately 50% of the PAW of the TS. This PAW might be sufficient to sustain savanna through the dry season if it is fully accessible, but provides limited safety margin. The CL simulation predicted high drainage, characteristic of the high rock and sand content of mine-site substrates, contributing to low PAW. Scenarios with reduced saturated hydraulic conductivity of substrates at 2-3m depth will be examined to inform landform designs for successful revegetation.

ORAL ABSTRACTS (CONT'D)

Fedder's Alley- An Environmental View

Seilheimer, Frankin; Mark O'Leary

City of Michigan City, Indiana

In an effort to increase the visibility of Lake Michigan the city of Michigan City, Indiana embarked on an internal effort to rid a nine acre area of coastal secondary dune habitat of over 70 years of neglect. This neglect led to a dense and foreboding green wall of invasive species consisting mostly of Siberian Elm, Norway Maple, European Buckthorn and a ladder of Ornamental Bittersweet. The area is adjacent to a long linear parking lot of over two hundred spaces that sat virtually empty even at the height of the summer beach season. It is the goal of this project that ecologically restoring this area will foster a setting that will promote an increase in public use of the area as a gateway to the Lake Michigan shoreline. Increase in use will help justify budgetary funding for future public amenities, such as a boardwalk or bathhouse, in this municipal park area. This symposium will provide a timeline of events detailing public reactions, municipal correspondence, federal funding partners, a rise in volunteerism and private business investment. Retrospective analysis will provide others attempting similar efforts an opportunity to avoid similar difficulties as the project moves towards completion.

Applying principles of Reconciliation Ecology in environmentally sensitive designs of coastal defense structures: a case study from the Mediterranean Sea.

Sella, Ido; Shimrit Perkol-Finkel

Ecological Marine Consulting LTD

With the proliferation of human population along coastlines, alongside with growing threats from sea level rise and increased storminess, coastal and marine infrastructures such as breakwaters, revetments and seawalls are becoming progressively abundant. Designed to withstand strong wave action, these structures are built from large repetitive units made of stone or concrete. Typical designs create inclined homogeneous surfaces, which compresses the intertidal zone to a narrow vertical belt, supporting low biodiversity and often dominated by nuisance and invasive species. In light of this, the ability of coastal defense structures to provide ecosystem services similar to those offered by natural habitats is severely compromised. Here we present a new approach of integrating principles of Reconciliation Ecology in the design of coastal defense structures. Results from a year-long pilot project evaluating the ability of ecologically active armoring units, made of innovative concrete matrices and designs, to provide valuable ecosystem services while maintaining their structural integrity and durability. This study, conducted in the temperate waters of the Mediterranean Sea (Haifa, Israel), indicates that the combination of an innovative ecologically active concrete mix with a complex texture and design recruits a more diverse and dense assemblage of both benthic species and fish in comparison to standard Portland cement armoring units. Results show a clear reduction in the dominance of invasive species and an increased abundance of native local species, similarly to assemblages typical to adjacent natural rocky habitats. The study demonstrates the potential ecological value of integrating environmentally sensitive designs into coastal defense structures.

Use of CLIMEX and Non-climatic Parameters to Refine Areas Suitable for Date Palm Cultivation in Spain under Various Climate Change Scenarios

Shabani, Farzin; Lalit Kumar, Atefeh Esmaeili

University of New England

One consequence of climate change is change in the phenology and distribution of plants. The unique and distinctive date palm (*Phoenix dactylifera* L.) in Spain may be negatively or positively affected by climate change, particularly if favorable climate conditions shift to other areas. This study set out to model potential date palm distribution (*Phoenix dactylifera* L.) under current and future climate scenarios using an emission scenario (A2), in conjunction with two different Global Climate Models (GCMs): CSIRO-Mk3.0 (CS) and MIROC-H (MR), and to refine results based on suitability under two non-climatic parameters: a) areas less than 10° slope and b) land use types in Spain. The refined results indicated that large areas in Spain are projected to become climatically more suitable for date palm growth by 2100. However, the results from the CS and MR GCMs show some disagreements, especially from 2070 to 2100. The refined MR GCM projected that approximately 22.86 million hectares in Spain may become suitable for date palm growth, while the CS GCM showed approximately 18.72 million hectares by 2100. In other words, the MR model projected more areas may become climatically suitable for date palm cultivation compared with the CS model. The refined results showed that only about 65% of CLIMEX results are suitable for date palm cultivations while the rest of the areas are unsuitable due to the unsuitability of land uses and slope. Impact of climate change upon the distribution of date palm may be dependent on cold and wet stresses.

Put the human disturbance for priming the vegetation succession to restore the degraded alpine meadow on Tibetan plateau

Shang, Zhanhuan

Lanzhou University

More than 90% of total rangeland areas were degraded by heavy climate change and human activity on Tibetan plateau. The big challenge is how to restore those degraded land from long time desertification (became desert), weedification (become poisonous-weed land), and barelandification (become bare land). Many studies indicated natural recovery was very hard in those degraded land for inertness characteristics of alpine meadow in high and cold environment on Tibetan plateau. Then, the primary task and approach is how to prime the succession of restoration and urge the vegetation to recovery as to the aim of normal meadow. Here, we conducted experiments of restoration to recovery to restore the extremely degraded meadow with poisonous-weed in Tibetan plateau. The result showed that, 1) high density of soil seed bank domination of pioneer species is the guarantee to produce

ORAL ABSTRACTS (CONT'D)

guard plants for development of plant diversity during the vegetation succession. 2) Eliminating the weed before the restoration was important approach to prevent weed growing after restoration. 3) The decreasing the grazing activity or rodent borrows is necessary during in the early years of restoration. In conclusion, there were three key points of human priming pathway of inducing vegetation succession of degraded grassland, 1) soil seed bank donation, 2) weed eradication, and 3) soil cultivation. Key words: Tibetan plateau, degraded grassland, restoration, seed bank domination

A decade of shoreland restorations on freshwater lakes in Vilas County, Wisconsin, USA: What has worked and what hasn't.

Sheehan, Mariquita I.; Stacy Dehne, Carolyn Scholl
Vilas County Land & Water Conservation Department

In 2001, the Vilas County Land & Water Conservation Department and Wisconsin Department of Agriculture, Trade, and Consumer Protection began designing and installing shoreland restoration projects on local lake shores. By 2012, there were over 80 installations in place. They range in complexity from planting native vegetation to bio-engineered construction projects, as well as hard armoring the shoreline. The objective in all cases is to protect water quality and restore native plant vegetation. We started a monitoring program of the installations in 2011. The scope and complexity of the installations, along with the science of shoreland restoration, have evolved over that decade. Therefore, it is not possible to directly compare the earlier projects with later ones. We have been able to observe and evaluate the various project components, and the situations in which they have been effective over time. We have also identified the conditions or installations which promote successful, sustainable, healthy native vegetation.

The big picture of riparian restoration in the Western US: what role is biocontrol?

Sher, Anna; Hisham El Waer, Rob Anderson
University of Denver

The restoration of riparian ecosystems in the American West has frequently included removal of exotic *Tamarix* (tamarisk, salt cedar), but many question whether this emphasis is appropriate, particularly in the context of biological control by the saltcedar leaf beetle, *Diorhabda* spp. There is some concern as to whether removal of the trees by this and other methods actually improves biological diversity and ecosystem function. New research is emerging and on-going that can give us insight as to both initial responses of ecosystems as well as possible long-term trajectories. Most striking is the variability between regions and even among restoration projects within regions in vegetation response; at one end of the spectrum there are sites with rapid re-colonization of functionally similar (but native) species and at the other, likely the loss of the only woody species that may grow there. Additional comparisons between projects that employ biological control alone versus mechanical and/or chemical removal reflect the slower but more selective nature of biocontrol. Putting all these outcomes in a larger framework of long term restoration goals is critical for any type of evaluation of whether *Tamarix* removal generally, or biological control in particular, is "good" or "bad". Such evaluation is critical for informing management decisions going forward.

Context-dependent stream restoration in a forested Michigan watershed and an urban Indiana watershed: Lessons for applied ecology

Shirey, Patrick D.; Gary A. Lamberti
University of Notre Dame, Department of Biological Sciences

Worldwide, monitoring of stream restoration projects lags restoration efforts by tenfold. In the Upper Peninsula of Michigan, we have monitored ecosystem response to multiple reach-scale, soft-engineering restoration efforts that added unanchored logs to tributaries of the Ontonagon River beginning in 2004. We show that recruitment of large wood provides geomorphic complexity that creates pool habitat near the base the logs where the bank is steep and riffle habitat just downstream of the submerged portions of the logs, while logs perpendicular to the banks and those with branches trap drifting leaves and other organic matter that feeds the macroinvertebrates that in turn serve as food for fish. In northern Indiana, we have monitored fish community response to reach-scale, hard-engineering restoration of two meanders constructed in 1997 along a 1-km reach of Juday Creek, a 3rd-order tributary of the St. Joseph River in South Bend, IN. During our annual monitoring of restored and unrestored reaches of Juday Creek, we observed in July 2011 that stream managers removed naturally recruited large wood from two unrestored reaches of the stream to enhance unobstructed flow, while artificial wood structures were added in other portions of the stream to improve fish habitat. After wood removal, fish biomass declined by 59% in one reach (19 g/m² in 2010 to 7.8 g/m² in 2012) and 76% in another (14.5 g/m² in 2010 to 3.4 g/m² in 2012). We will suggest ways to balance restoration efforts with stream and watershed management practices.

Build. Sustainable. Communities. Community building, ecological restoration, and historic preservation through urban core trail systems

Shoffner, Brett
University of Missouri-Kansas City

Urban core trail system development can be the catalyst that inspires community capacity development, ecological restoration, and historical preservation within often neglected and underused city park systems and the surrounding neighborhoods. Currently within Kansas City, Missouri there are five urban trails initiatives, all having commenced within the past 5 years through the Earth Riders Trails Association (ERTA). These trail projects not only improve urban core access to high quality, sustainable singletrack but also focus on removing invasive species, like bush honeysuckle, reforesting the

ORAL ABSTRACTS (CONT'D)

urban-community forest with native species, mitigating stormwater and soil erosion, and preserving habitat. ERTA and community volunteers have built over 80+ miles of sustainable trails for hikers, runners, and mountain bikers in the Kansas City region, while engaging park neighbors and community groups to take an active role in shaping their literal backyards. By engaging community residents through a comprehensive conservation process, people become more connected to their neighbors, their neighborhood, and to nature. In no other area can the effects from these socio-ecological efforts be seen more clearly than in Roanoke Park, where neighbors have come together to entirely restore a historic jewel of the city's Kessler System. Through leadership and innovation, ERTA and the Roanoke Park neighbors have not just transformed the landscape, but also transformed mindsets, and preserved Kessler's original vision.

The FRAME Program Part II: Patch and landscape level effects on breeding birds in urban forest fragments.

Shriver, Greg; Vincent Damico
University of Delaware

The FRAME program (Forest Fragments in Managed Ecosystems) is a long-term study of forest fragments along a gradient of urbanization. To facilitate this research, we established 32 sites in DE and PA and quantified soil macro- and micro nutrients, vegetation structure and composition, invertebrate biomass, and avian density and reproductive success. The FRAME design includes an exploration of multitrophic interactions in the novel ecosystems created by nonnative plant invasion, so detailed information on nonnative plant presence and abundance was collected at 428 points throughout the FRAME. The initial phase of this work was completed in 2012, although we continue to monitor all sites. The most commonly-occurring nonnative plant in our sites was *Rosa multiflora*. The presence of *R. multiflora* in the FRAME sites was positively and significantly correlated with higher levels of soil calcium, greater numbers of catbird (*Dumetella carolinensis*) territories, and greater numbers of Ca-rich prey. Over 40% of catbird nests found in our sites were in *R. multiflora* and 46% of catbird nests in rose successfully fledged young. Historical data from one of our sites (from the 1960s) shows a suggestive change between territories numbers for wood thrush (*Hylocichla mustelina*) - a urban avoider that does not nest in *R. multiflora* - and catbird territories. Other interactions seen, such as those between leaf litter volume and nonnative plant invasion, beg future research on interactions between nonnative earthworms and invasive plants.

Using the foraging behavior of yellow-banded bumble bee (*Bombus terricola* Kirby) and other pollinators to guide habitat restoration in northeast Wisconsin

Shutt, Nicole M.
USDA Forest Service

Recent declines in pollinator populations have prompted land managers to improve habitat. The Lakewood-Laona Ranger District of the Chequamegon-Nicolet National Forest in northeast Wisconsin is utilizing data from pollinator surveys. One site, the Catwillow Monarch Area (CMA) near Laona, is a gated system of trails and wildlife openings managed by the Forest Service for pollinators since 2010. The initial focus was on the monarch butterfly (*Danaus plexippus* L.) because common milkweed (*Asclepias syriaca* L.) is in many openings, but the CMA supports more than just monarchs. Surveys revealed a population of the yellow-banded bumble bee in the CMA, and this surprise presented an opportunity to incorporate bees in our two-part management plan. One goal is to remove all non-native invasive plants from the CMA through spot-application of herbicides in spring and autumn. The other goal is to have an abundance of native flowers in every opening throughout the growing season by using seeds from local native plants. Using 2011-2013 observations of *B. terricola* and other pollinators foraging in the CMA and elsewhere, we've assembled a list of pollinator-preferred plants to include in restorations. These species host caterpillars and together provide flowers from May to October, so if they are native to your area, consider including Wild Columbine (*Aquilegia canadensis* L.), Common Milkweed, Black-eyed Susan (*Rudbeckia hirta* L.), Wild Bergamot (*Monarda fistulosa* L.), Flat-top Aster (*Doellingeria umbellata* (Mill.) Nees), Grass-leaved Goldenrod (*Euthamia graminifolia* (L.) Nutt.), Purple Giant Hyssop (*Agastache scrophulariifolia* (Willd.) Kuntze), and sunflowers (*Helianthus* L.) in restorations.

Baited perches and the attraction of frugivores: Managing the seed source for habitat restoration and enrichment.

Silva, Wesley; Jéssica Gurgel, Larissa Nemes
Universidade Estadual de Campinas

Perches have long been proposed and used to increase seed deposition by frugivorous birds in restored sites. Despite having pros and cons, perches represent a cheap and efficient technique to promote seed rain to particular points where seed arrival is desirable. In a landscape context, perches are dead ends of the regional seed influx, attracting a sample of the seed types available at different distances in the vicinity. Here we propose a different use for perches, making them starting points for a known and controlled seed rain. In an urban habitat in Brazil we attracted frugivorous birds to a perch baited with fresh bananas. Seed samples of different plant species were prepared and enclosed in bananas and offered in a single perch at the edge of a 1 ha forest fragment. Seed size ranged from 0.7 to 3.2 mm in diameter, which is within the gape width of the smallest frugivore. Seven frugivorous bird species rapidly became used to the feeder and removed more than 97% of the 22,960 seeds offered. Seed fate was recorded by a grid of 1m² seed traps scattered throughout the fragment. Seed retrieval, although very low (< 0.25%), was represented in 78% of the seed traps. Baited perches allow controlling for the identity and quantity of seeds, give seeds the appropriate treatment in bird guts, spread seeds randomly to safe sites, are required in smaller quantities than traditional perches and can be easily operated in targeted areas to be restored or enriched.

ORAL ABSTRACTS (CONT'D)

Ecological Restoration of the Waikato River - a co-management challenge

Simmons, John; Bob Penter

Waikato Regional Council

The Waikato River catchment is the beneficiary of an NZ\$210 million indigenous peoples Treaty settlement clean-up fund to restore the water quality and mana of the catchment over a 30 year term. The Waikato River Authority (WRA) and Waikato Regional Council (WRC) are two agencies charged with the co-management responsibilities to deliver the vision and strategy for the Māori tribes with stewardship responsibilities of the river. The paper will address the long term vision for ecological restoration of the river, the issues that require remediation and how policy and plan development will lead to enhanced long term sustainable management of the land and water resources in the catchment. The Waikato River catchment has highly productive pastoral agriculture and plantation forestry, with a number of urban populations and processing industries. Biodiversity within this heavily modified environment has been compromised and degraded substantially. The symposium will showcase the impacts of this degradation on the Waikato catchment and what initiatives are being implemented to reverse the situation via ecological restoration projects. Several case studies are used to illustrate how novel initiatives have received funding to undertake pilot projects to remove koi carp, a pest fish in the lower Waikato River ; to eradicate yellow flag iris, an invasive weed species from riparian areas along the River, as a preliminary to re-establishing indigenous vegetation that was in place prior to European intervention; and opportunities to enhance the spawning capacity of inanga in areas that have been substantially degraded by agriculture and drainage activities.

Patch-burn grazing increases spatial heterogeneity of a restored Minnesota tallgrass prairie

Simmons, Matthew E.

University of Minnesota Crookston

Conversion of prairies to agriculture, suppression of fire, and the near extirpation of bison have significantly altered prairie structure and function. Currently, less than 1% of native tallgrass prairie remains. Recent prairie restoration efforts, such as patch-burn grazing (PBG), have attempted to reestablish historic disturbance regimes. In summer 2011, PBG was initiated in northwest Minnesota at Glacial Ridge National Wildlife Refuge, the site of the largest prairie and wetland restoration in the U.S. Objectives of this study are to assess and compare responses of prairie plant communities between PBG and a traditional burn-only approach. Initial results indicate that cattle utilization was higher on recently-burned patches than on unburned patches, but fence lines and areas near water sources were also heavily grazed and/or trampled. Visual obstruction readings showed that vertical plant structure was more heterogeneous in the PBG unit than in the control. Average litter depth was lower in the PBG unit than in the control, and frequency of bare ground was higher in the PBG unit than in the control. Results indicate that PBG increases spatial heterogeneity in terms of plant height, litter depth, and ground cover over traditional burn-only treatments. This has important implications for increasing diversity of ground-nesting birds and other wildlife in restored prairies. However, the higher amount of bare ground in the PBG unit may increase soil erosion compared to burn-only treatments, and the heavily-disturbed areas around water and along fence lines may be more susceptible to future invasion by exotic species.

Bush Regeneration in Sydney

Singh, Mritunjay

Bush-it Pty Ltd

The presentation aims to show an ecological restoration method in Sydney based on understanding the presence of resilience in fragmented remnants. The fragmented remnants are resulted from the large scale removal of native vegetation community after the arrival of Europeans in 18th century. European settlement and increasing urbanisation caused environmental issues including increased stormwater runoff containing higher nutrient, changes in fire regimes, soil erosion and a loss of indigenous land management knowledge and experience which in turn had a negative impact on biodiversity. Bush regeneration is a proven and effective way of reversing the process of declining biodiversity. Whilst some ecological restoration process accomplish restoration through replanting native species, addressing soil erosion and other important controlling measures, bush regeneration aims to stimulate the propagules already existing in the seed bank and is seen as a relatively simple and inexpensive technique to restore native flora. Bush regeneration was introduced in early 1960s by Joan and Eileen Bradley based on three main principles, i.e., start from the areas that have the best potential for recovery, minimise disturbance to the natural conditions and do not over-clear a heavily weed infested patch that cannot be maintained. Bush regeneration aims to mitigate negative impacts on remnant vegetation by removing exotic species and encourages native seeds to propagate from the seedbank and re-establish without the need for revegetation. For example, infested Lantana camara in dry sclerophyll forest can be removed and consolidate for an ecological burn which leads to bush regeneration in urban Sydney region.

Monitoring blue grama (*Bouteloua gracilis*), other native grasses and forbs, and climatic variables on an integrated green roof system in the Flint Hills Eco-region

Skabelund, Lee R.; Carolyn E. Blocksome, Mary C. Knapp, Hyung Jin Kim, Dede Brokesh

Kansas State University

This presentation discusses an integrated (non-tray) native plant green roof. Although the Flint Hills Eco-region has many plants potentially suitable for green roofs, in-depth studies in the region are absent. A primary goal for this project has been to examine the viability of selected native grasses and wildflowers on a south-facing green roof. In May 2009, this 300 square-foot rooftop in Manhattan, Kansas was planted with four native grasses, ten native wildflowers, and four sedums. Air and soil temperatures, relative humidity, wind speed and direction, and rainfall are monitored every five minutes. Water leaving the roof is frequently measured. Soil moisture is also being monitored in 2013. Selected plants are evaluated after each growing

ORAL ABSTRACTS (CONT'D)

season for height, basal diameter, and number of flowering stems. Total plant survival is documented each year. In 2009, plant survival was essentially 100 percent, with most plants exhibiting flowers/seedheads. In 2010, native plant survival remained over 90 percent and many new grass seedlings established. Supplemental watering was eliminated on the west side in 2011 and many plants died back there. Limited watering of the entire green roof resumed in 2012. Climatic data indicates that surface temperatures frequently reach 120°F or warmer on the semi-vegetated southwest part of the green roof, occasionally exceeding 150°F. Nevertheless *Bouteloua gracilis*, *Ratibida columnifera*, and *Sedum kamtschaticum* continue to grow well in this area. Implications for semi-intensive native plant green roofs are many, including the need for some supplemental moisture for soils less than eight inches deep.

Hardwood tree growth after eight years on brown and gray mine soils in West Virginia

Skousen, Jeff

West Virginia University

Surface coal mining in Appalachia disturbs hundreds of hectares of land every year. During reclamation, coal mine operators plant a variety of grasses and legumes to re-establish a permanent vegetative cover in order to meet erosion and site stabilization requirements. However, soil compaction and competitive forage species have hindered re-colonization of native hardwood tree species on these reclaimed sites. To evaluate tree growth on selected spoils and determine the effects of compaction, three 2.8-ha experimental plots were established at Catenary Coal's Samples Mine in Kanawha County, West Virginia. Two plots were constructed of weathered brown sandstone and the third plot was constructed of unweathered gray sandstone. Half of each plot was compacted. Each plot was hydroseeded with an herbaceous cover and planted with eleven hardwood tree species. Soil chemical properties and tree growth were measured since 2005. After eight growing seasons, average tree volume index was nearly ten times greater for trees grown in the brown sandstone treatments, 3853 cm³, compared to 407 cm³ in gray sandstone. Trees growing on compacted treatments had a lower mean volume index, 2281 cm³, than trees growing on non-compacted treatments, 3899 cm³. Average pH of brown sandstone was 5.2 to 5.7 while gray sandstone was 7.9. The gray sandstone had much lower fines content (40%) compared to brown sandstone (70%), which influenced nutrient- and water-holding capacity. After eight years, brown sandstone showed significantly greater tree growth and survival, and is a more suitable topsoil substitute than gray sandstone.

Overview of Restoration Economics and the Restoration Economy

Skrabis, Kristin E.

US Department of the Interior

While there may not be a universally accepted definition of ecosystem services across disciplines, ecologists' general classification of provisioning services, regulating services, cultural services, and supporting services, aligns with the economic concepts of use and non-use values. With the ongoing heightened interest in jobs and the economy, scientists and economists can work together to tell a more robust story of restoration—that restoration projects restore injured landscapes and resources, provide cultural and recreational values, perhaps provide commercial opportunities—and much of this good work creates jobs and helps local economies. Shorter-term economic benefits from restoration result from the spending to plan, implement and monitor projects. Longer-term economic benefits result from changes in ecosystem services, which may have market and/or non-market values. Economic evaluation involves the identification, measurement, valuation, and comparison of the benefits (outcomes) and/or costs (inputs) of a policy, program, project, activity or event. Options include, but are not limited to, benefit-cost analysis, economic impact analysis, cost-effectiveness analysis (expenditure analysis), and natural resource damage assessment. An overview of restoration-related economic methods will be provided as background for non-economists in anticipation of the session's speakers.

The Role of Economics in Quantifying Injury from Mercury Contamination and the Scaling of Required Restoration

Skrabis, Kristin E.

US Department of the Interior

As part of the natural resource damage assessment and restoration process, information developed on the type and degree of injury to natural resources is used to quantify the adverse effects caused by a hazardous substance such as mercury. To quantify these effects as damages, various economic methods are used to determine the cumulative loss associated with the injury and the equivalent amount of restoration needed to compensate the public for the services lost over time from the injury. Two restoration-based economic tools, Habitat Equivalency Analysis (HEA) and Resource Equivalency Analysis (REA), are commonly used to establish this equivalence. With a well-defined set of assumptions and relatively easy calculations, HEA and REA allow government agencies to reliably determine how much restoration should be required to make up for the injuries caused by mercury. An example will be provided from the South River in Virginia, USA, where this approach is being applied to establish necessary and appropriate restoration to compensate for the sublethal effects of mercury to songbirds. Efforts include evaluation of both local and international restoration options.

ELTI's Permanent Training Sites Initiative: Capacity Building for Tropical Forest Restoration

Slusser, Jacob L.

Yale F&ES ELTI, Smithsonian Tropical Research Institute

Understanding the fundamentals underlying forest ecology and the use of tropical forests has become indispensable to manage the provision of environmental services in a sustainable manner in highly fragmented landscapes. While in recent years valuable information has been generated in

ORAL ABSTRACTS (CONT'D)

multiple research projects, it has not been effectively transmitted to the various bodies that influence the management of forests. In fact, within Panama and Latin America there is a great need for training opportunities to help guide informed decision making about the management, use and restoration of tropical forests. As a way to address the need for capacity building in the Neotropics, the Environmental Leadership and Training Initiative (ELTI) has established field-based training sites that contain interpretative trails and demonstration areas which are utilized to deliver ecological restoration courses. ELTI develops a curriculum and a course manual for each site to address three topics critical to restoration; the principles of forest ecology and ecosystem services, land use and forest degradation and strategies to restore degraded areas. In addition, field trips are also an integral component of the curriculum, for which the participants learn about the land restoration approaches of local landholders and demonstrate the diversity of socio-economic values that influence decision making in modified landscapes. ELTI facilitates various training courses tailored to meet the particular needs of participants and their restoration objectives, which provide them with the knowledge and tools of how to conserve and restore forests and biodiversity in the Neotropics.

The importance of instream habitat modifications for restoring channelized agricultural headwater streams

Smiley Jr., Peter C.; Kevin W. King, Robert B. Gillespie, Kathryn E. Sanders, Norman R. Fausey
USDA-ARS

Science based information on the influence of restoration practices on fishes within channelized agricultural headwater streams in the Midwestern United States is currently lacking. Understanding fish-habitat relationships and fish responses to specific restoration practices will provide information needed to develop restoration strategies for these degraded streams that are common throughout this region. We conducted fish community assessments within channelized agricultural headwater streams within the Upper Big Walnut Creek watershed, Ohio to address the following research questions: 1) what is the relative influence of riparian habitat, instream habitat, and water chemistry on fish communities? and 2) what is the influence of grass filter strips on physical habitat, water chemistry, and fish communities? From spring 2006 to fall 2010 we collected fishes and measured riparian habitat, geomorphology, instream habitat, nutrients, pesticides, and physico-chemical variables from 14 sites in the Upper Big Walnut Creek watershed. We found that fish community structure is more strongly correlated with instream habitat than either riparian habitat or water chemistry. Our assessment of grass filter strips indicated that grass filter strips lead to the widening of the riparian zones and did not result in changes to riparian vegetative structure, geomorphology, instream habitat, nutrient concentrations, herbicide concentrations, and fish communities. The combined results of our assessments of fish-habitat relationships and grass filter strips suggest restoration practices that do not lead to changes in instream habitat will not benefit fish communities within channelized agricultural headwater streams in the Midwestern United States.

Road Impacts and Mitigation Strategies to Restore Landscape Connectivity in Florida

Smith, Daniel J.
Department of Biology, University of Central Florida

An important objective of conservation planning and reserve design is the provision for functional landscape connectivity. For instance, a well-connected network of reserves might support viable populations or metapopulations of species that might not be supported within single, isolated reserves. Roads present significant obstacles in achieving this objective. Recent research on the ecological effects of roads has demonstrated the range and intensity of impacts to landscapes and biodiversity. Empirical data and landscape models for different taxonomic groups suggest distinctly different types of sensitivity to traffic, roads and road-related habitat fragmentation; hence, they require different mitigation strategies to restore severed, altered or disrupted ecological processes and habitat continuity for native biodiversity. The Florida Ecological Greenways Network provides a large-scale blueprint for reestablishing a functional set of habitat connections that are necessary for maintaining sustainable wildlife populations. This network allows for adaptation and movement in response to urban sprawl as well as climate change and projected sea-level rise. A statewide initiative to address the impacts of roads on this network has led to mitigation planning efforts to restore landscape connectivity. Mitigation approaches from several past, ongoing and planned projects to restore these connections at interfaces with roads are presented.

Speaking the same language: How the Joint Fire Science Program disseminates research to practitioners

Smith, Rebecca A.; Martha E. Lee
Northern Arizona University

A knowledge broker is an intermediary body that encourages, translates and disseminates research; one such organization is the Joint Fire Science Program (JFSP). The JFSP encourages and disseminates science that is tailored to meet the needs of fire practitioners. The JFSP also encourages research that focuses on new lines of science, including restoration and technology that is responsive to practitioners' needs. The JFSP works to bridge the gap between researchers and practitioners by publishing research in a way that is understandable and useful. Many practitioners surveyed agreed that the information presented in the JFSP publications is easily understood. The JFSP disseminates the most current research through a variety of channels such as social media, websites, email and print. However, this research found that practitioners and decision makers prefer to receive information on fire ecology and fire management through links in an email and from the JFSP website. The most preferred formats are print, videos, and a printable pdf. In order to be useful, the dissemination of science needs to be tailored to meet the needs of those who read and use science.

ORAL ABSTRACTS (CONT'D)

Shoreline and playa revegetation within a hyper-salinized National Wildlife Refuge in Central Montana

Smith, Russell F.; James Bauder, Laura Smith, Robert Dunn

Montana State University

Across the western United States, impacts to landscapes as a result of human induced salinization (saline seep) are increasing. This study identified environmental characteristics and revegetation techniques that allowed plant communities to colonize a saline lakeshore at Hailstone National Wildlife Refuge in central Montana. We examined the physical, biological, hydrogeochemical and spatial characteristics which allowed facultative and obligate halophytes to thrive, and used these factors for use in restoration planning and revegetation of streambanks and a newly exposed lakebed. Specific data was collected along a topographic gradient and within repeating bands of vegetation along a lake shoreline. Percent plant cover, species, rooting and groundwater depths as well as a full suite of geochemical analyses was examined. Our data graphically depicted salt distribution patterns and, when combined with plant coverage and species composition data, demonstrated a species-specific salinity and hydrologic tolerance along a gradient. As the lake was dewatered to fulfill wildlife management objectives, field scale restoration trials were initiated along the shoreline. We manipulated the soil surface with scarification and protective cover, added amendments and conducted field seeding of native halophytes and cultivars to determine germination and establishment success. Soils that were scarified and seeded with salt tolerant species, and had hydraulic connectivity to groundwater and seasonal precipitation demonstrated germination and establishment during the course of the project. We confirmed that these techniques can be used to further revegetate the streambanks and playa at this site and furthermore, can be transferred to other restoration sites.

Urban Reforestation – 25 years of ecological reforestation in river valleys and ravines. Principles and pragmatics of economics, community and government support.

Smith, Stephen

Urban Forest Associates Inc.

25 years ago, Toronto, Ontario, Canada began a concerted effort to clean up its watersheds using ecological principles and community involvement. The author, a forester, moved from managing simple Boy Scout tree plantings to being involved in the planning, ecological management and practical implementation of a substantial percentage of the work to "Bring Back the Don River" to ecological health, a program that is still continuing. As part of an intense multi-level ecological urban renewal and improvement, this paper will document the implementation of ecological restoration aspects of some of the work on the watershed and communities that we were involved in. It will show the changing principles of native species management, changing approaches to financial support for the reforestation programs, and will discuss the practical problems of land ownership and jurisdictions. The involvement of the Ecological Restoration movement in Toronto and Ontario and other conservation and Great lakes area changes will be related to the watershed reforestation actions. Evolving principles for use of schools and community action for implementation will be documented. And finally the future of urban and suburban ecological restoration in the present climate of fiscal disorder and concern about world environmental changes will be discussed.

Ecological Restoration Opportunities on Chicagoland Urban-Industrial Lands

Sonneville, Colter; Daniel Goldfarb

Wildlife Habitat Council

How can Chicago land ecosystems be restored and connected to provide crucial wildlife habitat when over 95% of the region's land is privately owned? Industrial landowners such as steel mills, power plants, and refineries often have large undeveloped prairie, dune and swale, upland forest, and savanna environments that remain untouched by industrial processes. The Wildlife Habitat Council is a nationwide non-profit of expert consultants working with companies seeking to increase biodiversity and implement high value conservation and environmental education programs that directly engage company employees and local community organizations. This synergy often leads to collaborative natural resource management relationships between Chicago land industries and technical experts at government land-management and regulatory agencies. As the "greening" of urban areas continues to pick up steam, Urban-Industrial landowners must play a more active role in safeguarding the biodiversity of increasingly fragmented ecosystems.

Changes in tree species composition, structure, and aboveground biomass of tropical secondary forests indicate long recovery times and deviations from patterns predicted by a chronosequence

Souther, John D.; Erika Marin-Spiotta

University of Wisconsin-Madison

Abandonment of agricultural lands is leading to increased secondary forest cover in parts of Latin America and the Caribbean. For this study, we were interested in whether or not secondary forests on abandoned pastures in Puerto Rico regain key characteristics of mature forests over time. To test changes in structure and composition, we resampled a chronosequence of well-replicated secondary and mature forest plots nine years after the initial census. Specifically, we asked: Does time since establishment affect (1) species composition (2) forest structure (basal area and stem density), and (3) aboveground biomass accumulation? Additionally, we compared rates of change between survey years to changes expected based on 2003 chronosequence data. In both census years, species composition varied with forest age. The common pioneers *Cecropia schreberiana*, *Schefflera morototoni*, and *Tabebuia heterophylla* all reached maximum importance values in younger (≤ 39 years) forests. Another colonizer, the nonnative *Syzygium jambos* L., reached peak importance in 89-year-old forests. Basal area generally increased with age, peaking in 89-year-old plots. The effect of stand age on stem density varied by size class. Biomass increased with age, reaching a maximum at 89 years. Dominance of the monocot *Prestoea*

ORAL ABSTRACTS (CONT'D)

acuminata var. montana in mature forests likely explains lower basal areas and biomass estimates relative to 89-year-old forests. While approaching similarity with mature forests over time, secondary forests remained structurally and compositionally distinct. Patterns from the initial survey of the chronosequence predicted some within-stand changes from 2003 to 2012, though responses varied by specific metric and among age classes.

To graze or not to graze: Reconciling cattle grazing and restoration in a savanna invaded by alien grasses

Souza, Flaviana M.; Antônio C. G. Melo, Silvana C. P. M. Souza, Giselda Durigan

Forestry Institute

Invasion by alien grasses is one of the major threats to Neotropical savannas conservation. Eradication of those species is a difficult part of the restoration process, because current practices may be costly and negatively affect the ecosystem. Also, open savannas are extremely threatened because of woody encroachment due to fire suppression. Hence, cattle grazing might be an alternative method to control invasive grasses and reconcile sustainable management and restoration, but experimental studies are very scarce. Here, we present the results of a seven-year experiment in a Brazilian savanna invaded by an African grass, *Urochloa decumbens*, in which we assessed the woody plant community and grass biomass in grazed and ungrazed sites. The overall results showed that native plant community did not change over time in grazed plots. However, density increased around 70% in ungrazed plots, leading to a shrub encroachment. *Urochloa* biomass remained consistently low in grazed plots, whereas in ungrazed sites it increased 45 times, which can potentially increase risk and intensity of wild fires. We suggest that cattle grazing can be used as an effective practice to control invasive grasses and to restore open savannas. While extensive cattle ranching has no costs and may generate income, other techniques, such as herbicides or manual control of grasses may be expensive and unsuccessful, thus becoming unfeasible in some situations. Therefore, cattle raising could be a powerful approach to provide economical gain for ranchers, who might become important allies for restoration and conservation of savannas in the neotropics.

Linking hydrodynamics and ecology to assess alternative management scenarios for the Emiquon Floodplain Restoration Project

Sparks, Richard; Changwoo Ahn, Misganaw Demissie, Douglas Johnston, Yanqing Lian

Illinois Natural History Survey

Reconnecting rivers with their floodplains, after decades of isolation of the floodplains behind levees, is complicated by the altered conditions of the rivers and their watersheds. In the case of The Nature Conservancy's Emiquon Floodplain Restoration Project, opening the levees would expose the floodplain to unnaturally high summer water levels maintained by the downstream navigation dam and to unnaturally erratic water level fluctuations caused by watershed alterations, dam operations, and water diversions. Alternative reconnection scenarios were evaluated by their simulated effect on the growth of a flood-dependent group of plants, the moist-soil plant community. These plants provide food and habitat for wildlife and help stabilize sediments against erosion. The plant growth model responded to daily water levels generated by a hydraulic model. The most reliable production of moist soil plants, over a 30-year simulation, occurred with the use of gates in the levee that were operated to approximate natural seasonal flooding in Emiquon, river conditions permitting. The gated scenario produced moist soil vegetation in 24 of the 30 years, compared to just 9 years with the opened levee. In the 9 years where both approaches were successful, the gated scenario produced equal or greater acreages of moist soil vegetation. Gate construction is scheduled to begin this year.

'Nucleating' nurses: Adult remnant trees improve sapling growth in Haitian reforestation

Sprenkle, Starry D.; Kevin J. Rice, Truman P. Young

UC Davis

Habitat recovery following fragmentation is a critical process for effective ecological restoration of degraded plant communities. Regeneration centered on existing fragments is an innovative restoration strategy that holds promise for severely degraded lands. Tests of nurse tree effects in reforestation, linking landscape and restoration ecology, are rare. We examined whether solitary adult trees improve the performance of planted saplings of two high-value timber species, *Cedrela odorata* and *Swietenia mahogany*, and fast-growing nitrogen fixing legume, *Delonix regia*, planted at distances from 1 to 35 m from adult trees in a deforested landscape in Haiti. We measured survivorship and growth over a three-year period, drought avoidance/tolerance in the first dry season (evergreen and drought deciduous responses), and phenology of new growth response to the first rains. Drought-deciduous *C. odorata* showed improved survival and growth and decreased leaf retention during drought within 5m of adult trees. Its growth onset phenology was delayed at distances greater than 15 m from adult trees. *Swietenia mahogany* had a curvilinear increase in survival to a maximum at a 20m distance from the nurse tree followed by a curvilinear decrease in survival, and *Delonix regia* showed improved survival near adult trees. The results suggest that adult trees can act as nurse trees for planted saplings of diverse species, showing benefits to drought-tolerant species *S. mahogany* and *D. regia* up to 30 m away, perhaps due to wind- or sun- sheltering microclimatic effects. Adult trees should be considered as potential establishment nuclei for dry forest restoration projects.

Are hypoviruses the Holy Grail of chestnut restoration?

Springer, Josh; Anita Davelos Baines, Dennis Fulbright, Andrew Jarosz

Michigan State University

Several American chestnut (*Castanea dentata*) populations in Michigan are recovering from chestnut blight, caused by *Cryphonectria parasitica*, due to the invasion of hypoviruses. We are evaluating how hypoviruses affect blight population structure and chestnut recovery. Hypoviruses reduce virulence, inhibit sexual reproduction, and reduce asexual sporulation in *C. parasitica*. Mating type ratios are highly skewed in *C. parasitica* populations where

ORAL ABSTRACTS (CONT'D)

hypoviruses are present and near 50:50 when absent, suggesting that populations with hypoviruses are largely asexual. In consequence, vegetative compatibility group (VCG) diversity and overall genetic diversity using microsatellite markers are lower in *C. parasitica* populations with hypoviruses. One exception is at Frankfort, Michigan where hypoviruses are losing their foothold and the *C. parasitica* population has doubled the number of VCGs since 1996 and microsatellite diversity is relatively high. Tree growth and survivorship are significantly higher in chestnut populations where hypoviruses have invaded blight populations. Overall tree biomass is steady or increasing at these “recovering” populations. Demographic analyses found that recovering chestnut populations recapture a growth rate and population structure predicted for disease-free populations, and imply that hypovirus invasion of *C. parasitica* populations can lead to full scale recovery of American chestnut populations. The Frankfort site is again an exception; trees at this site are beginning to decline; suggesting tree recovery is not necessarily permanent. Future work needs to determine conditions that foster hypovirus spread. As restoration of American chestnuts occurs in the eastern part of the tree’s range, hypoviruses are likely to be an important component of blight management.

Next generation mitigation: Regional mitigation strategies for utility scale solar development

Springer, Nikki

Yale School of Forestry & Environmental Studies

Compensatory mitigation programs administered by regulatory and permitting agencies are a critical source for funding and advancing ecological restoration throughout the United States. Landscape-scale planning is quickly being adopted by many federal agencies as a means of incorporating ecological restoration, multiple and competing land uses, and environmental stewardship. As such, the strategic planning and prioritization of ecological restoration and mitigation projects is facing a necessary paradigm shift. The BLM is piloting a new eco-regional approach to the planning of restoration and mitigation projects for utility-scale solar energy projects on public lands. By following this year-long pilot program and conducting extensive semi-structured interviews with a diverse group of stakeholders, this work analyzes the BLM’s new approach to restoration and mitigation in several contexts: meeting federal regulatory requirements, meeting industry market demands, and meeting the ecological needs identified by the best available science. The BLM is using this program as a means of testing and evaluating new ways of incorporating eco-regional assessments into landscape-scale planning related to both resource extraction and conservation. A critical evaluation of the successes and shortcomings of this pilot program is a critical step in helping our nation’s largest landlord develop environmentally sound strategies for the next generation of development on public land that meet the economic needs of for-profit industry and are durable components of national-scale landscape planning. Though this case study is focused on utility-scale solar development, these mitigation and restoration planning strategies can and ultimately will be applied to all resource uses on public lands.

Peachtree Creek Restoration Greenway: Connecting People, Place and Nature along Atlanta’s Waterway

Stainback, Susan; Ryan Gravel, Sally Sears

Sylvatica Studio Landscape Architecture, Ecological Planning

Peachtree Creek is a surprising connector of people and places in Metropolitan Atlanta but the Creek corridor itself is generally inaccessible and practically invisible to the seven million people in the region. A remnant of a once vital natural system, the remaining lands, naturally occurring open meadows, wetlands, banks and forests are bound by urban edges and ravaged by invading exotic plants. Restoration of the naturally diverse habitats of the Creek corridor will help provide a retrofitting of the natural system within the urban fabric. To help return this historic waterway to its rightful place as a respected asset of the region’s natural resources, an inspired group of engaged citizens are working for its restoration, conservation and protection. The South Fork Conservancy collaborated with an interdisciplinary team of Urban Planners, Landscape Architects, Ecological Planners and Ecologists to plan a network of 30 miles of low impact walking trails that connect underutilized and inaccessible lands along the Creek to existing parks, cultural resources and neighborhoods. A first phase of development provides planning for 6 miles of trail from Buckhead to Emory University. The design envisions that the resultant trail system and restored ecosystem together with the reclaimed corridor will be a unique place in Atlanta, where nature takes precedence over the built urban environment. Its success will be measured by how it contributes to the health and livability of people in the City, how it creates new stewards of the land and how it contributes to the cleaning of the watershed.

Investigation of restored prairie sensitivity to interannual variability in precipitation

Stanton, Nicole L.; John M. Blair, Sara G. Baer

Kansas State University

Interannual variability in rainfall amounts is a strong determinant of aboveground net primary productivity (ANPP) in native tallgrass prairie. However, relatively little is known about how ANPP responds to interannual variability in rainfall in restored prairies, where directional changes in soil nutrient availability and community structure may interact with precipitation to influence ANPP. An understanding of the sensitivity and controls of ANPP responses to rainfall amounts in restored prairie is necessary to predict responses to current climatic variability and future climate changes. We compared ANPP responses to annual rainfall amounts for eight years between 1998 and 2012 in both native and restored prairie and found that ANPP in restored prairie was less sensitive to interannual variability in rainfall than comparable native prairie. Further, we found that, following an increase during the first few years of restoration, ANPP steadily declined over time in the restored prairie. This pattern also held true for plots receiving supplemental N (5g N/m² /year), suggesting that this decline was not due to decreased rates of N supply as expected in a restored agricultural field. Thus, we hypothesize that the decline in ANPP is due to shifts in community composition, which may also mask responsiveness to interannual variability in rainfall in restored prairie.

ORAL ABSTRACTS (CONT'D)

Novel ecosystems and climate change

Starzomski, Brian

School of Environmental Studies, University of Victoria

Climate change science has long recognized the possibility for dramatic changes in ecosystems due to shifting climate, and there are many recent examples of just these sorts of ecosystem changes. The most dramatic have been labeled novel, 'no-analog' or 'non-analog' systems, combinations of abiotic conditions with no modern equivalents that may lead to communities of species we have never seen living together before. The consequences of this are profound: how do we adapt to and manage ecosystems we have no experience with? How are our concepts of ecological restoration altered in the face of climate change? This talk will explore the consequences of changing climate for novel ecosystem development, persistence, and management.

From science to implementation: a case study of the Northeast Kingdom of Vermont to Northern New Hampshire (NEK-NNH) landscape linkage

Steckler, Peter

The Nature Conservancy

Conservation organizations and public agencies have made great progress protecting landscape-scale conservation areas in the Northeast Kingdom of Vermont to Northern New Hampshire (NEK-NNH) Linkage, including natural areas and their surrounding working forests. However, these areas are separated by river valleys with associated fragmenting features including transportation corridors, agriculture, and development that serve as impediments to the free flowing dispersal of wide ranging mammals including many Species of Greatest Conservation Need. Conservation science was used to identify high priority conservation pathways between the landscape-scale conservation areas to maintain opportunities for forest dwelling and wide-ranging wildlife to disperse across the Linkage over time. We developed three strategies to maintain and enhance wildlife connectivity within the conservation pathways of the NEK-NNH Linkage, including land protection, road barrier mitigation, and restoration. For the land protection strategy, we developed a framework that prioritizes specific locations to effectively and efficiently protect landscape permeability. We identified 23 road barrier mitigation sites within the Linkage and developed brief implementation strategies for each. Road barrier mitigation strategies focus on areas within the right-of-way of major roads in the Linkage. We similarly identified and developed brief implementation strategies for seventeen restoration sites. These occur on private and public lands where altering land management will improve landscape permeability for wildlife. The presentation will provide an overview of the conservation science completed, the connectivity strategies identified, and plans for implementation moving forward.

Using focal bird species to help guide land management at regional to local scales in southern Wisconsin.

Steele, Yoyi; Michael Mossman

WI Department of Natural Resources

Carefully selected focal species can be useful indicators of community or ecosystem health. Their prudent use can help effect adaptive management by simplifying monitoring. Moreover, when selected partly on the basis of regional population and conservation assessments, focal species can help guide management. The appropriate use of focal species is both art and science, incorporating an understanding of ecological relationships, responses to management, conservation issues beyond those of the selected species, and landowner or manager needs—applied at an appropriate geographic scale. We describe the selection process of focal bird species and their use to help direct several related management programs in southern Wisconsin, at scales that are regional (Southern WI Forest Bird Initiative), landscape (Lower Wisconsin River and Leopold-Pine Island Important Bird Areas), and local (individual properties within the LPI IBA). We considered bird survey data, regional and global assessments of species and community conservation needs (e.g., Partners In Flight plans, WI Wildlife Action Plan), measurement and understanding of species habitat needs, interrelationships and population limiting factors; also, the habitat potential of the management area in question, and practical factors (e.g., private landowner needs, agency goals) that help guide management. Selecting focal bird species that reflect management needs of other priority fauna and flora, or entire communities, better insures appropriate long-term management and can draw partners together for common goals.

Restoration of understory plant communities in an oil and gas development region

Stephens, Garrett J.; Mark W. Paschke, Danielle Bilyeu Johnston

Colorado State University

Declining Colorado mule deer (*Odocoileus hemionus*) populations have necessitated improved habitat management techniques. In particular, oil and gas development in the Piceance Basin of western Colorado has impacted critical winter range, creating a need for treatments that will increase forage. Pinyon-juniper tree removal is one such technique, however it is unclear which method of tree removal will most effectively promote forage species. Here, we quantify understory responses to pinyon-juniper canopy removal by three different methods: hydro-axing, chaining, and rollerchopping. Twenty-one 0.8-ha plots were treated during the fall of 2011 (7 replicates of each treatment). Half of each plot was seeded prior to mechanical treatment with a mix of native grasses, shrubs, and forbs. The project targets these main questions: Does mechanical thinning increase forage biomass? Which treatment is most effective? Is seeding in conjunction with thinning necessary for increasing forage biomass? Understory plant data were collected during the summer of 2012 and will be resampled again in 2013. Despite extreme drought conditions during 2012, we observed greater seeded annual plant biomass in seeded subplots compared to unseeded subplots, which suggests early seral annual species may be lacking in the seedbank. We also observed decreased grass biomass in rollerchopping and hydro-axing treatments relative to chained plots. This indicates contrasting understory impacts between the different mechanical treatments.

ORAL ABSTRACTS (CONT'D)

Reducing Zinc phytotoxicity and promoting revegetation in sub-arctic Canada

Stewart, Katherine; Steven Siciliano

Yukon Research Centre

Phytotoxicity in northern environments poses a serious problem for the successful revegetation of disturbed sites. Flin Flon, MB Canada is a prime example of an area where mining and smelting activities have resulted in soils with high levels of heavy metals (As, Cd, Cu, Hg, Pb, and Zn), severe nutrient limitations, increased acidity, and decreased microbial activity, which in turn has led to poor plant biodiversity and unsuccessful forest recovery. Zinc phytotoxicity is of concern, however, the simple application of dolomitic limestone has not been universally successful at the site and the use of soil amendments that can act as a more effective liming agent to raise soil pH or can adsorb and/or precipitate Zn at a more acidic pH may be necessary. We examined the germination and growth of a grass seed mix across a range of soil types with a number of soil amendments including fishmeal biochar, calcium bentonite and wood fibre mulch. Higher rates of germination, aboveground and belowground biomass occurred in soils with higher organic matter content and lower Zn concentrations. We observed higher aboveground biomass in soils with higher Zn concentrations and either high or low organic matter content treated with the combined fishmeal biochar, bentonite and mulch amendment, however, this difference was not significant. The incorporation of these surface amendments and changes in Zn speciation that will reduce phytotoxicity likely requires longer than a single growing season. Further monitoring and Zn speciation of treated soils is on-going to confirm observed trends.

The Economics of Restoration: Costs, benefits, scale and spatial aspects

Strassburg, Bernardo; Agnieszka Latawiec

International Institute for Sustainability

The relatively high costs of restoration projects are perceived as a barrier for their large scale implementation. It is therefore essential to transition from a paradigm where restoration is mainly seen as a very expensive activity that produces areas with no economic value to a new one where restoration is recognized as an investment in the development of areas that will provide goods and services to society. A crucial step is the development of business models for restoration, aimed at improving the return that restored areas can deliver to land owners. These can be made via a combination of reducing costs, increasing and diversifying revenues and decreasing risks. Additionally, exploiting economies of scale might offer important competitive advantage to large restoration efforts. Large scale restoration projects, however, have to consider their "land footprint", and devise strategies to deal with the impact of their demand for land in order to diminish competition for land. In a context of land scarcity, this is a fundamental consideration. Planning conservation efforts at landscape scale can substantially reduce the potential for conflicts with alternative land-uses and maximizes potential synergies between restored and agricultural areas. Developing careful land-use plans at landscape scale can also improve ecological and economic returns of restoration.

From floating wetlands, living piers, green bulkheads to algal turf scrubbers, the integration of ecological engineering with urban waterfront restoration

Streb, Chris

Biohabitats, Inc.

Historically, as cities developed, many urban marine waterfronts replaced historic wetlands with armored banks, eliminating the habitat and water quality function of wetland buffers. Polluted runoff from urban watersheds has further degraded waterfront quality with floating trash, algae blooms, and fish kills. Restoring ecological processes and functionality to urban marine waterfronts will take a mix of ecological restoration, ecological engineering, biomimicry and a good dose of creativity. Four promising cross disciplinary solutions provide a glimpse of how we can rethink restoration in highly altered near-shore environments; floating wetlands, living piers, green bulkheads and algal turf scrubbers. This presentation will provide glimpses into each one of these techniques including associated benefits, challenges and opportunities.

How the combination of Ecological Restoration and Landscape Architecture can create a Sustainable Corporate Campus

Street, Sara

Construction Specialties, Inc.

Construction Specialties, Inc.(C/S) is in the initial phase of creating sustainable human structures and ecological restoration components on their corporate campus in Muncy, PA. The landscape architecture components are an employee meeting area, universally accessible trail system, native plant nursery, stormwater capture and reuse, and stormwater best management practices. The ecological restoration encompasses reforestation, a warm season meadow, and a riparian buffer around a pond. This effort supports C/S internal efforts of creating Cradle to Cradle Certified building products. The long term goal is to become land stewards that host environmental education programs for local school students. This is a complex project that requires many fields of expertise. Once the project is installed, how will monitoring support the corporate entity goals? A Sustainability Scorecard can measure the values of: biodiversity, extent of impact, habitat conversions, invasive species, etc. as well as the traditional measurements: water use, energy use, carbon emissions, etc.

ORAL ABSTRACTS (CONT'D)

Fusing Eastern and Western outplanting practices for success: Restoring forests in Lebanon

Stringer, Darin

Pacific Stewardship LLC

Lebanon has a long history of deforestation dating back to the pre-Phoenician era and has only recently begun to focus efforts to restore forest cover. Unfortunately, seedling survival from initial restoration projects has been poor. Recently, the Lebanon Reforestation Initiative (LRI), a US AID funded effort to build community capacity to restore their lands, has achieved a fundamental transformation in the way tree seedlings are produced and planted in Lebanon using the Target Plant Concept. For outplanting practices, this shift has blended proven traditional methods, tools, and materials with innovative and scientifically supported Western-based approaches. Based on observations and collected data, changes have been implemented in planting timing, hole preparation, planting tools, and moisture conservation. Spring 2013 monitoring in areas where improved practices and high-quality container seedlings were used shows improved survival and vigor compared to surveys from the previous year. LRI is working closely with each community to insure these outplanting practices become ingrained and adopted in the long-term.

Can Municipal Effluent and Storm Drains Restore Dewatered Urban Rivers?

Stromberg, Juliet C.; Margaret S. White

Arizona State University

In arid regions urban rivers are often dewatered via diversions and groundwater extraction, but some of this water may return to the river as municipal effluent and storm drain runoff. Questions have surfaced as to whether these 'new' urban water sources can be directed to restore riparian ecosystems. We explore this topic by drawing from case studies in Arizona. In Phoenix, riparianization (irrigation) of the landscape, combined with large expanses of impermeable surfaces, produces considerable runoff. This water is discharged via storm drains into the Salt River, producing multiple short stretches of riparian vegetation. These discharges have a temporal signature that mimic regional flood patterns and maintain high species diversity, with reaches downstream from perennial storm drains as floristically diverse as actively restored sites. In Tucson, municipal effluent sustains surface discharge in the heavily dewatered Santa Cruz River basin. The hydrogeomorphology of the receiving stream strongly influences the extent of riparian forests, with nearly twice as much forested area in reaches where surface water and groundwater remain connected. Additionally, both effluent and storm runoff are nutrient-rich and produce shifts in species composition toward nitrophilic species (those with strong response to nitrogen addition). However, this shift is not necessarily accompanied by increased relative abundance of introduced species as has been observed in other regions. We conclude that effluent and storm drain runoff can be effective at achieving some degree of riparian restoration given the presence of suitable hydrogeological conditions, flexible expectations for outcomes, and ability to secure the water sources.

Active restoration of riparian migratory corridors in the Lake Michigan Basin in Ozaukee County

Struck, Andrew; Matt Aho

Ozaukee County Planning and Parks Department

The Ozaukee County Planning and Parks Department has implemented a comprehensive effort to restore aquatic habitat connectivity and improve the ecological function of existing riparian habitats throughout the County portion of the Milwaukee River Watershed and Lake Michigan Basin. The watershed downstream of Ozaukee County is highly urbanized, with little of the formerly-abundant wetland and riparian habitat remaining in its natural state, resulting in reduced native species abundance and diversity. Ozaukee County has significant contiguous tracts of relatively intact, high quality, and/or protected, suitable spawning and rearing habitat, if hydrologically connected and, in some cases, improved. Enhancing the ecological productivity of aquatic and terrestrial riparian habitat directly supports sustainability and/or population recovery for remnant desirable, native, and/or imperiled species. Since 2006, the Department's Fish Passage Program and partners have identified and removed/remediated over 180 impediments to aquatic organism passage, reconnecting over 100 stream miles and thousands of wetland and floodplain acres. These activities include large-scale dam removal and restoration projects. The Program is also developing a GIS-based fish and wildlife decision-support tool to prioritize in-stream and riparian habitat improvement and restoration projects for the maximum benefit of multiple target species. Tool outputs are guiding ongoing, large-scale habitat projects that include stream re-meandering, floodplain and wetland reconnection, and invasive vegetation control. Together, these activities constitute a landscape scale effort to restore the ecological productivity of fragmented and/or formerly degraded riparian habitat to benefit several native, remnant and/or imperiled fish, wildlife, herptiles and bird species.

Managing for resilience: an important but deceptively-simple concept

Suding, Katharine N.; Lauren M. Hallett

Department of Environmental Sciences, Policy and Management, University of California Berkeley

Ecological resilience, the size of the basin of attraction in which a system sits, is notoriously hard to measure. Now, punctuated with recent calls from government and conservation groups, we are tasked to manage for resilience, or in other words, to increase the size of the basin of attraction and better enable recovery after a stochastic event. In a recent survey of 200 restoration projects, we found that resilience is not commonly incorporated in restoration: 18% projects stated goals related to resilience, and only 5% specified a plan to measure resilience. In order to better incorporate resilience in restoration projects, we suggest a strategy, based on work with several conservation groups, that involves three components: 1) address gradually changing stressors, 2) prevent damage when a stochastic event occurs, 3) enhance recovery after the event by ensuring response components are intact. We end by discussing the example of managing for resilience in a changing climate.

ORAL ABSTRACTS (CONT'D)

Forest lepidopteran communities are more resilient to shelterwood management compared to more intensive management regimes

Summerville, Keith

Drake University

The goal of this study was to assess whether forest lepidopteran communities displayed three different forms of resilience following experimental timber harvest. Specifically, I examined how moth species assemblages were restored to pre-logging composition (compositional resilience), species richness (structural resilience), and guild diversity (functional resilience) after forest management. Lepidoptera were sampled from 16 forest stands managed with one of four harvest treatments: no logging, clear-cutting, shelterwood harvests, and group-selection harvests. Moths were sampled from all forest stands one year prior to harvest in 2007 and immediately post-harvest in 2009-2011. Moth community composition only appeared to be resilient to timber harvest in stands managed with shelterwood methods (15% biomass removed) or in the unlogged stands within managed concession units. Both total species richness and species richness of *Quercus*-feeding moths also appeared to recover to a near original condition three years post-shelterwood logging. In contrast, moth assemblages in clear-cut stands and group-selection stands (80% biomass removed) remained impoverished. Tests of functional resilience suggested that richness of species known to be pollinators was largely unaffected by timber management, and the number of moth species known to feed on herbaceous vegetation doubled in stands logged using group selection methods. Dietary specialists were disproportionately abundant in stands managed with less intense disturbance. These results suggest that most methods of forest management have short-term negative impacts on woody-plant feeding Lepidoptera, but that the effects are limited to a few years when the harvest method involves shelterwood cuts.

Restoring tiger landscapes in Sumatra: Lessons (not)learned, challenges & opportunities

Sunarto, Sunarto

WWF-Indonesia

Tigers (*Panthera tigris*) are in danger of extinction. Their populations have declined from ~100,000 to only ~3,000 individuals in a century and their habitat has shrunk to less than 7% of the historic range. Of the five extant tiger subspecies, the Sumatran tiger (*P. t. sumatrae*) is the most seriously threatened. Currently determined as Critically Endangered under IUCN criteria, the Sumatran tiger is likely to become extinct unless effective conservation measures are enacted. One of the most pressing threats is habitat loss, mainly due to conversion of natural forests into pulp-and-paper or oilpalm plantations. To restore the tiger population and ensure its long-term viability, two major steps are required. First, the critical core areas should be conserved. Second, more areas should be protected and restored, especially those that connect subpopulations. This paper discusses some lessons (not)learned, challenges, and opportunities from implementing a strategy to restore tiger population across multi-use landscapes in Sumatra.

Identifying high priority connectivity zones for restoration of longleaf pine in the southeastern USA

Sutherland, Ronald W.; Robert F. Baldwin, Paul Leonard, Rachael Carnes, Nick Haddad

Wildlands Network

Longleaf pine (*Pinus palustris*) forest was originally the most important ecosystem in the southeastern United States, but due to a variety of factors this forest has been reduced to a small fraction of its former range. The large blocks of longleaf that still remain are widely scattered across the Atlantic and Gulf Coastal Plains, with few existing corridors or connections between them. Restoring more longleaf habitat is a high priority for land managers in the region, but to date no detailed plans have been presented that could serve as a guide for targeting new restoration efforts in such a way as to reconnect the existing core areas into a more viable network. We have attempted to address this gap by running fine-scale habitat connectivity analyses focused on longleaf pine across the range of the tree species. Using Circuitscape and other connectivity analysis software, and a large parallel supercomputer, we have been able to create highly detailed maps showing the likely flow of longleaf-related organisms across the landscape. Dispersal resistance across various non-longleaf landcover types was calibrated as a function of both the similarity of the landcover to longleaf pine, and the degree of human-induced barriers imposed by urban developments and roads with varying degrees of traffic. Our results should serve as a very useful spatial template for guiding and prioritizing future restoration efforts for longleaf pine across its range, with benefits for a number of rare wildlife species.

Good intentions that went wrong: Using lupine in land reclamation in Iceland

Svavarsdottir, Kristin; Gudmundur Ingi Gudbrandsson, Johann Thorsson

Soil Conservation Service of Iceland

Lupinus nootkatensis originating from Alaska was introduced to Iceland in the late 1940s for reclamation purposes. It is a fast growing tall legume with high nitrogen fixing rate and high seed production - characteristics favored by many reclamationists. Seed production began in the late 1980s by the Soil Conservation Service of Iceland thereby enabling a large scale sowing of the plant on reclamation sites and in forestry. Simultaneously, worries were raised as the plant began to spread over large areas. Some 25 years later the plant is ubiquitous, not only on barren land as originally had been predicted but also on fully vegetated areas due to competitive advantage over native species. Lupine is still used for reclamation and forestry. Controversial debate has lasted on the issue during the last couple of decades but the extent of the lupine distribution has not been known. In 2012 a project began that aims at developing techniques for mapping the distribution of lupine using satellite images only. Due to the tall stature and high biomass of lupine compared to most native species the results up to date are promising and a distribution map is aimed to be completed in 2014. Such detailed knowledge on distribution is essential to priorities management efforts aimed at preventing further spread and extirpate the species where it is possible.

ORAL ABSTRACTS (CONT'D)

The Leopold-Pine Island Important Bird Area: Science, Partnership and Adaptive Management.

Swenson, Steve; Mike Mossman, Yoyi Steele

Aldo Leopold Foundation

The Leopold-Pine Island IBA is a complex of marsh, meadow, shrub swamp, floodplain forest, savanna, grassland and cropland spanning 15,000 acres along the Wisconsin and Lower Baraboo River floodplains and adjacent uplands between Wis Dells and Portage. We describe the IBA and how a researcher, planner and land manager have used birds as a common currency to bring together the NGO, State, Federal and private partners to determine common goals, set management priorities, and effect conservation on-the-ground, through a process involving research, partnership, perspective and strategic action. We began with a thorough inventory of breeding birds and their habitats using transects and point-counts, and volunteer "Breeding Bird Atlas" observations. We evaluated the bird and habitat data, linked birds to plant-animal communities and management actions, and identified priorities by applying regional and statewide bird conservation priorities to these data. This led to a strategic vision and property-specific objectives and management considerations that accommodated existing property goals yet contribute to "a whole that is greater than the sum of its parts." Inventory and longterm monitoring are done by staff and volunteers according to standard protocols and a pioneering adaptation of the eBird program, and partners are working together to share expertise and resources. Active involvement and a common vision benefit partners, and are essential to the project.

Restoring wildlife habitat and landscape integrity in low speed – low volume road systems

Switalski, Adam

Wildlands CPR

Low-speed low volume roads are a ubiquitous feature in natural systems throughout the world. The US Forest Service alone manages more than 375,000 mi (600,000 km) of primarily unimproved native surface roads. These roads dissect wildlife habitat causing fragmentation, avoidance, and overall loss of habitat among other impacts. The US Forest Service is in the midst of a five-year planning process to identify an ecologically and fiscally sustainable minimum road system. As the Forest Service moves to "right size" their road system, the agency has already reclaimed more than 50,000 mi (80,000 km) of roads through methods ranging from simply closing the road to entirely reclaiming the road through full recontour. Large-scale restoration of roaded areas has resulted in measurable benefits to fish and wildlife habitat and landscape connectivity across the US. Results from research and extensive Forest Service monitoring have demonstrated significant reductions in erosion and the risk of road-triggered failures. Recent research has focused on revegetation following restoration treatments as invasion of non-native plants remain a significant concern in some ecosystems. Benefits to fish and wildlife habitat have been explored including documentation of improvements to bull trout (*Salvelinus confluentus*) and black bear (*Ursus americanus*) habitat. Most recently, the role of road reclamation on ecosystem processes has been explored with results suggesting benefits to soil productivity and carbon sequestration. While just beginning to be explored, road reclamation may also help mitigate the impacts of climate change and restore landscape-scale connectivity.

Environmental Discourses in Borana Oromo: A Focus on Narratives

Tafesse, Teshome

Addis Ababa University

This study explored the discourses of environmental narratives as an organized, viable, and dynamic social force basic to the creation and dissemination of environmental messages in Borana Oromo of the southern Ethiopia. Under this major objective, the study discovered environmental beliefs and values, investigated environmental knowledge, power and ideology, and identified environmental positions the community has situated itself in. The study employed a qualitative approach in the analysis of data gathered through semi-structured interviews, focus group discussions, and extended participant and non-participant observations. The analysis was based on Fairclough's three-dimensional methodological approach of discourse analysis, which is helpful for elaborating empirically based theories. Based on the snowball data gathering technique, the researcher gathered data from key informants of Didara, Elwaya and Dubluk kebeles of Yaballo woreda, Borana zone. The findings revealed dominant environmental beliefs and values, which are organized under discourses of environmental necessity and survival, scarcity and security, hopelessness, inclusion and exclusion, seniority, responsibility, and obedience and disobedience. The findings also unveiled that Borana narratives are embedded with environmental ideologies- interdependence and communalism, which are deep rooted in the social, cultural, religious and political context of the community. The findings, as part of the environmental discourses, also investigated aspects of the indigenous environmental knowledge of the Borana community. The study also disclosed two dominant environmental positions-ecocentrism and restrained anthropocentrism that humans assume in their interactions with the natural environment in the community.

Evidence of species and functional group attrition in shrub-encroached prairie: Implications for restoration

Taft, John B.; Zachary P. Kron

Illinois Natural History Survey

Shrub encroachment is a significant threat in native grassland habitats that most prairie managers face. This study exams differences in native grassland plant species and functional groups (FG) associated with increasing levels of woody encroachment, based on leaf area index (LAI), and identifies thresholds relevant to restoration potential. The study questions were 1) how do ground layer species and FG cover, richness, and diversity differ with increasing levels of woody encroachment, 2) are there thresholds of woody encroachment relevant to restoration potential, and 3) are there ordered patterns of FGs associated with levels of woody encroachment that serve as ecological indicators? LAI was examined as a continuous variable and divided

ORAL ABSTRACTS (CONT'D)

into 4 equal classes for mean comparison tests. The study area is a 65-ha tallgrass prairie, old field, and shrubland mosaic in Lake County, Illinois. Density of plant functional groups declined significantly with increasing LAI. Significant declines with increasing LAI also were found for FG cover (dicot forbs, sedges, C3 and C4 grasses) and FG richness (dicot forbs, perennial monocot forbs, C3 grasses and C4 grasses). Native FGs most strongly associated with the lowest LAI classes were C4 grasses and dicot forbs (hemi-parasites and legumes were limited to the lowest LAI cover class, but were scarce). Study results suggest that opportunities for restoration remain following intermediate levels of woody encroachment and highlight ordered patterns of loss in the cover and richness of FGs that can be used as a guideline to evaluate restoration potential of sites undergoing shrub encroachment.

Role of forest ecosystem in mitigating global warming and implication for ecological restoration in Ethiopia

Takele Dime, Teshome; A.J. Solomon Raju

Andhra University

The study was conducted in Komto-Walane forest ecosystem with the objective of evaluating the soil organic carbon (OC) stock of the natural forest in comparison to the adjacent plantation and agricultural land. Soil samples were collected from the three land use types with four replications. Five pits from the four corners and the center of 20m*20m quadrat were dug up to 1m depth. Samples were taken at 0-10cm, 10-30cm, 30-60cm and 60-100cm depth increments from each sample depth and mixed separately to form sample for the quadrat. OC was analyzed according to Walkley & Black method. Other sets of soil core samples from each pit and depth were taken for bulk density determination. The result of the study revealed that the OC stock was significantly ($p < 0.05$) higher under natural forest. At 0-10cm depth the OC stock of natural forest was higher by 20.06 and 28.73 t ha⁻¹ which were equivalent to 38.07% and 54.53% than plantation and agricultural land respectively. Moreover, at 0-30cm depth natural forest was similarly higher by 44.06% and 52.12% in OC stock than plantation and agricultural land respectively. However, at the lower depth (60-100cm) the difference decreased to 22.33% and 14.62% respectively. This amount of organic carbon which was stocked in the soil because of the existence of forest would otherwise be emitted to increase the atmospheric carbon dioxide, the major cause of global warming. Hence, proper management of the remnant forest ecosystems and restoration of the degraded areas are fundamental option to mitigate global warming.

Comparative approaches to establishing a difficult-to-grow shrub for restoration: A case study using shaggy-barked manzanita (*Arctostaphylos tomentosa* ssp. *tomentosa*) in California.

Tallis, Joshua; Mary Carroll, Cynthia Fenter, Douglas T. Fischer, Danielle Muir, Mitch Siemens

ARCADIS U.S.

Shaggy-barked manzanita predominates in maritime chaparral in Monterey, California. In nature it reproduces primarily after fire, either from seeds or from basal sprouts originating from existing burls. It is a difficult species to grow from seeds or cuttings, so tends to be avoided by the nursery industry. In a recently planted 14-acre restoration site in Monterey, we improved our chance of success by 1) contracting with four different native plant nurseries to grow this species from cuttings and 2) salvaging small shaggy-barked manzanita shrubs and immediately transplanting them to the restoration site. Our results indicate that 64% of the transplanted manzanitas were alive 3 months after planting ($n=114$) and 30% percent of the container manzanitas grown from cuttings were alive two months after planting ($n=1,755$). Since salvaging is generally more labor intensive on a per plant basis we compare the benefits of salvage vs. nursery production. The restoration site presented challenges (a former Army base undergoing Munitions and Explosives of Concern remediation) for both propagation approaches due to the technical expertise and training needed to perform activities like plant salvaging, container planting, and collection of cuttings. Variables considered when comparing each approach prior to and during restoration implementation include available plant material, survival following planting, size of salvaged plant material, time interval to plant maturation, and introduction of potential nursery-borne pathogens to the site.

A case study to examine future directions of modeling niche difference and relative fitness difference relevant to restoration

Tansey, Erin E.

Trinity University

Invasion theory suggests that species coexistence is enhanced through niche partitioning and that species with overlapping use for limited resources will compete. Outcomes of competitive interactions can be determined through examining both niche differences and relative fitness differences of the species. Developing models is an important tool to inform restoration and conservation strategies, but models are pointless and even counterproductive when their assumptions limit them in accurately modeling species dynamics. Here I examine the limitations of some competition models with particular emphasis on a niche and fitness difference model proposed by Carroll et al (2011). I provide a case study of competition between a native (Sideoats grama - *Bouteloua curtipendula*) and invasive (King Ranch bluestem - *Bothriochloa ischaemum* var. *songarica*) perennial, C4 grass species in Texas to demonstrate the limitations of previous models and I propose a new model that aims to eliminate the common problems. The purpose of my presentation is to stress the importance of developing models that can be successfully translated into the development of applied restoration methods.

Law and ecological restoration: Creating operative legal frameworks for landscape level restoration

Telesetsky, Anastasia; Afshin Akhtarkhvari, An Cliquet

University of Idaho College of Law

One of the recurring themes in restoration work is the need to operate at an ecological landscape level. This is necessary to ensure space within which to preserve genetic diversity, the capacity for self-sustaining ecological functions, and ensure redundancies to avoid catastrophic disturbances. Operating

ORAL ABSTRACTS (CONT'D)

at the landscape level is not straightforward since political boundaries frequently bisect ecological landscapes. This presentation will describe a number of existing legal and policy efforts to address ecological restoration at the landscape level such as the U.S. Landscape Conservation Cooperatives and then propose additional legal reforms to promote cooperative transboundary restoration efforts. The analyses of the legal responses to landscape level issues relating to ecological restoration suggest that engaging with legal institutions and the legislative process is not straightforward. Since both the acts of legislating and ecological restoration are about making difficult choices among an array of socio-ecological options, it is important to understand the dynamic relationship between law-making and restoration activities. This presentation will argue that, with a few exceptions, legal responses at the landscape level have largely failed to engage holistically in identifying socio-ecological restoration objectives and that future legal directives need to take into account both the complexities of restoration work and the need for self-reflexivity.

What leads to success when restoring species-rich grasslands in central and northern Europe?

Temperton, Vicky M.

Plant Sciences (IBG-2), Forschungszentrum Jülich

Restoration of species-rich grasslands in central and northern Europe poses perhaps a special case in restoration, in that such habitats are usually semi-natural and require extensive human management or conservation measures to continue existing. Without such management (e.g. with intensification or extensification of land-use), such habitats disappear. This is the key threat to species-rich grasslands and heathlands in Europe. A pivotal question in restoration of such grasslands in Europe therefore is whether such changes (intensification and extensification) are reversible or not? This contrasts strongly with restoration of grasslands in the New World or in Australia, where it seems that the key limitation to restoration is the dominance of exotic species and detrimental effects on establishment of desired native species, as well as interactions with eutrophication / atmospheric N deposition. In my talk I will cover some of the well-known key limitations to restoring species-rich grasslands in central Europe (seed dispersal, microsite limitation, eutrophication) but also include a new approach, testing whether the sowing of different plant functional types in different sowing orders can affect assembly filters and hence long-term trajectories of restoration. I will particularly focus on the key question posed above: how easily can one reverse land intensification into successful grassland establishment? The talk will be embedded in the broader question of whether one can call human-dominated species-rich grasslands novel ecosystems or not, as well as the implications of novel communities and ecosystems for restoration of grasslands.

Life to ad(d)mire—Restoring drained and overgrowing wetlands

Tenning, Lisa; Annelie Lundgren, Fredrik Lundin, Johan Rova, Kristofer Paulsson, Magnus Strindell, Kristin Lindström, John Granbo, Thomas Hansson

County of administrative board of Jämtland

The Life to ad(d)mire project will restore 35 Natura2000 sites from the North to the South of Sweden. The project aims at stopping the decrease of the targeted habitats and species at these sites through hydrological restoration and vegetation measures. Wetlands have an important role to play in preserving biodiversity. Many plants and animals depend on wetland biotopes, and nearly 15 % of Sweden's threatened species live in peat lands or on freshwater margins. Hydrological changes and plant invasion in wetlands have an affect the animals and plants which live there. Other wetlands within the project have been used as for hay making in the past, but agricultural modernization has made this use unprofitable and therefore almost none of these sites are in use today. Agricultural species adapted to these ancient land uses are decreasing or going extinct due to overgrowing and change of management. Life is the environmental fund of the European Union and was founded in 1992. Life is thereby EU's financial instrument supporting Nature and Environmental conservation projects. Life Nature supports projects within Natura 2000. Natura 2000 is a network established for EU's most threatened species and habitats. Life Nature supports projects that contribute to the implementation of the EU's Birds and Habitats Directives, the Natura 2000 network and that support the goal of halting the loss of biodiversity.

Reproductive biology of *Lumnitzera racemosa* Willd. for its restoration in Indian mangroves

Thakur, Pratibha; A. K. Bhatnagar

University of Delhi, Delhi, India

Indian coastline was once dotted with extensive mangroves. Habitat loss, fragmentation and over-exploitation have led to their shrinkage, affecting not only the unique biodiversity but also the coastal human communities. Pollution and climate change have also emerged as potential threats. A series of conservation measures have been initiated to conserve and restore the mangroves. These include promotion of alternate sources of energy and an extensive afforestation programme. Restoration projects have been undertaken for olive ridley turtle, gharial and mud crabs. Afforestation is restricted to a few common mangroves. Restoration of threatened plant species requires a thorough understanding of their pollination and seed ecology. Studies on pollination ecology and breeding system of *Lumnitzera racemosa* Willd. (Combretaceae) were conducted in Devbag mangrove of Kali river estuary in Karwar, northern Karnataka (India) during 2008-2011. Trees are self-compatible with bisexual, protogynous flowers, pollinated by wasps, butterflies and moths. More than 80% seed set was observed in manual as well as natural pollination. Fruits are indehiscent and dispersed by water currents. Embryo abortion in seeds was much higher following natural pollination (78.38%) as compared to manual pollination with distant pollen (22.22%). Seeds formed following natural and manual pollination showed germination percentage of 11.76 and 16.67% respectively. Seedlings were not able to survive in natural conditions. It seems that pollination is restricted due to fragmentation, and inbreeding depression is the cause of embryo abortion and poor seedling survival. Optimal gene flow and pollen quality are important for restoration of the mangrove species.

ORAL ABSTRACTS (CONT'D)

Catastrophic regime shift and the alternative stable state of the Eastern Savanna Ecoregion, North America

Thomforde, Stephen

Great River Greening

Catastrophic regime shift and alternative stable state models (CRSASS) provide a framework to describe processes whereby functional ecosystems rapidly transition to dysfunctional ecosystems. CRSASS models are used to describe transitions in fresh-water, estuary, marine, and arid grassland ecosystems. CRSASS models force us to identify keystone species and processes which impose strong control over energy-chemical flows which in turn reinforce a particular biotic community. Knowledge of keystone controls on ecosystem processes allows us to design valid restoration strategies. I test CRSASS general principles efficacy to explain transitions and describe restoration strategies for the Eastern Savanna Ecoregion (ESE), North America. First I define the ESE in time and space. Second I describe keystone species and processes which reinforce both the functional and dysfunctional states. Third I develop state transition models to chronograph changes in biotic controls and associated alterations in energy-chemical flows which facilitate catastrophic regime shift and the alternative stable state. Results concur with CRSASS general principles, and through the framework emerge two alternative stable states for the ESE. The functional state is dominated by long-lived, recalcitrant, symbiotic, edible species that tightly regulate energy-chemical flows to produce quality ecosystem services. The dysfunctional state is dominated by short-lived, liable, competitive, inedible species that accelerate energy-chemical flows which prohibits quality ecosystem services. Both states self-reinforce through a set of biotic feedbacks and are therefore stable. In conclusion, CRSASS models provide a framework to develop robust narratives to explain observed trends in the ESE, while providing powerful insight for designing valid restoration strategies.

Meet the Challenge of Change: The Duty to Accept Novel Ecosystems

Thompson, Allen

Oregon State University

Throughout the 20th century those concerned with natural environments practiced conservation: protecting natural areas and wildlife from human development and other incursions. Especially in the 'new world,' a dualistic conception of humans vs. nature prevailed. Wild nature, environmental ethicists argued, bore a non-instrumental value in proportion to its degree of autonomy from human interference. The intrinsic value of nature was thus associated with historical conditions, prior to human affects. Conservation biology, restoration ecology, and environmental ethics converged on these value commitments. But in the 21st century we face a new challenge: anthropogenic and directional environmental change. Ethicists often invoke the principle (attributed to Kant) that "ought implies can." So, if there are effectively irreversible ecological thresholds, as postulated in the definition of novel ecosystems, then morally what ought we do? I argue that if we face irreversible anthropogenic environmental change, then we have a moral duty to future generations to adapt ourselves appropriately. In particular, if we face a future characterized by an increasing emergence of novel ecosystems, we have a duty to develop an appropriate managerial framework. This will inevitably raise a host of significant concerns and questions about the value of novel ecosystems. My thesis is that our moral obligation to adopt some framework for managing novel ecosystems at the landscape scale and develop an intervention ecology outweighs our otherwise understandable commitment to principles of non-intervention and promoting the value of historic nature. Part of what we owe the future is a new attitude toward ecological change.

Restoration Triage: An Ethical Perspective

Thompson, Allen

Oregon State University

Under conditions of increasing anthropogenic environmental change, how should we approach difficult decisions about the allocation of limited resources for restoration? An economic perspective may look to provide answers by appealing to efficiency and consequences through the application of cost/benefit analysis. Alternatively, I consider how the problem may appear from an ethical perspective grounded in an account of our obligation to undertake restoration. Different accounts of why we morally ought to do restoration are available in the literature; these may be categorized according to how restorative activity is understood to right the wrong that's been done. First, "harm views": human-caused degradation may be thought of as having brought about a loss of value, which humans are then obligated to return via restoration. Second, "virtue views": participation in restoration is morally required as a corrective to those deficiencies of character, individually or collectively, that ultimately are the cause of damage. Finally, "justification views": the obligation to restore, to rectify damages done to nature, arises from a failure to adequately justify to other members of the moral community actions that caused the damage. Benjamin Hale argues that appeal to interpersonal obligations has advantage over the harm and virtue views by avoiding the 'baseline problem' and addressing why restoration can fall out of a duty to remediate and make reparations. By considering more closely what future generations may be willing to countenance, I suggest that this account of our obligation to do restoration can also help guide us in prioritizing such obligations.

Land degradation and recovery following the Eyjafjallajokull 2010 eruption

Thorsson, Johann; Kristin Svavarsdottir, Asa L. Aradottir

Soil Conservation Service of Iceland

The 2010 Eyjafjallajokull eruption in Iceland has given us a valuable insight into the active degradation processes that govern land exposed to volcanic material deposition. Permanent plots were established around the volcano, covering denuded land, sparsely vegetated heathlands and woodlands in order to assess post-eruption conditions and to monitor land recovery. Plots were measured in summers 2010, 2011, 2012 and 2013. Experiments were also established to test the direct effects of the volcanic ash on vegetation and soil temperature. Dense vegetation, either grasslands or woodlands,

ORAL ABSTRACTS (CONT'D)

reduced ash dispersion, thus decreasing local erosion risk considerably. The ash also formed a temporal black blanket covering the soil which increased temperatures and may have facilitated mobilization of soil nutrients. An increase in harvest commonly reported during the following summer may be explained by such soil temperature change. Woody areas recovered faster than heathlands. Sites where severe degradation occurred and persisted through the monitoring period, were restricted to sparsely vegetated areas. This highlights the importance of ecosystem resilience in areas prone to disturbances. Changes in vegetation composition were also less in woodlands than open areas. Moss cover increased in open areas creating plant communities that can be less resilient than communities dominated by vascular plants. This study and the management experiences obtained after the Eyjafjallajökull eruption have shown how important land conditions prior to disturbances are. Therefore all land use planning must incorporate evaluation of land conditions and its resilience.

An in-situ experiment to evaluate differing sources of plant propagules on the restoration of the black cottonwood (*Populus trichocarpa* T. & G.) forest community

Tiedemann, Robert; Stewart Rood

University of Idaho, Center for Ecohydraulic Research

Modifications to floodplains have contributed to the direct loss of riparian wetlands, and the functions and services they provide to the public. River regulation by dams has had the secondary impact of muting natural processes - such as timing, duration, and magnitude of flood flow events - that contribute to the natural reproduction of riparian plant species. The need for propagules to restore these areas now far exceeds the availability and affordability of common materials and methods for restoration. This experiment tests the hypothesis that the use of readily available sources of differing, naturally occurring plant propagules (e.g. seasonal seed shower, wetland mulch, and riparian topsoil) and the timing of their application can influence the resulting riparian plant communities, with some more desirable than others. Native woody species such as black cottonwood and Pacific willow (*Salix lasiandra*) were favored by native sub-soil; and Wood's rose (*Rosa woodsii*), Sitka alder (*Alnus sinuata*), and coyote willow (*Salix exigua*) by wetland mulch. The proportions of native herbaceous species observed in each of the treatments also showed fidelity of a species to a particular treatment. Hardstem bulrush (*Schoenoplectus acutus*) grew exclusively in the wetland mulch while Torrey's rush (*Juncus torreyi*) exclusively in native sub-soil. In all treatments weedy species dominated test plots showing the importance of on-going maintenance by weed removal, control of wildlife, and application of temporary establishment water until a desirable restoration trajectory can be achieved that is likely to lead to the required level of naturally occurring functions and services.

Social and ecological factors influencing attitudes towards the application of high intensity prescribed burns to restore fire adapted grassland ecosystems

Toledo, David; Michael G. Sorice, Urs P. Kreuter

USDA-ARS

Fire suppression in grasslands systems that are adapted to episodic fire is a major factor that has contributed to the recruitment of woody species into grasslands worldwide. Even though the ecology of restoring these fire prone systems back to a grassland state is becoming clearer, the major hurdle to reintroducing historic fire at a landscape scale is its social acceptability. Despite the growing body of literature on the social aspects of fire, an understanding of human dimensions of applying high-intensity prescribed burns in grassland and savanna systems is lacking. We used structural equation modeling to examine how landowners' attitudes towards high-intensity prescribed burns are affected by previous experience with burning, perceptions of brush encroachment, land condition, proximity constraints, risk orientation, their fire management knowledge and skill, access to fire management equipment, and subjective norms. Our results suggest that experience, risk taking orientation and especially social norms (perceived support from others) when implementing prescribed burns play important roles in determining attitudes towards the use of high-intensity prescribed burns. Concern over lack of skill, knowledge and insufficient resources have a moderately negative effect on attitudes towards high-intensity prescribed fires. Our results highlight the importance of targeted engagement strategies that address risk perceptions, subjective norms and landowners concerns in order to increase the adoption of high-intensity prescribed burns that lead to landscape-scale grassland restoration and conservation benefits.

Improved restoration of mine-affected forests in the Philippines through innovative monitoring system using Landscape Function Analysis (LFA)

Tolentino, Jr., Enrique L.; Aljoy Abarquez, Aida B. Lapis, Rodolfo, Jr. L. Velasco, Eva Ocfemia, Remedios Evangelista, Armida P. Andres

University of the Philippines Los Banos

The presentation aims to provide rehabilitation managers of mining companies of the estimated US\$ 1 trillion mining industry with objective and reliable information concerning rehabilitation progress using the Landscape Function Analysis (Tongway & Ludwig, 2011). Piloted in six (6) mining companies in the three major islands of the Philippines, measurements were conducted during the wet and dry seasons in rehabilitated and analogue/reference sites. Initial results revealed that the average patch index ranges from 0.01 to 1.32 in rehabilitated sites. The analogue site ranges from 0.50 to 1.44. From the eleven Soil Surface Assessment parameters, the following LFA indices were computed: for rehabilitated sites, stability ranges from 1.5 -85.3, infiltration 1-68.3 and nutrient cycling 0.3-70.8 versus the analogue/reference forest values of stability (52.4-75), infiltration (25.2-76.5) and nutrient cycling (21.8-88.9). Absolute values for the various parameters have not been established in the Philippines yet but data revealed the significant differences with the analogue/reference sites and between rehabilitated sites. Significant disparities in LFA indices between rehabilitated and analogue sites should be warnings on the need to improve rehabilitation performance. Values indicate which biophysical functions are still impaired. The initial results showed LFA can provide mine rehabilitation managers with simple and scientifically validated monitoring parameters that relates to

ORAL ABSTRACTS (CONT'D)

the biophysical functioning of the landscape enabling them to see the progress of their rehabilitation efforts through time. Appropriate adjustments in resource allocation, adapting technologies and site-specific interventions can be made.

Ecological processes after restoration of boreal peatlands

Tolvanen, Anne; Oili Tarvainen, Anna Laine

Finnish Forest Research Institute /Thule Institute of University of Oulu

Almost one third, nearly 100 000 km², of the total land area is covered by peatlands in Finland, which is a higher relative cover than in any other country in the world. Over a half of the peatland area has been drained for forestry, and many invaluable peatland habitats are severely degraded. Restoration is a relatively recent management option of forested peatlands and is principally carried out in protected areas. Vegetation indicators are commonly assessed to indicate restoration success, but they can be slow to respond. Changes in the mineralization and decomposition rates may indicate sooner, if processes typical for undrained peatlands are initiating after restoration. We studied how restoration affects the hydrology, peat forming processes, and vegetation of boreal peatlands. Fens drained for forestry 30 – 40 year earlier were restored in northern Finland in 2007 by harvesting trees and by damming and filling ditches. After restoration, the raise of water level was immediate. Mineralization and decomposition rates, which were initially higher in drained peatlands, had usually slowed down to the level of undrained peatlands two years after restoration in 2009. Little changes occurred in the vegetation in two years. Five years after restoration in 2012, moss species typical for hollows were found in the filled ditches of restored peatlands, which indicates restoration-driven plant succession. The results show a sequence of changes in ecological processes after restoration, whereby hydrology recovers first, mineralization and decomposition rates thereafter, and the plant succession is the last process to change.

Measuring Success of Ecological Restoration Projects—the Use of Species Diversity and Richness Indices and Other Quantitative Measures

Toohill, Michael J.

BSC Group Inc.

Measuring project success is all too often an afterthought in a restoration project. This paper examines the aspects of up-front planning, establishing reasonable and measurable goals, reference systems, trajectory setting, and creating a monitoring program tailored to measurable goals. The emphasis of the paper is on this final step—structuring the post-restoration monitoring and making reasonable inferences of success based on monitoring data. Over the years a variety of quantitative and qualitative measurements have been used to judge the success of restoration projects. These range from simple, sometime qualitative, measurements such as percent cover (or percent bare ground or open water) to more data intensive measures such as functions and values analyses and habitat suitability indices. To more fully analyze success from a post-restoration data set the author suggests the use of a multi-tiered analysis. For example, monitoring success of a wetland restoration project might include answering the following questions: First: Does each plot still qualify as a wetland? (e.g. use of USFWS National Wetland Indicator status and the USACE wetland data plot protocol) Second: Are there changes in the community makeup? (e.g. use of stem counts showing succession change, counts of invasive species) Third: How diverse (robust) is the restored community? (e.g. use of species diversity/indices of heterogeneity) The author will use examples from several types of restoration projects to illustrate a range of quantitative measures of success, communication of the results, and will explain the uses of diversity/richness/heterogeneity measures in ecological restoration project evaluation.

Wind disturbances in the north west black sea region's forests in Turkey

Topacoglu, Osman; Arif Oguz Altunel, Oytun Emre Sakici, Erol Akkuzu, Ozkan Evcin

Kastamonu University

There are many factors which are effective in process of formation and development of the forests. Wind has a big effect on forest ecosystems in many regions of the world. Kastamonu region's forests which are located in Euro-Siberian vegetation zone is affected by wind disturbances from time to time. On 15th of March, 2013, the biggest loss of the recent years was recorded as a result of wind blowing 90 km/h. It is assumed that approximate loss is 525000m³. This study aims to find out the variables shaping the wind damage which affects Scots pine stands. For this purpose, broken/uprooted and standing trees, diameter of trees (dbh), tree height, crown width and length, root system of fallen trees, soil features (soil depth and bedrock type), topographical features and management methods are investigated. The results shows that, individual tree attributes, stand level characteristics and management methods significantly influence the severity and type of wind damage. The root-soil plate size and root system architecture are important components of tree stability. Since Scots pine can not develop its main root in stony soils, it develops shallow roots and is more prone to uprooting. The timing is also critical. It was observed that increase pit and mound topography caused by uprooting trees. This study has focused on the silvicultural precautions towards the possible wind disturbances in the future. Silvicultural suggestions for the study area have been made for minimizing the wind damage and ensuring formation of stabilized stand structure.

Use of seed bank samples for restoration purposes in the Pannon region of Europe

Torok, Katalin; Katalin Szitar, Krisztina Szilagyi, Norbert Barath, Krisztian Halasz

PreseCentre for Ecological Research, IEB HASnter: Katalin Torok

Seed banks are valuable tools for ex situ conservation of vascular plants to complement habitat protection. The use of their biological material for restoration needs further research. An EU funded project aims to collect half of the wild flora of the Pannon biogeographical region (800 species) by the establishment of the Pannon Seed Bank, and to test how the stored seeds can be used for reintroduction at degraded areas. Ten species (suitable

ORAL ABSTRACTS (CONT'D)

for storage) of the sand steppe community typical to the Pannon biogeographical region have been selected for the test case at a Natura 2000 priority habitat (Pannonic sand steppes and inland dunes) of the Kiskunság National Park. A two hectares old-field of more than 20 years of age is used to test the effect of storing time (1-3 years), seed collection year and meteorological circumstances on seedling emergence and survival. Seeds are treated according to the seed bank protocol. As pre-treatment, the invader milkweed was sprayed by herbicide, and strip ploughing was applied before seeding. In 2011 large amounts of seeds could be collected, but the extreme drought of 2012 reduced seed development significantly. This way the seeded area had to be restricted as compared to previous year (seeding density remained). Five species out of ten produced seedlings and survived by June 2012, at a rate between 0,01 to 1,32 %. A propagation experiment is set up with and without irrigation to increase the average 5000 seeds per sample to larger quantities for restoration.

Restoration of historic stream flows and landscape connectivity via dam removal and stream/adjacent plant community restoration in western Massachusetts

Touchet, Tom
AECOM

Linear ecosystems, such as rivers and streams, are often prone to fragmentation from a variety of human activities, including the installation of culverts and dams. The presence of dams in these riparian systems is particularly disruptive to a host of functions including sediment and nutrient transport and the hindrance of movement and usage of portions of the system by resident and migratory organisms. The presentation case study focuses on the removal of the Upper and Lower Hathaway Dams located in Dalton, Massachusetts and subsequent restoration of the adjacent plant community, stream channel, and historic flows for brook trout (*Salvelinus fontinalis*) habitat. The Lower and Upper Hathaway Dams were constructed around 1893 and 1908, respectively, to provide a water supply source for the City of Pittsfield until the late 1950's. Both dams were removed in 2010 as off-site mitigation for a dam repair project located nearby. The overall goal of the project was to restore the ecological integrity and connectivity of Hathaway Brook to allow migration of brook trout and other aquatic organisms from the Housatonic River to the upper reaches of the brook. Activities included: demolition of both dams, reuse of impounded sediment, installation of a new stream bed, and extensive planting of native vegetation using the adjacent natural ecosystem as the reference ecosystem for the final restoration product. Within a year following the completion of the project, brook trout were observed in the restored stream channel segments, in addition to many wildlife species observed within the restored riparian corridor.

A New Human-Nature Relationship in Pasture Management in South America

Tourrand, Jean; Fernando Coronato, Hermes Morales, Amaury Burlamaqui, Soraya Carvalho, Enzo Fasioli, Rene Pocard-Chapuis, Alejandro Schweitzer, Alejandro Saravia
Cirad

From the 16th century, the human-nature relationship in rangeland management in South America has been based on the mining practices of natural resources such as soil, water, natural vegetation and some cultivated forages. That was the best way found by the European settlers and their descendants to colonize new lands and progressively to develop the hinterlands. The weak sustainability of these mining practices have led to a gradual degradation of natural and cultivated pasture, more or less fast according to the ecosystem and the set of practices, especially overgrazing, bad use of burning and no respect of vegetative cycle. Based on the same research developed in three contrasted South-American biomes (Austral Patagonia, Argentina; Pampa, Uruguay; Western Amazon, Brazil), the authors try to better understand the complex sets of reasons which have led to adopt more sustainable pasture management. The method uses a comparative analysis of the mental models of local people about livestock activities in the past, the current situation and their future scenarios. Beside diverse land issues, the need to intensify the livestock production and the great offer of new technologies, the authors identify some human dimension factors such as the demand of local societies for collective livelihood improvement, the recent national and international environmental policies related to global warming and the stronger awareness of consumers for sustainable development. May be facing the global change, the practices of rangeland management will change in a more sustainable way, going to better society-environment interaction and human-nature integration.

Need of a new rangeland management for the Bedouin Society after a 15-years drought

Tourrand, Jean; Ibrahim Daoud, Veronique Alary, Mona Abdelzاهر, Adel Aboul Naga, Naem Moselhy
Cirad

The North Coast and western desert in Egypt is located between the delta of the Nile valley and the Libyan border. Bedouin tribes have developed farming systems based on flocks, small barley fields and some fig and olive trees. From 1995 to 2010, the annual rainfall didn't exceed 140mm. Due to the weak productivity of the rangeland and barley, breeders have to purchase by-products and concentrates. They overuse their herd by selling animals. The size of the herds decreases and breeders are obliged to find other sources of income, especially through economic migrations, out-farm jobs, occasional jobs or invested in wadi agriculture. Moreover, due to the lack of family labor who have preferred other activities, many breeders have reduced long transhumance. Maintaining the flocks in the rangeland near of the villages has induced a rapid degradation process. Facing the conjuncture of factors like low rainfall, strong wind erosion and overgrazing, the rangeland progressively disappeared, and the soil at the end of the process, giving nowadays wide lands of stones desert. Based on data collected in 182 farms and around 25 interviews with local stakeholders the authors show the poor efficiency of traditional rules of Bedouin tribes to manage the rangeland. Based on the analysis of vulnerability at the farm and family level and the social network, if restoring rangeland productivity needs new technologies from an agro-ecological point of view, this process must be implemented at the tribal level to define the rules and norms of future rangeland management.

ORAL ABSTRACTS (CONT'D)

Making the Case for Your Maintenance Budget: Lessons from Urban Stormwater Restoration.

Travaglini, Mary

Department of Environmental Protection, Montgomery County Maryland

If you built a public bathroom, would you arrange to clean it? If you bought a car, would you schedule the oil changes? So why would you restore a forest, river, prairie, or shoreline, and walk away? Yet, we all know maintenance budgets are the first to be cut, sometimes before the designs are finished. In many cases, if there is no maintenance budget, the entire restoration should be considered at risk for failure. Once all the landscape architects, engineers, planners, and builders walk away from a restoration project, success is usually guaranteed by the programs designed to maintain it until it is self-sustaining, or perhaps for a lifetime. Whether your project is a tree planting, invasive plant removal, stream restoration, species restoration, or urban restoration, maintenance will be necessary to ensure success. Some of the best lessons learned are from the maintenance professionals, as well. Maintenance is not just watering, weeding, or picking up trash, it is also repair and replacement of failed structures, dead plants, modified soils, storm repair, and more. Mary will share how maintenance of stormwater bioretention facilities has not only ensured success of urban restoration projects, but has brought lessons from the field on how to improve bioretention designs that reduce maintenance costs. She will also discuss other examples of maintenance needs for various kinds of restoration projects, and some projects that have failed from lack of maintenance. Walk away prepared to defend your maintenance budget, or include it if you forgot to.

Effectiveness of Water Management Practices at Tram Chim National Park, Vietnam

Truyen, Duong Minh; Karen S. Doerr

Can Tho University

Tram Chim is a remnant wetland of the plain of reeds, which was drained prior to reunification. Tram Chim was most well known for being home to the Eastern Sarus Crane (*Grus antigone sharpii*) and many other water birds. We used Tra Su Melaleuca Forest, a similar depressional wetland, as a comparison. The first objective was to analyze the hydrology of Tram Chim through a water budget and by assessing the variability and connectivity. The second objective was to survey the types of soils present and understand the processes involved. We found the water velocity at Tram Chim was close to 0. The pH values at Tram Chim indicate that water levels at unit A4 have been kept too dry for too long, causing acid soils to be oxidized, creating acid water when the wet season occurs. We also found the acid sulfate soils at Tram Chim were deeper in the profile than at Tra Su, indicating that more deposition occurred at Tra Su. Tra Su receives more high-energy water from the Mekong, which drains quickly and initially deposits larger sediments in larger quantities. Due to this problem, many managers at Tram Chim attempting to restore the hydrology while Tra Su maintains a constant water level at all times.

Moving toward a more dynamic platform for restoration and the need to consider extreme disturbance events

Twidwell, Dirac; Samuel D. Fuhlendorf, Brady Allred, William E. Rogers

Oklahoma State University

In order to meet the sustainability targets of scientists, policymakers, and the general public, broad-scale management frameworks are needed that guide resource management actions and conservation funding decisions at national and international levels. However, there are concerns that current management frameworks are not sufficiently addressing the various sustainability issues facing the human population – now and in the future. To this end, we reviewed state-and-transition models within the USDA-NRCS Ecological Site Description (ESD) Database, which is set to become one of the world's largest guiding frameworks for terrestrial ecosystem management as a result of U.S. government-mandated collaboration among federal agencies. In this paper, we present an overview of a national synthesis of the ESD Database. We discuss how state-and-transition models within ESDs promote management for invariance in ecosystem dynamics and do not move applied ecologists toward a more dynamic platform for conservation and restoration. Yet, our recent experimental work demonstrates that fire-dependent grassland ecosystems in the Great Plains are dependent on conservation and restoration efforts that fully restore the potential range of variability in fire as a biophysical process. While such an approach directly conflicts with modern anthropogenic values associated with development, infrastructure, food demands, and recreational perspectives in the Great Plains, a novel societal movement (prescribed burn cooperatives) has emerged to restore fire to Great Plains grasslands. We discuss the potential for this private citizen-organized effort to overcome sociopolitical constraints and meet restoration objectives in fire management.

Workshop: Earth without “art” is just eh

Ulrich, Cheryl P.

Weston Solutions, Inc.

The importance of art in communicating and building advocacy is a much-needed and untapped arena within ecosystem restoration programs. Artists think differently than engineers and scientists and can help drive the framing of implementation issues. Aviva Rahmani has defined four benefits of incorporating artists to our ecosystem restoration interdisciplinary teams: Artists can help build a driving narrative for community and the media. Artists are wild cards, often catching ideas ahead of science and being educative catalysts. Ecological artists can help build broad cultural constituencies. Ecological artist can initiate novel strategies to create a set of values. This will be an interactive panel discussion about the importance of art in communicating restoration. Cheryl Ulrich (Weston Solutions, Inc.) will set the stage by sharing the struggles of implementing the large multi-decade Everglades restoration program. Nanciann Regalado (US Fish and Wildlife Service) will then discuss the challenges of running a large outreach program for the Everglades and engaging the passionate stakeholders and building advocacy amongst a large diverse population. Gwen Eyeington (Artist and Environmental Science Publisher, J. Ross Publishing, Inc.), an Everglades artist will discuss her perspective of being a “pure artist” in the restoration

ORAL ABSTRACTS (CONT'D)

community. Finally, Mrill Ingram (University of Wisconsin-Madison, Department of Geography) will share her experiences of artists contributing to science as well as to issues of social justice through ecological restoration projects. The entire panel will then define opportunities for turning art into advocacy for ecosystem restoration. We will discuss potential uses of art to get alignment and financial support to fund ecosystem restoration efforts. This discussion will encourage conference participants to think beyond their current approach to outreach and building advocacy.

Large-scale Private Lands Restoration and Landscape Connectivity

Vacariu, Kim

The Wildlands Network

Working ranches can play a critical role as wildlife safe harbors and as stepping stones connecting public refuges and parks in the West. The Western Landowners Alliance is a newly formed non-profit that works to advance policies and practices_ that sustain working lands, connected landscapes, and native species. The Alliance has members from Sonora, Mexico to Alberta, Canada, who collectively steward 10 million acres of deeded and leased lands. Members are working to restore their lands to optimal health and to minimize the effects of grazing and other income producing activities. The Alliance organizes landowners into a community based on a shared vision of restored and productive land health, and advocates on their behalf at the local, state, and federal levels. This presentation will further explain this unique Alliance, review some of the stewardship models employed by participating landowners, and discuss the role of working lands in large landscape conservation and restoration.

Protecting Large-Scale Wildlife Habitat Connectivity through Continental Collaboration in the Western Wildway Network

Vacariu, Kim

Wildlands Network

One of the last best opportunities to identify and protect wildlife habitat corridors in western North America is upon us. Members of the Western Wildway Network (WWN), including many of the West's most respected conservation organizations, are collaborating to implement pieces of a 5,000-mile "Western Wildway" that stretches from Mexico's Sierra Madre Occidental north through the Rocky Mountains and associated ranges, grasslands and forests to Canada's "Yellowstone to Yukon region. Multiple regional protection and restoration efforts are underway that together represent the science-based recommendations of several Wildlands Network Designs (WNDs) covering the Sky Islands of SE Arizona and SW New Mexico, the New Mexico Highlands in northern NM, the Grand Canyon/Colorado Plateau ecoregion, the Southern Rockies in Colorado, and the Heart of the West region of NE Utah and SW Wyoming. Other compatible conservation initiatives in northern Mexico, Montana and Alberta/British Columbia, Canada round out the collaboration that makes the WWN's vision for a connected West one of the most ambitious wildlife conservation projects every undertaken. This presentation will detail the history of the WWN and the means by which the network intends to reach its goals, including the current "TrekWest" campaign designed to build a groundswell of support for national corridor protection rule-making/legislation, to identify connectivity problems and solutions, and to expand the existing WWN into an influential and powerful force dedicated to implementing a viable Western Wildway.

Rockhouse riparian demonstration project: creating breeding habitat for the endangered Southwestern willow flycatcher (*Empidonax traillii extimus*) in central Arizona

Valencia, Ruth; Lesly Swanson

Salt River Project

Salt River Project (SRP) operates a series of dams and reservoirs on the Salt and Verde Rivers in central Arizona to supply water and power to the Phoenix area. Operations at the largest of these reservoirs resulted in periodic inundation of riparian habitat used by breeding Southwestern willow flycatchers, an endangered species, and yellow-billed cuckoos (*Coccyzus americanus*), a candidate species, protected under the Endangered Species Act. As part of the mitigation for those impacts, SRP created 20-acres of breeding habitat for these species in the vicinity of the reservoir. The objective was to develop a dense stand of suitable breeding habitat using native riparian plant species: *Populus fremontii*; *Salix gooddingii*; *Baccharis salicifolia* and *Salix exigua*. Plants were installed using three methods, including a waterjet stinger for pole cuttings, hand planting for containers and a pneumatic staple gun for cuttings. Plantings were flood irrigated and monitored for health, mortality and growth by species and planting method. Total mortality of all planted trees was 30.1%. In 2009, protocol surveys for flycatchers and cuckoos were initiated. In that year, 3 cuckoos were detected. In 2010, 5 cuckoos were detected and 2 pairs confirmed and they continue to utilize the habitat each year. Flycatchers were first confirmed on the site in 2010. Three territories were occupied by single males but no females were detected. In 2012, we detected 24 adult flycatchers in 15 territories and confirmed 10 pairs and fledglings. This was the first confirmed occurrence of flycatchers breeding in a created riparian habitat.

Workshop: The Living Landscape Approach: A New Way of Engagement with Self, Community and Land

Van den Broeck, Dieter

Living Lands

Landscapes are complex systems where we need to engage with challenges with intertwined social, ecological and economical dimensions. This, combined with the dire state of our environment and social system, push us to look for a new way of engaging with the problem at hand and the people affected to collectively find and implement sustainable solutions and create more resilient systems. The engagement we are looking for is co-creative, adaptive, mutually beneficial, and is deeply built on trust and openness to create an enabling environment to interact with oneself, the community,

ORAL ABSTRACTS (CONT'D)

society and the landscape we live in. This new way of engagement needs to foster strong a sense of belonging, ownership and community to engage, capacitate and share resources for collective action for long lasting and sustainable solutions. As a contribution to this challenge, this workshop will create a co-learning space around our “Living Landscape” approach. It integrates the Presencing Journey, trans-disciplinary research and ecosystem approach. This approach provides opportunities for all stakeholders, by moving through the “U” process, to engage with a deeper place of inner reflection on the social-ecological system and their role within this system as a means to identify and create viable community-based responses what are well inform by strong (scientific) knowledge base and ecosystem thinking.

Balancing priorities in restoration - the issue of resilience

Van Diggelen, Rudy
Antwerp University

Until now, a major target in ecological restoration has always been to enhance biodiversity. In almost all projects the main question was how to improve the conditions for threatened (“red list”) species. However, this goal is no longer undisputed. There is a clear shift towards other targets, especially to restore resilience and ecosystem-services. Politicians like these words, which they interpret as “not needing much management and therefore cheap” (resilience) respectively “providing free services to mankind that otherwise would have to be paid for and therefore even cheaper” (ecosystem services). At the same time the large public is still mainly focused on the conservation and restoration of species and ecosystems. The present contribution will discuss the different targets in more detail, with a specific focus on resilience. It will summarize what is known about parameters that enhance resilience and explore the spatial implications in the context of a freshwater wetland landscape. I will translate the outcomes into practical knowledge, aimed at evaluating alternative scenarios for the restoration of degraded fen systems. Finally, I will evaluate to what degree there are synergies possible between restoration activities aimed at increasing resilience and those that seek to enhance other goals.

Northwestern US Forests: The Management Perspective

Van Horne, Beatrice
US Forest Service

Restoration of northwestern US forests on the dry east side and moist west side of the Cascade crest is a high priority for the US Forest Service. In practical terms, what does this mean? Timber harvest over the past century, along with fire suppression, has affected these forest types differently. In both types, “restoration” has come to refer primarily to mechanical thinning to mimic effects of natural wildfires. Where even-aged harvest has produced large areas of small-diameter trees and brush, such thinning may do a better job of restoration than prescribed burning. Thinning for improved production of wood fiber or to reduce fire risk can be quite different, however, than thinning for ecosystem restoration. Taking a very large-landscape perspective, thinning does not address the need for high-quality early-successional habitat. The system of reserves set up decades ago by the Northwest Forest Plan, in combination with multiple ownerships with multiple objectives to match, ignores the dynamic nature of these forests and constrains our ability to find a “sweet spot” for managing to meet multiple objectives. This region is pressed politically to produce merchantable timber to supply rural economies, to reduce fire risk, and to preserve habitat for endangered and threatened species. We have some great tools to predict management effects and find prescriptions that address multiple objectives, but how can we find ways to apply these tools across large landscapes?

Emiquon Fish Community Response to 6 Years of Restoration

Van Middlesworth, T.D.; Nerissa N. Michaels, Andrew F. Casper
Illinois Natural History Survey

Restoration of The Nature Conservancy’s Emiquon Preserve has led to both ecological and societal benefits. The restored floodplain sustains a diverse (10 species) and abundant native submersed aquatic vegetation (SAV) community that is otherwise difficult to find within the Illinois River Valley today. As the diversity and plant density increased since restoration, so has the species richness and biomass of native fishes. The excellent quality of the Emiquon Preserve’s SAV and fish communities provides excellent recreational opportunities to the public including fishing, hunting, and wildlife viewing, as well as new research questions for scientists. For example, 54% of the largemouth bass (*Micropterus salmoides*) population, 11% of the black crappie (*Pomoxis nigromaculatus*) population, and 14% of the bluegill (*Lepomis macrochirus*) population was considered to be at preferred, memorable, or trophy sizes in 2012. Another societal benefit is seen in the improved understanding of predator-prey interactions and potential invasive species control. Research on the diet analysis of piscivorous fish at the Emiquon Preserve, Tennessee’s Reelfoot Lake, and four southeastern Wisconsin lakes may suggest that healthy piscivorous fish populations may contribute to the suppression of invasives like common carp (*Cyprinus carpio*). The ecological and societal opportunities that have emerged from restoration of the aquatic vegetation and fish communities at The Nature Conservancy’s Emiquon Preserve will continually serve useful for future floodplain restoration efforts

Nucleation patch characteristics in abandoned pastures can improve seed rain and foraging time spent by dispersers

Varassin, Isabela G.; Ricardo P. Campos, Anderson L. Frigo, Marcelo R. Errera, André A. Padiá
Universidade Federal do Paraná

Nucleation patches may differ in ways they attract different frugivorous birds, influence their foraging behavior as well as the seed rain. Tree abundance and conspecific aggregation of nucleation patches (*Miconia cinerascens*) were related to bird foraging time and fruit consumption by multiple regressions and related to bird and seed rain composition by Mantel tests. Principal coordinates analysis was used to identify bird and seed rain

ORAL ABSTRACTS (CONT'D)

composition related to patch characteristics. A mathematical model computed the visitation flow rate as the total number of visits done by all disperser species. Visitation occurs due to affinity that accounts for the strength of the interaction, search efficiency, activity time and patch quality. Foraging time and fruit consumption were positively related to tree abundance and conspecific aggregation. There was a particular bird composition associated to tree abundance that changed interactions among plants and birds in different patches. The time foraging explained seed rain richness (40%) and patches more similar in bird foraging time were more similar in seed composition. Seed rain composition was not related to bird composition. From the modeling standpoint, the number of visits was positively related to patch abundance and affinity. Patch characteristics were important to seed rain because its effects on time foraging unrelated to disperser identity. For each design of nucleation patch, there is a saturation point in patch abundance beyond which the number of visits will not increase. That resulted in a higher number of visits to patches constituted by a median level of diversity and lower affinity.

The role of fire in restoration and management of southeastern pine savannas and woodlands

Varner, J. Morgan; William J. Platt, Alan J. Long, Leda N. Kobziar

Mississippi State University

Historically, some of the highest fire frequencies on Earth occurred in the southeastern USA Coastal Plain. Data from fire scars in pines, descriptions by early naturalists, and public land survey records all suggest that the Coastal Plain upland landscapes were characterized by discontinuous pine canopies, diverse understories dominated by warm-season grasses, and high plant and animal endemism. These fire-frequented savannas and woodlands were greatly altered by three major land-use changes: 1) logging of pines, which removed a source of pyrogenic fuels; 2) widespread agriculture and settlement, which resulted in extensive fragmentation and habitat loss; and 3) exclusion and alteration of natural fire regimes. Losses in biodiversity and imperilment of plant and animal communities have stimulated interest in restoring these ecosystems. Ecological restoration efforts focus on prescribed fire, for which there remains considerable scientific uncertainty regarding the importance of replicating presettlement fire regimes, the effectiveness of fire relative to other restoration practices in reversing altered fire regimes, and effects of ongoing climate change on fire dynamics of these ecosystems. Here, we review regional examples of restoration using fire and discuss ecological outcomes. We evaluate alternative conceptual models regarding fire's role relative to scientific uncertainty regarding the importance of specific fire attributes. The development of scientific concepts to guide restoration and management in fire-prone ecosystems, such as southeastern pine savannas, is a work in progress. Our efforts can serve as references for the development of conceptual models to guide restoration of other fire-prone ecosystems.

Prescribed fire, land-use history, and connectivity in the restoration of species-diverse, subtropical pine savannas

Veldman, Joseph W.; Lars A. Brudvig, Ellen I. Damschen, John L. Orrock, W. Brett Mattingly, Joan L. Walker

University of Wisconsin-Madison

Agricultural conversion and altered fire regimes are drivers of degradation in many savanna-grassland ecosystems, including pine savannas of the southeastern United States. In this ecosystem, understory plant communities on post-agricultural land (abandoned 60-90 yr in this study) have lower species richness and altered community composition relative to frequently-burned remnants. To better understand the effects of prescribed fire and land-use history on understory communities, we combined a large-scale dataset (256 sites in Georgia, South Carolina, and North Carolina) with structural equation modeling. Results showed that fire promoted species richness and abundance by limiting trees and consuming litter. On post-agricultural sites, tree cover and soil resource availability reduced diversity; agricultural history also had direct negative effects. To test the hypothesis that these direct effects were related to connectivity (propagule limitation), we quantified connectivity as the percentage of remnant habitat surrounding each post-agricultural site and used 'compositional similarity to reference' as a response variable. In linear models, connectivity (along with fire frequency and tree basal area) was an important predictor of restoration success; fire alone appears insufficient to restore post-agricultural sites located far from seed sources. Whereas our study sites were farmed and abandoned during the past century, conservation efforts in savannas and grasslands currently experiencing rapid agricultural expansion (e.g., Cerrado Biome) should seek to maintain remnant patches to serve as future propagule sources. As we develop restoration and management strategies for tropical and subtropical savannas and grasslands, we should consider the potentially interactive roles of fire, trees, litter, soils, and connectivity.

Using scenarios to find robust management solutions to highly uncertain futures

Veloz, Samuel; Nadav Nur, Leonardo Salas, Dennis Jongsomjit, Julian Wood, Diana Stralberg, Grant Ballard

PRBO Conservation Science

Managers and decision makers in the San Francisco Estuary are struggling to develop effective conservation and restoration plans because of the large uncertainty surrounding the future effects of sea-level rise and other aspects of climate change on tidal marsh ecosystems. We modeled the future distribution and abundance of five marsh bird species (through 2110) in response to changes in habitat availability and suitability as a result of projected sea-level rise, salinity, and sediment availability in the Estuary. To bracket the uncertainty, we considered four future scenarios based on two sediment availability scenarios (high or low), which varied regionally, and two rates of sea-level rise (0.52 or 1.65 m/100 yr). We evaluated three approaches for using model results to select the highest priority restoration projects. We found that simply using current conditions resulted in the poorest performing restoration projects selected in terms of providing habitat for tidal marsh birds in light of possible future scenarios. The most robust method for selecting restoration projects used projections from all future scenarios with a discounting of areas with high levels of variability among future scenarios. We show that uncertainty about future conditions can be incorporated in site prioritization algorithms and should motivate the selection of adaptation measures that are robust to uncertain future conditions. These results and data have been made available via an interactive decision support tool at www.prbo.org/sfbayslr.

ORAL ABSTRACTS (CONT'D)

Restoration of herb layer biodiversity in post-agricultural forests: from science to practice

Verheyen, Kris

Ghent University, Department of Forest and Water Management, Forest & Nature Lab

In many regions worldwide the forest area has greatly reduced due to the conversion of forest to other land uses. This is particularly true for densely populated regions with a long history of human occupation, such as northwestern Europe. Recognizing the importance of forests for biodiversity conservation and the delivery of a wide range of ecosystem services, forest expansion policies have been launched in many countries. However, biodiversity restoration in these recently established forests is often very slow; and this is particularly true for herb layer species. Colonization of herb layer species in recent forests is hampered by both dispersal and recruitment limitation. Many forest herbs lack adaptations for long-distance dispersal and their establishment and growth is often complicated by the altered biotic and abiotic conditions in the recent forests. Most recent forests are established on former agricultural land which is often strongly enriched with nutrients. These legacies of past agricultural use, such as increased bioavailable phosphorous concentrations, can persist for decades to centuries and targeted management actions are needed to achieve successful herb layer restoration. These actions include the lowering of the nutrient stocks prior to afforestation and a well-reasoned tree species choice allowing to maximally benefit from their ecosystem engineering capacity. In this lecture I will provide an overview of recent research results on the consequences of abiotic and biotic legacies of past agricultural use for forest herb layer restoration and will present the outcomes of studies looking into the effectiveness of mitigating management actions.

Three decades of insights from the process-based restoration of the Cosumnes River floodplain

Viers, Joshua H.; Rachel A. Hutchinson, Alison A. Whipple, Andrew L. Nichols, Nicholas J. Newcomb, Garrett C. Liles, Carson A. Jeffres, Alexander K. Fremier, David R. Smart, Graham E. Fogg

Department of Environmental Science and Policy, University of California, Davis

The Cosumnes River in California's Central Valley is the only major river in the Sierra Nevada without a large dam and thus is the only tributary to the vast Sacramento-San Joaquin River system with a quasi-natural flow regime. Its relatively free flowing nature has provided the basis for a series of natural experiments in process-based restoration of floodplains and adjacent riparian areas starting early in the 1980s. While highly transformed for agricultural purposes, the surrounding floodplains are now being subjected to natural biophysical processes, wherein water, sediment, nutrients and propagules flow through engineered levee breaches. The interacting processes result in complex geomorphic structures typified by depositional sand splays upon which dense stands of early successional stage cottonwoods and willows establish. After decades of annual flooding, successions of woody riparian plants occupy higher elevations of developing sand splays, while wetland plants dominate the lower-elevation and more poorly drained areas. Results from these experiments show that hydrologic gradients driven by heterogeneous floodplain topography, seasonally-variable flood flows, and shallow groundwater conditions have created a complex mosaic of floodplain habitats important for aquatic and terrestrial organisms. Benefits to this approach include increased growth rates in juvenile fishes, diverse structural habitat for neo-tropical songbirds, and enhanced recharge to local aquifers. Mimicking the dynamic processes and ecological functions resulting from these experiments – based on the seasonal floodplain reconnection of sufficiently high magnitude and duration to create geomorphic heterogeneity – has become the model for alluvial floodplain restoration throughout the region.

Costa Rican citizen cloud forest restoration through eco-loan financing

Villalobos, Manrique Esquivel; Luis V. Villa, Randall Varela Chaves, Evelyne T. Lennette, Alvaro Ugalde Viquez

Nectandra Institute

Since 2006, Nectandra Institute has worked with community water management associations (CWMAs) to promote and carry out cloud forest conservation in the upper Balsa River Watershed in northern Costa Rica. These community-based associations levy users' fees in order to provide potable water service, often with little government support. CWMAs are keenly aware of the hydrological importance of montane forests and wish to protect these ecosystems. NI launched its eco-loan financing (ELF) and watershed education/training program with the CWMAs as direct beneficiaries and strategic partners. NI makes zero interest loans to CWMAs to help them acquire properties with recharge zones surrounding water sources. The communities repay the loan principal, plus pre-negotiated "eco-interest" in the form of native forest restoration, watershed management, monitoring of restoration progress, and participation in citizen science projects and various educational/training activities. The loans enable the communities to own and control their water sources, while watershed education provides them with the knowledge needed to restore forests and maintain the watershed and its waterways. Under ELF, the water supply for 15,000 residents in 10 communities is now better protected; the communities now own and manage properties at the headwaters of at least 6 of the upper Balsa's 20 or so streams. Additionally, residents of our partner communities have dedicated many thousands of hours reforesting, monitoring, and learning about restoration on ELF-financed properties. The communities have not only assumed much of the restoration work, they are now spreading their knowledge and experience to neighboring communities.

Cottonwood forest expansion on deltas in dammed rivers: Is it passive restoration?

Volke, Malia; W. Carter Johnson

South Dakota State University

Cottonwood regeneration has sharply declined along the Missouri River due primarily to flow regulation by dams. Novel river habitats, including delta formations where tributaries empty into reservoirs, are one of the few places along the Missouri River where there is successful woodland regeneration, often dominated by cottonwood. The White River delta in South Dakota, formed at the confluence of the White River and Fort Randall Reservoir, represents a novel habitat where there is successful cottonwood establishment. Time-series analysis of riverine cross-sections indicated that

ORAL ABSTRACTS (CONT'D)

there has been an overall trend of channel and floodplain aggradation within the postdam delta, facilitating expansion of delta surfaces into and above the reservoir pool. Likewise, time-series analysis of aerial photography showed that woodland area increased by 69 percent in the postdam era. Field inventories of cottonwood forest stands indicated that a heterogeneous mixture of cottonwood forests exists within the White River delta region, and that the composition and structure of these forests, particularly the forest understory, may differ from those along natural river reaches. Expansion of cottonwood forests on novel delta habitats challenges the traditional definition of ecosystem restoration because expansion has occurred in the absence of any active reservoir management or restoration. Similarly, differences between novel and natural cottonwood forests raise questions about whether novel forests meet the conventional restoration target, even though similar ecosystem goods and services are provided. Current research will lead to an improved understanding of the contribution of tributary deltas to cottonwood recovery on the Missouri River.

Ecosystem Service Valuation Applied: Three County-Scale Case Studies in Washington State

Wahlund, Nora L.; Lola P. Flores, Jen Harrison-Cox, David K. Carlton

Earth Economics

Earth Economics is doing very interesting work applying ecosystem service frameworks and valuation to policy in Washington State. Three distinctive Washington State case studies illustrate different approaches, stakeholders and methods for achieving renewed investment in natural capital. Our first case study looks at how Thurston County, located at the base of the Puget Sound, applied ecosystem service concepts in response to the State Growth Management Act. Earth Economics used ecosystem service valuation to stimulate discussion with Thurston County's Planning Department, elected officials and stakeholders by calculating the additional economic flow of ecosystem benefits provided by the updated Critical Area Ordinance and the increase of protective buffers. The second case study looks at Pierce County and the Puyallup River Watershed. Earth Economics worked with Pierce County Surface Water Management to quantify the value of several land use regulations and capital projects designed to mitigate long-term flood damage. Those regulations are Channel Migration Zones, Compensatory Storage Requirements, and Deep and/or Fast Flowing Floodways. Earth Economics also worked to put a dollar value to the derived ecological benefits that would have accrued at each case study location had current regulations been in place at the time development began. The third case study applies ecosystem service valuation concepts to No Net Loss Policy and Shoreline Master Program updates for Clallam County, and includes dollar estimations for critical sediment deposition along the Strait of Juan de Fuca Coastline, contributing significantly to the ecological health of the nearshore ecosystems.

Plant regeneration and restoration: What is needed to establish viable, restored populations in future climates?

Walck, Jeffrey

Middle Tennessee State University

In our changing climate, recruitment from seeds is predicted to be among the most at-risk stages for plant communities. The two most pervasive impacts of climate change – temperature and moisture alterations – play a critical role in dormancy regulation and germination at the population scale and across the range of species. Barring other disturbances, temperature or moisture changes that remain within a species' tolerance range will enable persistence of the organism in its habitat. Directional selection for adaptation to changing environments may also offset impacts and enable persistence. However if the range of tolerance is narrow, and there is limited heritable variation, then the species must track the climate and migrate to suitable areas within its tolerance range or risk extinction. The range of tolerance for regeneration is not only critical for long-term sustainability, but also for successful reintroduction of species via ex situ seed banks. Tolerance ranges of some populations and species may be broad enough to accommodate out-planting at any future site, or they could be very specific, limiting future establishment locations. We know very little about key underpinning processes for the regeneration of plant species, including the capacity for long-distance seed dispersal and microevolution to result in adaptation in situ to changing environmental conditions. If we are to meet the challenges inherent in the restoration of degraded habitats, the potential limits and thresholds for plant regeneration and early recruitment must be understood under changing climates.

Emiquon: Introduction to a large-scale floodplain restoration

Walk, Jeffery W.; K. Douglas Blodgett, A. Maria Lemke, James R. Herkert, Michael Reuter, Richard E. Sparks

The Nature Conservancy

The Illinois River suffered many alterations during the 20th century : agricultural drainage and urbanization of most of the watershed; diversion of water from Chicago and Lake Michigan into the system; construction and operation of the lock and dam navigation system; extensive leveeing and isolation of floodplains from the river; and hydroclimatic change – all of which have disrupted the seasonal flood-pulse essential to the productivity and ecological function of the floodplain-river ecosystem. Yet, the Illinois has been repeatedly identified as a river with high floodplain restoration potential, and several such floodplain restoration efforts have been launched in recent decades. The largest is The Nature Conservancy's Emiquon Preserve, which, with the Emiquon and Chautauqua National Wildlife Refuges, comprises a 6,500-ha bluff-to-bluff floodplain complex recognized as a Ramsar Wetland of International Importance in 2012. With a continuing commitment of resources to science and monitoring, Emiquon will likely be among the world's most thoroughly documented floodplain restoration efforts. Historic data are available from this location prior to agricultural conversion in the 1920s and there is a local campus of research institutions, including two Illinois Natural History Survey biological stations, the University of Illinois Therkildsen Field Station, and Dickson Mounds Museum, whose scientists investigate the biophysical setting and the 12,000-year human history of this site. Long-term maintenance of Emiquon will balance the needs of a restored functional floodplain with the limitations imposed by the altered hydrology, high sediment loads, and invasive species present in the Illinois River.

ORAL ABSTRACTS (CONT'D)

Lifting the veil: Drivers of species loss and community homogenization in Wisconsin forests

Waller, Donald M.

University of Wisconsin - Madison

Humans are conducting massive experiments on ecosystems by fragmenting habitats, killing predators, introducing exotic species, boosting nutrient concentrations, and altering climates. Our ability to assess these impacts and track responses, however, is limited as we lack baseline data, controls, and adequate monitoring. We are using unusually complete baseline data from the 1950s to assess threats to species persistence and to untangle the drivers of ecological change across forests in Wisconsin, USA. Forest understories in N Wisconsin are losing pretty (biotically pollinated) wildflowers while gaining grasses, sedges, and ferns. The greatest rates of loss (>50% over 50 years) occurred in three State Parks. Forests in S Wisconsin are smaller and have lost more species (mean: 25%) while homogenizing in composition. Ecological drivers of these changes include overabundant white-tailed deer in the North and urbanization, habitat loss, and exotic invasions in the South. Plant diversity also declines in areas with higher levels of atmospheric N deposition. These trends may be accelerating as extinction “debts” due to habitat fragmentation and invasions continue to be paid. None of these trends would be evident were it not for the unusually detailed baseline data present in this locale. If Wisconsin is typical, temperate regions around the world may be experiencing similar, but largely invisible, species losses and biotic simplification.

The Blair Woods Project: R-Rated for Restoration

Walther, Judy; Nancy Manning

Environmental Survey Consulting

For the past five years a restoration project involving a mix of public and private support, in collaboration with the Audubon Society, has been under way in Austin, Texas. The project location is the Blair Woods Audubon Sanctuary, a small intra-urban nature preserve, donated to the Audubon Society by a University of Texas professor (Dr. Frank Blair). The Sanctuary is located in an underserved neighborhood and comprises three habitat types: riparian, woodland and savannah. The project includes three major focuses. The first is baseline data collection, consisting of gathering information on flora and fauna, and the development of a master plan. The second is habitat restoration, which includes removal of exotic, invasive species and planting and seeding native species in both the riparian and savannah habitat. The third focus is public outreach: to involve both the neighborhood and wider communities as volunteers in the restoration efforts, and to create an educational program for two local underserved elementary schools by engaging students in environmental studies. These three focuses overlap, with biologist and ecologists meshing with the public and student activities. Students study the site as scientists, gathering data on the various project activities: exotic/invasive removal, planting and seeding native species, study of the ephemeral creek for effects from the upstream neighborhood, assisting in the savannah restoration. The goal is to empower students and the community through better appreciation and understanding of habitat restoration principles.

Session 2: Mississippi River Basin: Working toward Integrated River Basin Management

Wamsley, Kent

The Nature Conservancy

Gulf of Mexico Hypoxic issues have been traced back, in part, to the increased export of nutrients and sediment from the Upper Mississippi River. The Nature Conservancy and many other partners take this challenge seriously in Indiana and across the basin which encompasses 3 states and drains over 33,000 square miles of Midwest Agricultural lands. Touching down in Indiana, TNC is working to restore/protect the Wabash River Floodplain through land acquisition and use of conservation programs such as the Wetland Reserve Program and the Floodplain Easement Program and strategic partnerships. They are a part of a partnership with the MRBI, USFWS, USDA, the State of Indiana, and private industry that sees the need to initially focus, leverage and raise nearly \$50 million to restore a 90 mile long wetland and forest corridor along the Wabash River. Targeting agricultural best management practices, establishing conservation easements with willing landowners in the floodplain and sharing lessons learned will lead to a restored system that provides vital habitat for the diverse fisheries of the Wabash and feeds the Mississippi River Basin. The Wabash River program is an example of whole system conservation from on-the-ground projects to large-scale policy outcomes that provide multiple benefits for producers, riverine habitat and associated species, and citizens of the State and region.

Developing a payment for ecosystem services model for ecological restoration and sustainable livelihoods promotion in alpine rangeland region on the Qinghai-Tibetan Plateau, China

Wang, Pu

Cornell University

Payment for ecosystem services (PES) is considered by many researchers as a promising approach to leverage government and private funding and improve efficiency for environmental conservation. Its effectiveness in poverty alleviation has been controversial. This study is conducted in alpine rangeland regions on the Qinghai-Tibetan Plateau, China, an ecologically fragile area where local herders' livelihoods are threatened by ecosystem degradation as the result of population growth, overgrazing, and climate change. A government-led eco-compensation program is currently undertaken in this region to compensate herders for reducing cattle densities or obligate herders to abandon grazing activities and accept compensation to relocate to small cities or towns. Previous studies indicate that this program has fallen short of its objectives because of flawed targeting strategies and poor implementation. Our research critically examines PES scheme as an alternative approach to the current program. The proposed PES project takes advantages of the financial resources of the current program, but requires redesign of targeting and compensation policies, and is based on voluntary contracts, which significantly reduces the negative impacts on the local herders. In addition, PES would have more precise targeting strategies to select

ORAL ABSTRACTS (CONT'D)

areas with the highest potential in ecosystem services provisions, thereby maximizing environmental benefits. The PES project could also provide local herders stable income streams compared to traditional grazing and promote sustainable livelihoods.

Understanding the influence of grazing pressure changes on soil organic carbon, ground cover and floristic diversity in Australian rangelands

Waters, Cathleen; Gavin Melville, Susan Orgill, Yohannes Alemseged, Warren Smith
NSW Department of Primary Industries

Productivity and biodiversity values underpin the rangelands but continue to decline. Anecdotal evidence suggests best management includes management of total grazing pressure (TGP) used in conjunction with rotational grazing and may not only enhance the natural resource but also impact on soil organic carbon (SOC). Contrasts between TGP (rotational grazing) and traditional Non-TGP (continuous grazing) were made using up to three paired paddocks at each of two study locations. Each paddock was stratified according to soils and vegetation, 20-25 points in each stratum were systematically sampled. A total of 589 points were sampled and analysed for total organic carbon at four depths. At each point biomass (kg/ha), occurrence and number of species, utilisation levels of dominant perennial grasses, dung counts and proportion of ground cover (bare, perennial, cryptogram, dung, rock) within a 0.25m² quadrat were measured as well as proximity to woody cover (trees and shrubs). TGP (rotational grazing) resulted in two and three fold higher levels of biomass and ground cover and were associated with significant differences in floristic diversity ($p < 0.05$). Significantly higher SOC concentrations ($p < 0.001$) were associated with higher perennial grass cover and the presence of trees and shrubs. This suggests management to promote increased perennial ground cover such as TGP and rotational grazing may serve as a restoration tool but also increase carbon stocks. We discuss how this will be tested over the next 12 months and highlight the importance in recognising the trade-offs between natural resource outcomes and agricultural productivity gains.

Habitat restoration and creation for multiple listed species at a small project site.

Webb, Lia; Ken Mierzwa
GHD

This project includes creek restoration, wetland mitigation, and habitat creation for multiple special-status species within enhanced, restored, and created habitats. Historically, river and wetland restoration projects have been successful at serving focused project goals such as flood control, wetland mitigation, or repair of site issues. When endangered species are involved, the project has leverage to require a holistic approach to accommodate a diversity of habitats for foraging, breeding, and dispersal for target listed species. This project included incorporating habitat diversity to mimic natural landscape level biodiversity on a small 12 acre site. An inclusive design approach is especially important for improved long-term functionality of created wetland and integration into the larger habitat systems. The project approach involved extensive hydrologic modeling as a basis of design for a complex site. This project demonstrates how habitats for species diversity can be overlaid within a wetland mitigation site by including restoration of historic site functions in creek, wetland, transitional, and upland habitats. The project included improvements to marsh for San Francisco garter snake foraging; ponds for California red-legged frog and western pond turtle; riparian to remove migration barriers and improve transitional habitat for dusky-footed wood rat; serpentine grassland for Bay checkerspot butterfly and garter snake; and oak woodland establishment for garter snake. This project “looks back and moves forward” by developing an integrative approach to restoration contrary to past wetland focused projects. This project incorporates multiple project goals, multi-species-specific requirements, habitat diversity, and functional improvements beyond a focus on wetland mitigation.

The economic and social reasons why few prairie and savanna plantings match the quality and diversity of our State Natural Areas.

Weber, Scott P.
Bluestem Farm

In spite of over 60 years of prairie and savanna restoration work in Wisconsin, few restorations or plantings match the composition and diversity of native remnant prairies or State Natural Areas. Often this shortcoming is attributed to ecological limitations, such as lack of proper soil conditions, plant succession, and competition with non-native species. However, most ecological theories are based on seed mix design and planting protocols that favor specific grasses and forbs. Seed mix regulations, impatience, ignorance of the composition of remnant prairies, highly variable seed costs and supplies, and excessive planting rates of aggressive species all contribute to a lack of authenticity and diversity. University research is also limited by time and money and therefore discriminates against species that take more than three years to mature. If our ecological theories of plant succession are derived from relatively poor seed mixes, then we often justify those mixes based on those theories. If we want to break this circular logic, we need to differentiate between what is economically possible and what is ecologically possible. A thirty year analysis of seed mix designs, several restoration projects (including government, private, and non-profit organizations), Wisconsin DNR seed purchases, nursery data, and costs show that economic and social factors are the main reasons for failure to plant prairies that mimic our natural areas.

Ecological restoration in a semiarid loess hilly area of China: experiences and consequences

Wei, Wei; LeiYang, Liding Chen
Research Center for Ecoenvironmental Sciences, Chinese Academy of Sciences

The Chinese loess plateau has long suffered from severe drought and water erosion, which makes ecological restoration in this region particularly difficult. During the past several decades, a series of vegetation rehabilitation and erosion control measures were conducted in this region. However, the

ORAL ABSTRACTS (CONT'D)

ecological consequences and effects may differ from each other according to the variation of countermeasures in practice. In this study, a typical area in the western part of the loess plateau was selected for further analysis. The effects of different vegetation types, plant succession stages, land preparation measures and micro-topography recreation types on soil moisture and water erosion rates were reviewed and analyzed. Moreover, the consequences of historical restoration experiences including check-dam construction, man-made/aerial seeding plantation, natural recovery/land closure, water resources collection projects and comprehensive watershed managements were all compared and discussed. Results indicated that successful ecosystem restoration in this special rain-fed region should be achieved by multiple ways simultaneously. Herein, suitable plant selection, proper planting density and necessary land preparation/created micro-landforms at sloping conditions before planting play key roles in improving the survival rates of plants as well as the ecosystem services of vegetation communities.

Oyster restoration in the face of climate change

Weissberger, Eric J.

Maryland Department of Natural Resources

Climate change models for Chesapeake Bay predict rising sea level, increasing water temperature, increasing salinity variability, and increasing ocean acidification. These changes should be accounted for when planning oyster (*Crassostrea virginica*) restoration projects. Sea level rise may open new habitat previously unavailable for oyster restoration. Increasing temperature may cause earlier spawning and faster oyster growth rates, but may also result in increased hypoxia, disease, and predation. Salinity predictions are uncertain, and are a function of sea level rise and precipitation. Higher salinity may result in increased spat set, but also greater predation and disease intensity and prevalence; lower salinity may have the opposite effect. Increased ocean acidification may result in weaker shells, rendering oysters, particularly larvae, more vulnerable to predation. In anticipation of sea level rise, habitat to support oysters could be created in shallow areas that will eventually be in deeper water. Improved storm water management could reduce salinity fluctuation by reducing stream flashiness. Improved land use practices could reduce hypoxia by controlling the amount of nutrients entering the water. Seeding with disease-resistant could reduce the incidence of disease. Predation on a small scale could be lessened by excluding predators. The effects of both predation and ocean acidification could be mitigated by growing oysters to larger size before transplanting.

What does ecological restoration mean to volunteers? Meanings, values, and interpretations

Weng, Yen-Chu

University of Washington

The involvement of volunteers has been an important part of urban-based ecological restoration projects. People of diverse backgrounds get together and contribute to a common goal of "restoration." However, there are many different meanings associated with the term. Through surveys and interviews with long-term volunteers involved in prairie-oak savanna restoration in the US Midwest, this study explored questions of meanings, values, and interpretations of ecological restoration from volunteers' perspectives. The results revealed that volunteers emphasized the practical learning aspect of ecological restoration and stressed the importance of human's assistance in the process. Metaphors of healing and stewardship were common in the responses. Volunteers also expressed great confidence in professional land managers and environmental scientists for directing restoration projects. However, differentiation was made with regard to "academic" science versus "practical" science. Questions concerning the different types of restoration activities, changes in volunteers' environmental behaviors, opinions on stakeholder control, and perceived challenges to ecological restoration were also addressed in this study. Variations in responses suggested that the volunteer population is composed of people of diverse interests and values. Organizations need to address this heterogeneity and provide opportunities for volunteer feedback in order to promote better collaboration between volunteers and restoration organizations.

New state connectivity and crucial habitat mapping is seeking to shape transportation plans and projects across 16 Western states

Western Governors' Wildlife Council (speaker to be announced)

Through a 2010 policy resolution, the Western Governorstasked their Western Governors' Wildlife Council (WGWC) with the development of a Crucial Habitat Assessment Tool (CHAT) to better inform transportation, energy, and land use planning across the West. The WGWC is nearing the public launch of that tool in December of this year, and would like to demonstrate its effectiveness for the pre-planning stages of transportation projects. The Western Governors' CHAT will provide data driven, GIS-mapped, and scientifically credible information on priority fish and wildlife habitats and connectivity in a consistent and compatible fashion across 16 western states. State-based CHATs are being developed parallel to the West-wide CHAT to support finer scale assessment and project specific planning, mitigation, and conservation as desired and needed by individual states. The Western Governors' CHAT will depict "crucial habitat" in a coarse-scale aggregated data layer, showing where the most valuable areas for wildlife "species of concern," game species, and habitat connectivity in a single GIS layer. This aggregated approach is meant to assist in the pre-planning process for infrastructure across the region, facilitating improved partnerships and collaborative decision making among energy and transportation developers, fish and wildlife managers, and land managers. The Western Governors' CHAT and the state CHATs offer opportunities for transportation planners to get ahead of the game on identifying areas deemed by state managers as "crucial" for wildlife. With this information, CHATs provide a framework for more expeditious project assessment and implementation.

ORAL ABSTRACTS (CONT'D)

Stew-MAP: Stewardship Mapping and Assessment in Chicago

Westphal, Lynne

Northern Research Station

We report on the results of a survey-based assessment of stewardship activities within the Chicago Wilderness region, work conducted as a part of the Chicago ULTRA-Ex project (Urban Long-term Research Area Exploratory Grant). Chicago Wilderness is a 270 member alliance focused on preserving and enhancing biodiversity throughout northern Illinois and parts of Wisconsin, Indiana and Michigan (USA). The results described include 369 stewardship groups including non-governmental organizations, community groups, municipalities and others who voluntarily filled out the survey between November 2010 and November 2011. Environment, education, community improvement, youth and recreation are the top five foci of the efforts of Chicago Wilderness Area stewards put their effort. Chicago Wilderness stewards work in a wide variety of settings, with prairie, woodland, community gardens, trails, wetlands and parks cited most often. Other stewardship group characteristics are reported, including staffing levels, budget, and number of volunteers and members. Comparison to other metro areas are discussed. Findings can be applied to restoration activities by stewards, land managers, and others.

The Social Science Data Set of the RESTORE project: A Study of Organizational Structure and the Decision-Making Process in Ten Chicago Wilderness Organizations

Westphal, Lynne; Cristy Watkins, Alaka Wali, Paul Gobster, Madeleine Tudor, Joanne Vining

Northern Research Station

One of the missions of the Chicago Wilderness (CW) alliance is to advance the science and practice of ecological restoration. While alliance members share broad common goals outlined in a 1999 Biodiversity Recovery Plan, the ways in which these goals are realized vary. With data collected by interviews and participant observation from ten CW alliance member organizations, we examined organizational structures and patterns of decision making processes. Guided by the Institutional Analysis and Development (IAD) framework, we used the "ADICO" grammar to extract the institutional statements (rules, norms, and strategies) used by each organization, and agent-based modeling to understand some key mechanisms of the group's collective decision-making processes. Analysis of perceptions of landscape and emotion deepened our understanding of these institutions and processes. By combining these analytical tools, we found that each organization must balance and prioritize a multitude of factors, including ecological management, research, and education goals, and a variety of associated stakeholders. We also arrived at an understanding that social capital (trust and respect) and communication between decision makers (via regular interaction and with the assistance of key influential liaisons) leads to enhanced collective decision making. Our data analyses further revealed that shared perceptions of, and connections to, the physical landscape produce strong and meaningful motivations for engaging in ecological restoration. One of our major emerging conclusions is that supporting multiple types of management styles is a strength of the Chicago Wilderness alliance.

Ribbons of Prairie: a restorative vision for the American Great Plains and Midwest integrating culture, agriculture and nature

Whitney, William S.; Kelly Kindscher

Prairie Plains Resource Institute

William Whitney, a Nebraska native, began in 1978 to plant biodiversity-rich prairies in Nebraska. During 35 years, which included founding Prairie Plains Resource Institute, a land trust specializing in education and restoration, Mr. Whitney has overseen development of methods which expanded annual plantings from less than .5 ha/year to more than 600 ha/year (1,500 acres), with a small staff and simple equipment working with a master plant list of approximately 250 species. Kelly Kindscher, a native of Kansas and Nebraska, has conducted research and planted prairies for over 25 years. His research on both prairie biodiversity and ethnobotany leads him to speak for the need of incorporating edible and medicinal plants into prairie restorations as this will not only involve people, but involve people in tending, harvesting and eating of wild onions, prairie turnips, groundnuts, plums, chokecherries, mints and Echinacea. By interweaving the diversity of edible and medicinal plants in restoration projects we can begin to interweave the cultural fabric of food and health and a vibrant local community. Prairie Plains Resource Institute's long-range plan, Ribbons of Prairie, is a vision for the American Great Plains and Midwest, aiming to restore biodiverse prairie along water corridors – ditches, waterways, creeks and rivers - particularly through intensive agricultural regions. This concept is inclusive of both authors' passion for all life as well as human community development, and essentially integrates cultural richness with nature and agriculture. This presentation will highlight their past works and add definition to their forward-looking ideas.

Can Archaeology Inform Wetland Restoration and Management? A Case Study from Emiquon.

Wiant, Michael; Bonnie Styles, Terrance Martin

Illinois State Museum--Dickson Mounds

The archaeological record consists of artifacts and ecofacts in sediment, each contributing information to an understanding of past landscape, ecology, and culture. Drawing on a long-term Illinois River valley archaeological research program, zooarchaeologists have assembled an extraordinary collection of animal bones, teeth, and shells that chronicles changes in environment and human ecology. The Morton site, the remains of a late prehistoric (ca. 1290 - 1400 ce) settlement, is located on the Illinois River bluff overlooking the Emiquon Preserve's restored Thompson Lake. Ongoing excavations have revealed a well-preserved and substantial assemblage of faunal remains, including both terrestrial and aquatic species, which provides insights into late

ORAL ABSTRACTS (CONT'D)

prehistoric paleoecology. The assemblage also begs a question: Can archaeology inform wetland restoration and management? We compare the Morton site assemblage as it relates to historical and contemporary fauna, evaluate the strengths and limitations of archaeological data, and consider if and how this information may contribute to the process of wetland restoration and management.

Balancing Priorities in Conservation

Wiens, John

University of Western Australia

Conservation and restoration ecology face similar challenges in their quest to enhance biodiversity by protecting places or repairing damaged habitats. The many species requiring continuing conservation and the magnitude of habitat degradation will place increasing demands on conservation and restoration. Funding to support this work will be inadequate, so priorities must be established. Conservation biologists have given considerable thought to prioritization, and elements of this thinking may help to inform prioritization in restoration ecology. Rather than deciding which places to protect independently, for example, one can consider how the addition of a place to those already protected will enhance the ecological value of the overall conservation portfolio. Decisions about which species merit investment of scarce conservation resources can be based on the likelihood of long-term population persistence. Prioritization inevitably entails multiple criteria, however, increasing the complexity of cost-benefit calculations. For example, how should cost, size, current condition, development threat, surrounding landscape uses, recreational value, provisioning of ecosystem services, beauty, opportunity, or a host of other factors be considered in deciding which area to protect? Balancing priorities depends on how such factors are weighted, who is doing the weighting, and who will pay the bills. Prioritization also means that some places or species will lose out—triage. Whether the result is extinction of a species, loss of habitat to development, or permanent degradation of an ecosystem that might have been restored, the consequences have ethical and societal implications that extend beyond science.

Sedge/grass meadow wetland restoration on agricultural land near Lake Ontario

Wilcox, Douglas A.; Alexander J. Healy

SUNY College at Brockport

Sedge/grass meadow wetland restoration was conducted at three sites on agricultural land adjacent to Braddock Bay of Lake Ontario. The project included baseline surveys in 2009, seed-bank emergence studies, implementation during summer 2010, and monitoring in August 2010-2012. Other Lake Ontario wetlands served as references. Implementation included disking and planting locally-sourced wetland seed mixes, plus seeds and plugs of Canada bluejoint grass and tussock sedge. Unplanted areas served as controls, and natural wetland remnants were not disturbed. Plant sampling was conducted in randomly placed 1m² quadrats, Importance Values calculated, and data analyzed statistically and by NMDS ordination. Following implementation, seeded species richness increased in each subsequent year, and agricultural weeds generally decreased. Fifteen of the 42 seeded/planted species, 38 remnant sedge/grass meadow associates, and 36 weed species were identified across years. Seed-bank emergence studies did not predict community composition following implementation. Instead, seeded species, remnant vegetation, and nearby refuge populations contributed to planted areas, as confirmed by the ordination, which showed that the 2009 communities had been displaced by 2010 and that overall communities in the planted areas changed each year and largely converged with unplanted controls by 2012. The future plant community at this site will likely depend on survival and expansion of wetland species, as influenced by soil moisture and competition from remnant weed species, which has been mitigated by mowing at 30cm to open the canopy. Disking, seeding/planting, and mowing are recommended in future restoration projects in this setting. However, hydrologic conditions must be considered fully.

Assessing the restoration of the ecosystem service of pollination on a UK moorland habitat: a network approach

Wilcox, Rose; Jonathan Walker, Jane Bunting, Graham Scott, Darren Evans

University of Hull

UK moorlands are of international importance due to limited global distribution, capacity for carbon sequestration and their association with threatened, specialised and rare species. Despite this, moorlands face great anthropogenic pressures from pollution, overgrazing, afforestation and wildfire, resulting in large scale degradation with approximately 40% of remaining UK heathland classified as 'poor' or 'suppressed' and at risk of future damage. This study investigated the restoration of pollination, a key ecosystem service, on areas of restored blanket-bog in the Peak District National Park, UK, to assess whether plant-pollinator interactions had been fully reinstated. For the first time, vegetation and plant-pollinator interaction surveys were conducted on fragments of moorland restored over three consecutive years and compared to nearby 'damaged/unrestored' and 'pristine' areas. Ecological networks were created to assess the complexity of the pollination network present for each restoration treatment to establish whether ecosystem function had been restored as well as species richness. Results showed that although mean vegetation height and species richness was considerably increased from that found on 'unrestored' sites, the actual cover of flowering species and consequently floral abundance was significantly decreased from that of 'pristine' areas. As a result of this lack of available pollen resources, networks from restored sites included less species and fewer interactions compared to 'pristine' sites. These findings suggest that although vegetation height and species richness may have recovered in restored areas, pollination has not yet been fully reinstated, with species interactions forming less complex networks than would be expected in a 'healthy' system.

ORAL ABSTRACTS (CONT'D)

History, policy and current innovations in the watershed approach to compensatory mitigation decision-making

Wilkinson, Jessica; Nicholas Miller

The Nature Conservancy

Ms. Wilkinson will provide an overview of the history behind adoption of the watershed approach to wetland and stream mitigation, a policy snapshot, and an overview of advances in application of the watershed approach.

Restoring oyster (*Crassostrea virginica*) habitat in the heart of New York City

Will, Robert; John McLaughlin, Terry Doss, Michael Spina

NYC Department of Environmental Protection

Jamaica Bay has evolved over the past 25,000 years as an important and complex habitat. However, the valuable resources that comprise Jamaica Bay have been lost over the past few centuries. This presentation examines the overall context of restoration in Jamaica Bay and one of the restoration pilot studies first implemented in 2009 – restoring oysters in Jamaica Bay. The purpose of the oyster pilot project is to address uncertainties associated with the NYC climate and environmental conditions to guide future practices, while attempting to aid efforts to restore and maintain water quality and ecological integrity. Oyster restoration is occurring in areas along the eastern coast of the U.S., but the idea of restoring oysters in the waters of NYC is new. Little attention has been paid to oyster restoration in urban watersheds such as Jamaica Bay in waters that are closed to fishing and shellfishing primarily due to fears of creating an attractive nuisance. Over the past four years, we brought together oyster restoration specialists and learned from their experiences, planted oyster spat in a number of areas in Jamaica Bay, and have been monitoring and testing the oysters to determine whether or not oyster restoration is possible in these urban waterways and the oysters can reproduce; and whether or not we can measure water quality differences due to the establishment of the oysters. We will discuss our results as well as the unique challenges of carrying out these projects, the lessons learned, and the direction for future efforts.

Ecosystem services restoration through collaborative bioenergy development: Innovation at the conservation-economy nexus

Williams, Carol; Paul Charland, Jim Lutes, Tom Elgin

University of Wisconsin

If managed properly, bioenergy produced from perennial grass feedstocks can deliver ecological conservation and agricultural production benefits simultaneously (i.e., multifunctionality). However, such systems are not widespread in the U.S. A major challenge is the “chicken and egg” dilemma; investors are unmotivated by lack of biomass supply, and biomass producers lack commitment to new crops and production systems without sufficient demand. A potentially transformative approach to overcome this challenge is collaborative development of at-scale bioenergy systems as jointly undertaken pilot initiatives. The pilot approach enables introduction of strategic change along with research that produces knowledge about the intended change, thereby reducing risk and uncertainty. To test this approach we have initiated a collaborative, at-scale pilot anaerobic digestion project in southern Wisconsin utilizing dairy manure and perennial grass biomass to produce compressed natural gas. Our goal is a self-sustaining bioenergy enterprise that improves on-farm nutrient balance, improves water quality and wildlife habitat within the project area, and advances research in the public interest. Additionally, our aim is to utilize and demonstrate market-based mechanisms (e.g., credits) that support conservation and profitability simultaneously. A consortium of partners has been formed from academia, industry, resource management agencies, and non-profit organizations. This consortium has launched a multi-year landscape-scale biomass harvest experiment and full feasibility study of a digester location in southern Wisconsin. In this presentation we detail our rationale, and the challenges and novel solutions thus far in our approach to achieving restoration of landscape multifunctionality through innovation at the conservation-economy nexus.

Charting assisted migration as a climate change adaptation strategy for native plant materials

Williams, Mary I.; R. Kasten Dumroese

Michigan Tech University/USFS

When choosing plant materials for restoration activities, existing guidelines focus on using local, native seed sources because they are best adapted to outplanting conditions. In many regions, this concept is expanded to transfer guidelines and zones that are used to guide the proper collection, propagation, and placement of native plant materials. By the end of the century, however, most landscapes in the western U.S. will have climates that are incompatible with current vegetation. Thus, ‘local’ becomes irrelevant and current static transfer guidelines and zones will have limited use given the dynamic changes in climate. Few adaptive strategies have been evaluated or implemented by federal, state, or private groups in the U.S. despite the increase in the amount of management planning during the past 30 years. One adaptation strategy at the nexus of plant transfer guidelines and climate change is assisted migration, defined as the intentional movement of plants in response to climate change. This strategy may be necessary, especially for native plants less adaptive or mobile. Assisted migration has gained attention since 2007 as a strategy to prevent species extinction and sustain ecosystem services. Researchers have proposed frameworks and guidelines on how to apply assisted migration to native plant materials, but specific recommendations are still lacking, which limits restoration practitioners from making informed decisions about climate change adaptation strategies. Drawing from conventional practices and proposed strategies, we chart the implementation of assisted migration and provide resources to facilitate collaboration and development of restoration plans.

ORAL ABSTRACTS (CONT'D)

Target plant concept: Genetic considerations in seedling selection

Williams, Mary I.; R. Kasten Dumroese

Michigan Tech University/USFS

The Target Plant Concept states that genetics are important when selecting plant materials for restoration plantings. Specifically, three genetic factors are paramount: source of genetic material, genetic diversity, and sexual diversity. Usually, locally sourced native plant materials are best because they are adapted to their local environments. Ensuring a high degree of genetic diversity in collections maintains potential for species adaptability to future changes. Collecting seeds and vegetative materials from many plants near the restoration site satisfies these concerns. For dioecious plants, sexual diversity is equally important to restoration success. By collecting, propagating, and outplanting female and male vegetative plant materials, future seed production is possible, which offers long-term sustainability and continued genetic diversity. This presentation highlights the benefits of maximizing genetic and sexual diversity of local collections and considers these genetic factors with respect to implementing assisted migration as an adaptive strategy to climate change.

Bee and plant community succession in riparian restorations from former farm land

Williams, Neal M.; Jennifer VanWyk

University of California

Although they are rarely the targets of restoration, pollinators serve a key role in the persistence of native plant communities within restored habitats. Thus, understanding the extent to which these functionally important, non-target species return over the course of vegetation restoration and what factors affect their communities may be critical to predicting long-term restoration outcomes. Growing concerns over the fate of pollinators worldwide reinforce the need to understand bee community responses to restoration efforts. We surveyed bee and plant communities at restored riparian sites and paired remnants of riparian habitat along the Sacramento River, California, USA at two different times following vegetation restoration (6 years and 15 years after restoration). The remnant plant communities were mixed riparian woodlands containing open areas and an understory of native and exotic grasses and forbs. We predicted that bee communities at restored sites would (1) become less speciose over time as tree and shrub canopies closed and (2) would become more similar to those in remnant sites as plant communities underwent succession. Species richness and abundance of bees did not differ between restored and remnant sites early in restoration; however, ten years later restored sites contained fewer bees and fewer species than did remnant sites. Communities at restored sites differed significantly from those at remnant sites early in restoration and remained so over time. In part these differences reflected responses of bees based on ecological traits. Wood-nesting species were underrepresented at restored sites compared to remnant sites.

Mitigation based in adaptation: El Salvador's ambitious community-based mangrove-restoration strategy

Wilmot, Fiona C.

Texas AM University

Despite serious misgivings about both the justice and efficacy of climate mitigation schemes on the part of critical climate scholars, El Salvador has produced an ambitious national climate change policy based on an ecosystem and landscape restoration strategy, in part for REDD-Readiness. This paper analyzes case studies of community involvement in restoration in the mangrove landscapes of the Biosphere of Xiriuatluc-Jiquilisco, El Salvador. It uses a livelihoods framework within political ecology.

Not all forests are created equal: Community-based restoration enhances cloud forest tree diversity, species composition, and the abundance of locally useful species in Andean Ecuador

Wilson, Sarah Jane; Jeanine Rhemtulla

McGill University

The number of community-based tropical forest-restoration projects has increased dramatically in the past decade. In coming years, as high deforestation rates coincide with increasing demand for forest ecosystem services, such projects will become even more common. Many restoration projects are underway in Andean cloud forests, which, given their megabiodiversity and alarming rate of disappearance, are understudied. My research investigates: 1) The efficacy of simple community reforestation methods to restore cloud forest tree species composition and diversity; and 2) How local people's preferences for certain trees affect those two metrics. This study takes place in Northwest Andean Ecuador, where only 10% of the original cloud forests remain, in five communities that initiated restoration projects in 2003 (planting 50+ native tree species). In 2011, we identified tree species along transects in five restored forests, five neighboring naturally regenerating forests, and five primary forests. We also surveyed 120 households on tree species preferences and uses. Tree diversity was higher in restored than in naturally regenerating forest; however, both were less diverse than primary forests ($p < 0.05$). Ordination analysis showed that all three forests had distinct species compositions, although restored forests shared more species with primary forests than did naturally regenerating forest, and contained more animal-dispersed species. Restored forest contained the highest proportion of 'useful' species. Thus, while restoring forest increased biodiversity, restored forests may represent a 'novel ecosystem' that is both distinct from the region's previous ecosystems and, because of its usefulness to people, likely to be more common in the future.

ORAL ABSTRACTS (CONT'D)

No lake is an island: restoring landscape connectivity for the closure of oil sands mines.

Wilson, Vivienne; David Austin

CH2M HILL Canada Ltd

Mining in the Alberta Oil Sands Region occurs rapidly on a landscape-changing scale. Mine leases are typically on the order of 20,000 hectares, the majority of which will be disturbed by mining occurring over decades. Entire watersheds and existing landforms are fundamentally changed by the process of removing and storing overburden, extracting ore, and building tailings containment. At end of mine life, operating approvals require reconstruction and revegetation of the surface of the land to a state that permanently returns it to a land capability equivalent to pre-disturbance conditions. An integrated planning process is required to consider dry and wet landscape surfaces within the context of linking progressive reclamation with operational requirements, providing confidence that site-wide water balances can support closure features, and demonstrating that wildlife habitat and revegetation goals are met. These closure plans have to consider the formation of new landscape features (including above original topography hills and ridges, aquicludes created by tailings storage, and pit lakes), the challenges of linking operational drainage planning to reclaimed surface drainage planning, and the interactions of landforms on one another with respect to the movement of surface water, groundwater and sediment. Examples will be provided for the planning of ecological function in pit lake systems and associated littoral and embayment areas, development of wetland systems that provide a treatment function as well as wildlife habitat, and the consideration of geomorphic design for above original topography structures that will change substantially over time and impact surrounding areas through diffusive and fluvial processes.

An Overview of the RESTORE Project

Wise, David H.; Lynne Westphal, Liam Heneghan, Alaka Wali, Paul Gobster, Madeleine Tudor, Joanne Vinings, Moira Zellner, Cristy Watkins, Kristen

Ross

UIC Biological Sciences

RESTORE stands for “Rethinking Ecological and Social Theories of Restoration Ecology.” Social scientists and ecologists on the Chicago Wilderness (CW) Science Team have been exploring facets of a unifying core research question: “How do different organizational structures and decision-making processes in the ecological restoration arena influence on-the-ground biodiversity results?” We selected 14 wooded sites (spread across the metropolitan Chicago region) managed by 10 CW organizations that were hypothesized to differ along several organizational axes primarily related to organizational complexity and structure, the extent to which volunteer stewards determine which restoration techniques will be applied to the land, and the degree to which research objectives determine restoration protocols. The social science researchers interviewed players on all levels of the organization that manages each site, although there was not a perfect one-to-one correspondence between site and group interviewed because of some overlap between organizational unit and sites within a political jurisdiction. The sites differed in total hectares managed and heterogeneity of management history, which dictated that the ecology researchers employ different sampling efforts across sites in collecting basic biodiversity data. A major challenge to answering the core research question has been integration of the ecological and social science data in a way that preserves the integrity of the replicates of each data set in this “natural experiment.” How this challenge was met will be discussed as an introduction to the following talks, which summarize the social science and ecological data, and how their joint analysis answers our core research question.

Restoring aerospace research facilities using pollinator seed mixes: Impacts of large-scale seeding efforts on local pollinators and key plants.

Wojcik, Victoria A.; Mary Rager, Chris Dunn, Paul Costa

Pollinator Partnership

The Santa Susana Field Laboratory (SSFL), located in Ventura, Calif., is a 2,850-acre former federal government rocket engine testing and energy research facility currently being cleaned up by The Boeing Company, NASA, and U.S. Department of Energy. The Boeing Company is the primary landowner and after cleanup, has committed to preserve its site as open space parkland pending habitat restoration. Pollinators are an integral part of any landscape, but are often overlooked in planning or restoration efforts. Cleanup and restoration at this site includes the first example of large-scale pollinator seed mixes. We monitored the impacts of targeted restoration using large-scale seeding over a three-year period, noting changes in pollinator and plant communities. Pollinator seed mixes significantly increased the occurrence of many native bee species when compared to un-restored areas. The site is also home to the Federally Endangered *Astragalus brauntonii* (Braunton's milkvetch) and California Species of Concern *Deinandra minthornii* (Santa Susana tarweed). Our data also indicate that proximity to restoration efforts benefit the reproduction of *D. minthornii*, with increased pollinator visits and correlations with significant increases in seed viability near pollinator seeding. Data gathered on this targeted restoration will aid other habitat enhancement projects. Coordinated outreach efforts will also encourage large-scale public and private land managers to consider restorations targeted at pollinators – a species group that supports all ecosystems.

Herbivory maintains altered vegetation and carbon flux in Tuolumne Meadows, Yosemite National Park: concepts for restoration

Wolf, Evan

University of California, Davis

Intense sheep grazing in the Gold Rush Era may have significantly altered the plant community and carbon cycling of Tuolumne Meadows. We measured the carbon flux to determine if the plant community at present is maintaining soil carbon levels or if soil carbon is decomposing faster than plants

ORAL ABSTRACTS (CONT'D)

are storing it. Loss of soil carbon reduces soil water holding capacity and plant available water, which can lead to further shifts in plant community composition. Contemporary small mammal and deer herbivory may be maintaining the plant community in an altered state, preventing recovery of a pre-sheep-grazing ecosystems. We installed a field experiment to exclude herbivory by deer and small mammals and planted native long-lived rhizomatous sedges into plots to determine if their establishment success is affected by herbivory. Ground disturbance and herbivory by rodents may also affect lodgepole pine establishment in the meadow, a potential trend towards conversion of meadow to forest. Ongoing herbivory and soil drying due to soil carbon loss may be preventing the reestablishment of plants necessary to the long-term stability of Tuolumne Meadows.

Restoration of native plant communities following saltcedar and Russian olive removal in Canyon de Chelly National Monument, Arizona.

Wolk, Brett H.; Jayne L. Jonas, Mark W. Paschke
Colorado State University

Over time, saltcedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) invasion has altered desert stream ecosystems, including channel narrowing and inhibiting or eliminating native understory plant communities. At Canyon de Chelly National Monument, Arizona, the National Park Service and Navajo Nation have been aggressively removing these invasive tree species. Little is known, however, about best practices for reestablishing native plant communities after invasive tree removal. Our objective was to assess effective approaches for restoring native plant communities following removal of saltcedar and Russian olive in Canyon de Chelly. We conducted a randomized complete block experiment to examine the effects of vertical mulch, seed mix diversity, and seeding rates on plant biomass and richness during the first three years after tree removal. We found vertical mulch strongly inhibited plant production and species diversity across all seed mixes compared to non-mulched treatments. In non-mulched treatments, effect of seeding rate depended, at least in part, on diversity of species in the seed mix. Seeding commonly used native perennial species at a standard seeding rate (650 PLS m²) did not increase native vegetation biomass or richness relative to non-seeded treatments. At this research site with a residual cottonwood (*Populus deltoides*) overstory, increasing the seeding rate and/or adding native early seral species to the seed mix was the most effective restoration approach to encourage production and diversity of desirable species during the first three years following tree removal.

Linking community involvement with ecological outcomes in local government restoration

Wortley, Liana
Griffith University

Social outcomes and community engagement are important aspects of ecological restoration. In Australia, community groups play a significant role in initiating and implementing projects and this provides a forum for social capital building as well as connecting people with the environment. In recent years however ecological restoration has become a larger, more critical component of natural resource management and it is necessary that restoration practices achieve the desired ecological outcomes in a cost-effective manner. Understanding how community involvement affects the achievement of ecological goals will help practitioners develop the best strategies for delivering effective restoration. This study explores this issue and aims to provide important insights into the interaction between social and ecological aspects of restoration. Key stakeholder interviews from four local government case studies are used to investigate the degree to which community involvement provides barriers or enablers to achieving ecological aims in local government restoration. The findings suggest that although community input may result in resources allocated away from priority ecological actions, community engagement is very important to long term success of local government restoration. A conceptual framework is developed from the results of the study linking community involvement with ecological outcomes to assist practitioners in optimising social and ecological aspects of restoration.

Restoration of high-altitude grazed peatlands in a changing world: An experience in the eastern Tibetan Plateau

Wu, Ning
International Centre for Integrated Mountain Development

Peatland, an ecosystem interface between water bodies and rangelands on the Tibetan Plateau, is traditional grazing lands used by Tibetan herders seasonally. It was estimated that the global pool of carbon held in peatlands makes up 12.3% of the global soil carbon with only 3% of the total land surface. On the eastern Tibetan Plateau the extensive Zoige peatlands, contain an estimated carbon content of 750 megatonnes – a significant proportion of Chinese peat carbon resources. In fact, peatlands in Zoige as well as others in the entire Tibetan Plateau, still function as grazing pastures for nomadic herders, especially when they are frozen or not waterlogged. About eighty percent of the peatlands on the Tibetan Plateau are grazed or browsed by domestic animals in winter and early summer. During the last forty years peatland degradation increased dramatically in this region with the development of human population and the rising demand for food, fuel and rangeland. Overgrazing and the resulting decrease in the quality of pasture fuelled the demand for new rangeland. This led to increased pressure on untouched peatlands. Climate change integrated with human drainage led to the peatland shrinking dramatically. In last ten years several pilot projects by national and international organizations have supported peatland restoration in the Zoige by replanting vegetation, rewetting and establishing co-management systems that involve multiple stakeholders for the many uses of rangeland resources. In this paper focus will be on the linkage among climate change, peatland management and adaptation of local communities.

ORAL ABSTRACTS (CONT'D)

Response and adaption of urban lakes with different trophic states to climate change: a case study in the Beijing city, China

Wu, Qiong; Xinghui Xia, Xinli Mou

Beijing Normal University, School of Environment

Effects of climate change on aquatic ecosystem have been a hot topic among scientists and governments around the world. However, few studies focus on urban lake systems. In this research, monthly water quality and ecosystem parameters, including total nitrogen (TN), total phosphorus (TP), chlorophyll a, chemical oxygen demand (COD), biological oxygen demand (BOD), dissolved oxygen, water temperature and etc., in twelve urban lakes of Beijing were analyzed from 2009 to 2011. Results indicated that TN in the urban lakes did not exhibit significant response to climatic variations owing to relatively lower TN concentration in the urban soil. For the highly eutrophic lakes, TP, chlorophyll a, COD, and BOD were positively correlated with precipitation, and negatively correlated with wind speed ($p < 0.05$). Chlorophyll a showed significant positive correlation with TP and temperature. Moreover, the abrupt increase of TP occurred in spring, which was associated with higher temperature induced internal phosphorus loading. In contrast, lakes with mesotrophication/light eutrophication did not show significant sensitivity to climatic variations owing to their better buffer capacity and regulation effect of algae growth. Beijing is undergoing increased temperature and storm frequency as well as decreased wind speed during the past five decades; the above results infer that water ecosystem of Beijing is becoming worse under this climate change trend. This study also suggested that urban lakes with different trophic states will respond differently to global climate change, and highly eutrophic lakes might face big challenges of water quality deterioration and algae bloom.

In-lake detection and classification of three invasive aquatic macrophytes using spectral reflectance and dissolved organic matter

Wylie, Caroline; Eric Sager, Céline Guéguen

Trent University

Estimating the extent and spread of invasive aquatic macrophytes (IAMs) using current sampling methods present challenges due to the size of the invaded systems and inaccessibility of these areas. In this study, we propose to apply remote sensing technology to map IAMs. It has been only recently that the application of these technologies for the mapping of IAMs has become feasible. The increased spectral resolutions (i.e. 0.4 m) has improved accuracy. This coupled with appropriate algorithms allows us to isolate the IAM signal from the background signal in the water body of interest with a reasonable accuracy. The overall goal of this study is to look at the potential of remote sensing technology as a tool to increase the efficiency of lake surveys for the detection of IAMs. Three IAMs Eurasian Watermilfoil (*Myriophyllum spicatum*), fanwort (*Cabomba caroliniana*) and water soldier (*Stratiotes aloides*) will be studied in inland lakes of Ontario, Canada. In particular, the use of dissolved organic matter (DOM) as an indicator for IAMs biomass will be tested and the IAM-specific optical signature will be derived based on the reflectance properties. This project has the potential to map/inventory aquatic macrophyte stands and detect species based on the signal they produce.

Restoration Planning Successes –US Army Corps of Engineers

Yahr, Ben J.; Amanda Stone, Dan Veriotti, Alex Brunton

Baird & Associates

Baird and URS have collaborated to provide assistance to the US Army Corps of Engineers Buffalo and Detroit Districts for engineering, science, and managerial services related to the Great Lakes Restoration Initiative. Restoration planning relied heavily on computer modeling and innovative planning and engineering techniques to ensure project longevity in the challenging Great Lakes environment while involving diverse groups of stakeholders, consultants, and governmental agencies. Project successes include: -- Boardman River: Modeling and restoration planning will restore connectivity for 20 miles of coldwater habitat adjacent to Lake Michigan through the construction of over a mile of stream channel, removal of two dams, sediment management, and revegetation. -- Toledo Harbor: A series of offshore islands in Lake Erie will provide over 1,000 acres of fish spawning, submerged, emergent, and upland habitat while accommodating over 20 million cubic yards of maintenance dredging material. -- Marion Mill Pond: Removal of a small dam and mill pond will restore coldwater habitat continuity along 33 miles of the Middle Branch River in central Michigan. Natural channel design principles were applied to the dewatered pond which will include wetland and prairie restoration. -- Anchor Bay: Collaboration with stakeholders to identify and prioritize 88 projects for GLRI funding based on relationships between pollutant sources, stressors, impacts, and beneficial use impairments within the Clinton River and Anchor Bay watersheds in southeast Michigan. The presentation will highlight a range of project types, scales, and restoration objectives funded through the GRLI in riverine and offshore environments.

Restoration of Replacement Habitat of the Two Endangered Species, Korean Golden Frogs and Narrow-mouthed Toads

Yi, Hoonbok; Chi Kyung An, Jae Han Shim, Hyun Jung Kim, Jong woo Nam

Seoul Women's University

This study was conducted at Seo-gu areas designated to build superblocs, in Incheon metropolitan city of Korea from January 2007 to October 2008. The purpose of this study was to conserve the two endangered amphibian species, the Korean golden frog and the narrow-mouthed toad, as creating the replacement habitats at the different place. Therefore, we analyzed the disperse pressure and the ecological characteristics of small scale habitats to find out their inhabiting environments. We caught 254 adults and 290 tadpoles for Korean golden frogs and 114 adults and 338 tadpoles for narrow-

ORAL ABSTRACTS (CONT'D)

mouthed toads by ten-time collecting by the direct survey for adults and the indirect survey and direct survey for tadpoles, and moved them to the replacement habitat. We found that the adult narrow-mouthed toads and the adult Korean golden frogs got off the ground between May and October used pools or fields of reeds as spawning grounds. They also have a hibernaculum and feeding place around 500 meters from their habitats. After we created the replacement habitats, we moved two species from original habitat to replacement habitat. The replacement habitat was composed of the similar conditions which they previously inhabited. We released the adult individuals, tadpoles to the site near the cattail community in which live easily for feeding and digging before the metamorphosis and less dangerous from the natural enemies. Monitoring for the two species should be mandatory at least for three years to find out their stable and successful establishment at the new habitat.

Beach ecology in a rising sea

Young, Rob; Orrin Pilkey
Western Carolina University

Sea level rise and our likely response to it places sandy beach ecosystems in danger of complete destruction. Beach replenishment, widely used to preserve eroding beaches, kills virtually all beach organisms. Recovery takes 2 to 4 years and since most replenished beaches north of Florida last 2 to 5 years before needing re-replenishment, a recovered ecosystem is often short-lived. The problem is that by the time sea level has risen 2 feet (in 60 to 80 years??) beach replenishment will no longer be economically feasible because the pumped-up sand will disappear very quickly. Thus, if funding is available, most barrier islands must be seawalled (seawalls destroy beaches) for their preservation unless the (much more preferable) retreat or demolish sea-level-rise response options are put in place. The only remaining beaches supporting a complete ecosystem will be in parks. The hundreds of miles of high-rise-lined shorelines along the Florida Peninsula present a particularly difficult ecology problem. The buildings are basically immovable. Seawalls are already being built at a fast pace in Florida and beach replenishment is widespread. The entire ecosystem of Florida beaches is in danger of destruction with a 2-foot sea level rise. To prevent this, a special effort will be needed to preserve the few existing natural shoreline reaches in Florida and to create other natural beaches by removing development. The questions remain: Will the cost of protecting threatened cities trump the cost of protecting beaches? Can beachless tourist communities flourish? Who pays?

Workshop: Community-Based Restoration: Developing Best Practices for Managing Volunteers

Yurko, Matthew
Community-Based Restoration and Education Program, California Coastal Commission

Community-based restoration encourages the community to be involved in all stages of a restoration project. Effectively managing a volunteer program leads to a knowledgeable and engaged community who take ownership over the project. However, involving the community in a restoration project comes with its own challenges and requires certain skills, methods, and techniques to be successful. In this workshop, we will develop and discuss the best practices for managing volunteers in community-based restoration projects. The results of this workshop are intended for publication.

Effect of restoration treatment, parent tree, and site on tropical forest tree seedling growth

Zahawi, Rakan A.; Corinna Eckert, Lisa Schwanitz, Miguel J. Chaves, Karen D. Holl
Organization for Tropical Studies

Planting trees is a common restoration strategy in degraded tropical habitats and may enhance natural seedling recruitment and development by improving soil conditions. We quantified the growth response (height, diameter, final biomass) of four native tree species [Ocotea puberula (Lauraceae); Otoba novogranatensis (Myristicaceae); Pseudolmedia mollis (Moraceae); Senna papilosa (Fabaceae)] grown under similar shade-house conditions but in soils collected from five restoration sites in Coto Brus county, southern Costa Rica. Soils were collected from 8-9-yr old active restoration plots planted with four tree species (two N-fixers), passive restoration plots (natural recovery), and nearby reference secondary forest. Study species were collected from beneath at least three mother trees, and either transplanted directly as seedlings (Ocotea, Senna), or germinated in trays and transferred. Five replicate seedlings were planted in each soil medium. Differences at 3 mo for Otoba and Ocotea were driven by parent tree for height and diameter but not treatment or site, whereas Senna and Pseudolmedia showed weak significance for parent tree and treatment. Below-ground biomass differences in Otoba (only species harvested thus far) were found among sites and parent tree but not for above-ground biomass. It is surprising that restoration plots were no different from reference forest, and although some species showed a site response, the effect was species-specific and weaker. Parent tree was, however, a strong indicator of initial seedling vigor in all species and appears to be the most important factor driving seedling growth in this system.

Embracing uncertainty: Looking back while planning ahead

Zedler, Joy B.
University of Wisconsin-Madison

Restorationists continually face uncertain outcomes of their recovery efforts. Looking back, records for wetlands show that we lost services despite requirements to compensate for human impacts. Looking forward, it is uncertain which targets will be suitable for highly modified wetlands and altered watersheds. For example, to restore Los Angeles' last remaining salt marsh, habitats must be reconfigured around roads and oil wells, with uncertain rates of sea level rise and urban runoff. Planning ahead, we can reduce uncertainty by extending time frames for restoration, broadening restoration over space and time to sustain ecosystems within regions over decades, and using watershed plans to prioritize work in subwatersheds with minimal services and in sites that can achieve specific services. And where unknowns seem overwhelming, we can embrace uncertainty by experimenting with alternative approaches via adaptive restoration--rejecting methods that miss goals and adopting those that work, learning while restoring. At the UW Arboretum,

ORAL ABSTRACTS (CONT'D)

three excavated wetlands appeared identical, but one ponded water and attracted cattails to dominate. It exported copious nutrients, despite being designed to remove them. Interdisciplinary research showed how underlying clay, ponding and cattails combined to preclude nutrient removal and reduce other ecosystem services. Future outcomes will be more predictable when wetland designers accept scientific findings and incorporate critical biological processes into nutrient-removal models. A remaining uncertainty is whether stormwater regulations can change accordingly. Looking back to Leopold, it seems he planned ahead by anticipating an evolving land ethic that can accommodate our need to accept, reduce, and embrace uncertainty.

Cutting edge tools for assessing ecosystem services and managing restoration projects

Zelaya, Al

The Davey Institute

Trees and forests in urban areas provide critical ecosystem services that enhance environmental and human health. However, many benefits of ecological restoration projects are difficult to quantify and management goals and successes may be limited to structural or biological characterizations. The i-Tree suite of software tools (www.itreetools.org) may address this gap by providing a method for a more comprehensive assessment - and valuation- of the ecosystem service benefits of restoration projects involving trees and wooded natural areas. i-Tree is a state-of-the-art, peer-reviewed software suite developed by the USDA Forest Service to provide urban and community forestry analysis and benefits assessment. Within the suite of i-Tree tools, i-Tree Eco is specifically designed to combine field data collected within an area of interest with local air pollution and weather data to quantify forest structure, environmental effects, and values to communities. The resulting analysis includes estimations of air pollution removal, carbon sequestration and storage, species diversity, avoided rainfall runoff, public health benefits, insect pest and disease risk, and economic values. By improving the understanding of tangible ecosystem services and values provided by ecological restoration, project planners and managers can connect management activities and goals with environmental quality, community livability, and policy development. Such an approach can facilitate restoration planning, case-making, and monitoring. This presentation will examine the collaborative potential and limitations of adapting the i-Tree Eco urban forest assessment tool for ecological restoration projects.

Biological invasion of North Italian floodplains by *Robinia pseudoacacia* L. and *Prunus serotina* Ehrh. and implications for forest restoration management

Zerbe, Stefan; Christian Ammer, Peter Annighöfer, Heike Kawaletz, Inga Mölder, André Terwei

Free University of Bozen-Bolzano

The North American tree species *Robinia pseudoacacia* L. and *Prunus serotina* Ehrh. are strongly invasive in many parts of Europe. In hardwood floodplain forests of the North Italian Po Plain, these non-native and light-demanding tree species coexist with the native tree species *Carpinus betulus* L., *Quercus robur* L., and *Ulmus minor* Mill. Successful competition with the natural vegetation has led to a high frequency and abundance of the non-native tree species in the Biosphere Reserve Parco del Ticino (west of the city of Milan, NW Italy), which is considered a threat for habitat conservation in those last remnants of riparian natural forest ecosystems. As those species have already been naturalized in the forests, management options for the restoration of native floodplain forests were investigated, taken the ecology of those species into account. Within a multi-disciplinary research team, we investigated the impact of the two non-native tree species on the diversity of the ground flora and seed bank, performed pot-experiments on the below- and above-ground competition impact of the non-native on the native species, and suggested different management options to cope with the non-native tree species. From our findings, we derived recommendations for the management and restoration of the natural floodplain forests along the Ticino river. The key message for forest management is that less intense forest management seems to be more successful for controlling the non-native species.

Ecological recovery and governance: Landscape replacement and recycling of Jiao Zuo clay mine in China

Zhao, Mei Hong

Huazhong University of Science and Technology

The Current situation of the research project: Jiao Zuo clay mine is located in the northwest part of Henan Province, in central China. Mining activities at Jiao Zuo have long lacked scientific planning and sustainable development strategies, causing the mine's environment to be damaged and the resources to be exhausted. In abandoned mines, especially, there exist more serious problems; such as secondary bare land, environmental pollution, species loss, resource exhaustion and maladjustment of ecological equilibrium. These conditions call for transformation, governance, protection and the recycling of such abandoned mines. Since 2009, the Chinese Government has invested a lot of money in the environmental recovery and governance of the Jiao Zuo mine restoration project. Concrete content of the research project includes: 1. Ecological recovery of abandoned mines. 2. Safety measures of managing abandoned mines. 3. Measures to protect the geology of mined landscapes. 4. Artistic methods of displaying traditional mining relics. 5. Methods of transforming abandoned industrial facilities. 6. Comprehensive development of historical and human landscapes in abandoned mining areas. 7. Artful ways of configuring public art works. 8. Design of signage system for scenic areas.

A riverscape transect approach to studying and restoring river systems: A case study from southern China

Zhou, Ting

Sun Yat-sen University

Rivers provide important ecosystem services to society, and play an essential role in maintaining the structure, function, and integrity of landscapes in which the rivers reside. Better understanding the patterns and processes in river systems requires a broader landscape approach that goes beyond the traditional linear and longitudinal focus. Such a landscape approach is especially important for effectively restoring and managing already damaged or

ORAL ABSTRACTS (CONT'D)

degraded rivers. We develop a riverscape transect approach by adapting landscape gradient analysis with pattern metrics to quantify the longitudinal variations in the spatial pattern of the river-land complex from headwater to mouth. Two rivers systems in southern China were used to develop and demonstrate the approach. For each river, we first constructed a riverscape transect, consisting of a spatial series of overlapping neighborhood landscapes, then computed a selected set of landscape metrics, and finally depicted the longitudinal profile of riverscape pattern with relative location-based plots. Our results have shown that this riverscape transect approach is conceptually consistent with the increasingly prominent river-landscape perspective and technically feasible with the aid of remote sensing data and landscape pattern analysis software. In particular, percentages of urban and native vegetation, patch density, and Shannon diversity were shown to be able to reveal riverscape structural variations along the two rivers which imply important ecological consequences and potential drivers for the observed changes. With properly chosen landscape metrics and ecologically defined river buffers, this approach can be effectively used in the planning and evaluation of river restoration and management efforts.

Trajectory of native plant recovery following herbicide treatment of five *Phragmites australis* patches in a Hudson River tidal wetland

Zimmerman, Christoher L.; Rebecca Shirer

The Nature Conservancy

The recovery of native plant communities after invasive plant control is influenced by environmental and site factors. We investigated changes in native plant communities over three years in and surrounding five *Phragmites australis* (Pa) patches (0.04-0.75 ha) in a 45-ha freshwater tidal wetland primarily composed of *Typha angustifolia* and *Peltandra virginica*. A glyphosate-based herbicide with an aquatic-approved surfactant was sprayed on the patches at a rate of six pints/acre in September 2010. Pa stem density and herbaceous plant cover were estimated pre and post-treatment within Pa patches and up to 10 m outside the patch pre and post-treatment in August. Before treatment, the three largest patches (0.30 - 0.75 ha) had significantly higher Pa cover than the other two patches and significantly lower native plant cover than the surrounding wetland. One year post-treatment, Pa stem density and cover were reduced by >90% in all five patches, and native plant cover significantly declined in the two smallest patches (<0.05 ha). By the second season post-treatment, native plant cover significantly increased compared to pre-treatment data in all but one patch and was not significantly different from the surrounding wetland. Composition in the three largest patches was significantly different from the surrounding plant community, with a high percent cover of disturbance-dependent species. The composition of the two smallest patches was similar to the surrounding wetland. Pre-treatment invasive plant cover and patch size strongly influenced native plant recovery and could indicate whether active restoration will be needed.

Prioritizing ecological restoration across Wisconsin's diverse landscape

Zine, Matthew

Wisconsin Department of Natural Resources

Coarsely divided by a biological tension zone that runs from northwest to southeast Wisconsin that divides the state between the more canopied mixed northern forests and the more open, oak-dominated, landscape to the south, Wisconsin presents two very different landscapes, with different anthropogenic and biological pressures, and subsequently, different management needs/approaches. The WDNR is responsible for overseeing and maintaining over 660 diverse State Natural Areas (SNAs) across this landscape, including a goal to protect and preserve the best remaining examples of Wisconsin's very diverse remnant landscapes. Because of the number, diversity and wide geographic distribution of SNAs, we are attempting to establish management priorities to address the universal issue of trying to manage plant communities/landscapes across a large geographic area with limited resources. A brief overview of this landscape and the SNA program, as well as our current state of management will first be provided, followed by highlights of the variables we are considering as we initiate this effort. These include the general management needs of northern and southern community types; community rarity, both within and beyond the state; how resilient the sites and communities are in the face of a changing climate; potential for large-scale management approaches (e.g., prescribed burning), and others. Practical and theoretical considerations, as well as the unknowns and knowns in terms of outcomes, will be part of the emphasis on the real-world issues we're facing and how they will likely play a role in our attempt to meet management needs across such a broad, diverse landscape.

Ecosystem restoration needs in Argentina

Zuleta, Gustavo

Maimónides University, Dept. of Ecology & Environmental Sc

Argentina is the world's 8th largest country and harbours more than 50 ecoregions and subregions including a high diversity of forests, shrublands, grasslands and wetlands along a 3800 km of environmental gradients. Although natural protected areas increased near 9 times since 1970 (27.288 to 234.000 km²), conservation efforts are still insufficient to guarantee sustainable figures. Based on land use review and GIS analyses at a national scale, restoration needs were established by ecoregion and rehabilitation approaches proposed. Grassland-type ecosystems are largely the most degraded ones (91% of 1.517.480 km² was replaced or modified), followed by forests (50%; 1.010.910 km²), and highlands (49%; 70.970 km²). Wetlands are still in good shape (19%; 73.567 km²). Pampas habitats are almost gone at a landscape level basically due to massive industrial agriculture. Cattle raising is responsible for moderate to high degradation in Monte and Patagonia, whereas mixed land uses primarily affect three ecoregions: Espinal open forests, Campos-Malezales subtropical savannas, and Chaco's semiarid forests. Exotic species invasion is an increasing degradation cause impacting wetlands and specific ecosystems. Mining, urban expansions, and forestry are still local disturbance factors. Despite 71% of Argentina's terrestrial and coastal lands is currently degraded, passive restoration is more needed than active approaches. Besides, an effective, national restoration strategy should be based on social actions rather than scientific-technological ones: (1) regulations and public policies update, (2) permitting enforcement, (3) stakeholders integration, (4) land planning, and (5) economic/consumption model rectification.

5th World Conference ON ECOLOGICAL RESTORATION

REFLECTIONS ON THE PAST, DIRECTIONS FOR THE FUTURE

POSTER ABSTRACTS

Analysis of the socioeconomic and ecological components of tropical restoration: A case of study in Selva Lacandona, Chiapas, México

Aguilar-Fernández, Rocío; Julia Carabias
Instituto de Ecología UNAM

The Selva Lacandona is the biggest remnant of tropical rainforest in Mexico. Originally this region covered 1.8 million hectares but, in the last 40 years, it has been drastically reduced to approximately 500,000 hectares. Specifically, the region of Marques de Comillas presents a high rate of deforestation, 51% related to a special pattern called perforations—anthropogenic gaps among the intact forest fragments. The outcome is a fragmented landscape where cattle and agricultural ranches have settled. Most of these pasturelands are abandoned, giving way to patches of transformed vegetation surrounded by primary forest. As these abandoned lands require immediate attention, our main goal is to develop a restoration model for the Marques de Comillas's perforations, including socioeconomic and ecological variables. The study took place in a 37 hectare perforation, which was originally cleared for livestock. We established 30 experimental units, and evaluated the efficiency of three restoration techniques, (livestock exclusion, manual removal of grasses, and the transplantation of native trees). We calculated the economical cost for applying each technique, measured the survival rate of introduced trees, and evaluated the intervention effect on natural regeneration. At the moment, the results show that the most efficient technique is introducing native species in a density of 650 trees/hectares, and removing exotic grasses manually. Moreover, we calculated the opportunity cost of restoration over livestock production in order to analyze the feasibility of the actual governmental programs focused on the promotion of rainforest restoration. Finally we present recommendations for perforation restoration in Marques de Comillas.

Natural Recovery in some sectors of the Demilitarized Zone in Kuwait

Al-Musawi, Layla; Meshal Abdulla, Mansour Taleb Abdullah
Kuwait Foundation for Advancement of Science

Over the last decades, the desert of Kuwait has been impacted with various anthropogenic activities. Following the 1991 Gulf War, a demilitarized zone (DMZ) was established in 1992 pursuant to the Security Council Resolution 689. The DMZ runs along the Iraqi-Kuwaiti border for 190 km (120 miles), and extends 5 km (3 miles) into Kuwait. In a survey undertaken in 2010, to identify the best locations for the selection of future protected areas in the State of Kuwait. Five Sectors of the DMZ representative of various plant communities in Kuwait were selected. The sites were surveyed for type and structure of vegetation present, indigenous insects, and soil properties (soil texture, permeability, pH, total organic carbon, minerals and nutrients). The fenced and undisturbed area exhibited a remarkable natural recovery. The analytical results were used to develop restoration priorities for future protected areas

Cottonwood (*Populus deltoides*) recruitment following the 2011 flood on the Missouri River, USA

Albers, Victoria L.; Mark D. Dixon, Michael L. Scott, W. Carter Johnson
University of South Dakota

Flow regimes along many large rivers have been modified by water management activities, often resulting in pervasive effects on riparian flora and limiting regeneration of cottonwood forests. On the Missouri River, six mainstem dams and reservoirs were constructed from the 1930s-1960s, resulting in cessation of flooding on many reaches and declines in cottonwood regeneration. In 2011, a large flood occurred, inundating large portions of the floodplain for over two months and constituting the largest flow on many parts of the river in the last 59 years. We assessed post-flood cottonwood recruitment by mapping patches of 2011/2012 seedling cohorts during the summer of 2012 in 15 focal reaches within six study segments of the Missouri River between Montana and Nebraska. Extensive cottonwood recruitment (728 patches) occurred throughout the 15 study reaches (225 km total) with most patches of seedlings occurring on non-vegetated sandbars. Spatial patterns of recruitment reflected differences in channel complexity among study segments. Patches below Garrison Dam in North Dakota were predominantly located along the main channel and adjacent to the mainland, while those below Gavins Point and Fort Randall dams (both in South Dakota/Nebraska) were found primarily along side/secondary channels on sandbars associated with islands. Vegetation sampling was conducted on 142 cottonwood seedling patches. Cottonwood stem density and percent cover were highly variable and presence of invasive species was relatively low. Seedling survival over the next few years will influence the long-term impact of these post-flood cottonwood cohorts on forest dynamics along the Missouri River.

POSTER ABSTRACTS (CONT'D)

Possibility of using *Sesbania sesban* for bioremediation of soil polluted by crude oil

Ali, Basim Abd; Hassan Ali

Natural History Research Center & Museum, University of Baghdad

The research has conducted to explore seed germination and growth parameters of *Sesbania sesban* in crude oil polluted Iraqi soils. Two types of soil (sandy and clayey) and four levels of pollution (0, 30, 60, 90 ml/kg soil) were tested. The interaction between Salinity and crude oil was examined by laboratory experiment. Results approved the validity of polluted sandy soil for seed germination. Level of pollution did not effect germination in this soil, but in clayey soil the trend was different. Light pollution improved germination and then it decreased with increasing pollution level. All growth parameters in sandy soil were at higher rates than in clayey one. While salinity of clay soil prohibited seeds to germinate, the addition of 30 ml/kg improved both of germination and growth. Higher pollution (90 ml/kg) resulted in 3% and 10% of Survival for clay and sand soil respectively.

Towards the reclamation of a degraded Oxisol: Influence of a selected best management practice on soil nano-particles and soil organic matter content

Alves, Marlene Cristina; Carlos M. Monreal, Sebastiao Nilce Souto Filho, Carolina S. Batista Bonini

Faculdade de Engenharia/UNESP

Urbanization activities in rural areas change soil properties which may result in low land productivity and increased soil degradation. There is little information on the effects of best management practices (BMP) during the reclamation of degraded Oxisols. This study investigated the effects of a selected BMP on particle size distribution, morphology of soil nanoparticles, and the content of soil organic matter (SOM) in an Oxisol. Particle size fractions were obtained by sonication and centrifugation in water and observed under a Transmission Electron Microscope (TEM). The BMP involved the soil addition of sewage sludge (60 t ha⁻¹) at the beginning of the experiment. Soil was cultivated with *Astronium fraxinifolium* (Savannah tree species) intercalated with the grass *Brachiaria decumbens* (reclaimed plot) for 8 years. An adjacent native Oxisol under Savannah served as the baseline for evaluating the reclamation process. Relative to the particle size distribution determined for the native Oxisol, the eroded soil presented a higher amount of sand-size and lower amounts of clay and nano-size particles (200-100, < 100 nm diam). Observations by TEM also showed that dispersed soil particles were dominated by spherical and hexagonal shapes in all three conditions. The content of SOM was highest in the native (20.4 g C, 1.2 g N kg⁻¹ soil) > reclaimed (8.5 g C, 0.5 g N kg⁻¹ soil) > degraded (5.4 g C, 0.4 g N kg⁻¹) Oxisol samples. These results show that nanostructure and SOM may be used as proxy for monitoring soil health in eroded Oxisols.

Native plants for successful roadside revegetation in Idaho

Ament, Robert; Monica Pokorny

Montana State University

Revegetation of roadsides following construction activity is a challenge for transportation agencies. Plant establishment must occur quickly to prevent slope erosion, reduce sedimentation in surface runoff, and avert slope failure. Poor establishment of desired native vegetation from prescribed seed mixes can result in noxious weed and other exotic species invasions. In an effort to improve roadside revegetation in Idaho, we monitored plant species' canopy cover, soil erosion and invasive weeds on three sites for five years following revegetation. Twelve other roadside revegetation projects representing multiple ecoregions of Idaho were evaluated on the fifth year following seeding. Field monitoring continues through July 2013 to assess additional reclamation sites. Data will be analyzed by shrub, grass, and forb groups for: native seeded, native non-seeded, non-native and weed species. Data will be analyzed for species diversity, species establishment, weed species encroachment, and site characteristics influencing revegetation success. In an effort to improve revegetation efforts in Idaho, recommendations for new seed mixes for each ecoregion in the State will be developed. These mixes will be based on desirable species that demonstrate successful establishment, persistence, weed resistance, and/or erosion control capabilities. To date, we have observed a low establishment and persistence of native forbs species that have been seeded along roadsides. This may be a factor of low seed viability, an influence of other roadside management techniques, or both. Initial observations suggest that desired species diversity or total native plant cover was not observed to be an indicator of resistance to weed species establishment.

Midwest-Great Lakes SER Chapter: Who we are, what we do, and what we will do.

Anderson, Roger C.; Young D. Choi, Peter C. Smiley, Jennifer L. Lyndall

Illinois State University

Midwestern United States consists of 12 states and six of them (Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio) contact Great Lakes. This subregion defines the boundaries of the Midwest-Great Lakes (MWGL) Chapter of the Society for Ecological Restoration (SER). This region has a diversity of ecosystems including prairies, a variety of forest types, savannas, wetlands, aquatic habitats including the Great Lakes, and wilderness areas. This diverse geographic area is impacted by agriculture, industry, urbanization, and invasive species. Consequently, ecological restoration projects within this region face a wide range of challenges. The MWGL SER Chapter was established in 2008 with a mission of promoting the science and practice of ecological restoration to assist with recovery and management of aquatic and terrestrial ecosystems within this region. Promotion of ecological restoration is critical for facilitating coordination and supporting grassroots restoration efforts. To communicate with chapter members and others we established a chapter webpage, developed a Facebook page, regularly publish chapter newsletters, and hold annual chapter meetings. Our first five

POSTER ABSTRACTS (CONT'D)

annual meetings (2009-2013) include sessions for oral and poster presentations, workshops, symposia, and at least one plenary session. In 2012, we filed our articles of incorporation and were formally recognized as a domestic non-profit organization by the State of Indiana and in 2013 we were recognized as nonprofit public foundation [501(c)(3)] by the United States Internal Revenue Service. We are currently developing a 5-year strategic plan that will incorporate input from our membership and will guide the selection of our future activities.

Inter- and intraspecific variation of above- and belowground traits in grassland plant species at a restoration site

Andrade, Bianca; Gerhard Overbeck, Gabriele Pilger, Guilherme Jecker, Ilsi Boldrini, Julia-Maria Hermann, Johannes Kollmann
Universidade Federal do Rio Grande do Sul / Technische Universität München

Understanding trait variation between individuals in response to environmental heterogeneity improves our knowledge of ecological processes. Most studies that analyse plant response by help of functional types work with mean traits for species, and intra-specific variation usually is not considered. We aimed at identifying patterns of biomass allocation trends and functional plant traits comparing individuals subjected to different levels of physical and chemical soil stress. We explore contrasting environments created by restoration treatments in the grassland reserve "Garching Heide", southern Germany. Samples were taken from two areas restored in 1993 (with and without top soil removal) and a control site of ancient grassland. We studied 14 species, of these eight present in all treatments. Four above- and belowground functional traits were analysed. Relative importance of trait variation among individuals, species and sites was assessed by variance partitioning. As expected, interspecific variation was more important than intraspecific variation, but contribution of the latter to total variation was considerable, especially for specific leaf area. We found that soil physical constraints had significant effects on intraspecific variation of plant height, specific leaf area and specific root length, while soil residual fertility did not affect plant trait variation. We found two different allocation strategies among species to overcome resource stress. The trends of functional traits in response to site condition was consistent across species. We conclude that caution must be taken when using mean trait values for plastic species along environmental gradients.

Bird for buck: What is the most cost-effective way to restore bird communities?

Ansell, Dean H.; Philip G. Gibbons
Australian National University

In southern Australia, the fragmentation and degradation of woodlands has led to significant declines in bird communities. Woodland restoration is widely employed to reverse this decline and is dominated by two techniques: (1) passive restoration involves the management of remnant habitats to remove threatening processes (e.g. fencing to reduce grazing pressure), and; (2) active restoration involving revegetation, with an increasing trend toward direct-seeding larger blocks through agri-environment schemes. Although there is significant public expenditure on these programs, the amount of funding relative to the size of the problem is small. Previous research has demonstrated the potential for significant increases in conservation outcomes by incorporating cost into decision-making. However, the cost of restoration is rarely reported or factored into evaluation of restoration programs. Thus, we do not know whether greater conservation outcomes can be achieved by allocating available funding in a different way. This project aims to compare the cost-effectiveness of different techniques used to restore woodland habitats in southern Australia. The response of woodland bird communities to different restoration approaches will be surveyed across sites varying in size, age and landscape context. Traditional measurements of species richness and abundance will be augmented with behavioural data to better understand the function of revegetation and woodland remnants in the ecology of woodland bird communities. Combining this ecological information with project costs will allow identification of key drivers of the cost and effectiveness of woodland restoration and contribute to optimal planning of woodland restoration projects.

The effects of topsoil addition and seeding of grasses in gravel-mine reclamation on vegetation succession

Aradottir, Asa L.; Hersir Gislason
Agricultural University of Iceland

Guidelines for gravel-mine reclamation now often instruct the salvage and addition of topsoil, commonly along with the seeding of herbaceous species. In 2006 we established an experiment in W-Iceland to test whether the addition of topsoil during reclamation of a gravel mine accelerated succession towards native heathland vegetation, compared to more conventional methods using a mixture of topsoil and subsoil over the reshaped mine. The following treatments were tested: (1) topsoil spread over subsoil; (2) treatment #1 + fertilization; (3) treatment #2 + seeding of grasses; (4) a mixture of topsoil and subsoil + fertilization; and (5) treatment #4 + seeding of grasses. Each treatment was replicated in five 80 m² plots arranged in a complete randomized block design. Vegetation cover and composition were assessed in the undisturbed heathland in 2005 and in the experimental plots in 2006, 2007, 2009 and 2012. The use of topsoil accelerated the formation of vegetation cover and a high proportion of the original heathland species were found in topsoil treatments #1 and #2. Conversely, seeded treatments had a very high abundance of grasses that inhibited the colonization and survival of many native species. From 2006 to 2012, the trajectory of the vegetation composition of all treatments was towards the original heathland vegetation, although they still had ways to go in 2012. These results indicate that the addition of topsoil can give vegetation succession a "head-start" compared to more conventional methods, but the seeding of grasses with topsoil addition is unnecessary and can impede succession.

POSTER ABSTRACTS (CONT'D)

Population dynamics of *Ariocarpus kotschoubeyanus* (Lem.) K. Schum (Cactaceae)

Arroyo-Pérez, Erika; Cecilia Jiménez-Sierra, Loraine Matias-Palafox

Universidad Autónoma Metropolitana

Ariocarpus kotschoubeyanus is an endemic cactus to Mexico, that is in the Red List of the IUCN (Near Threatened) and in the Appendix I of CITES. The aim of this study was to describe the population dynamics of this species in Queretaro (Mexico). We followed individuals for four consecutive years. Individuals were categorized by their coverage (cm²). Using a transition matrix model of Lefkovich, the finite rate of population increase (λ), the stable size class distribution (w) and size-specific reproductive value (v), were calculated for each year. For these years, λ values, were below or near to the unity, $\lambda_{\text{mean}}=0.8801(\pm 0.1435)$. Elasticity matrices indicate that the most important demographic process was stasis ($S=0.6654$); followed by growth ($G=0.1788$) and lastly by the fertility ($F=0.0051$). The retrogression were of particular important ($Re=0.1507$). Using a numerical projection model, we find that if the current trends continue, the population will become extinct in less than 40 years. The highest mortalities occurred in Adults (A1, A2 and A3), and these are due to natural causes (25.81%) and to illegal withdrawals (74.19%). The persistence of the species requires integral plans that include to authorities, researchers and people who are the heirs of this resource.

Amity Creek Restoration Initiative, Minnesota USA: Demonstration project to help restore and protect north shore Lake Superior Basin trout streams

Axler, Richard; Valerie Brady, George Host, Karen Gran, Jesse Schomberg, Grant Neitzel, Molly Wick, Jenny Jaspersen, Jerald Henneck, Elaine Ruzycski, Norm Will, John Geissler, Chris Kleist, Todd Carlson, Kate Kubiak, Keith Anderson, R.C. Boheim, Joe Magner, Dan Breneman, Lucinda Johnson, Brittany Story

U. of Minnesota-Duluth

Amity Creek is a coldwater trout stream, one of approximately 720 perennial streams flowing into ultraoligotrophic Lake Superior, the largest Laurentian Great Lake. Bedrock escarpments create steep, forested corridors with thin, erodible soils, low productivity, and “flashy” hydrology. Amity’s watershed is mostly undeveloped (~4% rural-urban, 6-8% impervious surface), but faces increasing urban and rural development with potential impacts from higher temperature, increased water/sediment runoff, riparian canopy opening, impervious surfaces, road crossings, and construction runoff. Climate change predictions suggest increased warming and frequency of severe storms. Amity was listed as *Impaired* in 2004 from excess turbidity from suspended sediment. In 2005, a private gift spawned the *Weber Stream Restoration Initiative* (www.lakesuperiorstreams.org/weber) to help restore and protect Superior Basin streams using Amity as a demonstration project for restoration, assessment, and extension and education activities. Projects carried out by the Partnership from 2005–2011 included two stream bank/channel stabilizations, a neighborhood stormwater reduction experiment, comprehensive water, habitat, and biological monitoring and outreach programs, and developing GIS landscape stressor maps highlighting areas of higher environmental risk. Additional efforts since 2011 have focused on: (1) stream restoration using BMPs in critical areas; (2) social tools to reduce erosion and stormwater runoff via a novel, on-line mapping for rural landowners; (3) a regional ditch design/maintenance manual; (4) geomorphic assessment of banks and bluffs using aerial and ground-based Lidar scanning; (5) assessing potential for increased groundwater storage to reduce flashiness; (6) WQ, habitat, and biological assessment; and (7) outreach activities.

Restoring pasture commons: An experiment in Paira Adivasi, Arid Central India

Babu, Suresh; Akshita Misra, Asmita Kabra, Suresh Babu

School of Human Ecology, Ambedkar University

Common pastures are a critical resource for the sustenance and long term risk mitigation for several million inhabitants of arid parts of the world. In India, several communities cope with severe biophysical constraints on productivity by means of nomadic pastoralism. This way of life allows them to make use of the scarce resources that are sporadically available across the landscape. What happens to such communities when they are relocated from their traditional grazing areas? Can their vulnerabilities be addressed by restoring and creating common pastures? This study details a recent experiment undertaken in such a relocated village - Paira Adivasi, near Kunho Wildlife Sanctuary in Madhya Pradesh, India. This project envisaged to develop a community based ecological restoration model to augment the need for fodder for a community that had recently lost all their grazing lands for a Lion conservation programme. The project involved a cluster of households donating their non-arable barren land to raise a community pasture. A detailed restoration plan was developed taking into account micro-topography, biological inputs, seasonality and rainfall pattern. The site preparation was followed by a systematic introduction of annual and perennial grass species with a range of palatability along with a few species of legumes that occur locally. After a year and a half, the above ground biomass has gone upto 2.5 tonnes/Ha and after another year, the households that participated in this experiment are likely to meet about 30% of their annual fodder requirements by co-managing the restored community pasture.

BambuChar: A novel project of a restoration based economy

Bacre González, Ramón Agustín; José Raúl Díaz Martínez, Juan José Melgarejo Murrieta, Diego Miguel Saavedra Olea

Instituto de Geología, UNAM

The Project BambuChar arises from efforts to produce a novel ceramic material, made up from clay and bamboo stabilized biomass, with high recalcitrant organic carbon content. The resulting material can be used as a basis for the production of Mexican handicrafts and green building materials

POSTER ABSTRACTS (CONT'D)

which contains or sequester atmospheric carbon on their matrices. The relevance of the project is the creation of a high value commercial chain to manufacture eco-friendly Mexican artistic pieces, which reflect part of the traditional culture of the states of Puebla / Veracruz and at the same time sequester CO₂ from the atmosphere. Socioeconomic improvements of local communities, in addition to the positive effects on the environment are considered very important in the project, and can be used as an example of a restoration based economy, in which you can achieve economic growth while providing a service with high environmental value, such as atmospheric carbon sequestration. The technology used on the project is a low temperature pyrolysis system to produce bamboo biochar, then the biochar is mixed with clay and some other materials protected with intellectual property laws. The main objective is to build the first commercial production line in the world of Mexican crafts and contemporary abstract art that capture atmospheric CO₂. The project stills at an early stage and expects to obtain/provide data of atmospheric carbon capture capabilities, and socioeconomic improvements in the months to come.

Wetland restoration and management of the common reed (*Phragmites australis*) in Greenwich, Connecticut

Baldwin, Matthew; Jennifer Mattei

Sacred Heart University

The Town of Greenwich, Connecticut, Wetlands and Watercourses Agency has started a *Phragmites* control study in one of its wetland that is dominated by *Phragmites australis*. This invasive species is a perennial grass with woody hollow stems that spreads horizontally by clonal growth forming dense stands that may reach up to five to six meters in height. *Phragmites* is a cosmopolitan species and has become quite abundant along the Atlantic Coast and in freshwater and brackish tidal wetlands of northeastern United States. Genetic studies reveal some populations are native but most are closely related to European varieties and thus it is considered an invasive species. Through competitive superiority, *Phragmites* forms a monoculture and alters the structure and function of diverse marsh ecosystems by changing species composition, nutrient cycles and hydrological regimes. Dense *Phragmites* strands can also decrease native biodiversity and quality of wetland habitat, particularly for migrating waders and waterfowl species. The Greenwich site, ~0.3 hectares, will be divided into 3 treatments during the summer of 2013: 1) mowed, 2) mowed and then covered with black plastic for one season, 3) glyphosate herbicide treatment. The success of the three treatments will be reported and a cost/benefit analysis will be discussed.

Response of bird communities to the 2011 flood on the Missouri River, USA

Balla, Esther C.; Chris L. Merkord, Mark D. Dixon, David L. Swanson

University of South Dakota

Cottonwood (*Populus deltoides*) forests along the Missouri River provide important habitat for migrant and resident landbirds. Periodic flooding created the conditions necessary for forest succession, a regime suppressed by the constructions of 6 mainstem dams from the 1930s-1960s. Despite flood control infrastructure, the Missouri River experienced a large flood from June–August 2011. To determine the effects of the flooding on breeding birds, we compared pre- (2009-2010) and post-flood (2012) densities along two segments of the Missouri River in South Dakota and Nebraska. During each season, we conducted point counts across 77 forest patches, stratified by age. Using program DISTANCE, we estimated densities for 33 bird species. We hypothesized that bird densities would decline in the first year following the flood, particularly in species associated with early successional habitats. In forest patches < 55 years old, 8 species increased in density, 21 decreased, and 4 showed no significant changes. These declines were consistent with strong post-flood changes in vegetation structure in younger stands. In forest patches > 55 years old, 10 species increased in density, 15 decreased, and 8 showed no significant change. Late successional stands were largely spared the effects of flooding. Thus, the declines observed for several species associated with this habitat type were unexpected. To assess potential long-term effects of the 2011 flood, forest successional dynamics and bird densities will be projected into the future using STELLA II® dynamic simulation software. Doing so will identify the potential restorative effects of flooding for bird communities along the Missouri River.

Plant Biodiversity, Traditional Knowledge and Agriculture in India: Bio-cultural Restoration

Bandyopadhyay, Baisakhi

Indian National Science Academy

The evolution of the Indian subcontinent and its placement at the junction of three realms makes it very rich in plant biodiversity. Agriculture started in India around 8000 years ago. Plant biodiversity was enriched with the introduction of crop species from Africa and West and Central Asia and development of various agricultural systems. Simultaneously, the science of botany progressed with the listing of plants and development of classification systems to support effective management and use of plant biodiversity. The medieval period is characterized by further intensification of these activities and management of forest plant biodiversity, which was revered as a source of food and other human needs. During the Mughal and British periods, systematic programs were initiated for bioprospecting, inventory, and conservation of plant biodiversity in gardens. The last century saw mechanization of agriculture and science-based documentation, collection, characterization and conservation of agro-biodiversity to support expansion of crops and genetic diversity. In recent years a lot of attention has been paid to indigenous knowledge systems and practices. We have explored some specific aspects of traditional sciences and technologies and compared them with the modern approach in the corresponding areas.

POSTER ABSTRACTS (CONT'D)

Where are the rare species?: The importance of land-use legacies in predicting rare and specialist plants in Wisconsin fens

Bart, David; Austin Yantes, Tara Davenport, Quentin Carpenter

University of Wisconsin-Madison

Calcareous fens serve as habitat for threatened and specialist plants. Consistent groundwater influence and low nutrient availability are considered the most important drivers of these species occurrence. However, the presence of these conditions does not necessarily predict the occurrence of rare or specialist species. We tested whether a history of plowing interacted with abiotic conditions to predict: 1) rare/specialist-species richness; and 2) the frequency of several rare/specialist species in Wisconsin calcareous fens. We measured root-zone volumetric water content (moisture), available-N and -P, conductivity, plowing history, and the presence/absence of rare or specialist species from 220 plots in 11 calcareous fens. An additional floristic inventory was conducted on each fen. We used PLS regression to determine the best predictors of rare/specialist richness and species frequency. The best predictors of rare-species richness were a lack of plowing, high conductivity, consistently saturated root-zones, and low nutrient availability. The same variables were important for predicting the frequency of each species. By far the most important single predictor was plowing, with most plowed fens having no rare or specialist species. The most likely explanation is that plowing removed rare/specialist species from the local propagule pool, and these species will need to be re-introduced when fens are restored.

Adaptation to a broad soil moisture gradient in a dominant prairie grass: Applications for restoration

Bassett, Tyler

Kellogg Biological Station, Michigan State University

Plant populations often show patterns of adaptation, and perform best when transplanted into their home environments. Selective agents driving adaptation, however, are rarely identified, confounding the selection of source populations for restoration. Alternately, intraspecific genetic variation may be more important in restored populations by increasing the chance that a pre-adapted genotype is introduced. I tested for the effect of adaptation and genetic diversity across a soil moisture gradient in the prairie grass *Andropogon gerardii*. I collected seed of three populations each from three soil moisture types (wet, mesic, dry). Additionally, I purchased seed originating from three separate commercial production fields, for a total of 12 populations. I transplanted established plants from all populations into three field sites: one wet, one mesic, and one dry. I established plots of either one population or all three populations for a given soil type. Soil moisture of origin and planting site significantly affected plant height and survivorship, but genotypic diversity had no effect. Performance of 9 of the populations was highest at the dry field site. Commercial populations outperformed natural populations. A significant interaction between soil moisture type and planting site would indicate adaptation to soil moisture. These were only marginally significant. Furthermore, populations did not perform best in their home soil moisture type. In summary, commercially produced seeds performed better than natural populations across a broad soil moisture gradient. This suggests that commercial seed may in general be preferable to seed from natural populations, except in cases where local adaptation is demonstrated.

Indigenous Arts and Sciences Earth Partnership: Sustaining community partnerships through cultural connections and ecological restoration education

Bauer-Armstrong, Cheryl; Curt Meine, Fawn Young Bear-Tibbetts, Cynthia Soto, Spring Rosales, Mike Parks, Patty Loew, Rick Hall, Maria Moreno

University of Wisconsin-Madison Arboretum

Earth Partnership for Schools (EPS) uses ecological restoration as a context for learning across discipline, age, learning style, culture and place. EPS is collaborating with Indigenous communities to integrate culturally accurate and authentic resources for relationship building, inquiry and citizen science process skills and ecological restoration across the curriculum in multiple learning environments. Indian Nations monitor and protect their natural resources, underscoring the need for Native scientists, yet Native Americans are the most underrepresented group in STEM fields. Native American children and all young people can benefit from understanding the contributions of Indigenous Arts and Sciences (IAS), integrating them with western STEM concepts while participating in restoring native ecosystems. We will present different viewpoints that are integral aspects of this holistic model, based on the values of *Relationship, Reciprocity, Respect, and Responsibility*. The following key points will be explored: Land ethics: Aldo Leopold and Indigenous perspectives; The dialogues continue: Indigenous Arts and Sciences Earth Partnerships; Urban Native populations and restoration; Native youth finding strength in their cultural heritage to become inspired to explore science careers; Rural partnerships: Forest Service and Tribal relationships; Learning to read the cultural landscape: An example of Service Learning.

Challenges in monitoring populations of an early successional endemic sedge, *Rhynchospora knieskernii* L.

Baumgarten, Joni M.; Matthew I. Palmer

Rutgers University

Monitoring dynamic plant populations with patchy distributions presents difficulties at both the local and landscape scale. A local population that shows a high inter-annual variation may be at greater risk of extirpation, but the capacity for rapid increases from remaining plants and propagule banks complicates decisions about management intervention. *Rhynchospora knieskernii* L. is a federally-threatened sedge endemic to southern New Jersey. The landscape-scale population is patchy in both space and time; it grows in primarily disturbed habitats and several populations have disappeared over the past 20 years, apparently due to competition from later-successional vegetation. Annual variation in population density may be determined by water-

POSTER ABSTRACTS (CONT'D)

table changes as well as successional changes. Establishing a rigorous monitoring strategy for this species will help inform conservation and monitoring efforts for other species with similar population dynamics. Nine sites with *R. knieskernii* populations were surveyed yearly between 2008 and 2011. At all locations, permanent transects with regular 0.042 m² (20.5cm by 20.5cm) plots were established and supplemented by [x] to [y] haphazardly placed plots of the same size. All *R. knieskernii* plants were counted, and the height, inflorescence production, and the production of perennating buds were recorded for five plants per plot. The populations showed high variability at the plot scale, ranging in density from zero to 234 plants/plot. Bayesian hierarchical modeling was used to quantify population trends over time. The monitoring protocol used here is transferable to other systems where fluctuating population dynamics necessitate detailed monitoring and modeling.

Landscape scale restoration in a multi-agency setting: A case study of the Cache River Joint Venture Partnership

Behnken, Jennifer A.; John W. Groninger, Erin J. Seekamp, James J. Zaczek
Southern Illinois University Carbondale

Large scale restoration measures necessitate the formation of collaborative partnerships. Within the United States, the Cache River wetlands in southern Illinois, a designated RAMSAR site, have been undergoing ecological restoration across multiple state, federal, and private ownerships. Although some aspects are coordinated under the Cache River Joint Venture Partnership (CRJVP), individual agencies and entities retain specific ownership priorities and approaches to management. This case study explores the dynamics among land managers employed by federal agencies, state agencies, and non-governmental organizations managing land and water resources in a hydrologically linked wetlands system within the CRJVP. Semi-structured interviews were conducted with twenty-five managers, including staff members who maintain active participation in restoration activities, and individuals who have worked closely with CRJVP. Triangulation of interview transcriptions, meeting observations, management plans, and other relevant agency/organization documents revealed emerging themes and patterns within the data. Grounded theory was applied to better understand how differences in institutional cultures, missions, and resources impact management practices across the landscape. Results suggest that administrative processes, funding sources, policy and regulations, mission statements, specified objectives, and management goals within and between agencies/organizations determine how institutional priorities and capacity impact management decisions and on-the-ground implementation. Institutional structures influence decision-making power and grassroots capabilities. Incompletely defined management and decision-making criteria challenge compatibility among partners and the central mission of the CRJVP itself. Implications of this research for the function of existing or future partnerships facing similar challenges will be discussed.

A multi-tiered catchment analysis of Upper Redwood Creek, an urban, trout bearing stream in Oakland, CA.

Beitz, Pamela
California State University East Bay

Upper Redwood Creek watershed (596 acres, 241 hectares) in Oakland, CA is an urban stream with high recreational use that supports the spawning and rearing of native rainbow trout. This research combines tracer studies (d18O, TDS and temperature) with hydrometric and GIS analysis to develop a conceptual model of the surface and subsurface hydrologic regimes for future stream restoration work. Stream flow and precipitation data were manually collected to provide data for this previously un-gauged watershed during the water years 2009-2011. The use of multiple methods of analysis and manual data collection provides a variety of analytical tools for small government, non-profit, and citizen groups involved in restoration projects. Tracer methods showed some agreement in residence time and groundwater contribution analysis. Mixing plots however, illustrate tracer affinity to different reservoirs of groundwater. d18O tracer analysis suggests a large volume of groundwater contribution to annual stream flow with a relatively short Mean Residence Time (MRT) while temperature analysis implies smaller groundwater volume contributing to annual stream flow with a longer MRT. Landscape organization (geology, soil, vegetation and slope) paired with MRT suggests that forested cover, soil depth and watershed area have the strongest correlation to flow path length and residence time. Temperature studies on the reach scale indicate that groundwater inflow rather than canopy cover exerts more control on damping stream temperature fluctuations. Results indicate that this steeply sloped watershed has significant groundwater resources and perennial flow in upper reaches due to tectonic fracturing and its remaining second growth redwood forest.

Forest restoration for the White-backed Woodpecker (*Dendrocopos leucotos*): An evaluation of the umbrella species concept

Bell, David G.
Swedish University of Agricultural Sciences

In Sweden, forest ecosystems have been largely altered and transformed into even-aged monocultures of coniferous trees. Apart from a decline in broadleaved trees, forestry has caused a deficit in coarse woody debris (CWD). Attempts to bring about change have mostly involved silvicultural precautions and forest protection, but ecological restoration is becoming increasingly important. A potential short-cut in choosing appropriate scales for restoration would be to restore habitats for so called "umbrella species". A possible candidate in Sweden is the White-backed Woodpecker (WBW). It requires large forested areas, mainly comprised of broadleaved trees, where it feeds on saproxylic insects in dead wood. Degraded forests (~ 4000 ha) have been restored for the WBW by removing Norway spruce (*Picea abies*). CWD has also been created from living birch (*Betula* spp.) trees. Despite an extensive captive breeding program the WBW is yet to recover, only 10-20 individuals remain in Sweden. However, many non-target species might benefit from forest restoration more rapidly. In this study, we evaluate the umbrella species concept by investigating how saproxylic beetles respond to forest restoration for the WBW. Beetles were sampled with flight-intercept traps and emergence traps. Since pristine environments are scarce, restored

POSTER ABSTRACTS (CONT'D)

forests were compared to commercial forests. We found positive, but non-significant, trends in species richness and abundance following restoration. There were, however, significant differences in community composition. Restored sites were also significantly richer in terms of red-listed species. This suggests that the umbrella species concept could be valid in ecological restoration.

Long-term, multi-species, multi-metric ecological monitoring of an urban stream restoration project in Bellingham, WA

Benjamin, Sara Brooke
University of Victoria

In an effort to improve conditions in degraded urban streams, managers today are increasingly turning to restoration practices. However, due to insufficient ecological monitoring data, very little is actually known about the ecological value provided by these practices. In response to this need, I will present an analysis of seven years worth of comprehensive ecological monitoring data at two heavily affected urban stream sites following implementation of restoration actions in Bellingham, WA. Monitored parameters include avian, amphibian, adult and juvenile salmonid, aquatic macroinvertebrate, water quality, temperature, vegetation and geomorphic survey data. I will analyze these different suites of data to determine (a) What does an analysis of trajectories for each of these variables tell us about restoration success relative to project goals and objectives? and (b) What does a multi-metric, multi-species analysis tell us about ecological integrity at these sites, and which indicators are the best predictors of this integrity? This research will help to fill a knowledge gap which currently handicaps all of our well-meaning restoration actions by contributing directly to the body of restoration monitoring data and improving the practice of restoration monitoring by pointing to some key parameters which may be the best, most efficient indicators of ecological integrity in comparable urban stream systems.

The impacts of invasive shrub removal on an urban avian community

Benson, David P.; Jody Nicholson, Samuel Jordan, P. Roger Sweets
Marian University

Invasive shrubs are a common part of the Midwestern U.S. landscape, especially in urban natural areas. The removal of these shrubs has been shown to increase the diversity and coverage of native vegetation. Less is known regarding the effects of invasive shrub removal on avian communities, especially in an urban environment. In this 12-yr. case study, we use breeding season point counts to describe the changes in avian community in a small urban natural area on the campus of Marian University in Indianapolis, IN before and after removal of invasive shrubs. We found 2009 birds during the 11 years of point count data from 2001-12 including 62 species with Northern Cardinal, Song Sparrow, and Baltimore Oriole having the largest populations. With the removal of invasive shrubs, canopy species such as Eastern Wood Pewee, Indigo Bunting, Tufted Titmouse, and Warbling Vireo increased while the shrub layer and frugivore species American Goldfinch, Cedar Waxwing, Gray Catbird, Northern Cardinal, and Wood Thrush decreased. Brown-headed Cowbird also increased substantially after shrub removal. We found no evidence that birds that decline with invasive shrub removal become more abundant in a decade of understory revegetation following invasive shrub removal. Although Brown-headed Cowbird increased and Wood Thrush decreased with the removal of honeysuckle, the fact that invasive shrubs act as an ecological trap may outweigh those negative changes for the avian community.

The Role of Pollinators and Restoration of True Mangroves: Bruguieras A case study

Binai, Nagarajan; Palanisamy M, StanleyRaja V, Bachpai VKW
IFGTB,ICFRE

True mangroves are viviparous where in sexual reproduction is obligatory. Hence, limitation in pollinator services could be critical in the survival of the species or the ecosystem. Studies on Pre Emergent Reproductive Success (PERS) were carried out in three mangrove types namely, Island (SouthAndamans: 10o00'N; 76o33') Deltaic (Pitchavaram: 11o25'52"N; 79o46'47"E) and Non Deltaic (Puthuvypu: 09o09'; 76o26') in India for a period of three years. True mangroves are adapted to Entomophily (*Bruguiera cylindrica*) Ornithophily (*B. gymnorrhiza*) and Psychophily (*Bruguiera parviflora*). We compared the overall reproductive success in the disturbed mainland mangrove formations versus the undisturbed Island mangroves. The more complex the pollination syndrome the species tends to become rarer. In terms of Pre Emergent Reproductive Success (PERS) entomophily was the most successful. *B. parviflora* exhibited the least PERS value of 0.0001. The trend of reproductive success were similar in the mainland and Island among the syndromes. *B. gymnorrhiza* exhibited greater reproductive success compared to mainland. However, in *B. cylindrica* PERS values were exactly opposite. These trends were correlative to the visitation pattern of the pollinators. Hence, without quantifying pollinator requirements in restoration of fragile ecosystems like mangroves seems incomplete.

On the use of compost to improve soil characteristics in restoration plantations: an initial analysis with three tropical dry forest tree species

Bonfil, Consuelo; Bruno Barrales, Adriana Núñez, Cecilia González
UNAM

Water stress is a major environmental filter for the establishment of restoration plantations in the dry tropical forests. Soon after being transplanted, plants must face a dry season lasting several months, and as a result death rates of $\geq 50\%$ during the first year are not uncommon. Several technics

POSTER ABSTRACTS (CONT'D)

have been used to improve survival rates, such as the use of nurse plants, mulches and soil amendments. However, the effects of adding compost have rarely been assessed in forestry plantations, especially in the tropics. We analyze changes in soil characteristics, as well as in survival, growth and biomass allocation of plants of three species (*Ceiba pentandra*, *Swietenia humilis* and *Crescentia alata*) in response to the addition of compost in a restoration plantation in Morelos, Mexico. 60 plants per species were transplanted in July 2012, and half of them were assigned to each treatment: adding 5 l of compost mixed with local soil (1:1 vol) or using only local soil to fill the hole. Soil pH, carbon (%) and organic matter (%) increased, apparent density decreased and soils texture improved when compost was added in relation to untreated soils. Plant survival was high during the first growing season irrespective of soil condition, and growth rates were not significantly affected by the treatments. After the first dry season plant survival was slightly higher in plants having compost in two of the three species. The plantation will be followed one more year in order to assess plant responses to the improvement in soil conditions.

Effects of micro environmental conditions on grass and shrub seedling emergence in denuded areas of the arid Patagonian Monte, Argentina.

Bosco, Tomás; Mónica Bertiller, Analía Carrera
Centro Nacional Patagónico (CENPAT-CONICET)

Our objective was to analyze the primary controls of seedling emergence of perennial grasses (*Nassella tenuis* and *Poa ligularis*) and evergreen shrubs (*Larrea divaricata*, *Schinus johnstonii* and *Atriplex lampa*) in denuded areas of arid ecosystems. We constructed microcosms (30 x 40 cm side, 28 cm depth) with intact soil extracted from denuded areas (>2m diameter) in six representative sites of the arid Patagonian Monte. We sow between 8 and 24 seeds of each species per microcosms and after sowing microcosms were subjected to the effects of levels of UV radiation (near-ambient and attenuated UV radiation), soil moisture (15-25% and 5-15% volumetric content), and litter cover and quality (without litter, low quality litter from disturbed and high quality litter from conserved plant patches). We evaluated the effects of these factors on seedling emergence of the target species during 3 months. Seedling emergence of perennial grasses had the highest values under conditions of high soil moisture and soil covered by high quality litter ($p < 0.001$) and was not affected by levels of UV radiation. Emergence of shrub seedlings was lower ($p < 0.001$) than that of perennial grasses and was not affected by studied factors, except that of *A. lampa* that was positively affected by near-ambient UV radiation under conditions of high soil moisture and low litter quality. We concluded that soil moisture and litter cover and quality were primary controls of seedling emergence of perennial grass in degraded arid areas. However these factors did not affect seedling emergence in shrubs.

Monitoring a large-scale restoration program of forestry company in the Atlantic Forest hotspot

Brancalion, Pedro; Roberto Mediato Cunha Sousa, Angelo Conrado Arruda Moura
Universidade de São Paulo

Ecological restoration is a rapidly emerging activity that requires the involvement of diverse sectors of the society if realized on a large scale. Essential within this mix are two key stakeholders: forestry and agricultural companies that manage large areas. In this presentation we will present the Ecological Restoration Program of Fibria in Brazil, an internationally-leading company in short fiber pulp that manages 974,400 ha of land within the Atlantic Forest biodiversity hotspot. The Restoration Program currently extends to over 6,000 ha. Among the restoration techniques employed by the program are plantings of mixed native species, enrichment plantings, encouragement of natural regeneration and the control of invasive species. These techniques make use of a large pool of native and endemic species. The areas under restoration are evaluated using a combined monitoring program consisting of field evaluations, data consolidation, subsequent analysis of results and operational recommendations to inform improvement actions. Monitoring indicators were defined in terms of their relevance to the ecological restoration process. Examples include the density of native and invasive plants, species richness and diversity, canopy coverage, and the composition of functional groups. The results obtained with this monitoring program are used to validate or improve the restoration techniques and adopt operational improvements, bringing gains in environmental quality and reducing operating costs. The template provided by the restoration program of Fibria can help the development of similar large scale restoration programs in other companies within Brazil or elsewhere.

Spatial distribution of the flora of the costal forest applied to restoration and conservation.

Brenes, Paola; Mery Ocampo, Wagner Peña, Oscar Chacón, Aaron Fallas
UNED- Vicerrectoria

In Costa Rica, most remnants of the dry forest ecosystems are located along the North Pacific Coast. For this reason, a significant portion of the dry forest is subject to the influences of the ocean's micro-climate factors, promoting the development of unique flora along the coasts. For decades these areas have been degraded and there is not an actual program for restoring this particular ecosystem. Diversity of tree and shrub species remaining in the first 50 meters of three beaches, Santa Cruz, Guanacaste was analyzed. Stratified sampling was carried out in the coastline, placing transects of 50 meters long. We chose a random subplot to determine density and abundance of flora saplings and perform a diversity analysis correlated with sea distance. In total we identified 25 species belonging to 18 families. Overall the study revealed a poor coastal forest, also there was no clear pattern of spatial distribution of the species; but through IVI was a tendency for *Bombacopsis quinata* (Jacq.) Dugand and *Conocarpus erectus* L. were more prevalent in areas close to the sea. For the farthest area, species like: *Bombacopsis quinata* (Jacq.) Dugand., *Guazuma umnifolia* L., *Hippomane mancinella* Lam and were the most abundant. The pacific coast area have a lot of limitations, especially if we do not have a good genetic and species diversity representation, but this data marks the base line to start the restoration process. Also this study enhances costal restoration as a tool for a climate change adaptation and ecosystem conservation.

POSTER ABSTRACTS (CONT'D)

Effects of oak woodland restoration treatments on sapling damage and composition in an upland mesic hardwood forest

Brewer, Steve

University of Mississippi

Oak-dominated (*Quercus* spp.) woodlands comprise a small fraction of the area in North America occupied prior to fire suppression. One important goal of restoring oak woodlands following fire exclusion is increased oak regeneration. Although oak sapling recruitment can respond positively to open canopies and prescribed burning, the combined effects of canopy gap size and duration and prescribed burning remain poorly understood. An oak woodland restoration experiment was initiated in 2004 in long-unburned upland hardwood forests in the loess plains of northern Mississippi. A treated (thinned, biennially-burned) plot was paired with an untreated plot at each of two sites. Within each treated plot, before the implementation of treatments, subplots were established at open edges adjacent to mowed clearings and within the interior of the plots to examine the effect of repeated prescribed burning in relation to proximity to large, persistent gaps. Measurements of species composition and changes in densities and sizes of saplings revealed that upland oaks comprised a significant fraction of sapling layer only at the edges of plots, irrespective of treatment. Biennial prescribed burning reduced sapling densities of upland oaks, but reduced the sizes of saplings at forest edges to a greater extent in non-oak tree species than in upland oaks. Hence, biennial burning could reduce the competitive effects of non-oak saplings, but it is incompatible with upland oak sapling recruitment if continued indefinitely. Accomplishing multiple objectives with fire likely will require maintaining sufficiently open canopies and considering a role for variable fire frequencies in promoting oak regeneration.

Gray Hawks, habitat restoration, and citizen science in the Lower Rio Grande Valley of Texas

Brush, Timothy; Teresa P. Feria, John S. Brush

Department of Biology, University of Texas-Pan American

Only 5% of the riparian woodland in the Lower Rio Grande Valley (LRGV) of Texas remains, and remnants are highly fragmented. Habitat restoration, begun in the 1980s, has restored woodlands of varying quality and size to former farmland. The Gray Hawk (*Buteo plagiatus*), a tropical raptor nearing its northern range limits in the LRGV, was re-confirmed as a breeder in the LRGV during 1987-1992. Early nests were in or near the largest tracts of remnant riparian woodland. Since 2008, the eBird citizen science program has accumulated records of Gray Hawk in some 15-20 year-old restored woodland tracts, as well as urban "forests" in older residential areas. Because most eBird data are from the non-breeding season, future research will focus on breeding-season habitat use and nesting. This charismatic raptor may serve as a flagship species for future habitat restoration efforts in the LRGV.

The effect of litter type (*Acacia* and *Eucalyptus*) on decomposition rates, extracellular enzyme activities and soil microbial communities in shelter belts

Carnovale, Daniela; Alan Richardson, Peter Thrall, Andrew Bissett, Geoff Baker, Philip Gibbons

Australian National University, Fenner School of Environment and Society

As decomposition is largely mediated by microbes, assessing extracellular enzyme activities as an indicator of microbial metabolism in soils and litter has increased. Numerous studies have examined the effect of litter types and litter mixing on decomposition rates, largely focusing on deciduous and northern hemisphere species. *Acacia* and *Eucalyptus* species are commonly used for revegetation in Australia and other parts of the world, yet little is known regarding how their litter might differentially impact on decomposition rates and extracellular enzyme activities. To investigate this, we established a litter decomposition experiment using a reciprocal design (litter x soil/land-use) in revegetation shelter belts to establish if litter type affects decomposition rates, microbial community and enzyme activities associated with C degradation. Litter bags with 2 mesh sizes were used to either exclude (<2mm) or allow access (>2mm) by soil macrofauna. Bags were filled with either *Eucalypt*, *Acacia* or a mix of *Acacia* and *Eucalyptus* litter. Enzyme activities were determined following recovery of bags at 1, 3, 6, 9 and 12 months. The abundance and structure of bacterial and fungal communities were assessed by terminal restriction fragment length polymorphism (T-RFLP) of 16S and 18S rRNA genes, respectively, and quantified by qPCR. Decomposition rates, community composition and enzyme activities are predicted to differ between litter types and mixing when applied to the different soils. Decomposition process in shelter belts can demonstrate how changes in community structure may drive soil function providing an indication on the success of revegetation on mediating soil nutrient cycling.

Bumble bee conservation at the University of Wisconsin-Madison Arboretum

Carpenter, Susan G.; Brad M. Herrick and Molly Fifield-Murray

University of Wisconsin-Madison Arboretum

Native pollinator populations are declining in range and size, with serious implications for native plant pollination and reproduction, ecosystem function and human agricultural systems. The 1200-acre University of Wisconsin-Madison Arboretum supports and fosters native pollinators, providing varied habitat, diverse native plants, nesting sites and insecticide-free areas in an urban setting. In the field and in collaboration with the Xerces Society and other experts, we have trained a corps of engaged citizen scientists who photograph, document and observe the bees throughout Arboretum gardens and restorations. This poster describes seasonal patterns, floral resource use and nesting sites for 11 bumble bee species at the Arboretum, including *Bombus*

POSTER ABSTRACTS (CONT'D)

affinis, the rusty-patched bumble bee. This species is absent from most of its range and threatened with extinction. We illustrate readily-implemented gardening and restoration practices which provide crucial habitat supporting bumble bee populations and ways to monitor these plantings. We present the successes and challenges in developing our citizen-based monitoring program for studying bumble bee populations and ecology. Integrating native plant gardening, ecological restoration, community volunteer engagement, photography, expert bee identification and tools for sharing regional data yields critical and immediately useful conservation practices to apply well beyond the Arboretum.

Environmental Recovery of Samdaiatuba's dike Mangrove Area, St. Vicente (SP - Brazil)

Castanheira, Solange dos Anjos; Pablo Garcia Carrasco, Larissa Fagundes Coutinho
USJT/Uicastelo

Low-income populations, to land or build their homes of stilts, also contribute to the degradation of mangrove areas. Based on the principles of the mangrove ecosystems are very important both ecologically and economically, and its degradation factor being productivity fishery collapse, the present study aimed revegetate mangrove areas degraded by human action. Was made in the mangrove of the area, a floristic and phytosociological study, the method of the point-centered quarter. Two areas were highlighted. Through the survey was able to confirm the occurrence of the three common mangrove species to the State of São Paulo: *Rhizophora mangle* L.; *Laguncularia racemosa* (L.) Gaertn. f. and *Avicennia schaueriana* Stapf & Leechman ex Moldenke, also was possible to determine the average spacing between seedlings at 1.5m, to be planted in the area of intervention. After collecting propagules were sent to the Environmental Park of Sambaiatuba's dike, were produced seedlings in nursery condition. To minimize the compaction of growth substrate was recommended to add a piece of land (or compost) for every two portions of the material from dredging initially used. Seedlings of *Rhizophora mangle* and *Avicennia racemosa* *Laguncularia schaueriana* were planted, with a median survival after two years, around 82%. After six years of the initial planting, the area is completely vegetated and trees are with an average height of 3.5m. An environmental education program, in this case: "Mangue alive, new life!", involving the surrounding community, especially the childrens, must accompany the process of recovery of degraded mangrove

Large-scale ecological restoration of the Cerrado in Amazon region, Brazil

Cava, Mario; Ingo Isernhagen, Natalia Guerin, Giselda Durigan
Universidade Estadual Paulista "Júlio de Mesquita Filho"

One of the most important obstacles in large-scale ecological restoration relies on the high costs of current practices of planting nursery raised tree seedlings. Finding less expensive and ecologically viable restoration has been a challenge for scientists. We compared three techniques aiming at Cerrado restoration in the Amazon region, Brazil: passive restoration (T1 – abandonment) and mechanized direct seeding of native trees and legume species in rows (T2), or broadcast (T3) (four replications each, 0.24 ha per plot). The experimental area was deforested by the 1980s and used mainly as pasture for about 25 years, and a native forest fragment remains close to the study site. Density and richness of the woody plant community (from 50 cm in height) has been used as indicators of restoration efficacy. At 12 months after planting, a total of 1,004 individuals of 61 species were recorded in the survey plots (a total of 720 m²). Among these species, 14 had been seeded and the other 47 entered the community by natural regeneration processes (resprouting or by seed rain). Neither the plant density ($F = 0.53$; $df = 2$; $P > 0.05$) nor the species richness ($F = 2.1$; $df = 2$; $P > 0.05$) differed among the three techniques. Considering that passive restoration has no costs and its efficacy does not differ from the direct seeding, we concluded that abandonment is the best solution to recover the highly resilient Cerrado vegetation under environmental conditions similar to the experimental area.

Filling the weed shaped hole: a plant functional trait analysis approach to riparian restoration planning.

Chapple, Dylan; Lauren Hallett, Nathan Bickart, Lawrence Fernandez, Katharine Suding
UC Berkeley

Invasive species control is a central challenge facing restoration practitioners attempting to establish native vegetation communities. In human-altered areas with long histories of invasive dominance, a full return to historical plant communities may not be feasible. Limiting similarity, where native species are selected for their similarity in trait characteristics to the target invasive species, has been proposed as one way to address the issue of effective invasive species control. We employed a functional trait-screening approach to determine which native plant species would be the best competitors with invasive ivy species (*Hedera canariensis* and *Hedera helix*) dominant at a restoration site. To test our research questions, we partnered with the Strawberry Creek Restoration Program (SCRCP), a community-based program focused on the restoration of Strawberry Creek, an urbanized waterway in Berkeley, California. To assess the restoration potential of different species, we selected 38 species native to Alameda County, California and assessed nine functional traits for each species. We scaled our data to capture ratios between trait values for these species and compared our results to the scaled ratios for *Hedera canariensis* and *Hedera helix* using a PCA. Using these results, we selected a suite of native species with similar traits to the ivy species and planted them in four randomized blocks along the creek. We will present results from our functional trait analysis and survivorship and performance data from the field plantings along with plans for future directions.

POSTER ABSTRACTS (CONT'D)

Establishing local work force for monitoring the restored wetlands of Wolf Lake in Hammond, Indiana, USA

Choi, Young D.; Rachel N. Shmagranoff, Eric J. Bird, Samantha A. Kinsman

Purdue University Calumet

Long-term monitoring is a crucial process for assessing success of ecological restoration projects. However, it is often considered expensive and time-consuming as it requires sustained supply of resources and trained workforce. In this sense, local volunteers and students, with adequate training, may become an alternative workforce to “expert professionals” for the monitoring at affordable cost. In 2012, Purdue University Calumet, in partnership with a grassroot organization Association for the Wolf Lake Initiatives and a local government agency Hammond Port Authority, initiated an education and outreach project (funded by the Lake Michigan Coastal Program of the Indiana State Department of Natural Resources) to establish a monitoring force for the restored wetlands of Wolf Lake, located in Hammond, Indiana. The project consists of three major activities. First, local college students were recruited and trained for monitoring the restored vegetation of wetlands. The students conducted a field survey to collect and analyze the data for assessing composition and diversity of plant species in the wetlands. Second, training workshops were or will be given to the local residents, who are the potential volunteers for the monitoring. The workshop consists of both indoor and outdoor instructions for identification of native and exotic plants, natural history of the Lake Michigan watershed, and ecology and values of wetlands. Last, three interpretive signages will be installed in the walking trail along the Lake's shoreline displaying the information given in the workshops, upon the project completion in 2014.

Revegetation of mining fields in Argentinean arid regions

Cony, Mariano; Jesús Páez, María Emilia Fernández

IADIZA-CONICET

Restoring ecosystems impacted by diverse economic activities includes, in most cases, “assisted” revegetation of such environments. In arid regions, drastic climate conditions and unfamiliarity with physiological aspects of native plant species relative to their establishment complicate the tasks for recovering these ecosystems. “Assisted” revegetation turns out to be an indispensable practice if the aim is to achieve restoration in the short and/or medium term. Development of “technological packages” for revegetation practices, based on a particular analysis of the environment to be restored and plant species to use, enhances the likelihood of recovery success. In the particular case of arid environments impacted by mining activity, total removal of vegetation and modification of soil physicochemical features are daily scenarios in this activity. Different techniques for revegetation of arid regions in Argentina are then discussed, as well as the need to generate non-existent basic knowledge of the plant species occurring in them, taking the example of studies which are underway in mining fields, at different levels of development. Selection of species, production of germplasm, methods of plant reproduction, production of nursery plants, conditioning and/or correction of soil or substrate, techniques for plant establishment in the final terrain and plantation maintenance practices are put forward and discussed. Preliminary and advanced results, both favorable and unfavorable, of revegetation experiences in mining fields in arid environments of Argentina are presented as well.

Vegetation recovery in 2-year old intensively restored floodplain during drought conditions

Cook, James E.

University of Wisconsin - Stevens Point

A degraded river and floodplain (7.4 ha) were restored in 2010-11 for mitigation purposes. The restoration included removal of ~ 25 cm of top soil, re-location of the channel, contouring of the floodplain, re-application of the topsoil, and then sowing a wetland seed mix. The primary research objective was to evaluate how vegetative dynamics are affected by a stressful (below-average precipitation) growing season. In 2011, we established a systematic array of 103 plots. These plots were re-surveyed in July 2012, and in October 2012, a subset (N=40) was inventoried. The cover and identity of all plants were determined. Dominance at the quadrat level was determined for each inventory period. Proportional gain, loss and turnover (Anderson 2004) were calculated from October to October. Despite a doubling of richness in the floodplain from Oct., 2011 to July, 2012, the average cover (37%, 30%) and species density (7.3, 5.8) decreased from October to October. The proportional loss was much greater (2.5X) than the gain; the net effect was a 40%+ turnover rate. The size of the wetland and fate of facultative species may explain this. Wetland obligates increased from 36% in 2011 to 53% in 2012 and the top two dominants in July and Oct., 2012, were wetland obligates. Above-ground biomass [488 g/m²] in Oct., 2012, was higher than expected. These results suggest a relatively high degree of resistance/tolerance to moisture stress among some wetland species, and a surprising level of resiliency in the community as a whole.

Does grasshopper herbivory promote cheatgrass dominance in sagebrush ecosystems?

Cumberland, Catherine; Jayne Jonas-Bratten, Mark W. Paschke

Colorado State University

Invasion by the exotic grass *Bromus tectorum* L. (cheatgrass) has produced widespread, persistent changes in the Intermountain West. Consequently, sagebrush shrubland is among North America's most imperiled ecosystems. Restoration of cheatgrass-infested areas has often failed, and there is a need to understand the factors limiting revegetation success. There is evidence that cheatgrass is a superior competitor for space and resources, but it's also possible that cheatgrass dominance is enhanced by native herbivores through the mechanism of apparent competition: species competing indirectly through shared natural enemies. For example, if the exotic is less preferred than native plants, herbivory pressure may increase on natives in the presence

POSTER ABSTRACTS (CONT'D)

of the exotic, thus facilitating exotic proliferation. In sagebrush shrubland, grasshoppers are often the dominant herbivores. Their feeding patterns have been shown to limit and structure plant distributions. This study aims to elucidate whether grasshoppers may be promoting cheatgrass spread through herbivore-mediated apparent competition. We used native plants commonly seeded in sagebrush restoration projects and the native generalist grasshopper *Melanoplus bivittatus* in laboratory trials and greenhouse experiments, to test how grasshopper herbivory affects native plants in comparison to cheatgrass. Grasshopper herbivory significantly increased mortality rates for most native plants in our study but had minimal impact on cheatgrass mortality. Certain native species were much more highly preferred and are therefore not recommended restoration candidates where grasshoppers are common. Study results may provide guidance regarding control of insect herbivores to improve restoration success in cheatgrass-invaded areas.

The use of NDVI to reduce the uncertainty of biomass estimates of large scale restoration projects in Tropics.

de Souza Vismara, Edgar; Paulo Guilherme Molin, Eduardo Gusson, Paulo Yoshio Kageyama
ESALQ/USP

Large scale Forest restoration activities in Tropics often show, after the first years of post-planting, an important variability of biomass stock along the project area. The variability is caused by both, environmental and technological factors and can make the cost of the inventory prohibitive. Remote sensing is very useful to deal with the variability when used as an auxiliary tool of the traditional inventory methods based only on field sampling units. The aim of this work was to apply the NDVI values, extracted from satellites images, as an auxiliary variable to estimate the aboveground biomass stock. The estimation was performed using the regression estimator method and was compared to the estimation based only on the information of the observed biomass. The biomass and NDVI was measured in 111 rectangular sample plots of 200 m² each, randomly located in a restoration area of 2001,2 ha located in several municipalities of the São Paulo State, Brazil. From these plots the mean biomass was determined using an allometric equation while the NDVI was measured using the available satellite images. The mean biomass estimate by regression estimator was 62,252.00 Kg/ha with 10.17% of uncertainty. The weighted mean biomass estimate by stratified sampling analysis was 63,835.00 Kg/ha with 17.98% of uncertainty. The results show that the use of NDVI as auxiliary variable was very effective to reduce the uncertainty of biomass estimate in project area.

How valuable are linear habitat elements for biodiversity? The case of reed strips along drainage ditches in an agricultural landscape with fragmented reed marsh.

Decler, Kris; Dirk Maes, Van Calster Hans, Ivy Jansen, Marc Pollet, Rudy Van Diggelen, Dries Bonte
Research Institute for Nature and Forest

Reed marshes have high conservation value in Europe but are often highly fragmented, especially in lowland areas with intensive agriculture. We looked at the importance of narrow linear reed vegetation along agricultural drainage ditches for diversity and conservation value of three terrestrial invertebrate groups (spiders, carabid beetles and dolichopodid flies), in comparison with fragmented, permanent reed marsh habitat (mostly nature reserves) in the same study area. Is the creation of additional reed strips along ditches as potential corridors between fragmented reed marshes a wise conservation/restoration strategy? Or should we rather invest in enlarging existing permanent reed marsh habitat? For neither of the three species groups we could find a significant difference in total species richness, number of typical wetland species and red list species between both types of reed habitat. Area of permanent reed marsh was more important than reed strips along ditches for biodiversity. Although there was a significant difference in species composition and abundance between both types, our results reveal the importance of agricultural drainage ditches as (at least temporary) habitat and potential corridor for many typical wetland arthropods and even red list species.

Severely degraded grassland remnants show signs of recovery following restoration of historic ecological processes: Responses measured by change in butterfly communities and vegetation cover

Delaney, John T.; Raymond A. Moranz, Diane M. Debinski, David M. Engle, James R. Miller
Iowa State University

In landscapes that have been severely altered through human influences, development and testing of restoration practices is paramount for conservation of flora and fauna. This includes restorations that focus less on recreating historic plant assemblages and more on improving function or stability of novel ecosystems. Here we test the utility of fire and grazing by domestic cattle to mimic historic disturbances in degraded tallgrass prairie remnants of the Midwestern U.S. We tested for change in habitat as quantified by comparing butterfly communities and vegetation cover (including litter and bare ground) in degraded and reference sites. Over the five years of the study, degraded sites became more similar to reference sites in both the butterfly communities and in vegetation cover. Response of butterflies mirrored the change in the vegetation cover, indicating that butterfly community responses are good indicators of habitat change in our study region. We used two types of burning and grazing treatments to restore the processes of fire and herbivory: 1) patch-burn grazing, where one third of the pasture is burned each year and grazed, and 2) burn-and-graze, where the entire pasture is grazed each year and burned every three years. The two grazing treatments did not differ from each other in their trajectories over time. Although land-use legacies are enduring features of degraded grasslands, these results indicate that restoration of historic ecological processes may help to reduce legacy effects. This is an important observation because novel ecosystems will play an important role in conservation in the future.

POSTER ABSTRACTS (CONT'D)

Changes in species composition of secondary tropical dry forests along succession – a meta-analysis

Derroire, Géraldine; John Healey, Per Christer Óden, Muluaem Tigabu

Bangor University (Wales), Swedish University of Agriculture Sciences

Tropical dry forests (TDF) are one of the most threatened ecosystems in the world. However, they have been less studied than tropical wet and temperate forests, although their ecology differs in important ways. Understanding the successional trajectories of TDF is of great importance for the design of restoration strategies aiming at fostering their recovery after deforestation and degradation. Deterministic models of succession predict changes of species composition, which can be reflected in changes in biodiversity indices. Our poster presents a meta-analysis based on the accessible published studies that have documented these changes in secondary TDF, in contexts of different environmental conditions and past-land uses, either by a chronosequence or a dynamic approach. Selected biodiversity indices, calculated for each age of recovery in each data set, are analysed using linear models to determine the relative importance of previous land use, current environmental conditions and current disturbance regime in explaining biodiversity changes during secondary succession. Similarity among the ages, and with mature forest, is then assessed as an indicator of the convergence and predictability of successional trajectories. Our results can help determine the relative utility of models of succession, and the relative generality of the different drivers of change in species composition. Such theoretical ecological outcomes can benefit science-based strategies for restoring the biodiversity of TDF by identifying the key environmental factors influencing the process of succession, the potential thresholds or barriers which should be targeted by intervention, the management actions that should be prioritised, and the most efficient indicators for monitoring.

Consequences of the “mesophication” of mixed-oak forests in the Appalachian Plateau of Ohio - effects of litter source and topography on fuel characteristics

Dietenberger, Mark; Matthew B. Dickinson, Todd Hutchinson

US Forest Service

Over large areas of mixed-oak forest in the eastern US, oaks are being replaced by more mesophytic species, prominent among them being red maple (*Acer rubrum*). Fire suppression figures prominently in this forest compositional shift and associated changes in fuels are expected to complicate the use of fire in oak ecosystem restoration. We designed a common garden fuels experiment involving replicated plots of litter originating from oak- and maple-dominated stands and a mixture of litter from both types of stands. The caged plots were distributed among topographic positions (four positions from xeric to mesic) over an Ohio Hills landscape. Litter was collected after leaf fall for four years and equal dry masses of litter of each type were spread evenly over each plot. A factorial analysis showed that litter depth (positively correlated with mass and bulk density) was strongly affected by litter source, with oak litter being deeper than mixed-bed litter, and maple litter being the thinnest. Topographic effects on litter depth were less pronounced while fuel drying rates were primarily determined by an interaction between topographic position and litter type. A distinct cage effect, probably caused by the damping of wind disturbance, resulted in litter compaction. Samples of intact litter and underlying soil from xeric and mesic plots were tested in a Cone Calorimeter (ASTM E1354-11a). Flammability of the samples reflected the compactness of litter beds and species differences in thermochemical characteristics. Overall, our results predict negative feedbacks on fire from forest compositional shifts that are mediated by topography.

Productivity did not predict other wetland ecosystem services

Doherty, James M.; Jeffrey F. Miller, Stephanie G. Prellwitz, Anita M. Thompson, Steven P. Loheide, Joy B. Zedler

University of Wisconsin-Madison

Recent studies show that multiple ecosystem services are typically traded-off within landscapes and watersheds (i.e., not all provided in a single site). Trade-offs at the site scale are less understood, yet common assumptions are that one site can provide many services and that one service can indicate others. Net primary productivity (NPP) in particular is assumed to indicate other wetland services (e.g., carbon sequestration, nutrient uptake, diversity support) even when correlations with other ecosystem services are not well known. To test for correlations among services, we measured NPP, flow attenuation, stormwater retention, plant diversity support, soil stabilization, and water quality improvement in three experimental wetlands that differed only in drainage rate. Natural variation in the clayey subsoil underlying our three experimental wetlands led to three hydrologic regimes (low, medium, and high drainage rates), which led to differences in all quantified services: the fastest-draining wetland provided the lowest NPP and the highest levels of the five other services, while the continuously-inundated wetland provided the highest NPP and the lowest levels of the other five services. We concluded that the five positively correlated services might be co-restorable, in a fast-draining wetland. Whereas very high NPP might actually hinder provision of some other services, especially plant diversity support. We recommend avoiding the use of NPP and plant cover as indicators of wetland services. Instead, we advocate direct measurements of multiple services. Restoration planning will improve with greater understanding of which services generally are, or are not, correlated.

Establishment of Savannah native tree species on a degraded area in recovery

dos Santos Batista Bonini, Carolina; Marlene Cristina Alves, Thaís Monique Souza Maciel, Sebastião Nilce Souto Filho, Otton Garcia de Arruda, Debora de Cássia Marchini

São Paulo State University

This study aimed to evaluate the development of Savannah native tree species in Oxisol that is beheaded in recovery for 19 years, being first used lime, gypsum and green manure (1992-1996), *Brachiaria decumbens* (1999-2011) and spontaneous Savannah native tree species (2006-2011). In this area an

POSTER ABSTRACTS (CONT'D)

Oxisol was deeply decapitated (about 5 to 8 m) due to excavation work for building purposes during the 1960 so that the underneath saprolite was first exposed and later on abandoned. In 1992 a field trial was established to assess revegetation of the degraded site. This study explores development of tree species were measured height and stem diameter, we were also studied the species (*M. acutifolium*, *M. lactifera* and *C. americana*) present in the area and the family of each species tree (Fabaceae and Dilleniaceae). Assessments were performed in the years 2010 and 2011. Found in the studied years the increased diameter of the trees studied, due to weather condition, with fewer rains, the tree species tend to increase the diameter. Mean height of trees studied remained the same or decreased because the increase of individuals in the plots, reduced the average height; but evaluating the trees individually, there was accretion in height. The number of individuals in the area increased in number, but the number of families remained the same. Therefore it is concluded that establishment of tree species was an indication of the recovery process of soil, and the species *M. acutifolium* was the most adapted and was influenced by treatments recovery.

Horseshoe Crabs (*Limulus polyphemus*) at Stratford Point: Contaminated with Lead or Leading to Population Success?

Efstration, Emily; Shea Jameel, John P. Rapaglia, Mark A. Beekey, Jennifer H. Mattei
Sacred Heart University - Department of Biology

Horseshoe crab (*Limulus polyphemus*) populations have been low but stable since their decline due to over harvesting and habitat modifications through the mid-1990's. During the early summer months throughout New England, horseshoe crabs come up on the beaches to spawn and each State employs a management plan to try to allow harvest and population expansion. Stratford Point (ST), Connecticut is a coastal estuary, and a conservation easement but formerly, a gun club. ST is located on the west side of the Housatonic River and consists of approximately 4.8ha of intertidal zone. Lead shot accumulated across the site for more than 60 years. Large scale remediation in 2000-2001 removed the bulk of these contaminants, but lead still remains in the sediment. Preliminary evidence indicates that lead levels are approximately one lead shot pellet per liter of sand. The state is debating with the land owner whether to bury the lead with a living shoreline or leave it as is. In the spring 2013, we will test for lead levels in spawning horseshoe crabs, their eggs, and the juveniles found on the site. We will compare these results to our reference site, Milford Pt. on the west side of the Housatonic River that is not contaminated with lead using the standard EPA lab protocols for an Inductively Coupled Plasma mass spectrometer. Results from the two sites will be analyzed for statistical significance to determine whether the lead is accumulating up the food chain indicating need for further remediation.

Long-term Change and Ecosystem Management in Remote Protected Areas: A Photographic Analysis of Willmore Wilderness Park (WWP) and Mount Robson Provincial Park (MRPP)

Falk, Jenna L.; Eric S. Higgs
University of Victoria

The Canadian Rocky Mountains are vast, and offer rich cultural and ecological histories, resources and opportunities. While the majority of direct impacts are limited to population centers and industrial resource extraction, the weight of our activities are nonetheless felt across the landscape. While remote areas are often protected to maintain ideals of undisturbed wilderness, these areas are often influenced by human activities directly (e.g. fire suppression) or indirectly (e.g. climate change, invasive species). Protected area management throughout the Canadian Rockies exemplifies logistical and moral complexities and difficulties in remote ecosystem management. This study investigates observable long-term remote landscape change in two protected areas in the Canadian Rockies, Willmore Wilderness Park and Mount Robson Provincial Park, and examines the resulting implications for management and restoration. Long-term landscape changes were evaluated through repeat photography with the Mountain Legacy Project. Historic survey images utilized included those from Lambert's 1927 Jasper North Boundary Survey, Nidd's 1944 Survey and Wheeler's 1923 Interprovincial Boundary and 1911 Mount Robson Surveys. Through focus groups using photo-elicitation with park managers, repeat photo pairs guided discussion surrounding the challenges relating to remote ecosystem management under rapid change. Initial analysis suggests that fire regime reconfigurations, invasive species and climate change have in some cases significantly influenced management in the Willmore Wilderness. In Mount Robson, balancing user needs with ecological stability necessitates the majority of capacity and resources be allocated to high use areas, leaving more remote areas without much direct intervention.

Restoration site prioritization model for two threatened endemic flora species of the Chilean Biodiversity Hot Spot

Fernandez, Igancio C.; Narkis S. Morales
Arizona State University, Landscape Ecology and Sustainability Laboratory

Because of the trade-off between restoration activities costs and successful results, it is crucial to discriminate among sites that have the best conditions for restoration of threatened species. However, this task could be particularly difficult to achieve if the remaining habitats for restoration of these species are scarce due to the loss and fragmentation of their natural habitat. Therefore, the development of tools to prioritize among potential suitable habitats for target species is a key task to increase the success of potential restoration strategies. To advance towards this goal, in this work we aimed to develop a site prioritization model for two threatened endemic flora species of the Chilean Biodiversity Hotspot, *Pouteria splendens* and *Beilschmiedia miersii*. We used the WorldClim database and Maxent software to generate a GIS bioclimatic based prediction of the potential distribution of these two species. The resulting layer was integrated with four open access layers (roads, land use inventory, national parks, sites of conservation interest) in a linear non-pondered model to predict the best sites for restoration initiatives with these species. Our results showed that potential distribution of both species

POSTER ABSTRACTS (CONT'D)

is highly overlapped with zones that have been severely transformed by human related activities. These results highlight the conservation risk of these species and support the urgency to define suitable habitats for restoration. The model worked well with these species, generating specific areas suitable for conservation and restoration initiatives. However, in order to make improvements, the use of more species for validation purposes must be done.

Anuran specialists as bioindicators of wetland integrity and restoration potential

Fill, Jennifer M.; Shane Welch, Jayme Waldron, Timothy Mousseau

University of South Carolina Columbia

The southeastern United States Coastal Plain supports the highest diversity of freshwater wetlands in North America. Despite their social and ecological value, these wetlands are experiencing a widespread and devastating decline. The integrity of isolated wetlands is a priority for environmental research, warranting development of techniques that indicate: 1) the degree of degradation associated with types of disturbances to wetlands and 2) the potential for wetland restoration success. Historical land-use patterns substantially influence modern conditions and provide predictive insight into future scenarios. Our project objective is to examine whether locally adapted anuran assemblages indicate wetland integrity based on patterns of historical land use. Localized life history traits potentiate the presence of species as legacies of past landscapes. We scored land use characteristics of twenty upland isolated wetlands in the southeastern U.S. Coastal Plain using digitized historical aerial photographs. We input these scores to mathematical indices of land use change and integrity. We used automated recording devices to sample wetland anuran communities. For each wetland, we compared the anuran assemblage to an integrity index score. We predicted that high-scoring wetlands (those further removed in space and time from structural land-use change and high-intensity disturbance) would support amphibian specialists. An assessment of wetland integrity that incorporates historical information increases the efficacy of realistic goals for wetland restoration and management. This practical approach (i.e., using anurans as integrity indicators) will enable stakeholders to assess the current functional condition of wetlands with various land-use histories, and make inferences for future management scenarios.

Response of soil microbial functions to liming: Ecological restoration of a large scale anthropogenic disturbance in the Canadian boreal shield

Garvey, Philip; Steven D. Siciliano

University of Saskatchewan, Department of Soil Science

Trace metal contamination of soils is often associated with anthropogenic and industrial activity. Metal pollution is thought to pose a greater risk to microbial communities than organic pollutants, due to the persistence of metals in the soil environment over time. One example of soil trace metal contamination occurrence on a large scale is that of Flin Flon, Manitoba. A 10,000 hector area of boreal forest surrounding Creighton, Saskatchewan and Flin Flon, Manitoba has suffered a loss vegetation and decline in soil quality, thought to be associated with zinc and copper smelting activities of the Hudson Bay Mining and Smelting Company Limited (HBMS). Efforts to remediate the site using lime have been carried out by community led initiative known as the 'green project'. However lime application in Flin Flon has been met with mixed results. Soil nitrification is the most sensitive soil microbial function to environmental stressors, such as trace element contamination. Heterotrophic nitrification rates are thought to be significant in acid soils but are not accurately predicted by environmental parameters. This study investigated the activity of soil heterotrophic and chemolithotrophic nitrifiers and the response of potential nitrification activity to liming. This study showed differences in the response of heterotrophic and chemolithotrophic activity in response to lime additions.

Eco-Restoration of Majuli Island, Brahmaputra basin

Gogoi, Prasujya

Jawaharlal Nehru University

Majuli is the World Largest Riverine Island which is rich both in natural and cultural heritage. It has been nominated as the World Heritage site by UNESCO. This riverine Island lies in between the mighty river Brahmaputra. The total area of the Island was 1200 sq km which has been reduced to 500 sq km approx due to recurring flood and erosion. Majuli Island is one of the main attraction point of both local and migratory birds. The Island is inhabited by 1.53 lakhs population according to 2001 census. Due to an increase in population there is an increase in the demand for food, fuel and living space which is ultimately resulting in disturbance of ecology. In this paper ecologically critical zones of the Island will be researched by using Weighted Overlay analysis method in GIS environment. LISS III 2009 image is used for classification of Landuse. Both primary and secondary survey has been conducted to find out the ground reality. Indicators are divided into Ecological, Anthropogenic, Natural disaster and Zone of Human Influence. The outcome of the weighted overlay analysis is a raster model indicating the most critical zone to least critical zone in graded colour shades. Problem Identification of the critical zone and protection and management of each ecologically critical zone are proposed.

POSTER ABSTRACTS (CONT'D)

Evaluating the red cedar (*Juniperus virginiana*) invasion downstream of Gavins Point Dam, Missouri National Recreational River, South Dakota

Greene, Samantha L.; James C. Knox

University of Wisconsin-Madison

Gavins Point Dam, the final dam on the Missouri River, alters downstream river form and function. Throughout a 59-mile downstream reach, the dam reduces overbank flooding and lowers the water surface by 1-3 meters. The lowered water surface and reduced overbank flooding is creating a terrace environment within the riparian habitat, limiting native cottonwood regeneration. Moreover, red cedar is establishing beneath the cottonwood stands. We conducted field surveys of stand composition and structure and measured physical and chemical soil properties to create a Bayesian statistical model of red cedar invasion of riparian cottonwood stands and to investigate patterns of soil indicators of ecosystem function along this flow-regulated reach. We found red cedars existed along the floodplain prior to regulation, but at a lower density than today. In addition, we found no significant difference in soil properties between red cedar and cottonwood soils. Rather, soil property differences are correlated to percent sand in the soil. We interpreted fluvial geomorphic surfaces and found soil type generally reflects the fluvial surface created before or at the beginning of flow regulation. Sandier soils represent higher energy depositional surfaces, such as islands and pointbars. Thus, these legacy geomorphic surfaces are a determinant of red cedar establishment patterns and soil property patterns. Land managers and other researchers needing to make predictions for other areas can use our model-building process to quickly map and assess impacts of invasion. The Bayesian model provides information about model certainty and feedbacks between environmental parameters to help target restoration goals.

The Ridges Sanctuary Ridge and Swale Restoration Project - Restoring Ecological Diversity for Interpretive Purposes

Gumtow, Jon H.; Melissa Curran

Stantec Consulting Services Inc

The Ridges Sanctuary is one of Wisconsin's wetland wonders. This 1,600 acre State Natural Area preserves one of the rarest wetland types in the state, the ridge and swale habitat. This 1,400 year old landscape is a complex interaction between groundwater and surface water discharge within an every changing Lake Michigan alluvial environment. The goal of this project is to restore a highly functional ridge and swale system in a previously disturbed area with linkage to the existing ridge and swale complex. Site restoration includes understanding hydrologic contributions and restoring habitat for rare plants. The project will serve as an interpretive opportunity to educate the public about wetland formation and functions. The approach to this project was to understand the hydrologic, vegetation, and physical geology/soils and use site specific data and local resources in the restoration design. One year of site-specific data collection was completed and supplemented with previous research data from The Ridges Sanctuary. Data included groundwater level monitoring to understand seasonal variations; vegetation surveys to understand plant diversity and opportunities to transplant rare species; and soil descriptions to restore the optimal topsoil and subsoil conditions similar to adjacent wetlands. This information was used to develop a restoration design and revegetation plan. The results demonstrate that understanding site specific conditions are critical to develop a high quality wetland restoration project especially in alluvial settings where soils vary greatly. At this site, proximity to dolomite bedrock outcrops and groundwater discharge greatly influences soil and vegetation composition.

An alternative technique to generate specific seed rain patterns by frugivorous birds in restored/enriched sites

Gurgel, Jéssica; Larissa Nemes, Wesley Silva

Universidade Estadual de Campinas

Seed dispersal performed by birds is important for the conservation and management of natural and disturbed habitats, generating different seed rain patterns that eventually will lead to the recruitment and establishment of many plant species. Implementing techniques that favor seed rain by frugivores in restored/enriched sites is critical in restoration ecology. Here we describe a novel and alternative technique that not only increases bird-generated seed rain but also allows the controlling for the seeds to be introduced. From January 2012 onwards we have been offering seeds of several plant species to frugivorous birds enclosed in banana pulp from a feeder located at the edge of an urban 1 ha forest fragment. Seeds of seven native or exotic plant species were offered totaling almost 23,000 seeds. Birds removed 97% but only 0.25% of these were retrieved in 27 1m² seed traps scattered through the study site. From six bird species visiting the feeder, *Turdus leucomelas* (Turdidae) and *Tangara sayaca* (Thraupidae) accounted together for 91% of the visits. Both are abundant and common species in a variety of altered and man-made habitats, including restoration sites, being important dispersers of a wide range of seeds. *Turdus leucomelas* is able to swallow seeds as large as 10 mm in diameter. Considering the ubiquity and abundance of frugivorous birds in many restored sites and their quick habituation to eat fresh bananas with seeds, this novel technique can be successfully used to generate specific seed rains in restoration/enrichment projects in the tropics.

POSTER ABSTRACTS (CONT'D)

Bracken Fern (*Pteridium aquilinum*) and Salal (*Gaultheria shallon*) Distribution and Abundance in Relation to Thinning and Burning in Skokomish Savanna Restoration, Olympic National Forest, WA.

Hamilton, Lindsey S.

University of Washington

Throughout western Washington, fire has been used for thousands of years by native tribes in order to maintain open landscapes that encourage particular plant communities and grazing habitat. This study takes place in the southeast Olympic Peninsula, on land that was traditionally burned, likely every 2 to 10 years, by the Skokomish tribe. With fire suppression a Douglas fir – salal (*Pseudotsuga menziesii* – *Gaultheria shallon*) forest established in a once savanna/woodland matrix. In 2002, the Olympic National Forest began to restore a 32-acre portion to enhance landscape diversity and to re-establish a culturally significant ecosystem. Bracken fern (*Pteridium aquilinum*) and salal are culturally important plants once managed for by Pacific Northwest tribes. Studies suggest that they can co-dominate a fire-managed system in the Pacific Northwest. The objective is to understand how restoration efforts using controlled fires have affected the distribution of bracken fern and salal with respect to environmental factors. In 2012, data on vegetation and environmental factors were collected from 79 plots in three study units: burned/thinned, thinned, and unburned/unthinned, and results analyzed using PERMANOVA. Burning is significantly correlated to increased abundance of bracken fern overall ($p < 0.0001$); soil moisture is positively correlated with bracken fern within the burned/thinned unit ($p < 0.05$). Thinning is highly correlated to a decrease in salal abundance ($p < 0.0001$). Results suggest that cool, frequent burning (< 10 years) could maintain a bracken fern and salal co-dominant understory. This study in effect supports Traditional Ecological Knowledge in restoration efforts.

Hotspots of world grassland restoration

Hermann, Julia-Maria; Johannes Kollmann

Dept Ecology and Ecosystem Management, Technische Universität München

World-wide, intensification and conversion of temperate grasslands for agricultural purposes has been precipitated by their combination of wide, treeless expanse, adequate soil depth and moderate climate. Ecological restoration of these grasslands is usually challenged by habitat fragmentation, increased nutrient loads, introduction and invasion of non-native species, and the fact that traditional ways of biomass removal are no longer economically sustainable. Yet restoration ecologists working in the prairies of North America, the pampas of South America, calcareous and sandy grasslands of Central Europe, the steppes of Eurasia, and the highveld grasslands in South Africa live different realities when it comes to technology, availability of seed material and management alternatives. Awareness of these different realities is a prerequisite to international collaboration and knowledge transfer in grassland restoration. We review a wide body of literature referenced in the WWW to compare, between these eco-zones: (1) Primary types of restoration sites – oldfields, abandoned grasslands, intensified grassland or other? (2) Primary objectives of grassland restoration - restoration of native species richness, grassland fodder and forage productivity, or both? (3) Techniques used to achieve these objectives, from spontaneous succession to “high-tech” approaches using herbicides, soil amendment and multispecies, regionally sourced seed mixtures. Special attention will be paid to the employment of selected varieties of native and even non-native species in grassland restoration.

Into the unknown! Blending stewardship and science in the ecological restoration of a unique northern limestone barrens habitat for endangered species

Hermanutz, Luise A.; Dulcie House, Corrina Copp

Memorial University

The long-term conservation goals of many endangered species recovery strategies include the restoration of critical habitat. Many restoration plans incorporate SER guidelines to ensure that critical habitats are restored using best ecological science; however, despite SER's emphasis to involve all societal sectors, many restoration projects fail to incorporate community partners and local citizens at the planning stage. The globally at-risk Limestone Barrens found on the Northern Peninsula of Newfoundland (Canada) is home to the endangered endemic plant Long's braya (*Braya longii*; Brassicaceae). The habitat and plant are threatened by gravel quarrying, human development, and off-road vehicle use. The legacy effects of quarrying are highly visible on the landscape with little evidence of natural recolonization due to change in physical habitat attributes, such as hydrology and cold-soil processes. In working with a local service group and government agencies, we developed a framework to incorporate citizens into our recovery efforts and ensure stable funding. Using this framework the local group has been pivotal in the planning phase, actively writing funding applications with our assistance, and acquiring funds allowing us to train citizens of the community and incorporate them in restoration activities such as garbage removal to prepare the site. The second phase of restoration activities has involved volunteers from all sectors, completing invasive species removal, native species transplantation and experimental substrate manipulation to determine appropriate quarry restoration protocols for Long's braya and natural vegetation reintroductions. Our approach has resulted in incredible community support and an eagerness to participate in endangered species conservation.

POSTER ABSTRACTS (CONT'D)

Land use change as a strategy to improve ecological connectivity in a mediterranean landscape: A case study in Catapilco, Chile.

Hernandez, Angela; Eduardo Arellano, Marcelo Miranda, Santiago Saura
Pontificia Universidad Catolica de Chile

Improve landscape connectivity is a restoration strategy to contrast the negative effects of habitat fragmentation. Mediterranean ecosystems are a particular type of dryland that account for less than 5% of the Earth's Surface. The Chilean Mediterranean landscape has undergone under drastic changes due to the historical process of land use. This work aims to evaluate the dynamics of a landscape in Central Chile and to establish a model of ecological connectivity to this landscape. The study was carried out in the rural area of Catapilco (-32.5°LS, -71.3°LW). The landscape changes were assessed through supervised classification of Landsat images (1975, 1981, 1992, 2001 and 2011). Connectivity was measured using the metric PC (Probability of Connectivity) with the Conefor 2.6 software. The main trends in landscape dynamics were: 1) increase in native forest (7.6% in 1975 to 16.0% in 2011) mainly due to the contribution of arborescent Shrub and 2) reduction of open chaparral (34.1% in 1975 to 18.4% in 2011) due to the abandonment of agricultural land. The connectivity model suggests that it was slightly improved (PC 1975 = 0.18%, PC = 0.34% in 2011) increasing the size of the largest patch and the connectivity interpatch, possibly by the abandonment of agricultural land, which resulted in regeneration of some species allowing their connection in some previously existing habitat areas, which caused the formation of some biological corridors. In conclusion, it is observed that the spinals can be used as ecological connectors changing the paradigm of silvopastoral use only.

Long-term changes in vegetation structure at a 60+ year prairie restoration

Herrick, Bradley M.; Marie Pichler, Paul H. Zedler
University of Wisconsin-Madison Arboretum

The Greene Prairie at the University of Wisconsin-Madison Arboretum is a restored 50 acre (20 ha) wet to dry sand prairie. Dr. Henry C. Greene almost single-handedly planted the abandoned corn field in the 1940's through the 1950's using native seed, prairie sod transplants and seedlings. Today Greene Prairie is one of the Arboretum's most diverse restorations, supporting over 200 native plant species. However, encroachment by invasive woody species and *Phalaris arundinacea* (reed canary grass) threatens the diversity of the prairie. Since the 1950s, the vegetation has been surveyed seven times, including a 2012 partial survey of the area invaded by woody plants. In this poster we report on plant species dynamics from a long-term dataset. Common prairie plants such as *Schizachyrium scoparium* (little blue stem), *Sorghastrum nutans* (Indian grass), *Lespedeza capitata* (round-headed bush clover) and *Liatis pycnostachya* (thick-spike gay-feather) have increased in frequency overall while these same species have decreased in frequency in the 9.6 acres (3.9 ha) of prairie invaded by *Populus tremuloides* (quaking aspen), *Cornus racemosa* (gray dogwood), and *Rhus glabra* (smooth sumac). Where reed canary grass has invaded and formed a 9.8 acre (4 ha) monotypic stand, almost all prairie plants have been lost. Due to past and current management efforts, the core of the prairie is still highly diverse and recent large scale clearing of woody species along the prairie edges will be monitored to assess changes in plant diversity.

Germination techniques and days to emergence for seeds of over 100 native plants used in restoration across the Western U.S.A.

Hitsman, Christopher M.; Brianna L. Stone, Kristin Oles, Catherine L. Cumberland, Kelsey M. Correia, Brett H. Wolk, Mark W. Paschke
Colorado State University

Information on the germination of Western U.S. native species across the breadth of plant classifications is lacking. However, the demand for such information is increasing as native species are being used more in restoration practices and horticultural settings. What little native seed germination information is available is scattered throughout species-specific publications and a handful of online databases. The Restoration Ecology Lab (REL) at Colorado State University has attempted to germinate approximately 120 species of herbaceous and woody plants native to the Western United States and recorded seed-pretreatment(s), germination conditions (light, temperatures, and watering regime), and germination timing and rates. Approximately 75% of the species tested needed no pretreatment to germinate in a greenhouse with daily watering, but seed scarification by sandpaper, acid washing, and/or bubbling in tap water tends to reduce dormancy and increase germination rates for the remaining 25%. Our species-specific germination information will be available through the REL website and applicable online databases.

Increasing ecological uplift using ecological modeling: A novel approach with a case study in Woodbridge, New Jersey

Hoelzle, Timothy; Mark S. Laska, Jessie Quinn, Zachary Lehmann
Great Ecology

Compensatory wetland mitigation is required in the context of Federal regulatory compliance under the Clean Water Act. Mitigation ratios of wetland acres impacted-to-wetland acres created are often established by federal and state regulators. However, it is becoming increasingly preferred to determine mitigation requirements based on a comparison of the wetland functions lost due to development and gained due to compensatory restoration. This is consistent with the 2008 Mitigation Rule of the Clean Water Act jointly released by the U.S. Environmental Protection Agency and the USACE that advocates for the goal of "No Net Loss" of wetlands or their functions. Estimating the ecological function of restored wetlands compared

POSTER ABSTRACTS (CONT'D)

to that of pre-project conditions requires a quantitative ecological model. Wetland Functional Assessments (WFAs) provide a method to assess ecological functionality using a suite of habitat attributes, which are used to calculate a composite metric to estimate ecosystem functions. WFAs can be used in wetland restoration planning and design to maximize the functional provision of restored wetlands and demonstrate to regulators the relationship of restoration attributes to the wetland functions they provide. We illustrate the process of using a WFA, the Evaluation of Planned Wetlands, in the planning, design, permitting, and implementation of wetland restoration to create the maximal amount of ecological uplift using a 185-acre remediation and restoration project currently underway in Woodbridge, New Jersey. We discuss the details of this approach and apply the results to the broader context of planning approaches to achieve successful ecosystem restoration.

Birds and butterflies respond to soil-induced habitat heterogeneity in experimental plantings of native tallgrass prairie species in Iowa, USA

Hokschi, Benjamin; Mark Myers, Jarrett Pfrimmer, James Mason

University of Northern Iowa

The positive association between habitat heterogeneity and species diversity has been well-documented, and the maintenance of habitat heterogeneity has been promoted as a key strategy to conserve biodiversity. We studied interrelationships between prairie plant establishment, habitat heterogeneity, and bird and butterfly biodiversity in an experimental prairie reconstruction in Iowa, USA. We seeded 48 research plots on three soil types with one of four treatments containing one, five, 16, or 32 species. During early establishment, neither bird nor butterfly abundance, species richness, or community diversity varied among the three soil types; however, there were significant treatment \times soil type interactions when comparing bird and butterfly community composition among plots. Grass-dominated plots on sandy loam were characterized by more bare ground with shorter, less dense vegetation and sparse litter compared to vegetation on loam and clay loam plots. Consequently, bird assemblages on sandy loam were dominated by species preferring open ground and sparse vegetation, whereas assemblages on loam and clay loam were dominated by birds preferring taller, more dense vegetation with abundant litter. In forb-rich plots, vegetation structure and individual plant expression varied greatly among soil types, and this variation greatly affected butterfly community composition. Our results demonstrate that plots established with identical seed mixes and management practices developed variable habitat characteristics due to variation in edaphic conditions and that animal communities were structured in response to this heterogeneity. We discuss the conservation implications of our findings in the context of the utilization of native prairie species as a lignocellulosic biofuel feedstock.

The role of prairie restorations and conservation plantings in dispersal networks for conservation biological control agents

Holland, Jeffrey; Helen I. Rowe, Insu Koh

Purdue University

In Midwestern USA, large prairie restorations and relatively small conservation plantings (CP) increase habitat connectivity. This may enhance the movement rate of wildlife in a well-connected habitats and the flow of wildlife from the prairie source and individual CP. Using graph and circuit theoretical connectivity measures, we tested these two hypotheses on insect natural enemies of soybean aphid to examine how a county-wide habitat network contributes to the delivery of pest control services to soybean fields and adjacent CP. We observed abundance of soybean aphids and predators in 15 CP and adjacent soybean fields. For graph connectivity, area- and distance-weighted incoming fluxes to the 15CP from connected semi-natural habitats were measured based on a range of negative exponential dispersal kernels. Distance was weighted by the percent of semi-natural area within ellipse-shaped landscape boundaries that are determined by correlated random walks. Regarding the flux as conductance in a circuit, effective conductance from the prairie to the individual 15 CP was measured. Using these two connectivity measures and aphid abundance we predicted the abundance of natural enemies in the selected sites. We found that only native ladybird beetles were influenced by the flux and conductance circuit measures across the network. The conductance variable predicted the abundance of the native predators better than Euclidian distances from the prairie. These results indicate that the well-connected semi-natural areas enhance the flow of native predators and prairie acts as a source. By optimizing the habitat network, managers can enhance the delivery of biocontrol services.

Ectomycorrhizal fungi and soil nutrients may improve tree growth in Neotropical restoration

Holste, Ellen K.; Richard K. Kobe

Michigan State University

Large scale deforestation and degradation underline an urgent need to understand how to restore ecosystem functions in Neotropical landscapes. Traditionally restoration efforts focus on species assemblages, yet in the face of climate change and highly species diverse tropical landscapes, rehabilitating ecosystem functions, potentially through mycorrhizal fungal-tree symbioses, may be a more attainable restoration goal. In nutrient poor landscapes, mycorrhizal fungi can help trees alleviate soil nutrient constraints to growth, and in particular, ectomycorrhizal fungi (EMF) may be more advantageous for nutrient capture than arbuscular mycorrhizal fungi (AMF, typically dominant in the Neotropics) due to their potential for increased nutrient uptake to their host trees. The importance of fungal-tree associations also may depend upon soil nutrient status. This research's objective was to examine different mycorrhizal fungal types in relation to tree growth (height and basal diameter) and soil nutrient availability in reforested pastures in Coto Brus, Costa Rica. Eight sites spanning a soil fertility gradient were reforested with four tree species (two species associated with each fungal type). After one and a half years, the change in height of EMF-associated species' (*Pinus caribaea* and *Quercus insignis*) was greater than AMF-associated

POSTER ABSTRACTS (CONT'D)

species (*Terminalia amazonia* and *Swietenia macrophylla*). Growth differences also were driven by site effects mediated through soil nutrient availability. Higher levels of base cations and phosphate generally increased AMF-associated species' growth, while higher levels of phosphate decreased EMF-associated growth. This study demonstrates the importance of site level nutrient availability on tree growth and the potential role of EMF in Neotropical restoration.

Invasive Species Population Dynamics in the Restoration of Avian Habitat in the Northeastern Estuary, USA

Hoosein, Shabana; George Robinson
SUNY University at Albany

Understanding invasive species expansion in the face of ecological change is one of the most important and difficult challenges in ecological restoration. Due to its extraordinary plasticity, *Celastrus orbiculatus* (Oriental bittersweet) coexists with changes in the canopy while altering biodiversity, tree layer composition, and critical bird nesting sites. We studied the distribution patterns of *C. orbiculatus* on a dredge spoil island along the Hudson River in Schodack, NY. We surveyed *C. orbiculatus* age, density and stem diameter throughout various parts of the island. There was a positive correlation between stem diameter and age ($r=0.765$). There was also a positive, but weak correlation between stem diameter and density ($r=0.289$). Mapping of species distribution showed high density patches of *C. orbiculatus* in dredge spoil communities and low density patches in the forest floodplain habitats. These results indicate that more mature *C. orbiculatus* plants have a larger stem diameter and occur within dense populations. Patches of high density areas according to habitat type indicates growth patterns in areas that may be promoting *C. orbiculatus* expansion. We plan on continuing experiments to understand Oriental bittersweet distribution in the spring and summer of 2013. We will be testing the variation in the survival and growth of new bittersweet recruits in areas that have been anthropogenically altered (dredge deposited sites), mycorrhizal associations according to site type and the survival and growth of new bittersweet recruits based on positive density dependence.

Increasing native milkweed seed availability for monarch butterfly and pollinator habitat conservation

Hopwood, Jennifer; Brianna Borders, Eric Mader, Mace Vaughan, Scott Hoffman Black
The Xerces Society

Milkweeds (*Asclepias* spp.) are the obligate host plants of monarch butterfly (*Danaus plexippus*) caterpillars and support diverse invertebrate wildlife with their nectar. The loss of milkweed from across the monarch's breeding range is considered a significant factor contributing to declining monarch numbers recorded at overwintering sites in Mexico and on the California coast. To offset the loss and degradation of monarch breeding habitat, the North American Monarch Conservation Plan recommends planting regionally appropriate native milkweed species. However, commercial sources of milkweed seed have been scarce across the southern tier of the United States, limiting opportunities to include the plants in habitat restoration efforts. In 2010, the Xerces Society launched *Project Milkweed*, an initiative to promote milkweed conservation on a national level and to increase milkweed seed availability in California, the Great Basin, the Southwest, Texas, and Florida. Working with the USDA-NRCS, native seed producers, and community groups, we have already brought more than 150 pounds of seed to market for species that were not previously available. Concurrently, Xerces is encouraging the inclusion of these valuable plants in pollinator habitat enhancement projects on agricultural lands, and large-scale plantings by transportation agencies, resource conservation districts, and natural resource agencies. These combined restoration activities will contribute to monarch conservation by increasing the abundance of their larval host plants on a region-wide basis, while also supporting pollinator populations.

Allelopathic effects of aqueous extract of exotic plant *Rhus typhina* L. on soil micro-ecosystem

Hou, Yuping; Lin Liu, Xin Wang, Xiaoyu Yan
College of Life Sciences, Ludong University

Rhus typhina, an exotic woody species introduced from North America, was identified as a main afforestation species in northern China. However, it is being increasingly realized that *R. typhina* become a potentially invasive species in its introduced habitats as its distribution keeps expanding. We investigated the effects of different concentration of fresh branches and leaves aqueous extracts of *R. typhina* (0, 0.005, 0.025, 0.1g dw/ml) on soil microbes, enzyme activities, soil nutrients and N transformation. Present data showed that the aqueous extracts of *R. typhina* had effects on soil micro-ecosystem by (1) increasing the amount of bacteria and fungi in a concentration dependant manner; (2) significantly enhancing the enzyme activities of urease and acid phosphatase along with its increasing concentration but not of invertase; (3) accelerating the soil organic carbon, total K, available N, available P and available K content, as well as the inorganic nitrogen supply through significantly increased soil mineralization, but not soil water content, pH, total N and total P. All these suggested that *R. typhina* could modify the composition of soil biota, the activities of soil enzyme and turnover of soil nutrition, which in turn facilitates its invasion in the field. This study provided experimental data both for assessment of impacts of exotic plant *R. typhina* on soil micro-ecosystem and for prediction of invasive potential of the species.

POSTER ABSTRACTS (CONT'D)

Restoring forest habitat through a memorial forest program at The Arboretum, University of Guelph

Hunt, Shelley; Richard Jordan, Sean Fox, Scott Young

University of Guelph

Nearly 25 years ago, The Arboretum at the University of Guelph and the Wall-Custance Funeral Home (both in Guelph, Ontario, Canada) entered into a partnership to restore native forest habitat through a memorial forest program. The program has focused on establishing forest corridors and shelterbelts in open areas on Arboretum grounds, through the planting of 26 different species of native shrubs and trees. Since its inception 15,000 trees and shrubs have been planted, financed through donations to the program by the funeral home (one tree for each funeral conducted) and by people wishing to memorialize a friend or loved one. Plantings are conducted by Arboretum staff, and a small percentage of each donation is put in trust to support tending of the planted trees, ensuring that they become successfully established. Demand from the public for the 'living memorial' that a tree represents has remained consistent and the program is still going strong. This is an example of a successful community-supported and financed forest restoration program that could be used as a model for other organizations.

What is the role of hydrochory in process-based restoration of riparian ecosystems?

Hutchinson, Rachel A.; Alexander K. Fremier, Hannah Marx, Kaya MacMillen, David C. Tank, Joshua H. Viers

Center for Watershed Sciences, UC Davis

The transport and dissemination of plant propagules through water, termed hydrochory, contributes to plant community composition on floodplains. The composition of transported material can significantly influence the success and trajectory of process-based floodplain restoration. Which seeds and propagules are transported is not only dependent on the dominant hydrological regime, but also varies seasonally and inter-annually. In this study – conducted within a process-based restoration of the Cosumnes River experimental floodplain – we collected and propagated in-stream organic material to quantify seasonal patterns of hydrochorous composition. We compared the composition of instream hydrochorous species collected throughout the winter flood season with extant vegetation and the seed bank to investigate how flood timing and discharge might influence community composition after floodplain reconnection. We hypothesize that mid to late season floods will be composed of species that are most beneficial to native riparian recruitment because of the timing of seed release from parent plants. We looked at patterns of nativity, plant functional traits, and phylogenetic diversity throughout the season and with different stream discharge rates to determine the composition of hydrochory and how the available species might impact floodplain vegetation. To identify how early season flooding in the 2013 water year affected community composition we looked at rates of turnover between hydrochorous material and extant vegetation and looked at NMDS ordination to identify changes in community composition. Preliminary results indicate that hydrochory will have a significant impact on floodplain plant communities through the provision of native and highly diverse propagules.

Sediment dynamics before restoration on a degraded marshland site: what we need to know before installing a living reef

Jahn, Jacqueline D.; John Rapaglia, Jennifer Mattei, Mark Beekey

Sacred Heart University

Salt marshes naturally attenuate energy by reducing the heights of waves and slowing currents through bottom friction. Energy attenuation reduces water's ability to transport sediment, leading to sediment deposition in salt marshes. Salt marshes are fed by deposition of sediments leading to a dynamic equilibrium between marsh growth and sea level rise. A fringing salt marsh was removed from the coastline at Stratford Point, CT during lead contamination remediation activities. Loss of marsh removed the natural protection from the coast leading to 30m of coastal retreat within ten years. A living reef will be established in order to break waves and recruit fine-grained sediments for the establishment of a new marsh. Prior to installation of the reef, it is essential to understand the wave climate, current climate and sediment transport in order to best locate the reef. Cera Diver pressure sensors were installed next to a multi-stage siphon sampler for one week in late April 2013 and one week in early September 2013 in order to establish baseline data. Pressure sensors (0.5 Hz) were able to recreate significant wave height, while sediment traps were used to determine instantaneous suspended sediment concentration (SSC) from three depths and three inundation heights. Significant wave height (Hs) ranged between 2 cm and 16 cm pending wind regime. SSC was strongly correlated to Hs. There was no correlation between tidal current and SSC. Wave energy strongly determines sediment transport in the area. Therefore, the reef should be installed perpendicular to dominant wave action.

Women hunters and their barriers to participation

Janiczak, Catherine

Ball State University

Ungulates can negatively impact the ecosystem structure and agriculture. Although there are methods to control ungulate populations (e.g. relocation, sterilization), hunting is accepted by wildlife managers as the most cost-effective and efficient way to control ungulate populations at the local level. In a society where fewer individuals understand conservation and restoration, hunting can help them understand the environment and ungulate overabundance. Researchers continually overlook one group of hunters: women hunters. Women hunters continue to increase according to the National Fishing, Hunting, and Wildlife-Associated Recreation Survey. It is important to understand the barriers to participation women have in hunting if

POSTER ABSTRACTS (CONT'D)

wildlife managers want to rely on hunters for ecological restoration. B.O.W (Becoming an Outdoors Woman) introduces women to outdoor activities including hunting. An important factor missed by this organization is who introduces women to hunting: their male spouses. During the Indianapolis 2013 Deer, Turkey, and Waterfowl Exposition, female hunters filled out surveys. Analysis of survey data indicate women are most often introduced to hunting by a male spouse and are more likely to hunt than single or divorced women. This fall, surveys will be distributed throughout Indiana to women hunters and the results will be presented. It is important to understand women hunters and their barriers to participation because women will ultimately decide what outdoor leisure activities their family participates in. Ungulates have had negative impacts on the ecosystem, so it is important to study hunters, especially women hunters; they are and can be stewards for ecological restoration.

Green fertilization enhances the photosynthetic performance of leguminous tree species in a forestry plantation in the Central Amazon

Jaquetti, Roberto; José Gonçalves, João Ferraz, Marciel Ferreira

Instituto Nacional de Pesquisas da Amazônia

Physiological tools can be used to monitor the success of restoration projects during their implementation, providing managers with better information for decision making. To investigate the photosynthetic responses of Amazonian forest species with respect to fertilization, the *Dipteryx odorata* (Aubl.) Willd. and *Inga edulis* Mart. leguminous tree species were grown in the field for the reforestation of a degraded area. The 2 species were submitted to different treatments: T1 = unfertilized control, T2 = chemical fertilization, T3 = green fertilization and T4 = green and chemical fertilization. The results showed higher net photosynthetic rates (A_n) in T4 for both *D. odorata* [13.08 $\mu\text{mol (CO}_2\text{) m}^{-2}\text{ s}^{-1}$] and *I. edulis* [20.65 $\mu\text{mol (CO}_2\text{) m}^{-2}\text{ s}^{-1}$]. The stomatal conductance (g_s) was higher for *I. edulis* compared to *D. odorata* in all of the fertilization treatments, and the highest values were reached in T4 for *I. edulis*. Higher values of dark respiration (R_d) were found in T1 [2.36 $\mu\text{mol (CO}_2\text{) m}^{-2}\text{ s}^{-1}$] for *I. edulis*. The highest transpiration rates (E) were found in T4 [7.61 $\text{mmol (H}_2\text{O) m}^{-2}\text{ s}^{-1}$] for *I. edulis*. T4 also showed higher values of a performance index (PI_ABS) compared to the other treatments for both *D. odorata* (2.89) and *I. edulis* (5.17). The chlorophyll *a* contents (Chl *a*) were greater in T4 for *I. edulis* [1.44 $\mu\text{mol g}^{-1}$ (fresh matter)]. Our results indicate that the combination of green and chemical fertilization is more effective in improving the photosynthetic performance of both species in a degraded area.

Numerical projection of population size of *Turbincarpus horripilus* (Lem.) Vac. John & Riha, a cactus in danger

Jiménez-Sierra, Cecilia L.; Ma. Loraine Matias-Palafox, Pedro Luis Valverde, María del Carmen Mandujano

Universidad Autónoma Metropolitana-Iztapalapa

Using projection matrix models of Leftkovich, the finite rate of population increase λ (\square), the reproductive value (v), and stable age structure (w) of a population of *Turbincarpus horripilus* was calculated. *T. horripilus*, is a small globular cactus native to Mexico and endangered. We simulated changes in certain inputs transition matrix and evaluate their effects over \square , and we made projections of the population size over the next 50 years: i) The reduction of the 20% of the value of permanence of Adult 4; ii) The decrease of 50% of the value of the fecundity of all size classes; iii) Decrease of 50% of fecundity inputs at all classes and simultaneously increasing 65% of the entrance of permanence of Adult 1. Reducing 20% of the input value of permanence of Adult 4 leads to population extinction in 45 years. Decreasing 50% of the fertility value of all classes maintains stable the λ value over time. Decreasing 50% of fecundity inputs at all classes and simultaneously increasing 65% of the entrance of permanence of A1, is enough to obtain an increase of 800% over the population size in 50 years. These numerical projections suggest that it is necessary the conservation of the larger individuals (A4) and that it is possible the use of seeds to propagate the species in greenhouses to obtain juveniles that can be introduced to the wild.

Marine biodiversity conservation plan zoning system based on integrated coastal zone management

Jinlong, Jiang

Third Institute of Oceanography State Oceanic Administration

This paper analyzed the relationship and the importance of each area to protect marine biodiversity, and crystallized direct impact areas and indirect impact areas for marine biological diversity protection. It proposes marine biodiversity conservation plan zoning system, in which the planning areas and the relevant land areas are divided into key protected areas for biodiversity protection, biodiversity conservation areas and biodiversity conservation supervision areas. The watershed boundaries and administrative boundaries should be considered comprehensively When partitions are delimited.

The State of Stream Restoration in the North Carolina Piedmont: An Assessment of Instream Structure Durability and Stream Bank Erosion

Johnson, Yari; Kim Hamlin, Ted Shear

North Carolina State University

We evaluated 583 instream structures from 19 stream restorations that were between 4 and 12 years old, focusing on damage to structure components and stream banks. The structures included rock cross vanes, single arm vanes, j-hook vanes, rootwad revetments, and boulder revetments. We also calculated Bank Erosion Hazard Indices (BEHIs) for the restored stream sections and sections of six reference streams. A threshold value for both structure condition and BEHI score was specified. This threshold value indicated the point where structure and bank condition may be questionable.

POSTER ABSTRACTS (CONT'D)

We found that rock cross vanes and rootwad revetments were the least durable structures, reaching the threshold value in 4 and 6 years, respectively. Single arm vanes and J-hook vanes did not pass the threshold value until 10 and 11, respectively. Boulder revetments approached but never reached the threshold value and were the most durable structures. The majority of BEHI scores in restored and reference sections were above the threshold value. No relationships were found between structure condition, structure density, or number of structures per stream and BEHI score. This suggests erosion is the result of large scale disturbances within the watershed to which both restorations and references are reacting similarly. Instream structure design should be critically examined to improve or remove structures that are not contributing to restoration success. Collecting pre-restoration erosion data and reference stream bank data annually will also be useful in determining success by providing tangible evidence of improvement during the monitoring period.

Challenges of Developing Propagation Protocols for Aquatic Plants Native to the Gulf Coast

Kauth, Philip; Patrick Biber

Gulf Coast Research Laboratory/The University of Southern Mississippi

In response to environmental impacts (hurricanes and BP oil spill) along the Gulf coast, restoration of coastal and marine habitats has become a priority. In particular, restoration of seagrasses and other submerged aquatic plants is vital for ecosystem health. To facilitate restoration, developing propagation protocols specific to Gulf coast plants is necessary, but challenging due to the lack of information on many species. Previous research on seed germination of *Vallisneria americana*, a submerged aquatic species with a declining presence in coastal habitats, reported germination percentages between 80-90% from northern latitudinal populations. Germination experiments using Mississippi Gulf coast populations revealed unexpected outcomes. Less than 8% germination occurred when seeds were germinated in the light (16-hr photoperiod) and dark at 10, 20, 30 or 40°C. As a result, cold stratification and gibberellic acid (GA) soak experiments were conducted. Seeds were cold-stratified under moist conditions for 0, 2, 4, 6, or 8 weeks followed by incubation at 30°C in the light. Germination was poor with less than 10% of the seeds germinating. Seeds were also treated with 0, 10, 25, 50, or 100 µM GA followed by incubation at 30°C in the light. The highest germination occurred at 50 µM GA, but it was only 7%. Following these unsuccessful experiments, a seed scarification experiment was conducted that led to increased germination percentages up to 90% when incubated at 30°C. This unexpected dormancy is a potential challenge to developing seed-based propagation protocols that practitioners can use to bolster plant numbers for restoration projects.

Are farmers at loggerheads with restoration? Ecologies of contexts drawn from in-depth interviews in the Driftless region of Wisconsin, USA.

Keeley, Keefe; Stephen J. Ventura, Mark Rickenbach

University of Wisconsin - Madison

Logging and grazing livestock have historically degraded the oak- and maple-dominated forests of the Kickapoo watershed, but these practices may hold the key to engaging farmers in restoration. I conducted 20 semi-structured interviews with farmers in this watershed about their motivations, constraints and values vis-à-vis their woodlands. Hillside woodlands offer farmers timber, fuel, hunting, and pasture, along with aesthetic and lifestyle benefits that play a strong role in their sense of place. Farmers embrace many perspectives, but often, financial considerations dominate land-use decisions. As such, forest restoration is constrained by property tax policy, time availability, perceived return on investment, and fluctuating market values for timber and land. Financial motivations to engage in restoration include timber stand improvement, providing cattle forage, and cost-share programs. Land ethics and ecological knowledge, along with the cultural norms and values that embed them, also influence restoration activity. These factors form the ecology of contexts – such as topography, tax policy, and family history – wherein farmers define themselves and their enterprises. Conservation efforts that fail to consider their ecologies of contexts are liable to leave farmers out, as has largely been the case with Wisconsin's Managed Forest Law, a tax-incentive forest management program. Conversely, since other tax programs incentivize woodland grazing, research and education on grazing strategies that control invasive shrubs like *Rosa multiflora* are more attentive to farmers' contexts than restoration strategies such as prescribed fire. Using farmers' stories as evidence, I argue that effective adaptive resource management requires careful integration of actors' contexts.

Indicators to evaluate restoration and management practices in two farming communities in arid to semi-arid savannas of South Africa: Land users' perceptions

Kellner, Klaus; Taryn Kong, Christiaan Harmse, Niels Dreber

North West University

This study forms part of the multinational PRACTICE project (Prevention and Restoration Actions to Combat Desertification: An Integrated Assessment) aiming at developing and testing an integrative assessment protocol (IAPro) for restoration and management practices to mitigate or prevent land degradation. Land users in the Mier and Molopo areas in South Africa have large stake in the management of their arid to semi-arid savannas, which sustain the dominant land uses of livestock farming and game ranching. Following IAPro, semi-structured interviews were conducted with local farmers representing different land tenures, government officials, and rangeland managers who formed part of an identified multi-stakeholder platform. These stakeholders (SHs) were asked to identify environmental and socio-economic indicators to evaluate the performance of degradation-mitigation practices. A total of 30 and 31 indicators were identified in the Mier and Molopo, respectively. These were combined with science-based indicators to form a condensed list of 11 indicators for both study areas. Subsequently, the SHs ranked the relative importance of the indicators based on

POSTER ABSTRACTS (CONT'D)

their subjective preferences. The production and value of forage (biomass), grazing capacity, and income and profit were ranked the highest in the higher rainfall Molopo area (450 mm/a), whereas the availability of water, personal factors, abundance of grasses and condition of animals were regarded as most important in the lower rainfall area of Mier (250 mm/a). This participatory approach stimulated the thinking among SHs about which indicators to use when making more informed decisions in the implementation of restoration and management practices.

Modeling Restoration Trajectories of Oligohaline Tidal Wetland Ecosystem Services in the Pacific Northwest: A Study of Young's Bay Tidal Reconnection Projects

Kidd, Sarah A.; J. Alan Yeakley
Portland State University

The objective of this study is to identify the rate of ecosystem service recovery in tidally reconnected oligohaline (salinity 0.5-5 ppt) wetlands on historically diked agricultural lands in the Columbia River Estuary. Global wetland loss has resulted in severe declines in ecosystem functions and services including water quality regulation, climate regulation, fish and wildlife habitat, and cultural heritage. In the Pacific Northwest, reconnection and restoration of tidal wetlands is fundamental for restoring endangered salmonid habitat. However the rates of ecosystem service recovery in these reconnected wetlands remains unclear. To identify rates of ecosystem recovery, a 53 year chronosequence of tidal wetland restoration sites will be evaluated to create functional restoration trajectory models. Evaluated projects will include sites hydrologically reconnected in 1959, 1980, 2002, 2005, 2006, 2008, 2010, 2012, 2013, and 2014 all within the Young's Bay Watershed. These sites will be monitored for two (2013 & 2014) years in conjunction with two diked pastures and two natural reference wetlands. Site monitoring will focus on evaluating plant community, carbon sequestration, soil development, and water quality. Regression and multivariate analysis will be conducted to evaluate if restoration trajectories toward reference levels can be observed. This research will provide insight into the major drivers and limiting factors of long-term tidal wetland ecosystem recovery. This information can be used directly by restoration practitioners, land managers, and tribes to identify if restoration outcomes are being achieved and provide insight to how projects can be adaptively managed to improve rates of ecosystem recovery.

GIS-Based Spatial Distribution Analysis of Eurasian Spoonbill (*Platalea leucorodia*) in Upo Wetland

Kim, HyoJun; HeeCheon Park
Kyungpook National University

This study was aimed to examine characteristics such as distribution and habitate density of *Platalea leucorodia*, the 'Class □ endangered species appointed by the Ministry of Environment' during wintering in Upo wetland where is a Ramsar wetland and a representative inland wetland using ArcGIS program, to see the effect of prolonged changes in ecological environment and climate on birds here. According to the continuing investigation from 2005 to 2012, the observed number of individuals of *Platalea leucorodia* has increasingly reduced. Therefore, *Platalea leucorodia*'s spatial distribution and density during wintering were analysed for five years from 2008, using ArcGIS program. When analyzing the year-on-year distribution, *Platalea leucorodia* was observed every year in front of the Upo wetland observatory and Sajipo 2. However after 2009, the distribution density in Sajipo 2 decreased by 46.2%, compared to 2008, according to the 50% kernel density estimation. The monthly analysis of distribution density also displayed that *Platalea leucorodia*'s distribution was concentrated in Upo, Sajipo 2 and waterside of Somok, excepting Mokpo and Jjokjibeol. In conclusion, the yearly and monthly analyses of distribution density show why the population and distribution density of *Platalea leucorodia* decreased each year. It was also revealed that they were associated with the changes of aquatic plants by the increase of area of lotus and the distribution of the predominant species, *Anser fabalis*, in addition to the recent hard cold in the winter.

Conversion of arable land to species-rich grasslands – possibilities and constraints for restoration success

Kirmer, Anita; Annett Baasch, Sabine Tischew
Anhalt University of Applied Sciences, Germany

In Central Europe, the area of species-rich grasslands is decreasing rapidly, due to intensification of agriculture, abandonment, and conversion to arable fields. In summer 2009, we implemented two large-scale trials on former arable land in the agricultural region of Saxony-Anhalt (Germany). Dependent on the site conditions, the chosen target communities are (1) a lowland hay meadow (Arrhenatherion), and (2) an alluvial meadow (Deschampsion). Both sites were treated differently: the Arrhenatherion site was cultivated (winter wheat, oat) without fertilization for two subsequent years, whereas the Deschampsion site was only ploughed before the experiment started. Seed material for restoration was harvested directly on species-rich donor sites (Arrhenatherion, Deschampsion) via mowing and threshing. Until summer 2012, both sites showed high transfer rates of common target species (70-80 %), but lower values for rare target species (30-40 %). Whereas on the Arrhenatherion trial, target species reached almost 100 % on total coverage, on the Deschampsion site the share of target species on total coverage amounts to 13 % (green hay) and 34 % (threshed material) respectively, thus reflecting the suitability of the receptor sites. In May 2013, on the Deschampsion trial, mowing once or twice a year was replaced by an all-year grazing regime with Heck-cattle to reduce the dominance of highly productive grasses and reed. On the Arrhenatherion trial, mowing in June and grazing in September is continued. With ongoing time, we expect both trials to develop continuously in direction to the intended target community.

POSTER ABSTRACTS (CONT'D)

Community assembly processes along environmental gradients in restored calcareous grasslands

Kollmann, Johannes; Timo Conradi, Katharina Staab, Vicky M. Temperton

Chair of Restoration Ecology, WZW, Technische Universität München

Niche-based community assembly processes like environmental filtering and limiting similarity shape the composition and diversity of ecological communities by filtering species out of a regional pool according to their functional traits. However, differences in community structure may sometimes be better explained by stochastic processes like dispersal or priority effects. For restoration, knowledge on how the importance of niche-based and stochastic processes changes along environmental gradients is crucial because this may help to adequately select or prepare restoration sites and to choose seed mixtures that are able to persist on a given site and thereby, to create restoration sites that are able to functionally re-connect fragmented landscapes in terms of abiotic and biotic site conditions. We present data from the first year of a running field experiment in which we aim to identify how the importance of different community assembly processes changes along environmental gradients in restored calcareous grasslands. For this purpose, the study consists of a 3x3 factorial randomized and replicated block design with two treatments, nutrient content and soil moisture, to capture a range of initial abiotic site conditions as found in real restoration settings. Each plot received a subset of 25 species that was randomly chosen from an experimental species pool containing 54 calcareous grassland species. Niche-based community assembly processes will be inferred from trait diversity measures but the prevalence of stochastic processes can be inferred from the dissimilarity between the initially sown subset and the community found in the respective plot at the end of the experiment.

Restoration of Tribal Ecosystems through Permacultural for Sustainable Development and Poverty Alleviation in Underdeveloped and developing countries

Koppula, Narsanna; Deepthi Vangala

Aranya Agricultural Alternatives

Permaculture/Permanent culture has globally proved workability in ecosystem restoration and sustainability. In the present scenario of ecosocial crisis, forest communities have a focal role to play in addressing the related concerns. The tribal areas of the underdeveloped and developing world provide a unique opportunity to apply the permaculture principles in ecosystem restoration, alleviation of poverty, efficient natural resource management and for the sustainable development from the grass root levels with community participation. Success at smaller-scale locally suggests a potential replication at global scale. The Tribal Permaculture case study has been implemented by the local NGO Aranya in Nirmal, Tribal area in AP. Activities and methods: 1) Permaculture farm development and practices; 2) Capacity building of the personnel/primary and secondary stakeholders; 3) Promotion of alternative energies; 4) Community food plant nursery; 5) Ensuring sustainability; 6) Disseminating knowledge and awareness on sustainability. Monitoring and Evaluation of project (both internal and external) are conducted. Sustainability and systematisation of experiences is ensured phasewise. The project results conclude the importance of creating incentives for conservation of Tribal ecosystems through Promotion of Permacultural practices, agro biodiversity for sustained food security, promotion of horticulture for nutrition security, efficient water resource management, alternative energies, supporting poverty alleviation through different Permacultural practices in integration with local technologies and prevent welfare losses among vulnerable Communities.

Effects of wetland plant functional group diversity on carbon storage and nitrogen removal

Korol, Alicia; Changwoo Ahn, Lisa Williams, Charles Lee

George Mason University

The uncertain reality of created and restored wetland development suggests that there may be ways to improve the design and management of these wetlands to ensure a greater likelihood of structural and functional success. One top research priority is understanding how the gain of plant diversity at early stages of restoration affects the development of soil properties and processes. Our study addresses this research need by quantifying the effects of functional group diversity of wetland herbaceous vegetation in outdoor mesocosms on the development of carbon storage and nitrogen removal through denitrification. We hypothesized that (1) increased functional group diversity would promote greater plant productivity through more efficient resource capture; (2) enhanced plant productivity would increase labile stocks of soil organic carbon and nitrogen; and (3) these stocks would promote the development of denitrification. We studied four functionally-distinct species: *Eleocharis obtusa* (i.e., obligate annual), *Mimulus rigens* (facultative annual), *Juncus effusus* (i.e., interstitial reed), and *Carex vulpinoidea* (i.e., interstitial tussock). To quantify diversity effects on plant structure, we measured plant morphological traits and above- and below-ground biomass; to quantify diversity effects on soil carbon and nitrogen properties, we measured soil organic and total carbon and nitrogen, and denitrification enzyme activity. Statistically significant differences ($p < .05$) on certain above-ground morphological traits (i.e., basal diameter, stem count, and stem height) between functional groups were found for the first growing season. The experiment is on-going and complete results garnered at the end of the second growing season will be presented.

POSTER ABSTRACTS (CONT'D)

Practical Guidelines for Wetland Prairie Restoration in the Willamette Valley, Oregon - Field-Tested Methods and Techniques

Krueger, Jeff; Dr. Thomas Kaye, Sarah Bois, Diane Steeck, Trevor Taylor, Peg Boulay
Jeff Krueger Environments LLC

Once an abundant ecosystem within the Willamette Valley of Oregon, native wetland prairies have declined dramatically in extent since the mid-1800s due to a variety of factors including agricultural conversion, urbanization, drainage, and colonization by invasive and woody vegetation. Today, wetland prairie habitat is regarded as one of the most imperiled in the Willamette Valley ecoregion, with less than 2% of its historic range remaining. However, some noteworthy progress toward protecting and restoring wetland prairies has occurred over the past two decades. This has included numerous large scale restoration projects, with the quality of results improving dramatically over time in terms of native cover, diversity, and resilience. The primary goals of our project are to continue to improve the long-term viability and success of wetland prairie restoration efforts through innovations in design and implementation and to document and share these lessons with a broad audience in the Pacific Northwest and elsewhere in the nation. With funding assistance provided by an EPA Wetland Program Development Grant, we assembled a team of experts with extensive expertise in wetland prairie restoration and management and are compiling lessons learned. In addition, we have conducted a series of replicated field experiments to test the effectiveness of various site preparation and management techniques and have made valuable findings. We are now consolidating the best methodologies for each phase of the restoration process and disseminating this information through a variety of methods including development of a user-friendly guide and web based platform, presentations, and field trainings.

Some Fuel Modeling and Potential Fire Behavior Studies in Turkey

Kucuk, Omer; Ertugrul Bilgili, Paulo M. Fernandes
Kastamonu University, Faculty of Forestry

Description of fuel characteristics is essential for fire behavior models which can provide decision-support for fire management. Fuel models describe fuel characteristics for input into fire modeling systems based on Rothermel's fire spread model. In this study, fire behavior data collected in field experiments in different fuel complexes in Turkey is used in the process of fuel model development. Nine fuel models were built for low and tall maquis, Anatolian black pine (*P. nigra* J.F. Arnold *subsp. nigra* var. *caramanica* (Loudon) Rehder) litter and different slash ages and loads. BehavePlus simulations of fire rate of spread, flame length and fireline intensity under typical summer weather conditions highlight the quite different fire potential between the studied fuel types. The difficulty in dealing with fuel complexes dominated by live fuels was evident from the simulations. On the contrary, the model correctly predicted the observed temporal decrease of slash fire behavior. This study shows the crucial importance of experimental fire data to parameterize fuel models.

Initial effects of restoring natural forest structures in Estonia

Laarmann, Diana; Henn Korjus
Estonian University of Life Sciences

The legacy of structural homogenization due to forest management for commercial products is a loss of biodiversity. A common policy in many European countries is to increase forest diversity by converting managed forests to more natural conditions. The aim of this study was to provide an early evaluation of the effectiveness of different restoration treatments to rehabilitate managed stands in order to increase their naturalness. Restoration treatments were imposed on 30-60 years old conifer plantations including gap creation with and without added deadwood, added deadwood without gaps, gaps plus overburning, and controls. We sampled stand structure, understory vegetation and beetles before and after treatments on 50 circular permanent plots. Diversity of different groups responded differently to treatments with understory vegetation diversity increasing the most in gaps with burning, lichens in gaps without burning and bryophytes with the addition of dead wood. Increased beetle abundance and greater species diversity was a direct effect of changed light conditions inside the canopy. Gaps with overburning had the greatest recruitment of tree seedlings. Stands that were homogeneous pre-treatment increased in heterogeneity in structural conditions and microclimatic conditions after treatments and therefore richness and abundance of different species groups increase.

Are Current Reclamation Strategies in the Alberta Oil Sands Effectively Promoting Soil Structure Development?

Laidlaw, Meghan; Cindy Prescott, Sue Grayston
University of British Columbia

Soil genesis occurs over thousands of years and yet in the reclamation of surface-mined areas, a soil that is capable of functioning similar to undisturbed soils is required within a much shorter time frame. During the oil sands reclamation process, key soil properties such as bulk density, water storage capacity, organic matter content, macrofaunal and microbial activity, and soil microstructure are significantly altered, which directly impacts the ability of these soils to re-establish functioning within this time frame. Reclamation ecologists have attempted to hasten soil development at reclaimed oil sands sites by experimenting with the addition of organic amendments such as peat and forest floor material, rapidly re-establishing vegetation by using cover crops until trees and shrubs can be planted, and exploring different vegetation prescriptions. However, it is unclear whether these treatments are successfully promoting soil structural formation. This study will compare soil structure in three vegetation prescriptions (coniferous forest, deciduous

POSTER ABSTRACTS (CONT'D)

forest, and grassland), aged 20-30 years, to soil structure in naturally fire-disturbed sites of a similar age in order to address whether structure is developing at reclaimed sites, and which vegetation prescription is most effective at re-establishing a soil structure similar to naturally disturbed sites. Expected results will be discussed and future reclamation strategies that could further promote soil structure will be suggested.

Measuring avian and herptile response to wetland enhancement in the St. Lawrence River basin

LaPan, Stewart J.

SUNY ESF

Wetlands within the Thousand Islands Region of the St. Lawrence River (SLR) have been subjected to a history of anthropogenic disturbances that threatens to undermine their diverse ecological services. Five wetlands in the SLR basin have been enhanced through the installation of water control structures and excavation of channels in *Typha* stands. These treatments are intended to restore ecological function, ameliorating the effects of long-term hydrological alteration in the river and its associated systems. Water level regulation has altered the range of annual and inter-annual hydrologic fluctuations in associated wetlands, allowing for the development of an invasive *Typha* monoculture and decreasing vegetation diversity. We will evaluate the effects of water level control (restoring a more natural hydrologic cycle) and excavation treatments (restoring connectivity) on avifauna and herpetofauna by comparing populations between treated and reference sites. We will survey marsh birds using a call broadcast and passerine survey, and will sample breeding amphibians using automated audio recording devices. Turtles will be sampled using baited trap nets for a capture-mark-recapture survey. We will also characterize vegetative composition in all surveyed wetlands to examine wetland enhancement effects, as well as potential habitat linkages with avian and herptile population metrics using general linear models and principal component analyses. The results of this research will serve to inform adaptive management practices within SLR wetlands.

Ecological restoration under progress in Seoul's Cheonggye Stream in Korea

Lee, Chang Seok; Sung Ae Park

Seoul Women's University

Restoration of Seoul's Cheonggye Stream converted a non-biological place to an ecological one. Biota, of which there was only 17 species before restoration, increased to approximately 400 species after restoration. Species composition of vegetation came to resemble that of the natural reference river. Compared to an unrestored urban river, species diversity increased, and the percentage of exotic species decreased. Consequently, naturalness, based on morphological and ecological characteristics, improved greatly. In addition, the restoration project contributed to microclimate control by reducing the temperature of the surrounding area and providing a core area for restoration planning in the ecological landscape to solve multiple environmental problems for the mega-city of Seoul. In conclusion, the restored Cheonggye Stream showed positive restoration effects in biological integrity, by recovering species composition similar to that of the reference stream; ecological stability, by expressing higher richness compared to the unrestored urban river; and improved water quality, as evaluated by biochemical oxygen demand (BOD). Restoration of the Cheonggye Stream is still underway and several requirements still need to be met to realize true restoration.

Development of Three-dimensional Finite Element Shade Model for Impact Assessment of PAR Reduction due to Shade Cast by Coastal Structures

Lee, Cheegwan

ENVIRON

Habitat conservation plans typically require the protection of aquatic vegetation (e.g. eelgrass) which provide habitat and food sources for important aquatic species. Nearshore developments including tall buildings, docks, boardwalks and other overwater structures have potential to affect aquatic vegetation. Shading created by these overwater structures reduces Photosynthetically Active Radiation (PAR). As a result, by blocking the light reaching the vegetation below the minimum requirement, the amount and/or quality of submerged aquatic vegetation may be significantly reduced or completely lost. A three-dimensional finite element shade model was developed to predict the shade cast by complicated three-dimensional structures over irregular bottom topography. The model calculates the shade and PAR distribution as a function of structure shape and size, height, water surface elevation change, water depth, and sun position. The model also incorporates the effects of light refraction and light attenuation through the water column on shade and PAR. Since the model employs a three-dimensional finite element technique, complex structures or topography can be resolved into the unstructured finite elements which are projected on the surface to calculate the shade. The shade model was validated with the measured PAR values and observed eelgrass distribution in a coastal area of Puget Sound. The results show that the model, coupled with knowledge of the light requirements of the vegetation, is a very useful tool in assessing the impact of overwater structures for habitat conservation and coastal restoration planning.

POSTER ABSTRACTS (CONT'D)

The mountain pine beetle (*Dendroctonus ponderosae* Hopkins), climate change, and scientists: Understanding the implications of rapid ecological change

Lettrari, Heike G.

University of Victoria

Rapid environmental and ecological changes are affecting physical, social, cultural, ecological, and economic systems, worldwide. An example that involves all of these systems is the climate-exacerbated mountain pine beetle (*Dendroctonus ponderosae* Hopkins; MPB) outbreak in British Columbia (BC), Canada. Projections from climate model output indicate a potential increase in both the frequency and level of disturbance events in BC, including those related to the MPB. These changes may trigger novel ecosystems, requiring non-traditional management and restoration approaches. Using a mixed-methods sampling strategy including interviews, this research project investigated whether and how rapid ecological change challenges scientists' historical understandings and methods of response to a large-scale ecological perturbation, like BC's MPB outbreak, and how the knowledge required to respond is being produced today. This project provides a snapshot of how scientists reflect on their roles in constructing, shaping, and producing the science that informs responses to rapid ecological changes such as the MPB outbreak. This project also investigates how the roles of scientific expertise may be changing. These insights have led to understanding how new knowledge is incorporated, how collaborative research across organizations forms, and how scientific experts respond to complex, multi-dimensional problems that have no easy answers.

Are widely distributed plant invaders more likely to be specialists or generalists?

Liao, Huixuan; Shaolin Peng, Qiaoqiao Huang

Sun Yat-sen University

"A jack-of-all-trades is a master of none" describes the paradox of being a generalist. On one hand, a generalist can exploit different resources and establish in various habitats. On the other hand, it may be less competitive than some specialized genotypes in certain environments. For invasive plants that distributed across a wide range of non-native habitats, it is interesting to know which strategy, specialist or generalist, is more important for their invasion success. Thus, we reviewed forty-three previous articles that had reported invaders' adaptations to environmental heterogeneity and analyzed the relative contribution of each strategy. It seemed that specialists were more common in the non-native range, which usually facilitated the formation of latitudinal clines and adaptations to water deficit. In contrast, generalists were more adaptive to altitudinal environmental changes and nutrient/light stresses. Our results suggested that though generalists were less common in the adaptation to environmental heterogeneity, they might be more important at smaller scale where gene flows among populations were not blocked by geographic barriers.

Assessment of molecular polymorphism of a *Ceiba aesculifolia* restored population

Lindig-Cisneros, Roberto; Sabina Lara-Cabrera, Edgar Olvera-Mendoza

Centro Investigaciones en Ecosistemas, UNAM

To quantify "urban heat island" effects in an altitudinal gradient as a *proxi* for climate change future conditions, we evaluated the genetic diversity of 72 *Ceiba aesculifolia* individuals, from experimental restoration plots established from 2170 to 2260 masl. Reintroduced individuals were compared with the population from which the seeds were obtained, additionally two external populations were evaluated, for a total of 123 individuals. Samples were analyzed with three AFLP primer combinations. Polymorphisms of 38.4% to 62.5% were obtained, with total genetic diversity (HT) of 0.1724 and diversity per population (HE) of 0.13 to 0.22. Plants from 2170 masl were the most diverse, very similar to those from 2230 masl, with a genetic identity of 0.9999. The UPGMA dendrogram indicates that the most similar populations were the progenitor population and plants from 2200 masl ($F_{ST} = 0.0045$). Through Bayesian analysis, three genetic combinations were determined ($K=3$), which were present at different proportions in each population. Discriminant Analysis of Principal Components resulted in two genetic combinations ($K=2$) with different proportions among populations but with an overall similar pattern with that of Structure results. Plants from 2200 masl were most akin to the progenitor population. These results suggest an altitudinal displacement, indicating the need to assist the migration of this species in order to safeguard its genetic diversity under urban heat island and climate change conditions.

Sabal palmetto woodland, a potential hybrid ecosystem in southeast Mexico: implications for conservation and restoration

Lopez Acosta, Juan Carlos

Universidad Veracruzana Centro de Investigaciones Tropicales

The sabal palmetto Woodland (SPW) is a tropical plant formation dominated by *Sabal mexicana*, with restricted distribution to southeast Mexico. Classical description mentioned that SPW is the result of human-driven conversion (probably pre-conquest) being the original vegetation a semi-evergreen tropical. The current physiognomy is dominated by *Sabal mexicana* and also some islands of vegetation of different sizes embedded in a matrix of grassland, with strong pressure by expansion of livestock and extraction of hydrocarbons. We examined in depth the floristic diversity modifications of recruited (diameter at breast height, $DBH \geq 1$ cm) and understory ($DBH \leq 10$ cm) plants, and its variation with anthropogenic disturbance, considering the more preserved site as a reference system. The floristic contingent included a total of 81 species in 2000m². Richness, composition and diversity were modified by disturbance. Recruited and understory vegetation in the disturbed site were 5- and 1.6-times less diverse than in the conserved site. Species

POSTER ABSTRACTS (CONT'D)

of mature in conserved vegetation were substituted by heliophytes in the disturbed site with a high dominance of *Sabal mexicana*, in which together with species such as *Cocoloba barbadensis* and *Phytocelobium dulcis* redirect succession paths forming particular physiognomic and hybrid system with new and historical species in a new arrangement. This new configuration preserves high diversity of woody plants. Currently this area is removed without regulation because it is considered “unnatural”. We show that this area reconfigured has a new ecological dynamics that can provide alternatives for their new revalorization and conservation.

Propagation of plants from the Lacandon jungle, useful for restoration

López-Valenzuela, Alejandra; Alma Orozco-Segovia
Instituto de Ecología, UNAM

Currently, in Playon de la Gloria (Lacandon jungle, Chiapas, Mexico) residents created an environmental management unit to preserve the rainforest and minimize the effects of deforestation. In 2009, some important lepidoptera species previous registered for this area was not recorded again. To favor the reestablishment of these species it is necessary the conservation of habitats and the reintroduction of the plant species (lianas) that feed butterflies. Lianas are very important for the structure and dynamics of ecosystems, but few studies have been made on their germination, storage behavior and use in restoration, even at the genus level, so it is necessary to generate basic information. For this we determined the effect of different treatments on seed germination of *Mucuna argyrophylla*, *Aristolochia grandiflora* and *Aristolochia maxima*. Seeds were germinated on at 25°C and 25-35°C. *M. argyrophylla* had physical dormancy thus seeds germinated in 60% after we did a hole in the chalazal area. Freshly collected seeds of *Aristolochia* germinated in high percentages *A. maxima* (89%) and *A. grandiflora* (45%). However, after two months of storage, the germination percentage of both species was very low (12%, 250 ppm of gibberellins). In *A. grandiflora*, 1500 ppm of gibberellins removed partially secondary dormancy and germinated in 20%, water smoke also improved significantly germination (23%) in respect to the control ($F(1,9) = 5.65$, $P = 0.0448$). We had no sufficient seeds of *A. maxima* to test this treatment. The insufficient hydration of *Mucuna* species suggest that the endosperm hardening.

Use of waste from the extraction of pulp and impact of savanna soil cultivated with eucalyptus and native tree species

Lucas Videira, Ligia Maria; Marlene Cristina Alves, Carolina dos Santos Batista Bonini, Laura Britto Garcia de Oliveira
Universidade Estadual Paulista

The construction of the hydroelectric power plant of Ilha Solteira located in São Paulo State, Brazil has taken lot of soil to make earthmoving, so going to the degradation of the area. This soil degradation led to lose their natural physical and chemical characteristics, leaving it barren. With the development of industrial processes and the consequent emergence of numerous products that became basic necessities, is the problem of waste generation as a byproduct. In order to return to this waste sustainably with nature, the objective of this study was to test the effectiveness of an organic compound residues arising from the extraction of cellulose, the recovery of a degraded soil from the planting of two forest species. The experiment was carried out at the Teaching and Research Farm, Ilha Solteira. The two treatments in main plots were plantations of hybrid *Eucalyptus* spp. and *Mabea fistulifera*. Subplots were tested doses of the compound and also the comparison with mineral adduction, and 5 treatments (D0 - without fertilization; DM - mineral fertilizer according to crop need; D10 - 10 t ha⁻¹ of compost; D15 - 15 t ha⁻¹ of compost; D20 - 20 t ha⁻¹ of compost). We analyzed the resistance to penetration into the layers of 0 to 0.4 m as an indicator of soil quality. We conclude that the treatments are regaining ground, however are still not very clear results. The species of *Eucalyptus* spp showed lower penetration resistance of the soil, however no treatment was distinguished statistically.

Creating nature parks from farmlands now within cities

Ludwig, John A.; David J. Tongway
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

With population pressures, cities are expanding into farmlands. To develop green space for wildlife and recreation from farms now within new housing developments, ecologists and community groups aiming to restore these lands face difficult challenges. This is especially the case for former farm pastures where clearing trees, sowing exotic grasses, and grazing livestock caused gullies and weeds. To illustrate this case, we describe a farmland restoration project in the city of Canberra in the Australian Capital Territory (ACT). The first step was setting clearly defined and measurable project goals, which was a challenge because of differing priorities within the community group; this is because of some focusing on high plant and bird diversity, and others on eradicating all weeds. Financing the project was also a challenge. After establishing goals, the second step was to critically analyze problems, such as soil erosion and weeds. After learning that excessive runoff in the landscape was perpetuating soil erosion and that grazing by kangaroos was damaging new plantings, the ecologist (DT) worked with the community group to design solutions (Step 3) and to apply technologies (4). For example, to slow and reduce runoff so that gullies could ‘heal’, community group volunteers applied inexpensive materials (rolls of coconut fiber) to impede flows of water into gullies. The group also worked with ACT Parks to control kangaroos, although some members resisted the culling of kangaroos. The fifth step was to monitor the effectiveness of applied restoration technologies so that timely repairs and adjustments could be implemented.

POSTER ABSTRACTS (CONT'D)

'Biophilia' and Interspecies Collaboration in Ecological Restoration: The Potential of Prescribed Grazing as a Vehicle for Community Engagement in Urban Settings

MacDonald, Eric A.; Zachary A. Richardson, Micahel E. Salter
University of Georgia, College of Environment and Design

This paper describes the results of an ongoing, university-initiated project that tests the potential of prescribed grazing as a means to catalyze citizen involvement in urban ecological restoration. Throughout the U.S., a number of initiatives are emerging in connection with scholarly research aimed at investigating the effectiveness and environmental impacts of prescribed grazing using sheep and goats. While the authors' project tested the effectiveness of prescribed grazing as a method of invasive vegetation removal, the effort also was designed to capitalize on the charismatic and gregarious nature of goats to attract curious passers-by, neighborhood children, and other community members to the site. Building upon E. O. Wilson's biophilia hypothesis and William Jordan III's reflections on the importance of social ritual and performance in ecological restoration, the paper discusses how several community engagement techniques were folded into the project. Participant observation, surveys, interviews, and video recordings were used to document and analyze the community's shift in perception of the site. The results of the project suggest that landscape architects should consider how animals may become vital partners in managing urban cultural landscapes, and catalysts for galvanizing community, promoting awareness of undervalued urban natural areas, and engaging the public in the process of reclaiming ecologically damaged urban landscapes. The paper includes case-based suggestions for how landscape architects may include prescribed grazing in designed landscapes that interweave plants, animals, and humans in ways that lead to greater knowledge of local nature, attachment to place, and participation in environmental stewardship.

Native plant establishment influenced by the method used to control spotted knapweed

MacDonald, Neil W.; Laurelin M. Martin, Tami E. Brown
Grand Valley State University

Restoring native plant communities on disturbed sites is hampered by invasive species, including spotted knapweed. Our objective was to determine effective treatment combinations to increase native plant establishment while controlling knapweed on a degraded site in western Michigan. We applied a factorial combination of treatments to 48 5-m by 5-m plots. Site preparation treatments utilized in 2008 included mowing alone and in combination with single applications of clopyralid or glyphosate. We seeded all plots in May 2009 with native grasses and forbs representative of Michigan dry prairies. Additional treatments included annual hand pulling of bolted knapweed, commencing in July 2009, and a prescribed burn in April 2012. In July 2011 and 2012, we estimated percent cover of all species on each plot and calculated relative percent cover, mean coefficient of conservatism (mean C), and the floristic quality index. By 2011, seeded native grasses and forbs had established on all treatment combinations, even on mowed-only plots with >50% knapweed cover. Glyphosate favored the establishment of some native species, but allowed rapid reinfestation by knapweed. Clopyralid maintained reduced knapweed cover, shifted plant communities toward non-native grasses, and resulted in greater mean C in both 2011 and 2012. In comparison, hand pulling maintained low knapweed cover (<0.1%) regardless of site preparation treatment and produced increased cover of several native forbs and grasses. In contrast, burning had little effect on plant community composition. Our results showed that knapweed control methods played a large part in determining the trajectories of the developing native plant communities.

Effects of environmental covariates on the *Guapira opposita* (Vell.) Reitz. (Nyctaginaceae)

Magalhaes, Simone; Simone Grego, Djair Durand, Ricardo Rodrigues, Paulo Ribeiro-Jr, Miguel Cooper, Pablo Torrado, Alexandre Silva, Alexandre Oliveira, Sergius Gandolf
Sao Paulo University

The forest formations have been correlated with the relief and the physical, chemical and biological properties of the substrate. In this study we analyzed the correlation between abiotic factors and the distribution of the predominant species *Guapira opposita* (Vell.) Reitz. (Nyctaginaceae) on a stretch of preserved dense ombrophilous forest of São Paulo state, Brazil. It was tested the hypothesis that the spatial pattern of the basal area of this species is determined by environmental covariates. This study was conducted in Carlos Botelho (PECB) State Park. A plot of 320 x 320 m, resulting 10.24 ha, was allocated in the area, and subdivided in 256 contiguous subplots of 20 x 20 m (400 m²). Physical and chemical analyzes were performed in each subplot, at two soil depths: 0-5 cm and 5-25 cm. All individuals present in the subplot with PAP (circumference at breast height – 130 cm) greater or equal to 15 cm were sampled. Geostatistical models were used to accommodate spatial patterns in addition to the effects of environmental covariates. We observed that topographical and soil covariate influenced the area basal development of *G. opposita*. We highlight that *G. opposita* has been indicated for restoration of riparian forests, and so, understanding the interaction between abiotic variables and vegetation, considering the existence of spatial correlation, is essential for the elucidation of forest dynamics, which will sustain the adequacy of management and conservation of forest remnants.

POSTER ABSTRACTS (CONT'D)

Survival of native species implanted in the restoration of the riparian vegetation of Pandeiros river (Minas Gerais State, Brazil)

Magalhães Veloso, Maria das Dores; Nathalie Cristine Alencar Fagundes, Frederico Almeida Macedo Honorato, Saimo Reblleth de Souza, Yule Roberta Ferreira Nunes, Walter Viana Neves
Universidade Estadual de Montes Claros

The riparian vegetations are associated with waterways, which play a key role in the water maintenance. Although protected by law, these areas suffer intense fragmentation and vegetation destruction compromising water courses and quality. This study monitored the survival of saplings established in the restoration of the riparian vegetation of Pandeiros river, to assess the success of the planting in vegetation restoration. The project was developed in three areas from Pandeiros river (Januária, MG), where 17,487 saplings were planted, distributed in 45 genera and 21 botanical families. The planting was carried out in December of 2009 and the saplings were monitored every three months for 12 months. The survival rate after six months of evaluation was 69.59% and after 12 months it was 36.66%. There was a decrease in the survival of saplings under water deficit occurring in the region from April to October. Despite the decrease, the survival was satisfactory (36.66%), especially for the species *Jacaranda brasiliensis* (Lam.) Pers (77.77%), *Triplaris gardneriana* Weddell (72.76%) and *Anadenanthera colubrina* Vell. Brenan (70.13%). A high survival percentage of these species may indicate a high adaptive plasticity in facing adverse conditions of disturbed environments. Both species are deciduous, heliophytic, pioneer of rapid growth, being essential in heterogeneous reforestation intended for vegetation restoration in degraded areas. It can be concluded that there was success in planting after a year of monitoring.

Implementing functional flows for riparian cottonwood (*Populus* spp.) restoration in the Oldman River Basin, Alberta, Canada

Mahoney, John M.; Karen M. Gill, Stewart B. Rood
Alberta Environment and Sustainable Resource Development

A unique diversity of riparian cottonwoods occurs in southwestern Alberta, Canada, where four species of *Populus* overlap and hybridize. The region is also Canada's national centre for irrigation agriculture which has led to diversion of water from all the regional rivers at rates that can exceed 50% of mean annual flow. We summarized the impact of water diversion on cottonwood forests in the Oldman River Basin in 1990. We developed an instream flow regime to sustain cottonwood forests that has been implemented opportunistically at the Oldman River Dam since 1994. The flow prescription requires flow ramping, a gradual flow recession after the spring peak, and increased flows during the hot and stressful period of mid to late summer. The flow regime has also been applied opportunistically in the Oldman River Basin at dams on the St. Mary and Waterton rivers since 2002. The operations at the three major dams were coordinated in 2010, 2011 and 2012 to implement prescribed flows to support basin wide cottonwood recruitment. Here we describe the effects of the resulting flow pattern that contributed to successful seedling establishment up to 200 km downstream from the dams. Rejuvenation of the riparian woodlands has been most successful along the Oldman and Waterton rivers. However, more than 95% of cottonwoods along the St. Mary River have been lost thereby limiting seed production and the possibility of subsequent cottonwood reestablishment. Our results demonstrate a successful method for sustaining riparian poplars downstream from dams in an extensively managed river system.

Recovery of soil fungi richness after implementation of agroforestry system

Malosso, Elaine; Phelipe Manoel Oller Costa, Natália Mirelly Ferreira de Sousa, Marina Alessandra Gomes Araújo
UFPE

Studying of mycobiota is important to cultivated soils as it gives information on the fungal community structure and its function, and also on the effects of environmental disturbance, including non-sustainable use of agricultural soils, on these communities. The aim of this work was to verify richness of filamentous and arbuscular mycorrhizal fungi in different systems of soil management. Soil samplings were carried out in the municipality of Abreu e Lima (Pernambuco, Brazil) in three areas: native Atlantic forest, monoculture (*Manihot esculenta*), and agroforestry system implemented 19 years ago in an area previously used for cassava monoculture. In each area, ten soil samples were collected at 0-20 cm. Isolations were carried out for the filamentous fungi using serial dilution and AMF spores were extracted from soil by wet sieving. Thirty-eight Glomeromycota species (9 genera) were registered. Twelve occurred in the native forest, 29 in the monoculture soil and 11 in the AFS. Monoculture contributed to 76% of identified AMF species. These species presented higher capacity of adaptation in soils submitted to different physical and chemical variations showing resistance to environmental disturbance. Different from AMF, higher number of filamentous fungi was found in the native forest (38) and AFS (37). Distribution of fungal communities in soil is mainly related to vegetation and quality of organic matter. Our results showed that using of AFS promoted recovery of filamentous and AM fungal communities whose structures in AFS are similar, after 19 years of management, to those found in the native Atlantic forest.

Evaluation of marsh restoration in the Venice Lagoon, Italy

Marchione, Alison; John Rapaglia
Sacred Heart University

Salt marshes provide ecosystem services e.g. wildlife habitat, sediment and pollution traps, as well as protection against flooding. Salt marshes exist in a dynamic equilibrium between the forces of accretion and erosion and may be threatened by a combination of human activity and sea level rise. Many

POSTER ABSTRACTS (CONT'D)

hectares of salt marsh have been lost in the Venice Lagoon, Italy due to these factors. In order to combat this loss, the City of Venice has implemented a vast marsh restoration program; using dredged material from the lagoon's inlets to build new salt marsh foundation. Natural marsh accretion rates in the Lagoon, average 1.5-2.5 mm/yr according to 210-Pb and 137-Cs results. Lower than current estimates of local sea level rise. The marsh restoration progress was investigated through surveys of Common Cordgrass (*Spartina anglica*) growth. Three marshes, located to the north of the city of Venice were sampled using five randomly placed permanent 1m² plots in summer 2013. Number of shoots and plant height were measured in the plots as a measure of growth. Three large diameter marsh cores were collected, sliced into 0.5 cm thick sections, and recent recruitment of fine-grained sediments was assessed with a Laser In Situ Scattering and Transmissometry (LISST) meter. These data were compared with marsh inundation data from the City of Venice to estimate current accretion rates per inundation event where Cordgrass is absent. Over time, we will be able to measure if Cordgrass growth accelerates sediment deposition to keep up with sea level rise.

Temporal changes in the physical habitat of restored boreal rivers: Assessing long-term persistence of in-stream restoration

Marttila, Maare; Pauliina Louhi, Timo Muotka, Aki Mäki-Petäys, Timo Yrjänä, Olli van der Meer, Ari Huusko
Finnish Game and Fisheries Research Institute

Many in-stream restoration studies have reported successful increase in habitat heterogeneity, but results on biological effectiveness have been inconsistent. One hypothesis states that the restored habitat structure does not persist for a long time, resulting in fading, unsatisfactory biological responses a few years after restoration. To address this question, we studied the durability of in-stream restoration in rivers of northern and central Finland by assessing short-term (0-7 years) and long-term (13-21 years) changes in physical habitat structure after restoration. We conducted repeated cross-section surveys before (n=14) and after (n=25) restoration in the 1990s and again in 2010, and recorded water depth, current velocity, substrate size and vegetation cover in 1-m intervals. The same set of measurements was conducted in 10 near-pristine sites. Restoration improved the physical and flow diversity in both short-term and long-term and changed the sites towards the near-pristine condition by decreasing mean velocity, Froude number and Reynolds number and by increasing mean depth, pool frequency and substrate size variability. The cover of aquatic mosses reduced by restoration activities recovered through time close to near-pristine levels. Parallel to quantitative results, qualitative visual observations also suggested that the restored channel structures had been reasonably durable. However, some deterioration was noted in gravel beds, re-wetted areas and stream banks, particularly in sites with extensive erosion and siltation. Our findings support the importance of long-term restoration monitoring to detect whether the beneficial effects on habitat diversity often observed in short-term studies persist through time.

Restoring Socio-Ecological Systems (SES): Exploring the Socio-Ecological Drivers of the River Restoration Process

Matsler, Marissa; Sarah Kidd
Portland State University

To inform river management and environmental policy decision-making we propose to identify the influence of social drivers of river restoration on project design and monitoring. Restoring and sustaining functional river ecosystems is one of the greatest environmental challenges of our time. Riverine systems are heavily used and depended on by humans, and commonly suffer degradation from anthropogenic exploitations. Degraded ecological integrity of riverine systems throughout the world has been linked to drastic declines in fishery and wildlife populations, as well as declines in human physical and mental health and wellbeing. Recognition of the importance of these habitats has resulted in large-scale efforts to restore and protect these areas with an estimated \$15 billion spent in the United States between 1990 and 2003. However, the appropriate approach to river restoration is contested; methods and metrics vary, and achieve different levels of ecological and social efficacy. We propose a mixed methods approach, combining Q-method surveys and interviews (that elicit perceptions and social drivers) with content analysis of management plans and secondary biophysical monitoring data (that reveal restoration goal statements and success metrics). We will use the novel ecosystem concept and distinctions between "active" and "passive" forms of restoration to evaluate restoration practitioners' perceptions. We expect perceptions of the role of humans in ecosystems, and ecological theory, to influence the translation of restoration project goals and objectives into applied methods and metrics on the ground. This information is essential for improving and evolving the riverine restoration process and its outcomes.

Towards shrubland restoration on the Arabian Peninsula: The potential for large-scale restoration in the Middle East

Mayence, C. Ellery; Patrick Courtney, Jason Stevens, Kingsley Dixon
The University of Western Australia and Botanic Gardens and Parks Authority

Arid and semi-arid habitat covers a large fraction of the Earth's surface – with a significant amount occurring in the Middle East. Saudi Arabia, being the crossroads of the ancient world, has a legacy of human utilisation of its desert habitats. Long-term use in conjunction with a fragile ecological setting has resulted in significant habitat degradation and loss. To begin rehabilitating degraded areas, Kings Park and Botanic Garden (Perth, Australia) and Arriyadh Development Authority (Riyadh, Saudi Arabia) have designed and implemented a large-scale experimental field trial. Located within Thumama Park – a unique and highly significant desert natural area representing an important recreational resource for the Arriyadh region – this trial is a massive undertaking with the potential to yield a tremendous amount of ecological insight. The trial includes 5 species of native *Acacia* (Fabaceae), 7 irrigation treatments, and 17 plant and seed treatments. In total over 50,000 seedlings will be planted in the first phase. The factorial design is completely cross-

POSTER ABSTRACTS (CONT'D)

classified so that all main and interactive effects can be investigated. In addition to the greenstock component, this research also assesses direct seeding using pre- and un-treated seed, different sowing depths, and microcosm enclosures to limit sand abrasion, wind desiccation, and soil moisture depletion. The restoration potential of several ecologically important non-*Acacia* shrubs and sub-shrubs is also being investigated. The project is intended to yield valuable insight into restoring regionally significant tree and shrub habitat, as well as move urban landscaping in a more water-efficient direction using native species.

Effects of white-tailed deer (*Odocoileus virginianus*) on bottomland hardwood forest restoration in the Upper Mississippi Valley

McGuire, Benjamin M.; Peter R. Minchin

US Army Corps of Engineers

Bottomland hardwood forests (BLH) in the Upper Mississippi Valley have been greatly reduced in area since European settlement. Since 1990, efforts have increased to restore this important ecosystem at sites within the floodplains of the Mississippi River and its major tributaries. In BLH restoration, it is usually necessary to actively establish large-seeded tree species (oaks and hickories) to overcome dispersal and recruitment limitations. We examined the effects of browsing and rubbing by white-tailed deer (*Odocoileus virginianus*) on the early growth and survival of root production method (RPM) seedlings of *Carya illinoensis*, *Quercus bicolor*, *Q. lyrata*, *Q. macrocarpa*, and *Q. palustris* on a site being restored to bottomland savannah at the Two Rivers National Wildlife Refuge, Illinois. Six groups of RPM trees were planted in fall 2009 with equal numbers of the five species. For each species, equal numbers of trees within each group were left unguarded or had a wire mesh deer guard of 1.52 m or 1.22 m in height. Each tree was tagged and the basal diameter and height were measured. Trees were re-measured in winter 2010/2011 and the area of bark damaged by deer rubbing was recorded. Analyses found that damage by deer rubbing was lower, basal diameter growth rate was higher and mortality was lower for guarded trees, with no differences detected between guard heights. Our results demonstrate the effectiveness of wire mesh guards and quantify the extent to which white-tailed deer negatively impact early growth and mortality in BLH restorations using RPM trees.

Testing the consequences of genetic diversity for restoration seeding success

McIlvenna, Patricia; Kristina Hufford

University of Wyoming

Studies have shown the importance of using native seed for ecological restoration, but collection of sufficient locally adapted seed for large-scale restoration projects can be prohibitive. Attempts to produce large quantities of desired species in commercial settings reduce these barriers, but may result in unintentional selection pressures, the loss of genetic diversity, and questionable suitability for restoration sites. Genetically diverse seed may be critical for the establishment of sustainable plant populations in altered environments and future climates. We will present findings from a greenhouse study comparing emergence and growth characteristics of single and multiple sources of *Sphaeralcea coccinea*, *Artemisia frigida*, and *Poa secunda*. This study tests the hypothesis that multiple accessions or sources of each species will increase genetic diversity of restoration plant materials and may therefore improve restoration outcomes. Results represent data collected as part of a larger research project examining the relative importance of genetic diversity and local adaptation for restoration success in semi-arid environments.

The Jamaica Bay Ecological Atlas: Assessing and Prioritizing Ecological Restoration Targets in an Urban Watershed

McLaughlin, John K.; Robert Will, Justin Bowers, Terry Doss

NYC Department of Environmental Protection

The authors present methods and initial results for the Jamaica Bay Ecological Atlas, a GIS database created to highlight vacant city-owned lots located within the Jamaica Bay watershed that have potential ecological restoration, stormwater management or green infrastructure opportunities. Using a combination of field work and GIS desktop analysis, existing conditions for vacant lots were assessed, and then restoration concept drawings were developed where appropriate. Assessed sites were ranked by their desirability for restoration (based upon metrics such as proximity to Jamaica Bay, Lot Size, proximity to existing green/open space, etc...), their availability for restoration, and additional selection metrics. The project presents an accurate appraisal of city-owned vacant lands and their potential future restoration opportunities, which will assist the City in striving to meet water quality goals within the Jamaica Bay Watershed. The GIS also creates a system for prioritizing these lands to meet City needs. Information to be presented includes methods and results, number and extent of assessed vacant lots, the unique approach for gathering data in the field, the GIS model developed to create ranking metrics, completed site assessments with summary metrics, and a number of the different proposed concepts for the vacant lands, including ideas for ecological restoration, stormwater management, and green infrastructure opportunities.

Excessive optimism to forest restoration success? Beginning a reassessment

Miazaki de Toledo, Renato; Rozely Ferreira dos Santos

Lepac - USP

Sao Paulo State has 3% of the Brazilian territory but is responsible for 33% of the national economy and 20% of the population; consequently is a major ecosystem services consumer. In contrast, forest cover has been reduced by 88%; and under this context, hundreds of "restoration" projects are starting

POSTER ABSTRACTS (CONT'D)

directed towards the return to “the nearest possible to original forest” through reforestation, which would be reliable under low-medium degradation context. Rehabilitation facing the real landscape status use be a disregarded option. Technical standards are based upon vigorous resilience feedback, which may be too optimistic, and may lead to flawed management. A top restraining factor for forest restoration is the landowner’s agreement. Are those volunteer lands suitable for resilience dependent reforestation projects? This study discuss this matter assessing straight forward indicators of environmental quality at volunteer areas. For this purpose we mapped the official data of erosion susceptibility and forest cover and overlapped with the volunteer areas for restoration databank (2013 official list, with 399 sites from 87 municipalities and 2,896ha available,). The results indicated that erosion susceptibility and forest cover are significantly different between volunteer areas and non-volunteer areas ($P < 0.001$); 54% of registered areas are highly susceptible to erosion, while the state rate is 34%; and the forest coverage rate at voluntary areas (5.4%) is half the state rate. This study concluded that is important to research deeper the structural and functional thresholds for specific strategies development with realistic expectations and greater chance of success.

Microclimate Modeling of Urban Trees in Street Pits

Miller, Argie; Tarik Zarrouk, Zhongqi Cheng Cheng
Brooklyn College

Atmospheric carbon is estimated to be increasing worldwide by approximately 2600 million tons annually. Urban forests have the potential to substantially reduce atmospheric carbon dioxide (CO₂) by sequestering it directly into soils as biomass, as well as indirectly by reducing energy demand in buildings. The preliminary study uses a simple model to estimate the carbon credit potential of these trees as part of the green infrastructure, in comparison to typical street trees and natural forest canopies. Actual field measurements will be conducted within the next few years. Trees of different species have been planted in recently constructed Streetside Infiltration Swales (SSIS) and Enhanced Tree Pits in the Jamaica Bay Watershed. Soil moisture content, sap flow data as well as leaf temperature inferred from infra-red images will be collected to assess the water and energy balance. These data will be incorporated with other estimates of the indirect benefits of green infrastructure to construct a preliminary carbon budget for urban areas. Such data will be useful for sustainable urban planning. If the urban canopy is developed and used to its potential, soils in these tree pits could potentially sequester a significant amount of atmospheric CO₂, soil and root systems would assist purification of storm runoff and most importantly, atmospheric temperatures caused by Urban Heat Island (UHI) effect would be significantly mitigated.

Effects of white-tailed deer (*Odocoileus virginianus*) on bottomland hardwood forest restoration in the Upper Mississippi Valley

Minchin, Peter R.; Benjamin M. McGuire
Southern Illinois University Edwardsville

Bottomland hardwood forests (BLH) in the Upper Mississippi Valley have been greatly reduced in area since European settlement. Since 1990, efforts have increased to restore this important ecosystem at sites within the floodplains of the Mississippi River and its major tributaries. In BLH restoration, it is usually necessary to actively establish large-seeded tree species (oaks and hickories) to overcome dispersal and recruitment limitations. We examined the effects of browsing and rubbing by white-tailed deer (*Odocoileus virginianus*) on the early growth and survival of root production method (RPM) seedlings of *Carya illinoensis*, *Quercus bicolor*, *Q. lyrata*, *Q. macrocarpa*, and *Q. palustris* on a site being restored to bottomland savannah at the Two Rivers National Wildlife Refuge, Illinois. Six groups of RPM trees were planted in fall 2009 with equal numbers of the five species. For each species, equal numbers of trees within each group were left unguarded or had a wire mesh deer guard of 1.52 m or 1.22 m in height. Each tree was tagged and the basal diameter and height were measured. Trees were re-measured in winter 2010/2011 and the area of bark damaged by deer rubbing was recorded. Analyses found that damage by deer rubbing was lower, basal diameter growth rate was higher and mortality was lower for guarded trees, with no differences detected between guard heights. Our results demonstrate the effectiveness of wire mesh guards and quantify the extent to which white-tailed deer negatively impact early growth and mortality in BLH restorations using RPM trees.

Stressful events affecting production and development of mangrove seedlings in nurseries for restoring mangrove ecosystem in the Amazonian Coast, Maranhão, Brazil.

Mochel, Flavia Rebelo; Ivanilson Luis A. Fonseca
Dept. de Oceanografia and Limnologia- Universidade Federal do Maranhao

Seedling production of mangrove species *Rhizophora mangle*, *Avicennia germinans* and *Laguncularia racemosa* was carried out from March 2009 to July 2012 in a nursery of 15m x 20m area. Mangrove saplings were raised in the nursery in proportions of 1 seedling per bag for *R. mangle*, 5 seedlings per bag for *A. germinans* and 10 seedlings per bag for *L. racemosa*. Oceanographic, climatic and biological parameters were surveyed and related to local rainfall, pH and salinity changes as well herbivore species and herbivory of seedlings. Stressful events along 2009 to 2012 comprised biotic and abiotic agents and the main stressors were hypersalinity in the dry season and herbivory in the rainy season. The herbivores found were mainly insects and crabs comprised by larvae of *Junonia evarete* (Lepidoptera), *Acromyrmex* sp (Hymenoptera), Acrididae (Orthoptera), *Argia* sp (Odonata), Diptera and crabs *Aratus pisonni*. The three species of mangrove seedlings were consumed by herbivores but *R. mangle* showed to be more susceptible to herbivory being attacked from May to August while *A. germinans* and *L. racemosa* were consumed from April to June. Irrigating with salt water (20 to 30 ppt) reduced herbivores occurrence and controlled herbivory events. Salinity management and feeding crab procedures kept mortality and losses in very low rates, usually less than 3% of all produced seedlings.

POSTER ABSTRACTS (CONT'D)

Straw and hay mulch effects on native prairie seedling establishment

Mollard, Federico PO; M. Anne Naeth, Anayansi Cohen-Fernandez

University of Alberta

Mulch can facilitate and inhibit seedling establishment on prairie sites under restoration due to its effects on seedbed conditions, germination and early seedling performance. A field experiment was established to determine the effects of straw and hay mulch on seedling emergence and establishment. The restoration site was in mixed grass prairie of southern Alberta, Canada. The seedbed was prepared with manual harrowing and plots were broadcast seeded with *Elymus trachycaulus*, *Bouteloua gracilis*, *Hesperostipa comata*, *Astragalus canadensis* and *Linum lewisii*. Hay and straw mulch was applied at two rates (300 and 600 g m⁻²). Seedling emergence and survival through the first growing season were evaluated. Results were species specific. Both hay mulch rates increased seedling emergence relative to bare ground for *Elymus trachycaulus* and *Linum lewisii*. *Astragalus canadensis* had more than ten times higher seedling emergence at low straw and both hay rates than without mulch. Low straw and both hay mulch rates had facilitative effects on *Elymus trachycaulus* and *Linum lewisii*. High straw rates hindered *Bouteloua gracilis* seedling establishment. These results suggest use of low mulch rates for increasing native plant recruitment in old fields situated in semiarid grasslands as they were able to overcome microsite limitations for seedling establishment.

Export of Phosphorus from a Restored Shallow Marsh in Northeastern Illinois

Montgomery, James; Marshall Eames, Kathryn Rico

Department of Environmental Science, DePaul University

In the Mississippi River drainage restored wetlands are proposed as an ecotechnology to reduce nutrients, sediment, and restore water quality in streams and rivers and ultimately the Gulf of Mexico. The effectiveness of shallow freshwater marshes at removing nitrogen and trapping sediment is well documented, but fewer studies address the efficacy of marshes at removing phosphorus from the waters. Since 1998, we have systematically monitored the water column for soluble reactive phosphorus (SRP), total phosphorus (TP) and total suspended solids (TSS) at five sites in a formerly farmed, restored marsh system at Prairie Wolf Slough on the Middle Fork of the North Branch of the Chicago River. The Chicago River system is phosphorus limited and interest in using restored wetlands to improve water quality in the region is high. Results have consistently shown higher concentrations of phosphorus leaving the marsh than entering through point and non-point flows. The long-term SRP and TP concentrations are nearly three times greater at the outlet from the marsh than at the inlet. Our recent research focuses on characterizing the phosphorus dynamics for the marsh. This presentation looks at the remobilization of phosphorus from soil and sediments as the source SRP and TP in discharge from the restored marsh. We analyzed soil and sediment samples and installed sampling cells in the marsh sediment and soils to collect interstitial water and to measure SRP. The information from this study will help when establishing expectations and goals for restoration projects and in selecting appropriate restoration endpoints.

Effects of nutrient (N15P15K15 and urea) amendment on the phytoremediation of petroleum-polluted aquatic environment by water hyacinth (*Eichhorniacrassipes* [Mart.] Solms)

Ndimele, Prince Emeka

Lagos State University, Department of Fisheries

This study investigated the effects of inorganic fertilizer (N15P15K15 and urea) amendments on petroleum degradation and uptake by water hyacinth (*Eichhorniacrassipes*). The experiment was conducted in two phases. In phase 1, 100g of water hyacinth were grown separately on experimental units (fresh borehole water) spiked with petroleum at concentrations of 0mg/l, 20mg/l, 40mg/l and 60mg/l. In phase 2, experimental units were spiked with petroleum at 4 different concentrations (0mg/l, 20mg/l, 40mg/l and 60mg/l) and then were randomly assigned fertilizer (N15P15K15) at 3 different concentrations (0mg/l, 6mg/l and 10mg/l) such that each petroleum treatment had the three fertilizer amendments. A similar procedure was repeated using urea as biostimulant. Each phase of the experiment lasted six months. Total petroleum hydrocarbon (TPH) in water column and water hyacinth were determined using APHA methods. TPH absorption by water hyacinth and relative degradation of TPH in water column varied significantly ($p < 0.05$) among the biostimulation units. At 40mg/l and 60mg/l initial crude oil concentrations, the water hyacinth in the control absorbed significantly ($p < 0.05$) higher hydrocarbons (6.84 ± 0.18 mg/kg and 7.13 ± 0.16 mg/kg for treatments spiked with 40mg/l and 60mg/l petroleum respectively) than the treatments amended with inorganic fertilizers. The degradation of petroleum hydrocarbons followed first-order kinetic model. This study showed that phytoremediation of crude oil by water hyacinth and inorganic fertilizer amendment to enhance crude oil degradation is achievable.

Biological soil crusts for northern mine site restoration

Ness, Isobel; Steven D. Siciliano, Katherine J. Stewart

Yukon Research Centre

Biological soil crusts (BSCs) are a ubiquitous and integral part of early successional vegetation communities and are composed of bacteria, cyanobacteria, algae, mosses, liverworts, fungi and lichens. These crusts can play an important role in the ecorestoration of disturbed sites through the retention of soil moisture, reduction of soil erosion and increase in soil organic matter, which can reduce artificial fertilizer application rates and promote plant community growth. BSCs can withstand dehydration and when moisture is available rapidly photosynthesize and fix atmospheric nitrogen leading

POSTER ABSTRACTS (CONT'D)

to C and N inputs in nutrient limited disturbed soils. The ability of BSCs to colonize mine impacted soils was assessed in a 3 month growth chamber experiment. We examined the growth, photosynthesis, respiration and nitrogen fixation of 3 slurry treatments: a pure *Nostoc commune* culture, a dried *Nostoc* spp. and mature BSCs collected on a mine site in Yukon, Canada on both tailings and mine impacted soils. The mature BSC slurry had the highest rates of photosynthesis, respiration, and nitrogen fixation compared with the other slurry treatments. There were no significant differences in nitrogen fixation between the tailings and mine impacted soils for the BSC slurry treatment. Inclusion of BSCs in soil amendments may improve revegetation success by establishing keystone communities and primary successional processes potentially returning disturbed ecosystems to a desirable trajectory. Further field experiments are necessary to determine the effectiveness of BSCs in large scale restoration and the determination of optimal application rates and delivery methods.

Gender inequality: a pro for vulnerability to climate change impacts and a spiral for sustainability of adaptation strategies evidence from the Choke Mountain Ecosystems, Ethiopia

Nigussie, Yalemzewd

Wageningen University and Research

Climate change stresses and incidences of unsustainable development projects are much higher in developing countries due to various factors including gender inequality. It is widely believed and evidenced that major climate change adaptation strategies depend on availability of information, access to credit, technology and other social services, and these in turn are predominantly decided by men mainly in developing countries like Ethiopia. This paper, thus, was intended to address the magnitude of climate change related vulnerability of households caused by gender inequality and factors that adversely affect sustainability of development projects in the Ethiopian Choke Mountain Ecosystems using established models, namely, “*vulnerability as expected poverty*” and “*ordered probit*”, respectively. Accordingly, it was found that presence of gender inequality in major household decisions as well as lack of participation of women in climate change adaptive and mitigation projects result in a higher vulnerability of households to impacts of climate change. In contrast, perceptions of project coordinators did not support the idea that gender inequality significantly affects sustainability of climate change mitigation and adaptation projects. To create a climate change resilient economy, we recommend for gender equality to be at the center of all development plans and programs implemented against climate change.

Development of *Nectandra membranaceae* (Sw.) Griseb saplings implanted in the restoration of a palm swamp in Southeastern Brazil under different flooding gradients

Nunes, Yule Roberta Ferreira; Nathalle Cristine Alencar Fagundes, Caroline Siqueira Santos, Camila Vanelle Ramos de Araújo Veloso, Claudiane Silva Saraiva, Helen Lima Araújo, Walter Viana Neves

Universidade Estadual de Montes Claros - UNIMONTES

Palm swamps (*veredas*) are plant communities that occur in headwater areas under hydromorphic soil. Despite the importance in the water balance in Brazilian savanna (*cerrado*), these areas are undergoing many impacts that culminate in its degradation, having restoration as an action of priority in these environments. This study aims to assess the development of *Nectandra membranaceae* saplings implanted in an experiment to restore the Acari palm swamp (Minas Gerais, Brazil) under different flooding gradients. We planted 1,295 individuals of *N. membranaceae* in January/2012 and measured the height and the stem diameter at ground level (DGL) every three months up to July/2012. The water layer was measured and assigned flooding classes - wet, soggy, soaked 1 (0 to 3 cm), 2 (3 to 6 cm) 3 (6 to 9 cm), 4 (9 to 12 cm) and 5 (12 to 15 cm) - to set the flooding gradients of all planted individuals. The analysis of variance (ANOVA) and Tukey post test were carried out. The height growth did not differ among the flooding gradients ($p > 0.05$; $F = 0.37$; $gl = 6$), but the diameter showed differences ($p < 0.05$; $F = 3.04$, $gl = 6$). The highest growth in DGL was observed in soaked 4 (1.29 ± 0.21 mm) and the lowest in wet (0.38 ± 0.10 mm). These results indicate a preference of *N. membranaceae* for areas with significant flooding events, being an ideal species to implanting near the flooded portion of the palm swamps.

The applicability of growth pole concept in the evolution of Avu in Owerri West local government area

Obasi, Mgbore N.

Alvan Ikoku Federal College of Education Owerri

This investigation is on the applicability of the growth pole concept in the evolution of Avu, in Owerri – West L.G.A. During the investigation, data collection was through the questionnaires, observation and from some past literatures, based on the research hypothesis, questions analysed. Such null hypotheses postulated are as follows: The rate of migration in Avu has no relationship with Owerri as a growth centre. The location of Imo state capital at Owerri has not improved the quality of life of the people at Avu. There is no significant difference between the backwash and spread effects on Avu from Owerri the growth centre, some of the findings of the investigation amongst others includes: that the concept is not applicable in the evolution of Avu, far backwash is stronger than the spread effect. Some recommendation includes plant a garden and trying of small scale breeding etc.

POSTER ABSTRACTS (CONT'D)

Comparison of Gwangneung Forest as UNESCO's Biosphere Reserve between 1990 and 2010 and Futuristic Conservation

Oh, Seung-Hwan; Yong-Chan Cho, You-Mi Lee, Joon-Hwan Shin
Korea National Arboretum of Korea Forest Service

Gwangneung forest, as old growth forest and located in Seoul metropolitan area, have been protected through 500 years and recently designated as reserve area as UNESCO's MAB programme. We examined environmental changes and compared vegetation characteristics (mean vegetation cover and species richness, species composition, indicator species analysis, and so on) through vegetation survey data in 1990 ($n=62$) and 2010 ($n=93$). During 30 years, mean temperature and precipitation of the Gwangneung forest area revealed upward pattern but the degree was larger in the former. Compared to early 20th, area of broadleaved forest, mainly dominated by *Quercus* spp. and *Carpinus laxiflora*, shrank by various plantations in lower and riparian areas. Total vegetation cover and species richness decreased from 295.9% ($t = 12.6, p < 0.001$) to 193.0% and from 46 species to 24 species ($t = 11.9, p < 0.001$), respectively. This pattern was common in both of broadleaved and Korean red pine forests. Divergence of species composition was observed. Vigorous establishment of planted tree species following the maturity such as *Pinus koraiensis* and *Abies hollophyla*, and ruderal species such as *Oplismenus undulatifolius* as ruderal species and dispersed by animals was observed in every forest types. Vegetation succession, soil acidification, and maturity of planted species were likely major factors of vegetation change. We recommend the conversion of various plantations to natural oak forests by reducing artificial forests in Gwangneung Forest Biosphere Reserve.

UNU-Land Restoration Training Programme: Training for a sustainable future

Orradottir, Berglind; Hafdis Hanna Aegisdottir
United Nations University Land Restoration Training Programme

One of the global challenges of this century is to fight land degradation and restore damaged land. It is essential that we succeed in this task to secure continuing ecosystem services by natural systems, and to secure a sustainable future for mankind. This is a task that needs to be addressed at different levels. Capacity building of professionals and institutions that deal with these challenges is an essential part of this undertaking. The UNU-Land Restoration Training Programme (UNU-LRT) offers training in ecological restoration of degraded lands and sustainable management of ecosystems for practicing professionals in developing countries. Our focus is on developing countries as the world's poorest inhabitants are most directly affected by land degradation but have least opportunities to react. We emphasize empowering women in this field as well as to help create an active network of professionals that can continue to collaborate after having attended the training at UNU-LRT. An effective network of professionals and practitioners that understand the importance of these challenges and work together to solve them, both locally and globally, is a promising way to produce the necessary changes to reach a sustainable future.

Native plant seeding techniques for burned Wyoming big sagebrush communities: Comparisons of drilling and broadcasting methods across multiple sites

Ott, Jeffrey E.; Nancy L. Shaw, Robert D. Cox, Mike Pellant, Bruce A. Roundy, Dennis L. Eggett
USDA Forest Service, Rocky Mountain Research Station

Wyoming big sagebrush (*Artemisia tridentata* var. *wyomingensis*) shrublands of the western U.S. have been widely impacted by overgrazing, annual weed invasion and wildfire. In the absence of active intervention, many burned shrublands will convert to annual grasslands. Post-fire rehabilitation provides an opportunity to stabilize and revegetate at-risk shrublands on public lands. The current policy shift from seeding non-native perennial grasses towards mixtures of native grasses, shrubs and forbs offers promise for restoring sagebrush communities. We carried out an experiment to test the effectiveness of newer techniques for establishing native species following wildfire across four sagebrush sites in the northern Great Basin region. We compared a conventional rangeland drill with a newer minimum-till drill, both equipped with extra boxes for small seeds that were broadcast on the soil surface in combination with chains or imprinters to enhance soil-seed contact. These "drill-broadcasting" techniques were compared against conventional broadcasting following drilling. Seedling density and cover measurements from 1-2 years after treatment revealed that (1) small-seeded species generally established equally well or better when broadcast using drills compared to conventional broadcasting, (2) large-seeded species established equally or less with the minimum-till compared to the conventional drill, (3) the minimum-till drill maintained more residual native plants and litter, but also more exotic annuals, and (4) variation among sites could be attributed to differences in elevation and post-seeding precipitation. We conclude that both conventional and newer techniques are viable options for seeding native plants following fire, although adverse site conditions remain an obstacle to plant establishment.

Baseline floristic data used to assess conservation priorities of ecological management in Garrard County, Kentucky

Overbeck, Will W.; Ron L. Jones
Eastern Kentucky University

Garrard County, Kentucky was the subject of a floristic study during the 2010 and 2011 growing seasons and resulted in vascular plant collections comprising 934 species in 473 genera and 129 families. Garrard County encompasses 60,570 hectares in Central Kentucky and includes parts of both

POSTER ABSTRACTS (CONT'D)

the Bluegrass Basin and the Knobs Norman Upland of the Interior Low Plateaus. Permitted collecting at Reynolds Prairie, The Nature Conservancy's Sally Brown Preserve, Tom Dorman State Nature Preserve, and Maywoods Environmental and Educational Laboratory was coordinated with state and private conservation agencies. Rare plant communities were included in this survey: Calcareous Mesophytic Forest, Limestone Sub-xeric Forest, Xerohydric Flatwoods, Shale Barrens, Limestone/Dolomite Prairie, and Bluegrass Mesophytic Cane Forest. Several state listed plants were documented: *Agalinis skinneriana* (Alph. Wood) Britton, *Carex crawei* Dewey, *Elymus svensoni* G.L. Church, *Onosmodium hispidissimum* Mack., *Phlox bifida* Beck subsp. *stellaria* (A.Gray) Wherry, *Prenanthes crepidinea* Michx., *Schizachne purpurascens* (Torr.) Swallen, *Spiranthes magnicamporum* Sheviak, *Ulmus serotina* Sarg., *Viburnum molle* Michx., and *Viola septemloba* Leconte subsp. *egglestonii* (Brainerd) L.E.McKinney. Invasive plant species such as *Alliaria petiolata* (M. Bieb.) Cavara & Grande, *Festuca arundinacea* Schreb., *Lespedeza cuneata* (Dum. Cours.) G. Don, *Lonicera maackii* (Rupr.) Herder, *Lonicera japonica* Thunb., *Lonicera standishii* Jacques, and *Microstegium vimineum* (Trin.) A. Camus form dense populations in some natural areas. Habitat loss and invasive species continue to degrade rare plant community remnants and populations of rare plants; applications of baseline floristic inventories can be used in assessing conservation priorities for landscape scale management decisions during ecological restoration.

Biological corridors connecting two large forest remnants promote evenness in a subandean avian assemblage.

Palacio, Rubén Darío; William Vargas

Universidad Icesi

Large forest remnants have been shown to sustain a diverse avifauna despite long term forest fragmentation, and are the source for re-establishing bird communities at the landscape level. I assessed the effects of ecological restoration on a subandean avian assemblage 10 years after the establishment of biological corridors that connect the forests of Barbas and Bremen in the Central Andes of Colombia. Bird data was obtained through visual and acoustic detection using a combination of point counts and Mackinnon lists supplemented with previously reported data. A total of 201 bird species representing 38 families were recorded with the highest species richness found in Barbas (170), followed by Bremen (166) and the corridors (133). The corridors provide suitable feeding ground to high requirement species such as the endangered Cauca Guan (*Penelope perspicax*), the Red-ruffed Fruitcrow (*Pyroderus scutatus*), the Crested Ant Tanager (*Habia cristata*) and the Green Jay (*Cyanocorax yncas*). The Morisita-Horn similarity index was high at 92% for the Barbas and Bremen forests; in contrast, between the corridors and the forests the similarity was 70% and 72% respectively. The beta diversity of the avian assemblage is best explained with a nested structure where the corridors have a subset of the species found in the large forests, with few species turnover. In addition, there was no evidence indicating the presence of locally extinct species. These results suggest biological corridors promote assemblage evenness in avian communities, yet don't encourage the recolonization of extinct species if they've been extirpated from the regional species pool.

Captive Breeding Study of the Endangered species Red-crowned Crane(*Grus japonensis*) and Mute Swan(*Cygnus olor*)

Park, So Young

Institute of Ornithology for the Ecological Environment

Study on captive-breeding of Red-crowned Crane(*Grus japonensis*) and Mute Swan(*Cygnus olor*), both identified as endangered species by the IUCN and Ministry of Environment, is being conducted by the Institute of Ornithology, designated as the ex-situ conservation organization by the Ministry of Environment. Since 2009, 3 pairs of Red-crowned Crane have laid 22 eggs. Among them, 19 specimens have spawned, and 10 have survived. First, the study for Red-crowned Cranes have shown that the hatching rates for the 22 eggs was 86.4%, and the survival rate for the spawned chicks was 52.6% considering that 10 have survived. With the first day of the year as a benchmark, the eggs took 132.7 ± 21.9 days on average to spawn. It took 124.8 ± 20.2 days on average during its primary breeding season, and 153.8 ± 6.9 on average during its secondary breeding season. The incubation period observed was from a minimum of 29 days to a maximum of 35 days, and the average was 32.5 ± 2 days. Secondly, the sex identification data showed 5 males and 5 females for Red-crowned Cranes, 13 male and 13 females for Mute Swans, and 2 males and 2 females for Black Swans.

A small mammal community in a mosaic of forest restoration: identifying the habitat trait filters to fauna recolonization.

Paula de Castilho, Camila; Wesley Rodrigues Silva

University of Campinas

Although many restoration and management strategies are implemented to restore degraded habitats, few evidences about the passive fauna recolonization on those new habitats are evaluated. This is the first study in Brazil aiming to assess the habitat trait filters that influence small mammal recolonization in a mosaic of forest restoration in São Paulo state. The site is located near the *continuum* of the Southeast Atlantic forest and is composed of several restoration treatments that have been implemented since 2001, forming a mosaic of regenerating and restored vegetation (pastures, plantings, second growth, forest fragments). Twenty sampling plots were selected among the mosaic and small mammals were captured monthly by pitfall traps (60L) in each sampling plot through June 2011. Species composition was similar between restored and natural regenerated plots but differ from the forest remnants. Forest plots had specialized and endemic forest species, some exclusive to them. Two specialized endemic forest species co-occurred in both restored and regenerated plots, but, as a rule, generalized species were more abundant and some were strictly associated with restored physiognomies. From the two groups of habitat trait filters evaluated (vegetation structure and food availability as fruits and arthropods), vegetation

POSTER ABSTRACTS (CONT'D)

obstruction at 0.5m from the ground, fruit availability, depth of litter and vegetation cover explained the occurrence of species in the mosaic. Despite the difference in species composition between restored and forest plots, the small mammal community seems to benefit equally from restoration and natural regeneration treatments.

Disappearing act: Tracking the fate of seeds in North American tallgrass prairie restorations

Pellish, Carmen A.; Paige A. Leytem, Sarah L. Kleinhesslink, Laura L. Jackson

University of Northern Iowa

The species diversity and spatial extent of North American Prairie restoration are critically limited by high seed cost and low (2-7%) survival of seeds to establishment. Observations of initial seedling emergence in both controlled studies and practitioner experience suggest that about 90% of seeds fail to emerge the first year; a large proportion of these are likely killed by seed predators including small mammals, birds, insects, and soil fungi. Others may eventually senesce or die germinating. The goal of the present study is to measure seed loss due to predation in prairie plantings at six locations in two Iowa counties, representing a full range of planting techniques. In spring 2013, five pairs of open and enclosed wire mesh cages were installed at each site immediately after seeding. The lower 10 cm of the enclosed cages was covered in Tanglefoot to exclude crawling insects. Rates of seed predation will be estimated by comparing cumulative seedling emergence in enclosed and open cages, at the end of the 2013 growing season. To measure the contributions of senescence and soil pathogens to seed mortality, we will mark seeds of four, large-seeded forb species with fluorescent powder, plant them inside enclosures, and then attempt to recover ungerminated seeds after 30 and 60 days of burial. Recovered seeds or their remains will be counted, tested for viability using a tetrazolium chloride assay, and examined for fungal damage. Results will help us to develop strategies to reduce pre-emergence seed mortality in restoration plantings.

The invasive mechanism of native plant species

Peng, Shaolin; Bao-Ming Chen, Ting Zhou

Sun Yat-sen University

Exotic invasive species have attracted people's attention and comprise roughly 0.1% of the introduced species found upon casual inspection (tens rule). Although tremendous studies focused on exotic invasive species, more attention has been paid to native invaders recently. What is the approximate proportion of native plants become invasive? To obtain native invasive plant species (NIPS), we searched the primary data and literature from published or official online database. We selected 5 countries/regions (China, USA, Australia, Chile, and Britain) to understand the NIPS and to estimate the proportion of NIPS to total native species. In order to understand the current status of native invasive plants and compare NIPS with EIPS, we conducted field survey in two forest sites, in Guangdong Province, south China. The results showed that the probability ranged from 0.11% to 0.70% based on the data in 5 countries/regions. Among the six regions/countries, China showed the highest proportion of native invaders (0.7%), then USA (0.56%), while Chile the lowest (0.11%). The results of field survey indicate that there were much more NIPS than EIPS. The study suggests that we should expand study interest to native invaders. Specifically, policy and management decisions should take into account of native invaders.

Participatory Reforestation of Verruga River in Vitória da Conquista, State of Bahia, Brazil

Pereira Santos Neto, Alcides; Julia Siqueira Moreau, Siléia Oliveira Guimarães

Federal University of Espírito Santo

The conservation and improvement of water resources constitute priorities in today's environmental agenda. In this sense, projects with local scope represent strategies able to combat various social and environmental problems. From these premises, the project "Participatory Reforestation of Verruga River", run and funded by the Universidade Estadual do Sudoeste da Bahia and the Environment Department of the city of Vitória da Conquista, operates with the aim of promoting educational and training actions in order to restore the gallery forest of the Verruga River in the surroundings of the Bem Querer Village, municipality of Vitória da Conquista, State of Bahia. The involvement of various social segments of the locality is a basic premise in carrying out the actions. The project is in progress since April 2010, and is structured on three pillars: 1) community education and mobilization with regard to social and environmental conditions of the locality; 2) qualification of young people for the production of forest seedlings. 3) gallery forest restoration with the participation of residents of the surroundings of the River. So far, 50 ha of gallery area have been restored and more than 2,000 people directly benefited. In the year 2011, the project won the recognition of the United Nations Environment (UNEP) and the firm BAYER, winning the prize "Young Environmental Ambassadors". In this way, the benefited community becomes protagonist of social and environmental transformations in the locality.

Quantifying the success of Floodplain Forest restoration projects: The case study of the Floodplain Forest at the Ouse Valley Park in Milton Keynes (United Kingdom)

Perez Linde, Natalia

Cranfield University

This project aims at developing a robust monitoring framework to quantify the success of a floodplain forest restoration project. A 50ha floodplain forest near Milton Keynes (UK) has been selected as a case study area. Outputs of this research will be used to develop a set of efficient and easy to understand

POSTER ABSTRACTS (CONT'D)

management guidelines for the floodplain forest based on a long-term monitoring approach. The approach selected for the monitoring programme is based on an Adaptive Monitoring Framework (AMF). AMF are based on an iterative process that start with a conceptual model, a set of key objectives followed by a robust sampling design and a monitoring programme that evolve over time. Based on this, a number of key variables have already been selected for the monitoring programme. The AMF has been supported by a set of research hypotheses as little information is available to build the conceptual model. These hypotheses underpin the overall monitoring programme and are summarised as follow: (a) The ratio between wetted and dry vegetation within the floodplain forest is specific of the elevation and the water table level and (b) The development of vegetation within the floodplain forest will contribute to improve the water quality of the river Great Ouse and adjacent channels. The statistical sampling design looks at maximising the information that can be gathered from the ecosystem based on the above hypothesis. This paper presents the first attempt to develop a robust monitoring framework for floodplain forest and discusses the potential for its implementation in similar projects.

Restoring ecosystem productivity in degraded areas of Brazilian Atlantic Rain Forest: a functional diversity approach

Piña-Rodrigues, Fatima C.M.; Luis Eduardo Nogueira, Luciano Lopes Reis
UFSCar- Sorocaba

Functional methods aims to restore the ecosystem's processes and diversity applying a dense and functionally diverse system, close to undisturbed forests. In a restored area, three plots (10000m²), with different density of plants (T1 – dense plantation with 0.5x0.5m; T2 – semi-dense 1x1m; T3 – conventional 2x2m) with twenty three species (60% pioneers; 40% non-pioneers). Diameter at the breast height (DBH), total height (H) and litterfall were sampled four years after the planting. According t-test, DBH of pioneers and non-pioneers were higher in plot T2 (9.24 ± 0.63 cm; 8.15 ± 0.48 cm), however there was no difference between pioneers - T1 (8.32 ± 0.59 cm; 4.97 ± 0.21 cm) and T2 and T1 and T3 (7.73 ± 0.26 cm; 5.18 ± 0.29 cm). Only non-pioneer's height was significantly different. T2 (6.49 ± 0.30 m) exhibited the highest values, followed by T3 (5.26 ± 0.19 m) and T1 (4.97 ± 0.21 m). The highest estimated aboveground biomass was in T1 ($63.69 \text{tonC}/10.000\text{m}^2$), followed by T2 ($54.17 \text{tonC}/10.000\text{m}^2$) and T3 ($23.96 \text{tonC}/10.000\text{m}^2$), however T2 exhibited higher litterfall ($10.38 \pm 0.09 \text{tonC}/10.000\text{m}^2$) than T1 ($9.69 \pm 0.08 \text{tonC}/10.000\text{m}^2/\text{year}$) and T3 ($9.97 \pm 0.07 \text{tonC}/10.000\text{m}^2/\text{year}$). Semi-dense system demonstrated higher performance probably due to the combination among individual development, aboveground biomass and litter formation, suggesting that, in this condition, the resource use is maximized, promoting a faster soil covering and emergence of new niches to be explored by others functional groups.

Strategies for restoration of ciliary forests in the wetlands of Maranhão State, northeastern Brazil, using plant species of environmental, utilitarian and economic value.

Pinheiro, Claudio Urbano; Flávia Mochel
Federal University of Maranhão

Many species of ecological interest, important to the ciliary environments in their interactions with fauna and flora, as structural components, or sources of food for fish species, or as shelters and reproduction sites, are understood by local people as important, but not enough to avoid their extraction when necessity appears. Therefore, it can be very important the selection of plant species of recognized utilitarian and/or economic value as well as of confirmed ecological value to receive attention and a place in ciliary forests recovery programs. In this context, the notion of conservation can be placed into people's mind: a) through a direct and of short term way – by selecting plant species of community interest, which will have a better chance of developing in these areas by the care that will come from the human interest; b) through an indirect way of medium and long terms – by educating the new generations, oriented to conservation. However, one way does not exclude the other. The reforestation model tested in this project followed mainly local interest, producing seedlings and planting selected species to areas, composition and densities which allow their use and management along the years. These areas were named Special Plant Formations for Buffering the Pressure on Ciliary Forests. This model showed that although the communities recognize the ecological value of plant species and their environmental importance, they also recognize in some of them a bigger value of use and/or potential utilitarian and economic value, of which they take better care.

Reforestation as a restoration strategy of degraded semi-arid lands in central Mexico: Biomass accumulation

Plascencia-Escalante, F. Ofelia; Araceli Ventura-Ríos, Gregorio Ángeles-Pérez, Patricia Hernández de la Rosa
Colegio de Postgraduados

In central regions of Mexico *Pinus cembroides*, species that naturally grows in semi-arid areas, have been affected by different disturbance types, such as fire, insects, diseases, and especially deforestation for land use change. Deforested lands were utilized for a short period of time for crop production, and then shifted to grazing. This history of land use exacerbated nutrient losses by severe soil erosion. In 1998, local communities with the aid of official institutions in the Valle del Mezquital, in Hidalgo State, started a reforestation program as a strategy for restoring degraded lands. The main planted species was *Pinus greggii* for its adaptability to areas with low rainfall and shallow soils. We assessed the biomass accumulation process in reforestations of different age (5, 9, and 15 years), and in a *Pinus cembroides* forest as a reference site. We established eight circular sampling plots of 400 m² along a transect in each reforestation and reference site. All individuals were labeled and its dbh (diameter at breast height) and height were recorded. Total biomass was calculated through allometric equations. The reference site had a total biomass of 40.71 (± 6.3) Mg ha⁻¹. Our data showed that biomass in reforestation areas increased as increased the time since establishment. However, the oldest reforestation still did not reach the amount of biomass

POSTER ABSTRACTS (CONT'D)

attained by the reference site ($15.09 (\pm 1.15)$ Mg ha⁻¹). The youngest reforestation surveyed had $0.09 (\pm 0.01)$ Mg ha⁻¹ of biomass after five years of establishment. Different biomass accumulation rates were observed.

Riparian restoration on the Duncan River through flow regime changes: Design, implementation, and analysis

Polzin, Mary Louise; Stewart Rood
Vast Resource Solutions Inc

BC Hydro initiated a new flow regime for the Duncan Dam with the goal of benefiting fisheries and the floodplain forests of the Duncan River below the dam. A ten-year riparian vegetation monitoring program was implemented to evaluate the impacts of the flow regime on *Populus trichocarpa* (black cottonwood) and other riparian vegetation. The study provides site-specific data to assess the river flow regulation impact and improve understanding of the relationships between flow regime, physical environmental conditions, and riparian vegetation. Analysis used surveyed belt transect lines that enable assessment of plant occurrences in four dimensions, the three Cartesian coordinates for spatial parameters (X- longitudinal position, Y-distance from water, Z-elevation above water) and time. The benefit of this design provides: the ability to evaluate the sequence of plant species and communities; vegetation positions along transects associated with a single longitudinal position; no gaps in the elevational positions and a single anchor point that simplifies transect re-establishment in subsequent years. Repeat aerial photography was also utilized to quantify changes in the area of riparian vegetative classes and the active channel edge. Early results after three years of monitoring indicate that the river flow regime is the primary driver of black cottonwood recruitment along the Duncan River. Recruitment along the Duncan River may be lower and occurs within the active channel compared to the reference reach, the adjacent Lardeau River. Key factors are emerging which will be included in the analysis over the next six years.

Assessing peatland connectivity from phenotypic variability within populations of white fringed orchid.

Poulin, Monique; Laurent De Vriendt, Stéphanie Pellerin
Université Laval

Reserves' connectivity is a critical factor to consider in conservation assessments since isolation may affect the persistence of a plant population. Indeed, higher pollen and seed movements between sites may increase genetic diversity within populations and improve their mean fitness and evolutionary potential. Higher connectivity may therefore engender higher phenotypic variation of functional traits within populations. Here we assess the impact of peatlands connectivity on trait phenotypic variation within populations for a model species: the White fringed orchid (*Platanthera blephariglottis*). Peatlands occur as isolated patches in the landscape and form significant archipelago in south-eastern Canada. We chose 20 peatlands in the Saint-Lawrence River Valley, with varying degree of connectivity (defined with different metrics of population isolation). We surveyed 20 individuals within each population for the following traits: plant height, number of leaves, leaf area, number of flowers, length of flower stalk, length of labels, length of petals and sepals, length of nectar spur and length and dry weight of capsules. Correlation between population connectivity and trait variability was assessed. We present the preliminary results of this study which will imply genetic assessment in the coming future.

Understory succession of riparian zones is induced by tree planting, but strongly depends on spatial autocorrelation

Poulin, Monique; Béranger Bourgeois, Anne Vanasse
Université Laval

Riparian zones are species-rich ecological corridors structuring biodiversity within landscapes, but have been highly degraded by agricultural intensification. Their ecosystem services, e.g. erosion control and water filtering, are commonly restored by tree planting. Yet, the impact of this restoration approach on understory communities remains poorly understood. We aimed to assess if tree-planting induces a plant succession driving understory communities toward undisturbed riparian forest communities. A total of 67 riparian zones restored by tree planting 3 to 17 years ago and undisturbed riparian forests were sampled in two agricultural watersheds of southeastern Québec (Canada). Plant abundances were inventoried using a number 1 m² plots proportional to site area. Ecological variables included plantation year, canopy cover, farming culture of adjacent field and hydrological measurements. Spatial autocorrelation of plant communities was modeled using asymmetric eigenvectors maps. Principal Response Curves showed that understory plant species specific to riparian forests begin to reestablish 12 years after the tree plantation. However, spatial autocorrelation contributes to understory composition as much as local ecological variables (each explaining 15% of the variation). Among them, canopy cover, elevation above river and farming culture appears key factors for understory riparian species, according to redundancy analysis. These results show that tree planting in disturbed riparian zones is efficient to induce a plant succession: the development of canopy cover drives the reestablishment of understory communities typical of riparian forests. The major role of spatial autocorrelation suggest that planting trees from upstream to downstream could enhance the restoration efficiency of riparian zones.

POSTER ABSTRACTS (CONT'D)

Restoration seedings of energy disturbances invaded by an exotic annual (*Halogeton glomeratus*) in the Wyoming Basin

Prasser, Nick P.; Ann L. Hild
University of Wyoming

In the Wyoming Basin, domestic energy extraction has created a need for wildland reclamation seeding. In arid and saline sites, the annual exotic, *Halogeton glomeratus* has invaded sagebrush and salt desert shrub systems. Presence of this exotic has increased with disturbance and halogeton's influence on re-vegetation seedings is unclear. Meeting restoration standards in the Wyoming Basin is especially difficult because annual precipitation is low (halogeton and establishment of native seedlings). We document cover and seedling densities to compare competitive ability of native shrubs, forbs and perennial grasses with halogeton in the field. A companion greenhouse study was initiated in spring 2013 to evaluate competitive interactions of halogeton with 12 native species in a controlled setting. Baseline cover on the five reclamation sites prior to seeding in 2012 was: 10% exotic seedlings, 21% native species, and 34% bare ground 22% litter and 2% rock. Irrigation treatments in the first summer did not appear to influence halogeton seedling emergence in the following fall. Effective restoration following disturbance is essential to sustaining ecosystem function following energy extraction.

Monitoring of neoecosystems evolution resulting from vegetational restoration activities along buried pipeline in Italian Alpine Environment

Raggi, Leonardo; Ilaria Valentini, Euro Buongarzone, Antonio Caffarelli, Giuseppe Oriolo, Michela Tomasella
Saipem SpA Eni Group

The Malborghetto Bordano gas pipeline (48") is a section of the natural gas pipeline from Russia, and crosses the Italian Eastern Alps which are characterized by a variety of complex ecological systems. Following pipeline construction, vegetational restoration activities were carried out to stimulate the natural evolution of ecosystems, restore the habitats and the landscape over the long term. The effectiveness of these activities was assessed by monitoring the vegetation (and soil) starting from the ante-operam phase over a period of 12 years. Surveys were carried out in 8 test areas representative of highly different ecological situations existing along the pipeline corridor, and consisted in floristic, phytosociologic and structural investigations (for wood species only). The collected data was processed statistically. In each area, a hierarchical classification with the Similarity ratio was applied to the matrix of every survey to distinguish the ecological groups as a function of different parcels and areas. Clustering was used to better comprehend the relationship between the surveys and the overall ecological value of the florula observed in every area. Other comparisons using Scatterplot and clustering showed a correlation between various soil parameters and the evolution of vegetation. The results showed areas with greater evolution dynamics, also in relation to the restorations performed, assess the natural renovation, the degree of stabilization of the floristic composition and the quantitative ratio among species, determine the distance compared to the natural reference model, and identify the ecological value of groups of species.

The study of flora of Miandasht wildlife Refuge

Rahimi, Alieh; Morteza Atri
Islamic Azad University

A wide area of Iran is covered by arid and semiarid regions. Miandasht Wildlife Refuge with 84435 Ha area, with mean annual precipitation equal to 250 mm and 912-1082 a.s.l altitude rang, located in North Khorassan province. Climate of the region is semiarid. This region is located in Irano-Turanian area. This survey was carried out from the point of views of floristic studies of this region. Eco-phytosociological method was used. Plant species were identified by using of scientific sources, particularly Flora Iranica and Flora of Iran. 274 plant species, subspecies and varieties which belong to 163 genera and 37 families from angiosperms and gymnosperms were known. Chenopodiaceae, Asteraceae, Brassicaceae and Poaceae have the highest number of species, respectively. *Astragalus* with 18 species have the most species in flora of the region. According to Raunkiaer classification, therophytes with 145 species are the most frequent life form and followed by chamephytes with 29 species (%10.82), geophytes with 23 species (% 8.5) and phanerophytes with 19 species (%7.09), respectively. Irano-Turanian elements with 202 species are the most frequent chorotype and followed by Irano-Turanian and Mediterranean, Irano-Turanian and Saharo-Sindian, Irano-Turanian and Europe-Siberian, pluriregional and cosmopolitan elements. 35 plant species with medicinal value were known in this region. Among 174 recognized species, 31 species are endemic of Iran. From vulnerability point of view, 17 species are low Risk and 13 species are Data Deficiency. The most of the species were ruderals. They established in this area because of overgrazing and natural disturbance.

Estimating costs of prairie restoration to inform landscape-scale conservation planning: A survey of restoration practitioners across Minnesota

Refsland, Jodi M.; Laura Phillips-Mao, Susan Galatowitsch
University of Minnesota

Landscape-scale restoration planning requires cost estimates that reflect varying site conditions and project goals. Without these, planners must rely on estimates that treat the landscape as a homogenous unit, leading to underestimated costs and labor required to undertake landscape-scale restoration.

POSTER ABSTRACTS (CONT'D)

To generate accurate cost estimates for prairie restoration planning and identify the sources of cost variability, we surveyed restoration practitioners in Minnesota about common restoration practices and associated costs and labor. We presented four site scenarios differing in vegetative cover and asked respondents to indicate the actions, equipment, cost, and time required to restore each site to a mesic prairie or wet meadow. We created two versions of the survey, assuming either low budget (Utility) or high budget (Conservation), to reflect differences in project goals. We calculated means and ranges of costs for individual restoration activities and summed them to produce per-acre costs of each restoration scenario. We found variability in both the cost and type of restoration practices employed, ranging from an average of \$1753/acre to restore crop to utility prairie and \$4096/acre to restore a site invaded by woody and herbaceous perennials to a conservation wet meadow. Reported cost differences were driven primarily by variability in the number and type of management actions preferred by survey respondents, regardless of the practices described in each scenario. These results provide land managers and policy makers with more detailed estimates and identify the activities that most influence restoration costs, ultimately enabling more effective landscape-scale restoration planning.

Restoring the plant community of wetlands of the Upper St. Lawrence River

Regan, Matthew J.; Donald J. Leopold, John M. Farrell

State University of New York College of Environmental Science and Forestry

Anthropogenic alterations to the hydrology of freshwater coastal marshes can adversely affect the composition and structure of the wetland plant community. For over the past 50 years Upper St. Lawrence River water levels have been stabilized by regulation plan 1958D administered by the International Joint Commission (IJC). This reduced variability has promoted narrowleaf cattail (*Typha angustifolia*) and hybrid cattail (*Typha x glauca*) vigorously encroaching upslope, and replacing, sedge meadows. We evaluated the use of two possible methods for restoring the wetland plant community. Water control structures were installed at two marshes to regulate water levels independently of the IJC. Excavations at two marshes were designed to promote habitat connectivity, and excavated spoils were used to recontour habitat mounds. We surveyed the vegetation in the first summer (2012) following treatments along an elevation gradient representing different water level histories. The restoration treatments had a significant effect on plant community composition during the growing season ($p < 0.05$), although there was no significant effect on percent cover of *Typha* spp. and sedges (*Carex* spp.). The gradient from 74.28 through 75.04 m above sea level had a significant effect on species richness, diversity, percent cover of *Typha* spp. and *Carex* spp. (all $p < 0.05$). The 2012 growing season was abnormally dry and likely affected the wetland vegetation response. The second growing (2013) season with possibly less extreme weather conditions should elicit a different response than observed last year. We will continue monitoring to test treatment effects on plant community responses.

Comparison of local and non-local taxa in grassland restoration under future climate conditions

Richards, Jennifer L.; Dana M. Blumenthal, Elise Pendall, David G. Williams

University of Wyoming

Successful restoration will depend on how future atmospheric CO₂ concentration ([CO₂]atm) and climate warming influence plant establishment and growth. Although local natives are often preferred, non-local natives may be better suited for, and more successful in restoration under future climate conditions. We introduced a mixture of local and non-local species into disturbed microsites within a multifactor global change experiment in Wyoming northern mixed-grass prairie. The seed mix included species naturally found 1) across northern mixed-grass prairie and southern short-grass steppe ('broad-range'), 2) exclusively in northern mixed-grass prairie, and 3) exclusively in southern short-grass steppe. Plots were exposed to a factorial combination of ambient or elevated [CO₂]atm (390 and 600ppm) and ambient or warmed temperatures (+3C night, +1.5C day). We predicted seedling establishment and growth of broad-range and southern species would be higher than northern species in plots exposed to combined elevated [CO₂]atm and warming, but northern species would preferentially establish and grow in plots experiencing ambient conditions. After one growing season, 7- to 12-fold more individuals from southern and broad-range species established in all plots compared to northern species. Compared to C3 species, 12- to 42-fold more C4 individuals established in all plots. Thus, broad-range, southern, and C4 species established preferentially. The pattern of establishment among species was not influenced by global change treatments during the first growing season. With further increases in plant cover, global change treatments are expected to influence the outcome of plant competition, the magnitude of soil moisture feedback, and community structure.

Wetland management and restoration and its connection to public education

Rider, Mary; Jennifer Mattei

Sacred Heart University

According to the EPA, twenty-two states have lost at least 50% of their original wetlands. Despite progress in legislation designed to protect inland wetlands in many states, the degradation of wetlands continues to be an ongoing threat. Without the interest of local people many small wetlands, overlooked by legislation, will be destroyed in the coming years. The ecological services wetlands provide, e.g. wildlife habitat, vast biodiversity, and clean water, are not always immediately evident to local residents without the access to comprehensive and clear educational tools. Aquariums have long been a powerful tool for educating people about issues that are globally distant, and have great potential for educating them about local issues as well. There is a freshwater marsh at Mystic Aquarium, in Connecticut that has long been undeveloped as a research and educational vector. Water quality control, fauna and flora control/identification, hydrological studies and educational development have all been neglected in lieu more exotic exhibits that may attract more visitors. The study and future management of this marsh will provide information to thousands of visitors that pass through the

POSTER ABSTRACTS (CONT'D)

aquarium daily and the ability to understand the importance of inland freshwater wetlands and their conservation. Preliminary data show that this marsh is dominated by bullfrogs (*Rana catesbeiana*), high in Nitrogen and low in invertebrate larvae because it is treated with larvaecide to control for mosquitos. The ability of aquariums to educate while entertaining and to simultaneously reach visitors of all ages makes this opportunity both ideal and powerful.

The effects of habitat restoration at Bitter Lake National Wildlife Refuge on the presence of the endangered and endemic marsh snail, *Assiminea pecos*

Roesler, Elizabeth L.; David L. Rogowski
Texas Tech University

Phragmites australis (common reed) is an aggressive, invasive plant species that occupies riparian areas, outcompeting most of the native vegetation within that habitat. This invasion may have negative impacts on species that overlap the same niche, especially ones that are imperil, such as *Assiminea pecos* (*Pecos assiminea*). *Pecos assiminea* is a semi-terrestrial, endemic, and endangered snail limited to Chaves County, New Mexico, and Pecos County, Texas. Portions of Bitter Lake National Wildlife Refuge (BLNWR) in Chaves County have been designated as critical habitat for this species. The objective of this research is to evaluate the response of *Pecos assiminea* to the removal of the invasive common reed, *Phragmites australis*. At Bitter Creek in BLNWR, *Phragmites* will be removed in three sections, one per year, with the goal of restoring the vegetation to reflect that of the native ecosystem. Determining *Phragmites*' impacts on the sensitive invertebrate will be done by implementing two survey methods, search quadrats and wooden tiles, to monitor the presence of *Pecos assiminea* along Bitter Creek throughout the restoration process. A comparison will be made to a nearby sinkhole, having little presence of *Phragmites*, however, having a relatively large and stable population of *Pecos assiminea* based on preliminary data. We expect to see an increase of establishment of *Pecos assiminea* in the next few years with the decreased presence of *Phragmites*. This research can then be used to further develop management plans for *assiminea*, as well as other threatened and endangered species at the refuge.

Effective control of small, dense *Phragmites australis* patches in Great Salt Lake wetlands

Rohal, Christine B.; Karin M. Kettenring, Eric L.G. Hazelton
Ecology Center and Department of Watershed Sciences, Utah State University

Phragmites australis has been expanding rapidly in the wetlands of the Great Salt Lake (GSL). Here we present the first year of results for a multi-year study, which examines the effectiveness of six treatments for controlling small (50mx20m), dense patches of *Phragmites* at sites along the eastern shore of the GSL. The treatments are 1.) a summer mow, followed by a fall glyphosate spray, 2.) a summer glyphosate spray, followed by a winter mow, 3.) a fall glyphosate spray, followed by a winter mow, 4.) a summer imazapyr spray, followed by a winter mow, 5.) a summer mow, followed by placement of heavy-duty black plastic for solarization, 6.) an untreated control. Percent cover of *Phragmites*, density of *Phragmites*, species richness, and vegetation structure were measured to understand the response of *Phragmites* and native vegetation to treatments. Soil moisture, nutrients, and salinity were monitored for their impact on treatment effectiveness. In our results, we found that summer mowing as well as summer herbicide spraying, regardless of herbicide type, significantly reduced *Phragmites* inflorescence density compared with the fall herbicide treatments. This reduced inflorescence production will greatly limit the ability of *Phragmites* to spread further by seed. Also, even after just one year of control treatments, we found that the diversity of native plant communities increases across all treatment types but the effectiveness in fostering native plant recovery varied widely. The findings from this multi-year study will be used to develop best management practices for controlling *Phragmites* in GSL wetlands.

Analyzing impacts in floodplain zones after an oil spill from a pipeline rupture

Rood, Stewart; Karen Gill, Evan Hillman, Samuel Woodman, David Pearce
University of Lethbridge

During a moderate flood in June, 2012, a crude oil pipeline ruptured in the Red Deer River in Alberta, Canada. This released about 3000 barrels (450,000 l) of light sour crude oil, which flowed with the flood-waters over the floodplain zones and through the balsam poplar (*Populus*), sandbar willow (*Salix*) and wolf-willow (*Elaeagnus*) saplings. We established study sites in areas of heavier oil coatings and observed 300 tagged saplings over two growth seasons. The extent of oil coating varied, reflecting the different leaf structures of the species. The coating was initially oily, and with evaporation it became a tacky residue within two weeks. The oil occluded stomata, and without transpirational cooling the coated leaves were much warmer than control leaves. The coated leaves subsequently senesced and abscised (dropped), within about four weeks for sandbar willow and more gradually in poplar and wolf-willow. Although the coated saplings grew more slowly than non-coated control plants, they produced new shoots and their shoot growth recovered. Within ten weeks, oxidation resulted in dry, chalky black coatings on stems and the river shorelines, and with fading the affected vegetation and shoreline zones were almost undistinguishable from unaffected regions by the second summer. We thus conclude that riparian vegetation is fairly resilient relative to crude oil exposure and we recommend limiting vegetation removal to heavily-coated areas, since this clean-up treatment could accelerate the undesirable expansion by reed canary grass (*Phalaris*) and other invasive plants.

POSTER ABSTRACTS (CONT'D)

Regeneration in old-field restoration areas in South of Brazil

Rosenfield, Milena; Rodrigo S. Bergamin, Débora G. Ettrich, Kátia Zanini, Sandra C. Müller
Universidade Federal do Rio Grande do Sul

Restoration ecology aims at restoring ecosystem processes, species composition and community structure. In restoring areas, regeneration is a process that enables an increase in structural and functional complexity and is limited by several factors that affect arrival of propagules, seed germination and sapling survival/growth. In this study, regeneration was evaluated in a restoration project located in the south of Brazil. The study sites consist of areas covered by native and exotic grasses, native shrubs and a few remnant and regenerating trees. Sites differ in history of land use (grazing) and distance from forest fragments (which determined density of trees planted at each site). Natural regeneration was analyzed at the beginning of the project (isolation and planting) and after two years. Regeneration showed an increase in number of total individuals but this difference was not statistically significant ($P=0.34$), probably because a large variability in abundance was found across study sites. Past condition (grazing) had no effect on regeneration ($P=0.31$) neither did density of planted trees ($P=0.20$), whereas grass cover was negatively related to natural regeneration (abundance and species richness). This preliminary analysis in our study sites did not identify a clear pattern determining regeneration in old-field restoration areas, but source areas do not appear to be a limiting factor. In this initial state of restoration, even though structural complexity is low and fruit availability for dispersers is still scarce, competition with grasses/shrubs may determine regeneration success.

Effects of the seed bank and interseeding in reconstructed tallgrass prairies

Rossiter, Stephen C.; Marissa A. Ahlering, Brett J. Goodwin, Kathryn A. Yurkonis
University of North Dakota

Disturbances such as fire and mowing temporarily increase available resources for plants, opening a window of opportunity for establishment. During the recovery of vegetation after disturbance in remnant prairies, seedling establishment is often negligible compared to vegetative regrowth. It is unclear if this is true in reconstructions. We tested the effect of seedlings in two, 25-year-old, low diversity reconstructed prairies by removing seedlings, allowing seedlings, and adding seed in 1x1 m plots and comparing their diversity over two growing seasons. Disturbance frequency effects were tested by clipping each treatment zero, one, or multiple times. In the wetter field site, seedling removal plots had the lowest species richness and highest evenness, seedlings allowed plots were intermediate, and plots with added seed had the highest richness and lowest evenness. In the drier site, only adding seed impacted richness (higher) and evenness (lower). In both sites, the seeds present in the seed bank were over 80% from non-native species. Seedling establishment was quantified along with light, water, and nitrate availability within each seeded plot. In the wetter site, resource levels did not predict seedling numbers. In the drier site, seedlings were more numerous in less frequently clipped plots which had less light and thus less exposure. Seedling establishment from any source never affected community diversity suggesting that while some seeds establish, reconstructions are primarily maintained by vegetative reproduction. However, given the non-native dominated seed banks, any management intended to increase seedling establishment could result in increased non-native cover.

Cycling event doubles as invasive species outreach tool by highlighting volunteer restoration efforts

Sabo, Autumn E.
University of Wisconsin-Madison

The Town and Country RC&D of southeastern Wisconsin, USA wanted to reach a new audience about exotic invasive species. We organized a scenic bike ride with stops at natural areas where habitat restoration is underway. At the stations, representatives from different volunteer organizations discussed on-site invasive species management and hosted a range of displays including before and after site photos, control equipment, restoration plans, and specimens of target species. The educational stations doubled as refreshment breaks with volunteers distributing locally sourced snacks. We enhanced the typical ride registration packets by adding native plant plugs and brochures about invasive species and the local volunteer groups managing them. We asked participants and volunteers to complete written surveys to both evaluate the efficacy of the event in teaching about invasive species and to better understand what stimulates restoration volunteerism. We will report on each component of the event to guide outreach planning and summarize survey results to help land managers recruit volunteers.

Seed rain captured by traps in a Semi-deciduous Seasonal forest fragment in the state of São Paulo – Brazil

Schiavon Machado, Manoela; Nathalia Mota Ribeiro, Paulo Kageyama
Esalq - USP

Plants reproductive events are crucial to the success of the population. Seed dispersal and seed rain are mechanisms of natural regeneration as well as the initial phase of the community organization. Phenological studies are essential to understanding the processes of recruitment, structure and spatial distribution of plants population. Also, it provides subsidy to the Restoration Ecology field, and the seed rain is both an indicator of the natural regeneration potential of a given area as an efficient method of seed collecting. That being considered, the present study sought to investigate the reproductive phenology of native woody species by analyzing the richness and abundance of the seed rain in a preserved Semi-deciduous seasonal forest fragment in São Paulo-Brazil. Inside the forest fragment were installed five seed traps measuring 1m², 1m above the ground and 20m distant from each other. The material found on the traps was collected every fifteen days and then identified and quantified; this way it was possible to establish

POSTER ABSTRACTS (CONT'D)

the amount of seeds and the number of species on the experiment. The species found on the experiment were arranged according to the ecological succession group, and the seed dispersal along the year was related to the temperature and precipitation curve. It was also possible to relate the season of the year with the seed dispersal syndromes encountered, allowing us to infer about the ecosystem dynamics. It was possible to expand, based on the data analysis, the understanding of the natural regeneration processes typically found on mature tropical forests.

Assessing ecological restoration of riparian forests at the landscape scale

Scott, Michael L.; Mark D. Dixon, W. Carter Johnson, Lisa A. Rabbe, Terrance Malloy
Utah State University

Large dams and reservoirs have altered riverine and riparian ecosystems worldwide. Gauging the effects of these changes and assessing the potential role of ecological restoration are rarely addressed at larger spatial and temporal scales, particularly for larger rivers. We examine issues relevant to large-scale and long-term restoration and conservation of riparian forest ecosystems along the Missouri River in six reaches that have been influenced by large, in-channel dams or extensive channel works, from Montana to Missouri. A geospatial database was used to combine information from historical maps, surveys and aerial photographs, and along with extensive field measurements, including re-sampling of long-term plots, we quantified the spatial extent of pre-development riparian forest, as well as successional trends in the structure and composition of post-dam forests, post-dam conversion of forests to other land uses or cover types, and the contemporary pattern and extent of forest establishment. Although forest persistence and establishment patterns varied in detail across reaches, new forest stands in general are far less extensive and are shaped by geomorphic processes that differ from the pre-dam era. Forest conversion has been extensive in the post-dam period and successional change in remaining stands is being influenced by novel flooding and groundwater regimes, the invasion of non-native plant species and introduced tree pathogens. The challenges of large-scale restoration of riparian forests along large rivers are daunting, but if undertaken, will require active, extensive and sustained effort.

Bats in restored areas: Community structure and use of space in a 12-years-old restoration project in the Atlantic forest of Brazil

Scultori, Carolina; Wesley Rodrigues Silva
Universidade Estadual de Campinas

Bats play a crucial role in restoration, contributing as pollinators, seed dispersers and controlling animal populations. We analyzed how bat community varies in a mosaic of vegetation types following different restoration treatments begun in 2001-2002 in the Atlantic forest of southeast Brazil. The study site is a former cattle ranch where 20 points randomly selected were sampled from May 2011 to April 2013, resulting in 687 captures, 15 species of bats. Richness (13 spp.) did not vary between rainy (September to March) and dry seasons (April to October), but the capture rate was bigger in the wet period (0,454 bats/hour of mist nets, contrasting with 0,296 bats/hour in dry period). Bigger diversity indices (Simpson 1-D = 0,5828) were found in forest remnants, followed by areas originally covered with pasture with arboreal regeneration (0,2794), and pasture with herbaceous regeneration (0,2048). Some rare species and species related to well-preserved habitats were found throughout the area, regardless the current physiognomy. Insectivores were captured more abundantly in forested and structured areas, hematophagous more related to areas undergone tree planting, and frugivores formed the bulk of the community, occurring in the whole area. *Sturnira lilium* was by far the most abundant species in the area. Despite the differences in the original vegetation cover and restoration treatments applied, the local bat community seems to continually adjust itself to the different restoration trajectories found in the area, especially the frugivores, a guild responsible for the transportation of autochthonous and allochthonous seeds.

Society for Ecological Restoration Great Basin Chapter

Shaw, Nancy
SER Great Basin Chapter

The Great Basin Chapter is focused on the portions of the western states of Idaho, Utah, Nevada, Oregon and California that comprise the Great Basin geographical – ecological province. The Great Basin contains some of the most endangered ecosystems in the United States and restoration factors prominently in land management priorities. Consequently, the need for SER representation in the Great Basin is evident. Organized in 2011, there are already 45 members working to promote ecological restoration as a scientific and technical discipline and a strategy for environmental conservation in the region. Recent activities have included a field tour in Utah which visited seeding efforts from sagebrush rangelands to alpine meadows, a co-hosted field day with the SageStep Program in Idaho with discussions of post-wildfire dust emissions and soil stabilization efforts and a drill calibration/operation workshop at the Birds of Prey National Conservation Area. The Chapter is now beginning to plan for a 2014 Joint Annual Meeting with the SERNW Chapter.

From lawn to pollinator habitat: Engaging northeast Wisconsin communities in small-scale restorations

Shutt, Nicole M.
USDA Forest Service

Government offices and school grounds often have mowed lawns that don't support many native species. Yet these sites can have great potential for restoration and learning, especially when near towns or cities. Since 2006, the Lakewood-Laona Ranger District of the Chequamegon-Nicolet National

POSTER ABSTRACTS (CONT'D)

Forest has worked with many partners to bring student-directed ecosystem restoration to schools and communities in northeast Wisconsin. Students collect seeds from native herbaceous plants on Forest Service (FS) lands in October, then clean, stratify, and sow the seeds during winter to grow plants in their classrooms for restorations at their schools and FS offices in May. Three local schools have created more than 7,200 square feet of restorations on their properties, and students use these plots as outdoor learning grounds. The District has a 7,400 square foot restoration at one office and is expanding the other office's restoration from 250 square feet to a goal of 9,000 square feet by 2015 with help from the community. Part restoration, part gardening, these plots provide habitat for pollinators and other wildlife while demonstrating how landscaping with native plants can provide beauty and reduce maintenance costs. Learn tips and techniques for turning even a small area into a native plant oasis, from site selection and analysis, to assembling a list of appropriate species and collecting seeds, to monitoring and maintenance. Anyone can restore pollinator habitat by turning lawn into local-genotype native plant restoration gardens at a school or office, in a yard, or anywhere in a community.

Evaluation of indicators of forest restoration area Semideciduous Forest of the Lowlands, Espírito Santo, Brazil

Siqueira Moreau, Julia; Marcilene Favalessa, Fagner Luciano Moreira, Sustanis Horn Kunz, Marcos Vinicius Winckler Caldeira
Federal University of Espírito Santo

The forest restoration actions implemented should be evaluated and monitored, but little has been done to analyze the effectiveness of recovery. The aim of this study was to evaluate indicators of forest restoration in Vale Nature Reserve, in Espírito Santo. The project was implemented in 2007 and the pre-planting and maintenance (held until 2010) activities adopted were: manual mowing, selective chemical weeding and ant control. The random planting of seedlings of 54 species of native shrub and crowning-tree natural regeneration were conducted. The indicators evaluated were: species and families richness and number of individuals planted and regeneration. This evaluation was performed at three and five years after the establishment of the experiment, being sampled and identified all individuals with DBH ≥ 5 cm. In the year of implementation (2007) there were 9 families and 12 species belonging to the natural regeneration process. In 2010, 17 and 31, respectively, were identified between planted and regeneration, whereas in 2012, 14 families, with emphasis on the Fabaceae, and 29 species. It was possible to see an increase in species richness and families until 2010, when the maintenance was still being held. In 2012, despite a growing number of individuals (140 to 334), there was a decrease in the number of families and species. This fact can be explained by lack of maintenance, probably suggesting that the three-year period was not sufficient to develop the ability of self resilience of the environment.

Effects of allelopathic chemicals of common reed (*Phragmites australis*) on aquatic invertebrates

Soto, Sasha D.; Elizabeth L. Roesler, David L. Rogowski
Texas Tech University

Common reed (*Phragmites australis*) has invaded vast areas of Bitter Lake National Wildlife Refuge (BLNWR) in Roswell, New Mexico, which is home to a variety of endemic, threatened, and endangered species. *Phragmites* rapidly is becoming a world-wide problem for native vegetation communities. Little is known about the ecological effects of such a vigorous invasive plant species. Pecos assimineae (*Assiminea pecos*), a semi-terrestrial endangered snail, is potentially negatively impacted by this monotypic invasion. Research on *Phragmites* and *Assiminea* interactions is important for the management and conservation of this rare snail. It is known that *Phragmites australis* releases allelopathic chemicals that negatively affect other plants; leaching of these chemical has inhibited germination and growth of roots and shoots. Perhaps these allelopathic chemicals also negatively affect aquatic and semi-terrestrial invertebrates, resulting in avoidance and possible increased mortality. We are interested in the potential allelopathic effects of *Phragmites* on aquatic invertebrates. Samples of *Phragmites*' (leaf and litter) will be dried, ground to a powder, and then soaked in water to extract potential allelopathic chemicals. We will expose the allelopathic extracts to the Phantom Cave snail (*Pyrgulopsis texana*) used as a surrogate for *Assiminea pecos* to record and analyze behavioral responses (e.g. avoidance). Various concentrations of *Phragmites* extracts from several sites at BLNWR will be tested. We expect greater snail avoidance with increased concentrations of *Phragmites* allelopathic extracts. Removal of the invasive plant will restore native vegetation and improve habitat conditions at BLNWR.

Agricultural utilization of green manure, sewage sludge and pastage: effect on the chemical properties of soils and recovery of degraded areas

Souto Filho, Sebastião Nilce; Marlene Cristina Alves, Otton Garcia Arruda, Rômulo Guimarães Giacomio, Débora de Cássia Marchini, Carolina dos Santos Batista Bonini
São Paulo State University

It is known that sewage sludge has a high content of organic matter and nutrients, acting as supply nutrients to soil and plants. This study aimed to evaluate the effects of human intervention techniques for recovery, after seven years, having been used a Savannah tree species, green manure, sewage sludge and pasture on the chemical properties of na Savannah Oxisol on human intervention, which retreated 8.5 m of soil for construction of a hydroelectric power plant, after seven years. The experimental design was randomized blocks with six treatments and five replication, which was implemented in 2004 and the treatments were: 1-Control - bare soil (without management), 2-species tree- *Astronium fraxinifolium*, 3 - *A. fraxinifolium* + *Canavalia ensiformis*, 4- *A. fraxinifolium* fodder *Raphanus sativus* by 2005 was replaced in 2006 by *Crotalaria juncea*, 5- *A. fraxinifolium* + *Brachiaria decumbens* + sewage sludge (60 t ha⁻¹, dry basis). Were studied the condition of Savannah native vegetation. Were analyzed chemical attributes of the layers from 0.00 to 0.05, 0.05-0.10, 0.10 to 0.20 and 0.20-0.40 m. The results were analyzed by performing the variance analysis and Scoot-Knott test at 5%

POSTER ABSTRACTS (CONT'D)

probability to averages comparison. The treatment *A. fraxinifolium*+*Brachiaria decumbens*+sewage sludge management is more suitable for the recovery of degraded soil under study, since increased Soil phosphorus, Organic matter, pH, magnesium, base saturation, ion exchange capacity in the two upper layers analyzed.

Groundcover vegetation responses to oak woodland restoration treatments in northern Mississippi, USA

Spiegel, Kimberly S.; J. Stephen Brewer

University of Mississippi

Fire maintained woodlands and savannas were an important ecosystem in the upland landscape of the Midwest and interior South of the United States prior to 20th century fire suppression policies. Oak-dominated woodlands in northern Mississippi that have experienced fire suppression are now closed canopy forests colonized by historically off-site fire-sensitive tree species. Closed canopies result in oak regeneration failure, reduction in groundcover plant diversity, and reduced flammability. The groundcover layer is important for many wildlife species, providing food, habitat, and nesting materials. A long-term restoration experiment was begun in 2004 at Strawberry Plains Audubon Center in Holly Springs, Mississippi. Paired treated and control plots were replicated at each of two sites, wherein treatments consisted of prescribed burning combined with canopy reduction. Nested subplots were established systematically to quantify cover, abundance, and composition of groundcover vegetation. Results revealed increases in several species of legumes (*Lespedeza repens*, *Stylosanthes biflora*) as well as the open oak woodland indicator *Helianthus hirsutus*. Some weedy annual species, e.g. *Erechtites hieraciifolia* and *Acalypha gracilens*, also responded positively to the treatments, at least initially. The warm season perennial grasses *Andropogon virginicus* and *Schizachyrium scoparium* also increased in response to treatments, which is important because they will increase flammability at the ground cover layer and could competitively suppress weedy annuals. The invasive *Lonicera japonica* declined in treated subplots. Several desirable responses occurred, including more grasses and legumes which provide nesting material and food for wildlife. An undesirable response also occurred with increased weedy species.

Using native herbivores to mitigate Eurasian watermilfoil invasion and restore New England lakes

Steele, LaTina; Michele Guidone

Sacred Heart University

Many lake restoration efforts nationwide focus on the removal of invasive aquatic plants, such as Eurasian watermilfoil (*Myriophyllum spicatum*). This plant has become a nuisance species in many lakes, leading to costly and often ecologically harmful eradication efforts. Unfortunately, there are relatively few effective alternatives for restoring lakes that have been invaded by *M. spicatum*. In this study, we explored the use of herbivores native to Connecticut that tolerate deterrent chemicals produced by *M. spicatum* and might provide an alternative to chemical treatment or mechanical removal of Eurasian watermilfoil for use in restoring New England lakes. We used a series of laboratory feeding experiments to determine which native herbivores consume *M. spicatum* and which combinations of herbivores are most effective in reducing standing milfoil biomass. To gain a more complete understanding of milfoil's impacts on local ecosystems, we conducted field experiments to document the effects of predator presence on milfoil consumption and herbivore community composition and diversity. While data are currently being collected, our results could point to management strategies to mitigate established milfoil populations and facilitate restoration of affected lakes.

Climate change impacts on habitats of wild ungulates in Aerjin Mountain National Nature Reserve, China

Su, Xukun; Shikui Dong, Shiliang Liu

Beijing Normal University School of Environment

Aerjin Mountain National Nature Reserve is one of 3 refuges for three kinds of ungulates (Tibetan wild donkey (*Asinus kiang*), Tibetan antelope (*Pantholops hodgsonii*), and wild yak (*Bos grunniens*)) that are endemic animal species in Qinghai-Tibetan Plateau (QTP). Pinpointing the main factors that impact on habitats of wild ungulates is critical for species protection management. Climate change as the natural factor is the main factor that impacts on habitats of wild ungulates in Aerjin Mountain National Nature Reserve. For the sake of sustainable development of wild ungulates in the future, we selected mean year temperature and precipitation as the main climate change variables to simulate the development tendency a hundred years later for identifying the impacts on habitats of ungulates. Results suggest that: in the first scenario, mean year temperature was the main factor to impact habitats of wild ungulates. According to noticeable changes in mean temperature, suitable habitats for wild ungulates decreased radically. In the second scenario, mean year precipitation was the main factor to impact habitats of wild ungulates. Due to differences of mean year precipitation, habitat fragmentation for wild ungulates was more obvious. In the third scenario, mean year temperature and precipitation impacted on habitats of wild ungulates jointly. The suitable habitat pattern of wild ungulates changed dramatically.

POSTER ABSTRACTS (CONT'D)

Life to ad(d)mire-Restoring drained and overgrowing wetlands

Tenning, Lisa; Annelie Lundgren, Johan Rova, Kristofer Paulsson, Henrik Gustafsson, Magnus Strindell, Sara Lamme, John Granbo, Kristin Lindström, Thomas Hansson
Länsstyrelsen Jämtlands Län

The Life to ad(d)mire project is restoring 35 Natura-2000 mire and wetland sites in Sweden. The project aims at stopping the decrease of habitats and species at these sites through hydrological restoration and vegetation measures. The hydrological restoration is targeted by filling the ditches draining the mires; most of these restorations are done by excavators. Peat is used for filling the ditches, logs and cloth are used as plugs to stabilize the structure. This method gives an immediate positive effect on the surface water. In other parts of the mires the ditches are given a more natural appearance by meandering morphology, this method can be used where the peat banks are weathered. Overgrown wetlands are cleared from shrubberies and weed. The vegetation is removed with the help of clear cutters and/or smaller machines that do not to leave any marks in the terrain. These overgrown wetlands were historically used for haymaking. Agricultural species adapted to these ancient land uses are decreasing or going extinct due to overgrowing habitats and modernized agricultural management. Before, during and after the restorations there is monitoring of the vegetation, bird populations, groundwater levels and water chemistry. Life is EC 's financial instrument supporting Nature and Environmental conservation projects, the goal is a decreasing loss of biodiversity within Europe. Life Nature supports projects within Natura 2000-sites. Natura 2000 is a network established for EU 's most threatened species and habitats. Life Nature supports projects contribute to the implementation the Birds and Habitats Directives.

Stratford Point restoration: From gun club to coastal dune habitat

Timoney, Caitlin; Jennifer Gazerro, Jennifer Mattei, Anton Leenders, Mark Beekey
Sacred Heart University

Coastal zone habitats exist in areas of high disturbance that vary in cause, frequency and intensity. Disturbances, both natural and anthropogenic, can disrupt ecosystem functions in an area. Through our remediation efforts, we are working to restore ecosystem functions to Stratford Point, a degraded coastal property located at the junction of the west side of the Housatonic River and the Long Island Sound in Connecticut. With its proximity to the Housatonic River Estuary, Stratford Point historically supported a substantial tidal marshland patchwork of dune and coastal grassland habitats. After becoming home to the Remington Arms Gun Club from 1926 to 1986, concerns arose over lead shot accumulation in the environment and forced the club to cease its operations. After a large-scale remediation during 2000 to 2001, the upland habitat was re-graded and seeded with a mixture of fast-growing drought and salt-tolerant grasses. With an initial remediation complete, the next question lies with how Stratford Point should be further restored. Initially, Milford Point, a local protected wildlife management area, was used as a local reference site, as both sites are similar to the same disturbances (e.g. flooding from hurricanes and sea level rise, human trampling, invasive species, etc). However, recent documents have surfaced containing 80-year-old land coverage information on Stratford Point. In the case of Stratford Point, is it better to restore the degraded location to the plant species and composition of the local reference site, or to regress and restore according to the information in the 80-year-old published documents?

LIFE Peat Land Use, Quantification and valuation of ecosystem services to optimize sustainable re-use for low-productive drained peatlands

Tolvanen, Anne
Finnish Forest Research Institute and Thule Institute of the University of Oulu

Low-productive drained peatlands cover 20% (ca. 0.8. million ha) of the drained peatland area in Finland. These peatlands do not produce enough timber to fulfill commercial purposes, and simultaneously, their biodiversity is degraded, they may continue environmental loading to watercourses and act as greenhouse gas sources. A key question is to plan the future use of these peatlands by simultaneously balancing multiple needs addressed to them. In the Finnish Government Program on the sustainable use of mires and peatlands, an assessment of the cost-efficiency of re-use options of low-productive peatlands is called for, and reforestation, restoration and peat harvesting are mentioned as the most relevant re-use options. This new 5-year EU funded LIFE project brings information, which directly fulfills the targets set in the Government Program. The project quantifies, values and predicts the state of peatland ecosystem services, and optimizes their levels in the land use to fulfill requirements and constraints set in regional, national and EU policies. Future scenarios on the impacts and cost efficiency of seven re-use options are predicted; 1) no measures, 2) tree biomass harvesting for bioenergy, 3) intensive forestry, 4) restoration, 5) peat harvesting, 6) peat harvesting and reforestation, 7) peat harvesting and rewetting. States of biodiversity, GHG fluxes and environmental loading are predicted after these seven re-use options. A decision support system is created, which consists of model predictions, numeric optimization maximizing the monetary value of the re-use options, participatory decision support tool analyzing trade-offs and preferences of stakeholders, and GIS based maps.

Effects of tallgrass prairie restoration on native bee communities in northeastern Illinois

Tonietto, Rebecca; Daniel Larkin
Northwestern University and Chicago Botanic Garden

We evaluated the effects of restoration on native bee communities using a chronosequence of prairies restored in former agricultural fields in northeastern Illinois. We compared bee communities of 10 restored sites (2-37 years old) with 4 old fields representing unrestored controls and 4

POSTER ABSTRACTS (CONT'D)

remnant prairies as reference communities. Bees were collected three times during each growing season for three consecutive years using pan traps and netting. We conducted detailed vegetation and habitat surveys to quantify foraging and nesting resources at each site. We also quantified surrounding land-use cover at multiple radii. Floral community and ground cover composition were significantly different by habitat type, with restorations intermediate to old fields and remnants. Restoration age was positively correlated with floral diversity, yet negatively correlated with floral abundance. We collected 4,740 bees, representing 23 genera. We collected more bees from sites with greater floral abundance regardless of floral diversity or restoration age. There were similar proportions of carpenter and leafcutter bees in restorations and remnants, yet very few of either from old fields. Over 75% of bees collected from old fields were sweat bees. The bumble bee community was similar among habitat types and was not correlated with forb communities. We are currently identifying bees to species, and will evaluate bee communities based on taxonomy, species-traits and phylogenetic relationships. Our results to date indicate prairie restorations attract diverse and abundant native bee communities. Preliminary recommendations to land managers include focusing on floral diversity as restorations mature to support more diverse bee communities.

Relative abundance and feeding habits of native piscivorous fishes at The Nature Conservancy's Emiquon Preserve and Reelfoot Lake: Can native fish control common carp?

VanMiddlesworth, T.D.; Greg Sass, Timothy Spier, Bradley Ray
Illinois Natural History Survey

During 2011-2012, we sampled Reelfoot Lake, TN to better understand why it is not dominated by common carp (*Cyprinus carpio*). Reelfoot Lake is similar to The Nature Conservancy's Emiquon Preserve in that they are both shallow, disconnected floodplain lakes containing bowfin (*Amia calva*), spotted gar (*Lepisosteus oculatus*), largemouth bass (*Micropterus salmoides*), and common carp. However, these lakes differ in that Reelfoot Lake is over 100 years old, while the Emiquon Preserve is only 6 years old. We used standardized pulsed-DC electrofishing at random and fixed sites to assess the fish communities and the stomach contents of bowfin, spotted gar, and largemouth bass in both lakes to test for prey selection and young-of year and/or juvenile common carp predation. Our catch-per-unit effort data suggests that the largemouth bass relative abundance at Reelfoot Lake was lower than that of the Emiquon Preserve. Bowfin and spotted gar relative abundances at Reelfoot Lake were higher than those of the Emiquon Preserve. The relative abundance of common carp was similar to those of bowfin and spotted gar at Reelfoot Lake in 2011 and lower in 2012, whereas the relative abundance of common carp was greater than those of bowfin and spotted gar at the Emiquon Preserve. Our bowfin, spotted gar, and largemouth bass diet analyses suggest that they may not be selecting for young-of year and/or juvenile common carp as a prey type. So these species may not be directly influencing common carp via predation but perhaps indirectly through other pathways.

The restoration method changes the microstructure of plant-pollinator networks? A study case in early successional areas in Atlantic Forest

Varassin, Isabela G.; Jana M. T. Souza
Universidade Federal do Paraná

Recently, restoration practices are being evaluated from a functional standpoint. Biotic pollination may enhance the resilience in restored areas so it is an important ecosystem service to be taken into account. We evaluated the restoration of plant-pollinator interaction networks in early successional areas in South Atlantic Forest, Brazil. We evaluated the relative contribution of restoration method, geographical distance, plant composition, pollinator composition, temporal abundance of flowers and insects, plant-pollinator temporal overlap to predict the establishment of pairwise interactions. Pollinators and plants visited by them in six plots in reforested areas and six plots in natural regenerated areas were sampled monthly, during 20 months. Flower abundance was counted in three months, during the summer. The relative contribution of each factor to predict network microstructure was analyzed by structural equation modeling. Contrary to the initial expectations, the structure of pairwise interactions was not explained by the restoration method, probably because the landscape is a conserved forest matrix and due to differences in the initial conditions among plots, a small temporal window in the successional processes and or a large variability in smaller spatial scale. Phenological overlap explained more than half of the network microstructure, so it was considered the best predictive variable, followed by temporal abundance and plant composition. We suggest that the species selected to restoration practices in tropical forests should have different flowering phenologies to attract and maintain a diversified group of pollinators during the whole year. Studies under a larger successional window and in more disturbed areas are necessary.

Pre-restoration native bee survey at former surface mine sites offers insight into value of reclamation to local pollinator community

Wallace, Jessie; Karen Goodell
Ohio State University

Surveys of native bee communities before and after strip mine restoration can provide insights into the recovery process and help assess the value of reclaimed lands to pollination services of the surrounding landscape. During 2012 and 2013, I sampled native bees using pan traps at five 2-5 acre former mine sites (slated for restoration) within a forest-agricultural matrix in Southeastern Ohio to determine if pollinator communities vary temporally and spatially at a fine scale. I predicted that due to high disturbance, the community would contain mostly generalists, and relatively high proportion of twig-nesters because of high availability of nest sites. 48 species of bees were identified, out of 643 total individuals. Small-bodied soil-nesting species were the most common, with relative abundance of five major families being (most to least): Halictidae, Andrenidae, Apidae,

POSTER ABSTRACTS (CONT'D)

Megachilidae, Colletidae. A small proportion (20%) were captured on more than ten occasions, suggesting high within-season species turnover. 32% of species were represented by a single individual. Cleptoparasites were present in low numbers. Seasonal abundance and richness followed a bimodal distribution, peaking in May and July. Individual mine sites did not differ significantly, suggesting species pool should be measured on a larger scale. As unreclaimed mine lands offer no floral resources themselves, species composition post-restoration should reflect that of adjacent habitat. Therefore, comparisons to samples from nearby field habitat may offer insight as to which species are expected to colonize newly restored sites based on life history traits and local abundance.

The soil enzyme activity and nutrient dynamic response to experimental warming in the Tibetan plateau

Wang, Xia; Yu Wu

School of Environment, Beijing Normal University

Knowledge about the role of soil enzyme activity in nutrient cycling and response to climate change in alpine ecosystems is still rudimentary. We conducted two separate studies to assess the relative role of warming on soil enzyme activity and the nutrient of carbon, nitrogen and phosphorus in the Qinghai-Tibet Plateau, China. Experiments were conducted for 2 years (short-term) and 10 years (long-term) under a controlled warming system. A free-air temperature enhancement system (FATE) using infrared heaters significantly increased soil temperatures (average 1.5–2.0°C) from 0 to 15cm depth. The results demonstrated that neither short-term nor long-term warming caused changes of the soil total carbon (TC), total nitrogen (TN), total potassium (TP), soil Organic carbon (SOC), available nitrogen (AN) and available potassium (AP) at soil depths of 0–15cm in grassland. Specifically, we found that the short-term warming significantly increased the microbial biomass C and the soil cellulose, significantly reduced on the soil urease. However, long-term warming significantly increased soil cellulose, the effects of long-term warming on microbial biomass C, N, P, the urease, catalase and phosphatase were not significantly, compared to the ambient treatment. The study suggests that warming on the soil enzyme activity and microbial biomass may have a short-term effect, this effect would go away gradually along the long-term warming. These results may have important implications for ecosystem dynamics under the climate warming in the region.

Short term restoration of highly disturbed construction sites

Weber, Irene J.; Mark Grinter, Susan M. Morgan, William A. Retzlaff, Peter R. Minchin

Southern Illinois University Edwardsville

When construction sites are inactive for several months, temporary restoration is used to prevent erosion until construction resumes or more permanent restoration is implemented. Currently, the Illinois Department of Transportation prescribes the same temporary restoration method, seeding a perennial rye and oats mixture, regardless of seeding date or site location. The purpose of this research is to evaluate the effectiveness of the currently prescribed methods and determine if different seed mixes, soil preparation and mulching methods will yield more successful results. We are performing experiments at four locations across Illinois, with seeding occurring at each site four times throughout the year. Climate patterns vary across Illinois, suggesting a need for variation in temporary restoration specifications statewide. Factorial combinations of ten seed mixes by two soil preparation methods by three mulching methods are being tested, with three randomized blocks per planting at each site. Vegetation height is measured at two month intervals and vegetation cover is determined using image analysis in Adobe Photoshop. Preliminary results from the fall 2012 seeding suggest that the current specification is inferior to other tested methods. Annual rye performs best in southern Illinois while cold weather grains (winter wheat, cereal rye, and barley) perform better in northern Illinois. Mulching with straw mat facilitates the best vegetative cover and minimizes seed predation. The soil preparation methods tested have equivalent effects on vegetation establishment. The experiments will continue until fall 2013 and results are expected to lead to modifications of the temporary stabilization specifications for Illinois.

Soil-based revegetation of a degraded ultramafic and serpentinitic roadside cutslope in the Northern California Coast Range

Weigand, James F.; Victor Claassen, Arek Fristensky, Matthew Curtis, Ryan O'Dell

Bureau of Land Management

Plant growth is difficult on ultramafic and serpentinitic soils. When the preexisting serpentinitic topsoil is removed by excavation or landslide, growth is even more difficult. Sites can become chronically barren and erodible. We approached revegetation of such a harsh site by deconstructing multiple plant growth-limiting factors and addressing each in turn. Treatments and amendments to maintain endemic species on the revegetated slope avoided introducing annual weeds. Infiltration was increased on the compacted substrates to capture rainfall and retain it in deeper soil horizons. Artificial fractures were created to percolate water deeply and reduce evaporation losses during the rainless Mediterranean summer. Field-measured hydraulic parameters and Hydrus-2D software were used to achieve on site an infiltration capacity sufficient to imbibe a 25-year 1-hour storm event with no surface runoff. Plant-source compost amendment was limited so that ambient calcium:magnesium ratios were still selective for serpentine-adapted plants. Plants collected locally were either seeded on site or were germinated in cardboard plant bands which were then installed intact on the slope. These steps reduced initial water loss and encouraged roots to grow downward into the fractured and amended substrate. Plants included *Achillea millefolium*, *Ceanothus jepsonii*, *Elymus multisetus*, *Melica californica* and *M. torreyana*. A few *Elymus* and *Melica* plants in better microsites flowered and seeded the first year. Plants of all the listed species survived in various sites on the cutslope. Plant survival was low on less intensive surface-only treatments.

POSTER ABSTRACTS (CONT'D)

Defining life history strategies of tropical dry forest tree species: Implications for future restoration projects

Werden, Leland K.; Justin M. Becknell, Jennifer S. Powers

University of Minnesota - Twin Cities

The initial establishment of early successional tree species, followed by enrichment plantings of mid to late successional species, has been effective in the active restoration of moist forests in Costa Rica. However, basic life history information, which is necessary to apply this forest restoration approach, is lacking for tropical dry forest (TDF) tree species. This study aims to quantify the successional strategies and patterns of dominance of 32 abundant tree species in an extensive sample of naturally regenerating forest inventory plots in Guanacaste, Costa Rica. In order to accomplish this, we used a dataset of 84 20 x 50 m plots in Sector Santa Rosa and Palo Verde National Park that includes a chronosequence of stands ranging in age from 5-100 years. In each plot all trees >10cm DBH have been identified and measured, and extensive data on soil properties have been collected. Results show some species have strong positive or negative associations with nutrient availability and ongoing analysis aims to group these species by their dominance in different successional stages to determine at which point early successional species are outcompeted by later successional species. Understanding typical successional age ranges of species in naturally regenerating TDFs, and the nutrient use strategies of specific species, could prove invaluable when designing mixes of tree species for active restoration projects, and when determining soil nutrient requirements for initial species establishment. Information gleaned in this study will be used for the development of future TDF restoration projects in Costa Rica.

Reconnecting a riverine landscape by comparing ecological and hydrogeomorphic gradients of the past and present

Whipple, Alison A.; Andrew Nichols, Julie Beagle, Robin M. Grossinger, Joshua H. Viers

University of California, Davis

Large-scale estuarine and riverine restoration, such as current efforts in California's Sacramento-San Joaquin Delta, is benefitted by approaches that support reconnection of hydrological and other physical gradients that enhance ecosystem functions. Due to widespread landscape modification, however, it is often difficult to recognize underlying processes and resulting ecological patterns indicative of ecosystem functioning under unmodified conditions. Here we use the relatively natural flow regime of the Cosumnes River and its adjacent floodplains to examine and better understand such gradients, processes, and patterns. We coupled previously conducted historical ecology research with geospatial and hydrological analyses to identify differences in ecological and hydrogeomorphic gradients between tidal wetlands and riverine floodplains of the early 1800s and present. Despite the Cosumnes River's natural hydrograph, movement of water within the landscape is substantially altered. The comparison provides new insights into expected outcomes from current floodplain restoration efforts given physical limitations, such as levees, depleted groundwater, and incised channels. Based on noted differences in hydrogeomorphic patterns, we anticipate that resulting vegetative response from current efforts may not be indicative of historical conditions. However, these differences also suggest that opportunities exist for using the flow regime to improve linkages between landscape elements supported by restoration, such as intentional reconnection of seasonal floodplains and other process-based restoration projects. Though reconstructing the past is neither an option nor a goal, supporting processes within the contemporary landscape in ways reflective of past function – perhaps in different locations or at compressed scales – may produce more resilient ecosystems.

Great Lakes coastal wetland monitoring program assists restoration efforts

Wilcox, Douglas A.; Donald G. Uzarski, Valery J. Brady, Matthew J. Cooper, Terry N. Brown

SUNY College at Brockport

Coastal wetlands are among the most threatened and ecologically important habitats in the Laurentian Great Lakes. In 2000, the Great Lakes Coastal Wetlands Consortium developed a basin-wide monitoring plan to determine the condition of coastal wetlands, and with funding from the Great Lakes Restoration Initiative via USEPA GLNPO, implemented the program in 2011 through the combined efforts of university and agency collaborators. Chemical and physical parameters, vegetation, invertebrate, fish, amphibian, and bird data were collected from randomly selected Great Lakes coastal wetlands across the basin using standardized protocols. This stratified randomized design was intended to inform future protection and restoration efforts. However, additional wetlands designated for restoration efforts were also sampled as benchmarks to develop baseline data for evaluation of future progress. A total of 382 wetlands were sampled during 2011 and 2012, and distinct differences among lakes were observed. Wetlands on lakes Erie and Ontario had the lowest average species richness for plants, macroinvertebrates, birds, and fish, and had the most non-native fish and plant species. Lake Huron wetlands had the highest invertebrate, fish, and bird taxonomic richness on average. Lake Superior wetlands had the fewest non-native plant species compared to wetlands on the other lakes. A total of 23 wetlands were sampled as benchmarks in the first two years, and some restoration projects have since begun implementation. Follow-up sampling in 2013-2015 will provide initial monitoring data for these restoration sites using standardized protocols that can be compared across lakes and wetland types.

POSTER ABSTRACTS (CONT'D)

Moapa dace (*Moapa coriacea*) numbers increase ten-fold after stream restoration on the Warm Springs Natural Area in Southern Nevada

Winkel, Von; David Syzdek
Southern Nevada Water Authority

The Apcar Stream, a tributary of the Muddy River, located on the Warm Springs Natural Area approximately 7 miles northwest of the town of Moapa, Nevada, is home to the Moapa Dace (*Moapa coriacea*), a small endemic and endangered fish. By 2011, the value of the Apcar stream for Moapa dace habitat had been severely compromised by decades of intensive agricultural activities. The width of the stream averaged more than 15 feet, the water was slow and choked with cattails, and introduced, exotic fish were thriving. An additional impact to the stream and the Moapa dace came in the form of a wildfire that destroyed most of the vegetation along the stream in 2010. During 2011 and 2012, a 1300-foot section of the Apcar Stream was narrowed to an average width of 5 feet. Pools and riffles were incorporated into the design of the reconstructed stream and stream banks were stabilized with vegetation consisting of an over-story of Goodding's willow (*Salix gooddingii*), velvet ash (*Fraxinus velutina*) and Western honey mesquite (*Prosopis glandulosa* var. *torreyana*) and an understory of 13 species of grasses, forbs and shrubs. Materials consisted of 2800 cuttings, sod plugs and propagated plants, all obtained from the Muddy River drainage. Plant survival was approximately 30% for cuttings, 90% for sod plugs and over 70% for propagated plants. Moapa Dace rebounded from a low of 23 fish before restoration to 328 fish after restoration; a ten-fold increase.

Avian Response to Tidal Salt Marsh Restoration at Bandon Marsh National Wildlife Refuge in Southern Oregon

Wishnek, Benyamin; Paul Adamus, Bill Bridgeland
Oregon State University

During the last 150 years over ninety percent of the estuary habitat in the Coquille River system in Oregon has been lost or altered due to anthropogenic activity. A portion of this degraded habitat is included in Bandon Marsh National Wildlife Refuge (BMNWR). The 360 ha BMNWR is comprised of the Bandon Marsh and Ni-les'tun units. The Ni-les'tun unit was formerly a tidal marsh but was diked and drained for agricultural purposes in the early 20th century. The marsh was restored by the US Fish and Wildlife Service in 2011 with the primary goal of expanding habitat for migratory birds and fish, and became the largest tidal marsh restoration project in the state of Oregon. Ongoing bird surveys have been conducted on a weekly basis on both the restoration site and natural tidal marsh habitat during the breeding season, and on a bi-weekly basis during the non-breeding season beginning two years prior to the restoration. To partially justify the resources expended for this project, managers intend to determine if project goals for the avian community were met. This research seeks to describe the changes in species' density and community composition of the birds targeted by the restoration. Analyses will be conducted at both the foraging guild and the individual species levels. Population densities of resident species and community diversity indices will be used to describe changes in the avian community composition before and after restoration and inform expectations of restoration practitioners about the avian response to tidal marsh restoration projects.

Effects of land degradation and artificial restoration on carbon storage in alpine grassland ecosystems of the Headwater Area Nature Reserve on the Qinghai-Tibet Plateau, China

Wu, Yu; Yuanyuan Li
Beijing Normal University, China

Numerous combined factors, such as overgrazing and climate change, affect the soil organic carbon stock in the alpine regions of China and all of these factors lead to grassland degradation. This study centred on extrapolating the field survey to whole region of the headwater area on the Qinghai-Tibet Plateau and quantified carbon loss due to severe grassland degradation as well as response of carbon storage to the establishment of artificial grassland in black-soil-land. The distribution map of black-soil-land was made, indicating that the majority of severely degraded grasslands distributed in the east and centre of the Headwater Area Nature Reserve. We analysed the soil properties in different grasslands and calculated relative soil organic carbon change among grasslands at different stage of succession. The results showed that the black-soil-land in this area suffered nearly 311.3Tg of carbon loss compared with non-degraded grassland and the scenario analysis among different artificial cultivation ages(5y, 7y, 9y)in black-soil-land revealed carbon storage would increase by 14.88Tg , 26.33Tg after 5 and 9 years, respectively if all black-soil-land in this area was restored by means of artificial reseedling while 7y artificial establishment decreased carbon storage by 11.90Tg instead. All of these concluded that the effect on carbon stock increase was not followed by cultivation age; there is an optimal artificial cultivation age. The research could help reveal how soil organic carbon would change under different cultivation ages and its relationship with soil properties, offering scientific theory in restoring black-soil-type grasslands in the future.

Local responses to ecological restoration policy in a changing situation: case study of Switch from Fuelwood to Electricity in Wolong Nature Reserve, southwestern China

Xu, Jianying
Capital Normal University

Wolong Nature Reserve, one of the largest giant panda (*Ailuropoda melanoleuca*) reserves in China has suffered from serious habitat degradation. Local people's dependence on and collection of fuelwood was considered as main reason of continued habitat loss. Electricity, available throughout Wolong, was taken as energy alternative to replace fuelwood. Hence, a new restoration policy/project, Switch from Fuelfood to Electricity(SFFE),

POSTER ABSTRACTS (CONT'D)

was implemented compulsively in 2000. According to our investigation in 2003 and others' study, the majority of local households continued to use fuelwood as their main energy source. The adoption of electricity was affected by demographic, electricity factors (price, voltage, and outage frequency) and local traditional custom. What's more, the SFFE policy triggered conflicts between local people and the reserve. In addition, another restoration policy, Natural Forest Protection Project, was threatened because of its close relationships with electricity fee. Therefore, SFFE had great significance in ecological restoration, protected area management and biodiversity conservation. However, great changes happened in Wolong after earthquake in 2008 in Sichuan Province according to our investigation in 2011. Comparing to 2003, more and more people began to accept the SFFE policy and their dependence on fuelwood reduced greatly. Especially, optimistic changes happened in local recognition of electricity price and fuelwood consumption in cooking (both human food and pig fodder) and heating in winter, which were once considered the main reason of rejecting electricity. It was attributed to local improved socio-economic conditions, especially relocation and rebuilding after earthquake. Dynamic management should be involved in restoration policy evaluation.

The Great basin provisional seed zone map: A tool for developing genetically diverse native plant materials for ecological restoration

Youtie, Berta; Nancy Shaw

Eastern Oregon Stewardship Services

Wildfires, exotic annuals, primarily *Bromus tectorum* (cheatgrass), and increasing population pressure have caused widespread degradation of *Artemisia tridentata* var. *wyomingensis* (Wyoming big sagebrush) communities in the Great Basin of the Western United States. Federal laws, policy, and regulations prescribe the use of native species for restoration, where feasible, to provide healthy communities that are resistant to exotic invasives and resilient to climate change and other environmental stressors. Native forbs are seeing increased use to improve diversity and provide habitat and food sources for sage-grouse, pollinators and other species. Selection of genetically appropriate material is essential for restoration projects, but seed transfer guidelines are lacking for native forbs. To aid in matching seed sources with planting site conditions, we used a provisional seed zone map that is based on climatic data (minimum winter temperature and an aridity index). Omernik ecoregions were overlain to provide subdivisions within seed zones. We mapped known collection sites of three key native forb species: *Lomatium dissectum* (fernleaf biscuitroot), *L. triternatum* (nineleaf biscuitroot), and *Penstemon speciosus* (royal penstemon). Using these maps we identified where each species was most common and could be considered for use in restoration. We also determined whether the number and distribution of known seed collection sites in each zone was adequate for developing a genetically diverse seed source for that zone or whether additional collection sites were required. When combined with knowledge of the species' biology and microsite requirements, the provisional seed zone map provides a valuable tool for plant material selection.

Measurement of ecological disturbance in coal mining area with highgroundwater level: Taking Xuzhou Coal Mining Area as a study case

Zhang, Shaoliang; Huping Hou, Zhanjun Xu

China University of Mining and Technology

Plain Eastern China is a region with developed economy, dense population, advanced agriculture, and also a region with abundant coal resource and long history of mining such as Xuzhou, Kailuan whose mining activity has extended for more than 150 years. Coal mining with long time and high intensity not only emerged large amount of subsidence and waterlog, but also damaged prominently ecosystem. The paper, using Remote Sensing technology and site investigation, develops a measure model to ecological damage with measurable indicators including Net Primary Production (NPP) and organic carbon in soil. Based on the improved CASA model, the NPP variation and spatial distribution between time intervals of 1987, 1998, 2005, and 2008 are measured. The results indicate that the influence from mining activity on NPP is greater than that from climate change, and the impact scope by climate change is from 0.111 gCm⁻²month⁻¹ to 3.333 gCm⁻²month⁻¹ while mining activity is from 90.525 gCm⁻²month⁻¹ to 107.892 gCm⁻²month⁻¹, so NPP is an effective indicator to measure ecological impact of mining activity. Site investigation and analysis discovers that waterlog size and topographic slope in subsidence area are the main factors causing organic carbon variation, and soil bulk density, saturated hydraulic conductivity, and clay content are higher correlation with organic carbon. The result from the model indicates that in the study area of 42.15Km², 9.1×10⁴ metric tons of organic carbon reduced during the mining life, so coal mining is carbon source due to soil carbon pool disturbance.

Impacts of small hydropower stations on ecological environment and restoration countermeasures in the Yangtze River basin

Zhao, Weihua; Qingyun Li, Huiqun Cao

The Changjiang River scientific research institute

Small hydropower stations play an important role in satisfying the requirements of electricity for rural working and living conditions. However, its unreasonable plan and disorder development cause great destructions to the ecological environment in some rivers in recent years. A case study of small hydropowers in the Yangtze River basin, which was divided into three zones, was carried out for assessing the positive and negative effects of small hydropowers development on the ecological environment. The results indicated that the small hydropowers had a positive role in protecting forests and reducing greenhouse gas emissions. The phenomenon of homogenized river discharge and river's dry up caused by rural hydropower was striking. The river water quality was also influenced by small hydropowers in dry season. Significantly effects of small hydropowers on the community structures

POSTER ABSTRACTS (CONT'D)

and standing crop of aquatic organisms were observed. Its impacts on the soil erosion were limited. In response to the existing problems, the present study offers some environmental restoration countermeasures, including division management of rural hydropower development, implementing of engineering environmental restoration measures, strictly executive system of environmental flow, establishment artificial pool-step systems and green small hydropower certification system in the Yangtze River basin.

Study on the ideas and methods of delineating ecological red-line in China

Zou, Changxin; Jixi Gao

Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection

The red line is generally refers to impassable boundaries or number. The Chinese government firstly proposed to delineate ecological red-line task in 2011, the delineation of ecological red-line was a pioneering and also an exploratory work. The author defines "ecological red-line" as a land space which must be protected strictly, and has a highly strategic significance to the maintenance of national and regional ecological security and the sustainable development. The author thinks that the main functions of the ecological red-line are protecting important ecosystem services and human living environment, and maintaining biodiversity. Specifically, the important ecological function regions include water source conservation areas, water and soil conservation areas, sand fixation areas and flood regulation and storage areas, etc, the human living environment include water-land transition zones, ecotone, expansion of desertification, etc, the areas of biodiversity conservation include the habitats of protected species and ecosystems. The Methods of delineating ecological red-line differ from different types of ecological red-line zones. Ecological red-line of important ecological function areas should delineate the areas with the most important ecological functions by the assessment of importance of ecosystem services; ecological red-lines of human living environment are delineated by the most fragile and sensitive zones which be defined by evaluation of ecological environment; ecological red-lines of biodiversity conservation are delineated by the assessment of conservation status, protection gap-analysis and determining the minimal area to keep species or ecosystem alive. In order to strengthen the long-term management, ecological red-line must have clear boundaries.

Environmental management in a highly urbanized watershed: rehabilitation needs, land use planning and social implications

Zuleta, Gustavo; Bárbara Guida Johnson, Cristina Lafflito, Gabriela Amuchástegui, Gonzalo Barrios

Lomas de Zamora University, Faculty of Engineering

Growing urbanization continues to severely degrade natural ecosystem remnants due to intensive exploitation, unsustainable development, and lacking land use planning. In particular, impacts on watercourses are still considerable in many parts of the world, as in the Matanza-Riachuelo watershed (MRW), one of the most polluted in Argentina. It is dominated by one of the 27 world's megacities (Buenos Aires) downstream, while in the upper basin agriculture almost completely replaced natural grasslands. In 2010 we started an investigation project in order to provide realistic solutions to reverse degradation in the MRW. We developed four lines of research: ecological restoration, landform rehabilitation, land use planning, and social perception. We analyzed satellite imagery and aerial photography, developed spatially explicit models in GIS, performed field surveys, and identified and interviewed key social actors. Main results were: riparian areas constitute an opportunity to restore degraded habitats and their level of degradation is in correspondence to the land use in the adjacent floodplain; periurban land use presents potential for recovery and environmental management acting as a buffer between urban and rural areas; quarry open pits, which are distributed mainly in the middle part of the basin, represent one of the major impacts on the physical environment and have potential for habitat creation; perception with respect to degradation, rehabilitation needs, and effective management measures vary widely among stakeholders. We discuss the potential and suitability of these findings as a planning tool for the decision making of 15 municipal authorities responsible for the watershed management.

5th World Conference ON ECOLOGICAL RESTORATION

REFLECTIONS ON THE PAST, DIRECTIONS FOR THE FUTURE

AUTHOR INDEX

A

Abdullah, Meshal	7
Abernethy, Robert.	7
Abu, Yusuf.	7
Aegisdottir, Hafdis Hanna	8
Aguilar-Fernández, Rocío	198
AlAteeqi, Sarah	8
Albers, Victoria L.	198
Alexander, Ted.	8
Ali, Basim Abd.	199
Alignan, Jean-François	8
Alleger, Sue Ann.	9
Allen, Edith B..	9
Allison, Stuart K.	9
Al-Musawi, Layla	198
Alves, Marlene Cristina	199
Ament, Rob.	9
Ament, Robert	199
Amir, Hamid	10
Andersen, Kelly M.	10
Anderson, Jeff K.	10
Anderson, Roger C.	10, 199
Andrade, Bianca	11, 200
Andruk, Christina M.	11
Ansell, Dean H.	200
Appelbaum, Stuart	11
Aradottir, Asa L.	12, 200
Arellano, Eduardo	12
Argueta Pineda, Jose Maria	12
Aronson, James	12, 13
Arroyo-Pérez, Erika	201
Aschenbach, Todd	13
Asem, Samira	13
Atkinson, Michael R.	14
Austin, Valer.	14
Axler, Richard.	201

B

Babu, Suresh.	14, 201
Bach, Elizabeth M..	14
Backus, Laura L.	15
Bacre González, Ramón Agustín	15, 201
Baer, Sara	16
Baer, Sara G..	15
Baker, S. Paige	16
Bakker, Jonathan D.	16
Baldwin, Matthew	202
Balla, Esther C.	202
Ballantine, Kate A.	17
Balsdon, Jennifer Lau	17

Bandyopadhyay, Baisakhi	202
Barak, Rebecca S.	17
Barber, Timothy R.	18
Barik, Jyotiskona	18
Barker, Steve	18
Barr, Stephanie A.	19
Bart, David	19, 203
Barth, Molly A. F.	19
Bassett, Tyler	203
Battershill, Chris	20
Bauer-Armstrong, Cheryl	20, 203
Bauer, Jonathan T.	20
Baughman, Owen W.	20
Bauman, Jenise M.	21
Baumgarten, Joni M.	21, 203
Bautista, Francisco	21
Bean, Dan W.	22
Beard, Catherine	22
Beauchamp, Vanessa B.	22
Bechara, Fernando.	22
Behnken, Jennifer A.	204
Beier, Paul.	23
Beitz, Pamela	23, 204
Bell, David G.	204
Benini, Rubens de Miranda	23
Benjamin, Gretchen	24
Benjamin, Sara Brooke.	205
Benson, David P.	205
Berg, Joe	24
Bess, James A.	24
Beverlin, Jason.	24
Beyer, Amy	25
Beymer-Farris, Betsy A.	25
Binai, Nagarajan	25, 205
Birchenko, Inna	25
Blanco-García, Arnulfo	26
Blickenderfer, Mary	26
Blodgett, Jono.	26
Blodgett, K. Douglas	26
Bloodworth, Ben	27
Bluhm, Jodi D.	27
Bogue, David	27
Boisson, Sylvain	28
Bonfil, Consuelo.	205
Boone, Randall	28
Boring, Lindsay R.	28
Borkenhagen, Andrea	28
Bosco, Tomás	206
Botelho, Rui.	29
Bouazza, Karma	29
Boudell, Jere A.	29

AUTHOR INDEX (CONT'D)

Bousquin, Stephen G.	29
Bowers, Keith	30
Bragg, Tom	30
Braid, Samantha	30, 31
Brancalion, Pedro	31, 206
Breen, Daniel B.	31
Brenes, Paola	206
Brewer, Steve	207
Bried, Jason	31
Brody, Marc	32
Brookner, Jackie	32
Brownknight, Jason	33
Brown, Rebecca L.	32
Brown, Sibylla	33
Brudvig, Lars A.	33
Brush, Timothy	207
Bulot, Adeline	33
Burger, James	34
Byers, Dave	34

C

Callahan, Renee	34
Callaway, John C.	35
Camacho, Fernando	35
Campbell, David G.	35
Cane, James	35
Canning, Robert.	36
Cardoso, Fernanda C. Gil	36
Carlson, Jason	36
Carnovale, Daniela	36, 207
Carpenter, Susan G.	207
Carrick, Peter J.	37
Carroll, Mary C.	37
Carvell, Claire.	37
Casper, Andrew	38
Castanheira, Solange dos Anjos	208
Cava, Mario	208
Chang, Yuan-Hsiou.	38
Chapman, Ted	38
Chapple, Dylan	208
Chazdon, Robin	38, 39
Cheng, Antony S.	40
Chen, Guang C.	39
Chen, Hua	39
Chen, Keliang	40
Choi, Young D.	40, 209
Choy, Steven	40
Clark, Heidi	41
Clarkson, Beverley.	41
Clarkson, Bruce D.	41
Clevenger, Tony	42
Cline, Eric A.	42
Collier, Kevin J.	42
Collier, Marcus John.	43
Collins, Dan	43
Comer, Patrick	43
Cony, Mariano.	209
Cook, James E.	209
Cooper, David J.	43
Copp, Corrina J.	44
Crawford, Kerri M.	44

Crehan, Ryan	44
Crespo, Antonio M.	45
Cruz, Elizabeth B.	45
Cullinane Thomas, Catherine	45
Cumberland, Catherine	209

D

D'Amico, Vincent	45
Damschen, Ellen I.	46
Davelos Baines, Anita	46
Davenport, Tara E	46
Davis, Anthony S.	47
DeAngelis, Bryan M.	47
DeAngelo, Chip	47
Decleer, Kris	210
Delaney, John T.	210
Delisle, Marion	47
Demchik, Michael	48
Derner, Justin	48
Derroire, Géraldine	211
DeSilvey, Caitlin	48
de Souza Vismara, Edgar	210
Devides Castello, Ana Carolina	48
Dhokal, Balram	49
Dickens, Sara Jo M.	49
Dieleman, Hans	49
Dietenberger, Mark	211
Dixon, Mark D.	50
Djorjevic, Alexandra E.	50
Doherty, James M.	50, 211
Domingues Torezan, Jose Marcelo	50
Dong, Shikui	51
Doo ha, Yang	51
dos Santos Batista Bonini, Carolina	211
Drenthen, Martin	51
Duff, Alison J.	52
Dunning, Kathryn	52
Durigan, Giselda	52
Dutoit, Thierry	53

E

Edwards, Stephen	53
Efstration, Emily.	212
Egan, Dave	53
Egerton-Warburton, Louise	53
Eisenberg, Cristina	54
Elting, Ryan	54
Engel, Vera Lex	54, 55
Erickson, Todd E.	55
Evette, Andre	55

F

Faist, Akasha	55
Falk, Donald A.	56
Falk, Jenna L.	212
Fant, Jeremie	56
Farag, Aida M.	56
Faust, Betty	57
Felson, Alexander J.	57
Fernandes, Geraldo	57
Fernandez, Igancio C.	212

AUTHOR INDEX (CONT'D)

Ferreira, Miguel	57
Fevold, Brick	58
Fiallos Ortega, Luis Rafael	58
Filley, Timothy	58
Fill, Jennifer M.	213
Finch, Deborah	58
Firn, Jennifer	59
Fleenor, Adam	59
Flint, Shelby A.	59
Florentine, Singarayer	60
Follstad Shah, Jennifer	60
Forbes, Anthony	60
Forbes, Nicolette T.	60
Ford, Anabel.	61
Ford, Gina.	61
Forestieri, David A.	61
Fornwalt, Paula J.	61
Fragoso, Fabiana Palmeira	62
Frank, Cristina A.	62
Franklin, Jennifer	62
Freudenberger, David	63
Froude, Victoria	63
Frouz, Jan	63
Fuentealba, Beatriz	63
Fuller, Heather E.	64

G

Galatowitsch, Susan M.	64
Galbraith; Betsy	64
Galindo Canabal, Víctor Andres	65
Ganguli, Amy C.	65
Gao, Qingzhu	65
Garcia, Matthew.	65
Garen, Eva	66
Garvey, Philip	213
Gaucherand, Stephanie Albertine.	66
Gilmore, Michael P.	66
Gobster, Paul	67
Goffner, Deborah	67
Goggin, Patrick O.	67
Gogoi, Prasujya	213
Gómez, Mariela	72
Gómez Ruiz, Pilar Angélica	72
Gomola, Courtney	68
Gonzalez Sargas, Eduardo	68
González, Yazmín	68
Goodell, Karen	69
Gossman, David	69
Gottlieb, Sara	69
Gove, Aaron D.	69
Govers, Gwyneth L.	70
Grabowski, Jonathan H.	70
Gratton, Louise	70
Greene, Samantha L.	214
Griffiths, Christine	70
Guerrini, Anita	71
Guloglu, Yavuz.	71
Gumtow, Jon H.	71, 72, 214
Gurgel, Jéssica.	214

H

Haapalehto, Tuomas	73
Haase, Diane L.	73
Haase, Steve	73
Habberfield, Michael W.	73
Hadley, Diana	74
Hägglund, Ruaridh	91
Hagy, Heath	74
Hahner, Jason	74
Hale, Jason A.	75
Haley, David.	75
Hall, Carol M.	75
Hallett, James G.	76
Hallett, Lauren M.	76
Hall, Sarah L.	76
Halme, Kati	77
Hamerlynck, Olivier.	77
Hamilton, David P.	77
Hamilton, Lindsey S.	215
Hamilton, Robert	78
Hancock, Boze	78
Haner, Judy	78
Harper-Lore, Bonnie L.	78
Harrington, Andrea	79
Harrington, Rory	79
Harris, Jim A.	79
Harris, Zack R.	79
Hartman, Brett D.	80
Haselmayer, John	80
Haskell, Daniel E.	80
Havens, Kayri	81
Havlick, David.	81
Hekkala, Anne-Maarit	81
Heller, Nicole E.	81
Helzer, Chris	82
Heneghan, Liam	82
Henkes, Rollie.	82
Herget, Mollie E.	83
Herkert, James R.	83
Hermann, Julia-Maria	83, 215
Hermanutz, Luise A.	215
Hernandez, Angela	216
Herrick, Bradley M.	216
Heslinga, Justin L.	84
Hesseldenz, Thomas F.	84
Hick, Aurélie	84
Hickman, Karen R.	85
Higgs, Eric S.	85
Hilke, Jens	85
Hill, Kirsten.	86
Hill, Kristina	86
Hinck, Jo Ellen	86
Hinz, Christoph	86
Hitsman, Christopher M.	216
Hobbs, Richard J.	87
Hoelzle, Timothy	87, 216
Hokschi, Benjamin	217
Holland, Jeffrey	88, 217
Holste, Ellen K.	217
Hooper, Michael J.	88

AUTHOR INDEX (CONT'D)

Hoosein, Shabana	218
Hopkins, Arlene	88
Hopwood, Jennifer	218
Host, George	89
Hotchkiss, Sara C.	89
Hourdequin, Marion E.	89
Hou, Yuping	218
Howell, Evelyn	89
Hufford, Kristina	90
Hull, Ruth N.	90
Hume, Ellen.	90
Hummel, Peter C.	90
Hunt, Shelley	91, 219
Hutchinson, Rachel A.	219

I

Isaacs, Rufus	91
Isselin-Nondedeu, Francis	92

J

Jackson, Stephen T.	92
Jacobs, Douglass F.	92, 93
Jacobs, Jefferson	93
Jahn, Jacqueline D.	219
James, Phil	93
Janiczak, Catherine	94, 219
Jaquetti, Roberto	94, 220
Jensen, Jens	94
Jiménez-Sierra, Cecilia L.	220
Jinlong, Jiang	220
Jobe, Jordan	94
Johns, David.	95
Johnson, James E.	95
Johnson, Laura E.	95
Johnson, Lea R.	96
Johnson, Marcha.	96
Johnson, Wade A.	97
Johnson, W. Carter	96
Johnson, Yari.	97, 220
Jonas-Bratten, Jayne	97
Jordahl, Harald "Jordy".	97
Jordan III, William R.	98

K

Kane, Douglas D.	98
Kanga, Erustus	98
Kaphegyi, Thomas A.M.	99
Kareksela, Santtu	99
Kaunzinger, Christina M. K.	99
Kauth, Philip	100, 221
Kay, David.	100
Keeley, Keefe	221
Keenleyside, Karen A.	100
Kellner, Klaus	100, 221
Kellogg, M. Lisa	101
Kemper, Patricia C.	101
Keulartz, Jozef	101
Khan, Amin	101
Kidd, Sarah A.	222
Kiehl, Kathrin	102
Kilbane, Simon	102

Kim, HyoJun	222
King, Elizabeth G.	102
Kirmer, Anita	103, 222
Kleiman, Bill	103
Kleintjes Neff, Paula	103
Kodym, Andrea	103
Kollmann, Johannes	223
Koppula, Narsanna	104, 223
Korol, Alicia.	223
Kramer, Andrea T.	104
Krueger, Jeff	224
Kucuk, Omer	224
Kurt, Sevinc.	104
Kwon, Hyuksoo	104

L

Laarmann, Diana	224
Laidlaw, Meghan.	224
Landhausser, Simon	105
LaPan, Stewart J.	225
Larson, Brendon MH	105
Larson, Diane L.	105
Larson, Elizabeth A.	106
Lawrence, Beth	106
Leahy, George	106
Lecaillon, Gilles	107
Lee, Chang Seok.	107, 225
Lee, Cheegwan	225
Leff, Michael	108
Lemke, A. Maria.	108
Lemke, Michael J.	108
Lenfant, Philippe	108
Lenhart, Christian	109
Le Stradic, Soizig	106
Lettrari, Heike G.	226
Lev, Deborah	109
Leverich, Glen	109
Lewis, Kemit-Amon	110
Liao, Huixuan	226
Li, Jimpeng; Shikui Dong.	110
Lindell, Catherine	110
Lindig-Cisneros, Roberto	110, 226
Litt, Andrea R.	111
Liu, Junguo	111
Liu, Shiliang	111
Lokman, Kees Lokman	112
Long, A. Lexine	112
Long, Quinn	112
Lopez Acosta, Juan Carlos	226
López-Valenzuela, Alejandra	227
Love, Byron	112
Lubke, Roy A.	113
Lucas Videira, Ligia Maria	227
Ludwig, John A.	227
Luiting, Victoria T.	113
Ly, Yihe	113
Lyndall, Jennifer.	114
Lyons, Kelly	114

AUTHOR INDEX (CONT'D)

M

MacDonagh, Peter	114
MacDonald, Eric A.	115, 228
MacDonald, Neil W.	228
Madav, Ramesh P.	115
Madikizela, Bonani	115, 116
Magalhaes, Simone;	228
Magalhães Veloso, Maria das Dores	229
Magness, Dawn R.	116
Mahaney, Wendy M.	116
Mahler, David	116
Mahoney, John M.	229
Mahy, Gregory	117
Maier, Craig M.	117
Majka, Brian	117
Malosso, Elaine	229
Manha, Khaleel K.	118
Marchione, Alison	229
Marcus, Mickey	118
Marin-Spiotta, Erika	118
Marlowe, Lee	118
Marques, Márcia C. M.	119
Martinez, Dennis	119, 120
Marttila, Maare	230
Masson, Solène	120
Matsler, Marissa	230
Mattei, Jennifer H.	120
Maurer, Debbie	120
May, Christopher A.	121
Mayence, C. Ellery	121, 230
Ma, Zhiyuan	114
McCaw, Matt	121
McCoy, Emily	122
McDonald, Tein	122
McEuen, Amy B.	122
McGlone, Christopher M.	122
McGuire, Benjamin M.	231
McIlvenna, Patricia	231
McLaughlin, John K.	231
McLeod, Kylie.	123
Mcphee, Jennifer M.	123
McTavish, Michael JM	123
Meine, Curt	124
Meissen, Justin	124
Melchior, Martin	124
Mendoza, Carl.	124
Menges, Eric S.	125
Merino-Martín, Luis.	125
Meyer, Michael W.	125
Miazaki de Toledo, Renato	231
Middleton, Beth	125
Mierzwa, Ken	126
Miller, Argie	232
Miller, James D.	126
Miller, James R.	126
Minchin, Peter R.	232
Minteer, Ben A.	126
Minton, Dwayne	127
Misztal, Louise	127
Mittendorf, Erin E.	127

Mladenoff, David	128
Mochel, Flavia Rebelo	128, 232
Mohanty, Braja Narayan	128
Mollard, Federico PO	233
Moncayo-Estrada, Rodrigo.	128
Montgomery, James	233
Montoya, Daniel.	129
Moore, Lucy	129
Moore, Kelly D.	129
Morales, Narkis S.	129
Moreno Mateos, David	130
Morton, John M.	130
Morton, Lois Wright	130
Mullah, Collins	131
Munro, John W.	131
Murphy, Stephen D.	131
Myers, Mary	131

N

Nagel, Linda.	132
Ndimele, Prince Emeka	233
Ness, Isobel	233
Newingham, Beth A.	132
Nigh, Ronald	132
Nigussie, Yalemzewd	234
Nilsson, Christer; Lina Polvi	133
Noreika, Norbertas	133
Nost, Eric	133
Nowacki, Gregory.	133
Nowak, David J.	134
Ntshotsho, Phumza	134
Nunes, Yule Roberta Ferreira.	134, 234
Nussbaumer, Yvonne.	134

O

Obasi, Mgbore N.	135, 234
O'Connell, Margaret A.	135
O'Connor, Marcie.	137
Oh, Seung-Hwan	235
Ohsowski, Brian M.	136
O'Leary, Mark J.	135
Orradottir, Berglind	235
Orr, Bruce K.	136
Ostergren, David	136
Ott, Jeffrey E.	235
Overbeck, Gerhard E.	136, 137
Overbeck, Will W.	235
Owens, Katie	137

P

Packard, Stephen	137
Padovezi, Aurélio	138
Palacio, Rubén Darío	236
Pandiyani, Maduraiveeran	138
Parker, Thomas G.	138
Park, SoYoung.	236
Paschke, Mark W.	138
Paula de Castilho, Camila	236
Paulios, Andy	139
Pearce, Lilian M.	139
Pearse, William D.	139

AUTHOR INDEX (CONT'D)

Pearson, Monica M.	140
Pellish, Carmen A.	237
Peng, Shaolin	237
Pereira Santos Neto, Alcides	237
Perez Linde, Natalia	237
Perkol-Finkel, Shimrit	140
Perring, Michael P.	140
Peturdottir, Thorunn.	140
Peyton, Scott D.	141
Pfeiffer, Kent E.	141
Phillips-Mao, Laura	141
Piña-Rodrigues, Fatima C.M.	142, 238
Pinheiro, Claudio Urbano	238
Pinheiro, Claudio Urbano B.	142
Pinno, Brad	142
Pinto, Jeremiah R.	142
Piper, Jon K.	143
Plascencia-Escalante, F. Ofelia	238
Platt, Emily K.	143
Podadera, Diego Sotto	143
Pöll, Constantin Eduardo	146
Polster, David F.	143, 144
Polzin, Mary Louise	144, 239
Pope, Karen	144
Potvin, Catherine	145
Poulin, Monique.	239
Powell, Jeff R.	145
Powers, Jennifer	145
Prach, Karel.	145
Prasser, Nick P.	240
Punongbayan, Andalus T.	146
Pyke, David A.	146

Q

Questad, Erin J.	147
Quideau, Sylvie	147
Quinn, John M.	147
Quivik, Fredric L.	147

R

Raggi, Leonardo	240
Rahimi, Alieh	148, 240
Rahmani, Aviva	148
Redman, Scott.	148
Reeves, Matt C.	149
Refsland, Jodi M.	240
Regan, Matthew J.	241
Rehounkova, Klára	149
Reid, J. Leighton	149
Reining, Conrad	149
Ren, Hai	150
Ren, Lei	150
Rice, Kelly N.	150
Richards, Jennifer L.	241
Richardson, Bryce	151
Richardson, Bryce A.	151
Richardson, Leslie	151
Rider, Mary	241
Robb, Lindsay	151
Robertson, Morgan	152
Roels, Steve	152

Roesler, Elizabeth L.	242
Rogers, Deborah L.	152
Rohal, Christine B.	242
Rood, Stewart.	153, 242
Roos, Robb	153
Rosenfield, Milena.	243
Rossiter, Stephen C.	243
Ross, Kristen	153
Ross, Laurel	153
Rountree, Mark W.	154
Rowley, Susan	154
Rozumalski, Laura	154
Ruggiero, Daniel A.	155
Ruiz Talonia, Lorena	155
Runyon, Justin	155

S

Saari, Steven A.	155
Sabai, Daniel	156
Sabo, Autumn E.	156, 243
Sack, Catharina	156
Salmo III, Severino.	156
Sato, Luciane Missae	157
Schiavon Machado, Manoela	157, 243
Schopmeyer, Stephanie A.	157
Schwartz, Norman B.	158
Scott, Michael L.	244
Scott, Richard	158
Scultori, Carolina	244
Segura, Jillianne	158
Seilheimer, Frankin	158
Sella, Ido	159
Shabani, Farzin	159
Shang, Zhanhuan	159
Shaw, Nancy.	244
Sheehan, Mariquita I.	160
Sher, Anna	160
Shirey, Patrick D.	160
Shoffner, Brett.	160
Shriver, Greg	161
Shutt, Nicole M.	244
Shutt; Nicole M.	161
Silva, Wesley.	161
Simmons, John	161
Simmons, Matthew E.	162
Singh, Mritunjay.	162
Siqueira Moreau, Julia	245
Skabelund, Lee R.	162
Skousen, Jeff	163
Skrabis, Kristin E.	163
Slusser, Jacob L.	163
Smiley Jr., Peter C.	164
Smith, Daniel J.	164
Smith, Rebecca A.	164
Smith, Russell F.	164
Smith, Stephen	165
Sonneville, Colter	165
Soto, Sasha D.	245
Souther, John D.	165
Souto Filho, Sebastião Nilce	245
Souza, Flaviana M.	165

AUTHOR INDEX (CONT'D)

Sparks, Richard	166	Valencia, Ruth	180
Spiegel, Kimberly S.	246	Van den Broeck, Dieter	180
Sprenkle, Starry D.	166	Van Diggelen, Rudy	180
Springer, Josh	166	Van Horne, Beatrice	181
Springer, Nikki	167	VanMiddlesworth, T.D.	181, 248
Stainback, Susan	167	Varassin, Isabela G.	181, 248
Stanton, Nicole L.	167	Varner, J. Morgan	181
Starzomski, Brian	167	Veldman, Joseph W.	182
Steckler, Peter	168	Veloz, Samuel	182
Steele, LaTina	246	Verheyen, Kris.	182
Steele, Yoyi	168	Viers, Joshua H.	183
Stephens, Garrett J.	168	Villalobos, Manrique Esquivel	183
Stewart, Katherine	168	Volke, Malia	183
Strassburg, Bernardo.	169		
Streb, Chris	169	W	
Street, Sara	169	Wahlund, Nora L.	183
Stringer, Darin	169	Walck, Jeffrey	184
Stromberg, Juliet C.	170	Walk, Jeffery W.	184
Struck, Andrew	170	Wallace, Jessie	248
Suding, Katharine N.	170	Waller, Donald M.	184
Summerville, Keith	170	Walther, Judy	185
Sunarto, Sunarto	171	Wamsley, Kent	185
Sutherland, Ronald W.	171	Wang, Pu	185
Su, Xukun	246	Wang, Xia	249
Svavarsdottir, Kristin.	171	Waters, Cathleen	185
Swenson, Steve	171	Webb, Lia	186
Switalski, Adam	172	Weber, Irene J.	249
		Weber, Scott P.	186
T		Weigand, James F.	249
Tafesse, Teshome.	172	Weissberger, Eric J.	186
Taft, John B.	172	Wei, Wei	186
Takele Dime, Teshome	172	Weng, Yen-Chu	187
Tallis, Joshua	173	Werden, Leland K.	250
Tansey, Erin E.	173	Western Governors' Wildlife Council	187
Telesetsky, Anastasia	173	Westphal, Lynne.	187, 188
Temperton, Vicky M.	173	Whipple, Alison A.	250
Tenning, Lisa	174, 247	Whitney, William S.	188
Thakur, Pratibha	174	Wiant, Michael	188
Thomforde, Stephen.	174	Wiens, John	188
Thompson, Allen	175	Wilcox, Douglas A.	189, 250
Thorsson, Johann	175	Wilcox, Rose	189
Tiedemann, Robert	175	Wilkinson, Jessica	189
Timoney, Caitlin.	247	Williams, Carol	190
Toledo, David	176	Williams, Mary I.	190
Tolentino, Jr., Enrique L.	176	Williams, Neal M.	190
Tolvanen, Anne	176, 247	Will, Robert	189
Tonietto, Rebecca	247	Wilmot, Fiona C.	191
Toohill, Michael J.	177	Wilson, Sarah Jane.	191
Topacoglu, Osman.	177	Wilson, Vivienne	191
Torok, Katalin	177	Winkel, Von	251
Touchet, Tom	177	Wise, David H.	192
Tourrand, Jean.	178	Wishnek, Benyamin	251
Travaglini, Mary	178	Wojcik, Victoria A.	192
Truyen, Duong Minh	179	Wolf, Evan	192
Twidwell, Dirac	179	Wolk, Brett H.	192
		Wortley, Liana.	193
U		Wu, Ning	193
Ulrich, Cheryl P.	179	Wu, Qiong	193
		Wu, Yu	251
V		Wylie, Caroline	194
Vacariu, Kim	179, 180		

AUTHOR INDEX (CONT'D)

X

Xu, Jianying 251

Y

Yahr, Ben J. 194

Yi, Hoonbok 194

Young, Rob 194

Youtie, Berta 252

Yurko, Matthew 195

Z

Zahawi, Rakan A. 195

Zedler, Joy B. 195

Zelaya, Al 195

Zerbe, Stefan 196

Zhang, Shaoliang 252

Zhao, Mei Hong 196

Zhao, Weihua 252

Zhou, Ting 196

Zimmerman, Christoher L. 196

Zine, Matthew. 197

Zou, Changxin 253

Zuleta, Gustavo 197, 253