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Invasive Plants and the Wildland/ Urban Interface

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Session 1: Laws & Regulations

Regulations We Use as Tools to Deal with Invasive Plants

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The California Department of Food and Agriculture, Pest Exclusion Branch, is responsible for mitigating the risk of pests entering California on shipments of agricultural products. Noxious weeds and weed seeds can be found contaminating shipments such as containerized nursery stock, aquatic plants, baled hay, and seeds for propagation. CDFA biologists and county inspectors, working together within California's Pest Prevention System, enforce laws and regulations that are intended to exclude, destroy, treat or otherwise mitigate the pest risk associated with weed-infested shipments. Other branches within the Plant Health and Pest Prevention Services Division of CDFA enforce laws and regulations aimed at preventing the spread of noxious weeds within the state. Nursery Services enforce nursery stock cleanliness standards to maintain the pest-free status of nursery stock produced and sold within California, and the Integrated Pest Control Branch is responsible for eradicating noxious weed infestations at locations throughout the state.

Encouraging Conservation on Private Lands Through Permit Coordination

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A growing number of farmers and ranchers in California are interested in making voluntary environmental improvements to their land, but are discouraged by the time, cost, and complexity of complying with regulatory requirements. The environmental regulations intended to protect natural resources often become an unlikely obstacle to conservation work. In response to this problem, the Permit Coordination Program was created by a partnership between Sustainable Conservation, the Natural Resources Conservation Service, and local Resource Conservation Districts, to assist private landowners by simplifying the permitting process for small, net environmentally-beneficial restoration projects.

This program is based on a proven model of coordinated, multi-agency review where programmatic permits are obtained that cover future implementation of a specific suite of conservation practices—such as exotics removal, revegetation, streambank stabilization, and sediment basins—that improve water quality and wildlife habitat. Once established, the program creates "one-stop regulatory shopping," where landowners may install the pre-approved practices without seeking individual permits, provided they agree to comply with permit conditions. By essentially approving largely similar, inherently beneficial projects at one time, regulatory workload is reduced, and in turn, more landowners are compelled to complete high quality conservation work that improves

the economic and environmental sustainability of their property. This model has been remarkably successful since its inception in Elkhorn Slough in Monterey in 1998, and it has subsequently expanded to watersheds in San Luis Obispo, Santa Cruz, Marin, and Mendocino Counties.

San Diego County's northwestern watersheds are an excellent match for program extension, given the rapid urbanization into sensitive wild lands, need for ecological restoration, experienced partners, and willing landowners. Permit negotiations are ongoing, with conservation work under the program planned for late summer 2005.

Why You May Need a Licensed Pest Control Advisor

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California has nearly 5,000 California EPA licensed pest control Advisers (PCAs) providing pest management consultation for the production of food, fiber and ornamental industries of this state. PCAs provide crop production advice concerning land preparation, planting, fertilization, irrigation, cultivation and harvesting of food, fiber, ornamental crops and landscape settings. PCAs are licensed by the State of California Environmental Protection Agency (EPA) to provide recommendations for the agriculture use of pest management materials, including chemical pesticides, organic pesticides and beneficial insects.

Who needs a license? And which license? What is the difference between a PCA, QAL, QAC? What is a written Recommendation and when is it needed? Who do PCAs work for?

Qualifications for PCA licensing include a degree in Agricultural Sciences, Biological Sciences, or Pest Management, and college level curriculum that includes science courses for a total of 39 units. Applicants must then pass a written examination in the categories in which they expect to work and provide consulting advice. To maintain a PCA license they must complete a minimum of 40 hours of Cal EPA approved instruction relating to pest management within each two-year licensing period.

Herbicide Toxicology and Signal Words

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When confronted with weeds, chemical herbicides are frequently an important management option. A large number of chemicals are formulated as herbicides and their basic short-term (acute) toxicology is indicated by the signal word that is carried prominently on the label. The three signal words, in order of increasing toxicity, are caution, warning and danger. Oral, skin, and inhalation lethalities, plus eye or skin irritation and dermal sensitization comprise the basic "six pack." Additional toxicity potential is considered during the registration process, and ultimately there potential for adverse effects will be evaluated and weighed in the risk assessment process that is concerned with longer-term exposure. To illustrate the process glyphosate, diuron, triclopyr, 2,4-D, and dandelions will be briefly reviewed.

Session 2:
Cutting Edge Research I

Invasion of *Arundo donax* in Riparian Ecosystems of Mediterranean-Type Climates: Causes, Impacts and Management Strategies

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The alien plant giant reed (*Arundo donax*) is rapidly invading riparian ecosystems along rivers of mediterranean-climate regions, forming extensive stands or monocultures. Factors such as quantity of water, nutrients, and light abundant in riparian ecosystems of mediterranean- climate regions are thought to increase the competitive ability of *A. donax*. *Arundo donax* increases the risk of flooding, creates fire hazards, outcompetes indigenous species for scarce water resources, and reduces the value of riparian habitat for wildlife. This paper discusses research related to the causes and impacts of *A. donax* invasion and proposes several management strategies for the eradication of *A. donax* based on location and size of the infestation. Results of field and experimental studies indicate that increased nutrients, water and light in riparian ecosystems of Southern California play a large role in the process of *A. donax* invasion. In addition, *A. donax* infestations in riparian ecosystems helped to spread recent wildfires in Ventura County. The first priority management strategy recommended is removal of *A. donax* from riparian terraces where infested areas are easily accessible and located adjacent to fire-prone habitats. Secondly, we suggest that a watershed removal plan is developed to eradicate *A. donax* from all floodplains. Unless *A. donax* is removed from floodplains on a watershed scale working from the headwaters downstream, *A. donax* is likely to recolonize removal areas during flood events. Both riparian terrace and floodplain areas require revegetation with native plants to insure continued success of *A. donax* eradication and restoration of functional riparian ecosystems.

Using a Computer-Based Diagnostics Program for the Identification of Weedy Grasses

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A diagnostics program developed by Dr. Richard Old is the framework for the development of a computer-based identification guide for California weeds. Currently, the grasses and grass-like species portion of the program is completed and includes 206 species throughout California. This includes members of the Poaceae, Cyperaceae, Junaceae, and Typhaceae. The broadleaf portion of the program will be completed by 2005 and will include an additional 790 species. The program allows the choice of any characteristic, vegetative or reproductive, for the identification of individual species. The greater the number of characteristics used, the higher the probability that a specimen will be correctly identified to species. This program is also the basis to the WSSA 1000 Weeds of North America diagnostics program. In addition to identification characteristics, the program contains descriptions of all 206 grass species, as well as multiple color photographs of each species. The program will be demonstrated using a few common grass species.

Are Exotic Species Shrinking Serpentine Refugia for Native Plants? The Case of a Rare Annual Jewelflower in Santa Clara County, CA

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The alteration of California's grasslands by exotic species has underscored the importance of serpentine soils as refugia for native plant species. Competitive pressures of exotic grassland species, combined with their rapidly evolving adaptation to exist on unique serpentine soils, have forced native species to retreat even farther within the serpentine soil environment to extremely harsh shallow soils amidst rocky outcrops.

Streptanthus albidus var. *peramoenus* (Most Beautiful Jewelflower) is a rare plant found only on small patches of serpentine substrate in the San Francisco Bay area (Alameda, Contra Costa, and Santa Clara Counties). I hypothesized that this plant is restricted to shallow serpentine soils due to competition from abundant annual exotic plants that occur in the deep serpentine soils. To test this hypothesis, I performed a factorial experiment manipulating the presence of exotic plant species in both shallow and deep soils within patchy serpentine grassland habitat in Santa Clara County.

Overall, exotic removal stimulated *S. albidus* var. *peramoenus* germination in both deep and shallow soils, but the effect was greater in deeper soils than in shallow soils. Further, survivorship and fecundity were both higher when exotics were removed in both deep and shallow soils. These findings validate the hypothesis that exotic plant competition restricts the jewelflower to shallow soils. If management efforts and restoration plans reduce exotic plant abundance deep serpentine soils near rocky outcrops, then it may be possible to not only maintain existing populations of this plant on shallow soils, but also expand the plant's distribution onto deep serpentine soil areas that currently harbor mainly exotic species.

Implications of Global Change for Exotic and Native Species in California Grasslands

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Resource competition is one of the few community-level, mechanistic theoretical frameworks for predicting invasion. Resource competition theory predicts that human-caused nitrogen deposition and altered precipitation, by changing resource supply, may have serious consequences for plant invasion. Nitrogen deposition is increasing in many regions of California and precipitation is predicted to increase in the near future. Because exotic and native plant species in California have been shown to have different requirements for, and impacts on, limiting soil nitrogen and water it is important to understand the interactions of these two limiting resources and how they affect native and exotic species abundance. To predict the response of exotic and native grassland species to human-caused global change, we conducted a resource addition experiment at Sedgwick Reserve, Santa Ynez, California in which we applied factorial combinations of nitrogen and water to a mixed native and exotic grassland. We find that nitrogen and water are colimiting and that dominant exotic species increase in

abundance at the expense of native species with the addition of these resources. Our results suggest that attempts to restore and conserve California grasslands may be increasingly challenged by human-caused global change factors such as nitrogen deposition and altered precipitation patterns.

The Role of Pre-Fire Fuel Manipulations in the Invasion of Alien Plants

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Federal and state agencies are currently implementing large pre-fire fuel manipulation programs to reduce the threat of catastrophic wildland fires. An unintended result of these programs may be the introduction of invasive plant species. We investigated the effect of fuel breaks on alien plant invasion and evaluated the spread of alien species from fuel breaks into adjacent wildland areas. We examined fuel breaks across California representing different construction methods, maintenance regimes, and fire histories. Relative and absolute alien cover, density, and species richness were significantly higher within fuel breaks than in surrounding wildland areas. Alien plant abundance was significantly affected by over story canopy cover and percent of bare ground. Fuel breaks constructed by bulldozers had higher relative alien cover, lower over story canopy cover, and more bare ground than those constructed by other methods. Alien plants were most likely to spread into wildland areas that had experienced more numerous fires during the past fifty years. Our data suggest that fuel breaks provide establishment sites for alien plants, and that surrounding areas are susceptible to invasion after disturbances such as fire. Fuel break construction and maintenance methods that maintain some over story canopy cover and minimize exposure of bare ground may be less likely to promote alien plant invasion.

Impacts of Mowing and Bud Destruction on Yellow Starthistle Root Dynamics and Flowering

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Yellow starthistle is a serious weed in California, Oregon, Washington, and Idaho. Two widely used management techniques, mowing and classical biological control, generally do not kill the plants, but may reduce seed production. Our objective was to compare the impacts of late spring and early summer mowing and flower bud destruction on yellow starthistle growth and reproduction. Plants were grown in PVC columns, 3.3 m high and 0.46 m in diameter with horizontal mini-rhizotron tubes installed at 30 cm increments at depths from 0.3 to 2.7 m. Columns contained topsoil and were irrigated to field capacity. Seeds were planted in early January. Columns were assigned to one of three treatments: control, plants clipped to a 10 cm height at the bolting stage three times and plants with all flower buds destroyed weekly for the first eight weeks of flowering. Roots reached 2.7 m when they were about 12% of maximum abundance and plants were at 15% maximum height (still rosettes). Flowers first

occurred when plants were about 50% of maximum height and roots were approximately at their maximum abundance. Root abundance decreased and root longevity was reduced by both treatments. Aboveground biomass was reduced by mowing, but not by bud damage. Relative biomass allocated to flower production was not affected by either treatment. Number of flowers was reduced 67% by mowing but not by bud damage. Mowing reduced mean flower diameter 6% while bud damage caused a 14% reduction. These impacts resulted in 76% and 21% reductions in estimated seed number per plant for mowing and bud destruction, respectively. This study demonstrates the immense potential of yellow starthistle to compensate for both severe defoliation and flower bud damage.

Session 3: Habitat Fragmentation and Edge Effects

Habitat Fragmentation in California: Current Extent, Rate of Edge Generation, and a Look at Our Likely Future

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California's land-use history defies superlatives. The greatest number of rare species and habitat in the continental US, beset by the largest wave of suburbanization ever recorded, with an annual dollar-value topping the gross national product of three-fourths of the nations on the planet. Confronted with this surreal level of habitat conversion, ecologists usually transition from concern to anger, and then despair. We ultimately arrive at one of two positions: a resolve to manage the margin between human and wild ecosystems or to withdraw to defensible wildlands. This critical decision is based on our perception of habitat degradation; which for most of us, now forms within a framework of habitat fragmentation. Geographic Information Systems have dramatically clarified our models of fragmentation, but in the process have focused attention on the dichotomy of natural versus human areas (polygons). This dichotomy tends to minimize ecosystem processes such as plant invasions, which function across boundaries. Cal-IPC is in a unique position to advance broader concepts of fragmentation and edge, based on the ecological management of invasives. With the proper perspective, we may even be able to offer a third alternative to retrenchment and retreat: recovery of natural elements in areas we have ceded to human ecosystems.

A Comparison of Flora in San Francisco's Fragmented Natural Areas

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The greatest threat leading to the loss of biodiversity is habitat destruction. As our population continues to increase and the demands on our landscape escalate, habitat is reduced to smaller and smaller fragments. In the 49 square miles of the San Francisco peninsula, the Recreation & Park Department's Natural Areas Program manages 500 acres of parkland. These areas consist of oak woodlands, grasslands, scrub, dunes,

riparian and lacustrine habitats of varying sizes. San Francisco is an ideal area to study Edward O. Wilson's concept of island biogeography, since it was once a contiguous area rich in diversity that is now fragmented by urbanization, yet remains diverse in flora. This talk will focus on how vegetation type, area, time since isolation, edges and degree of disturbance factor into adaptive management priorities and decision making.

Highway Corridors: Crossing Political Boundaries

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While highway corridors connect our country's citizens, they also connect us to Canada and Mexico. Some 12 million acres of highway rights-of-way or roadsides separate motorists from neighboring natural areas, agricultural fields, urban parklands and more. These often disturbed roadsides can aid and abet the movement of invasive plants. State Departments of Transportation are doing everything they are able to prevent weed movement to their neighbors, regardless of political borders. They need your help.

Managing Remnants of Natural Habitat in an Urban Sea

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The California Department of Parks and Recreation manages over 40,000 acres of habitat in the Los Angeles area, surrounded by and interspersed with an urban population of over 13 million people. This challenging task is one that will be faced in the future by land managers in less populated parts of the state as commercial and residential development and associated infrastructure fragment natural habitat and create miles of urban wildland interface. Developments, roads, power lines, fuel modification zones and even recreational facilities such as trails create habitat disturbances that facilitate invasion by exotic species. The exotics create further habitat fragmentation and also have the potential to alter habitat function and ecological processes. The proximity of residential development to areas that are being actively managed can also add the element of political controversy. The land manager is required to utilize a wide variety of skills and techniques in these complex situations.

Session 5: Invasive Plants and Communities

Who Cares About Weeds? Thoughts About Sustaining Cal-IPC's Relevance in a Changing World

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How can Cal-IPC remain vital and relevant in California's changing political climate and shifting demographics? How can individual and organizational decisions work to increase the significance and longevity of the work we do? How can we strengthen and grow the constituency who supports the work of all our organizations? This talk will explore the role of education and volunteerism and its vital role in ensuring a strong and healthy future for both Cal-IPC and the field of restoration ecology at large.

Eradication in California and Abroad: Explaining Success and Failure

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Successfully eradicating an invasive plant species—that is, removing every single individual from every population in a region—can substantially reduce the long-term control costs and economic impacts associated with that species. Public agencies and their partners sometimes mount effective eradication campaigns, but in other cases they fail to act, or their actions lead to failure. Why are there such remarkable differences in outcomes?

In my doctoral dissertation, I aim to help answer that question. I plan to explain the variation in eradication success by examining invasive plant eradication efforts in at least three heavily invaded regions characterized by significantly different policy environments: California, New Zealand, and Australia. This comparative approach allows me to test whether there are national differences in policy outcomes. If time permits, I may add other localities to my study.

In this talk I present a brief preview of my findings based on three lines of research: a literature review of invasive plant eradication efforts worldwide, interviews with eradication practitioners in California, and a survey of Cal-IPC members regarding current and historic eradication efforts and nascent invasions (that is, candidates for eradication efforts).

Integrating Ecological, Social, and Economic Perspectives on the Spread of Invasive Species

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Modeling approaches for analyzing the ecology of invasive spread are well developed, but very little has been done to connect and integrate these ecological models with social and economic considerations, such as human-mediated dispersal, land use patterns, or economic costs and benefits of invasion and control. We describe an interdisciplinary approach to the analysis of invasive spread that integrates these factors. Our approach targets species that are known invaders but that are at an early stage of invasive spread. It is at this early stage of spatial spread that forecasts of ecological and economic risk are most useful. As a case study, we are studying the spread of spotted knapweed, which is at an early stage of spread in California.

The project has four components: 1) predicting potential range using habitat suitability models; 2) vector analysis, in particular the relationship of spread to human behavior; this includes patterns of transportation, fire control, and movement of agricultural commodities; 3) forecasting the risks of spread using dynamic spatial models; 4) economic and futures scenarios, including the bioeconomics of controlling spread, and the implications of changes in human populations, transportation patterns, and climate. We focus on results from the first three project components.

To predict the potential range of spotted knapweed in California, we constructed habitat suitability models from landscape variables (climate surfaces, land cover classification, elevation) using a genetic algorithm. The models were constructed from point location data for spotted knapweed in Washington, Oregon, Idaho, Montana, and Wyoming. Predicted habitat suitability extrapolated to California coincided well with point location data for California. the habitat suitability model suggests that spotted knapweed occupies less than 5% of its potential range in California.

To examine possible spread vectors in California we used an expert opinion approach. We asked land managers how specific infestations of spotted knapweed had arrived and whether transfers were likely to have come from within or from outside the state. The most common responses were from unspecified activities related to roads, transport of contaminated straw, hay, and alfalfa, construction equipment or activities, and fire equipment or activities.

To forecast the risk of spread in California we constructed dynamic spatial models to estimate the probability that a location will become "infected" within a given time. From the model predictions we can produce maps of California, showing the risk of spread in each location over different time horizons. Model parameters were estimated from the location-date data for California using a conditional likelihood approach to account for the presence-only nature of the data. Our initial models account for the current spatial pattern of infestation within California, dispersal from outside of California, long-distance dispersal by the major road network within California, and short-range dispersal. Extensions and improvements to this model will include incorporation of habitat suitability, as well as spread vectors identified in the expert opinion survey.

Addressing Community Concerns: Los Angeles County WMA's Best Management Practices for Vegetation Management

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Portions of Los Angeles County have recently been effected by bans on the use of herbicides by public agencies due to growing concern from constituents regarding herbicides. The Los Angeles County Weed Management Area (LA WMA) supports integrated vegetation management strategies including the appropriate use of herbicides. Therefore, we decided to prepare a report on Best Management Practices for Vegetation Management to educate individuals, businesses, government entities, and politicians on all of the currently known methods of vegetation management, effectiveness of the technique, cost, safety, and potential environmental impacts for all methods. This document is also designed to assist individuals, businesses and government agencies in developing Best Management Practices (BMP's) for vegetation management. To accomplish this we explained three separate but related topics of integrated vegetation management; vegetation control methods, the pros and cons (risks/benefits) for each of these methods, and the sites where these methods are suitable. The general format discusses each method including information on the pros and cons, a brief description of components of an integrated vegetation management plan, and finally guidelines to develop an integrated vegetation management plan by type of site. Sites include: wild lands, rights of way (roads, flood control, utility, easements), private property (small, large, individually owned, owned by conservancy or preserve), urban, rural,

parklands/open space, riparian, aquatic, wetlands, public (federal, state, local, tribal, schools/universities, water districts, special districts), and ornamental landscapes.

Tools in the Toolbox: Community Based Stewardship in the Management of Invasive Weeds

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Across California volunteer and local communities are mobilizing to combat invasive weed populations. While they do require certain conditions to function successfully, given appropriate measures, such groups can be an integral tool in weed management – especially in times of funding scarcity. Yet such community based groups form an often overlooked and under appreciated tool in the management of invasive weeds. In the Salmon River area of N. California a local watershed group is not only arguably the most effective weed removal effort in the region, this organization is well on its way toward the eradication of Spotted Knapweed. Plant populations that numbered in the tens of thousands five years ago are now in the range of single digits. The number of seeded plants found in the watershed has been cut in half each of the last three years. This presentation will summarize lessons learned from the Salmon River case study to describe the benefits of community based stewardship in the effort to maintain native ecosystems. Although they require energy to establish, once constituted, community based efforts have the potential for wide reaching results. Indeed a watershed full of engaged local residents provides more eyes on the ground than a few individual County Agriculture or Forest Service employees. Furthermore, community members can carry on projects in times when funding is reduced. Finally, community engagement is rewarding in itself. Residents of the Salmon River watershed report social, political and ecological benefits of their involvement including community education and empowerment and support of cultural traditions. This research is part of an ongoing study funded by a NSF IGERT program on Biological Invasions at University of California at Davis. The findings presented here are based on one year of participant observation, over fifty in-depth interviews and archival analysis.

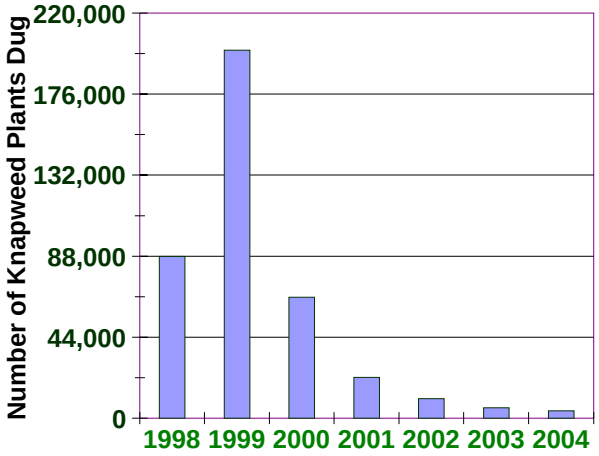
The Salmon River is located in Northern California in the Klamath Mountains -- between the Marble Mountain, Trinity Alps and Russian Wilderness Areas The Salmon River region is remote, pristine and biologically significant. Spotted Knapweed, a non-native plant of high priority in California, was found along the Salmon River in 1997. Ninety percent of community members oppose the Forest Service's plan to apply herbicides. The Karuk Tribe passed a resolution against the use of herbicides in their ancestral territory. Community members threatened direct action. The Forest Service has received more comment letters on the current Noxious Weeds Environmental Impact Statement than any other recent action – including timber sales.

Although it initially appeared to be a thorny issue for land managers, community opposition to spraying has led to a highly effective volunteer based program of hand eradication that is now in its ninth year. In fact, the Salmon River Restoration Council now has the most extensive weed eradication program in the region. The success of the community based weed eradication program on the Salmon River is measurable on a number of fronts. Community members have removed 396,204 knapweed plants since 1997. Volunteer days are over 1,500 in a community of ~ 250 people. Furthermore, the weeds program has provided employment to a region with extreme poverty. From a weed management standpoint success is measurable as well. 109 of 246 sites had no plants this year. The number of seeded plants has dropped from in the hundreds to 15 in 2002 and 8 in 2003. In 2004 no seeded plants were found. In 2004 alone they have garnered, 207 volunteer person days, 85 people, 216 paid person days, employment for up to 14 people, dug 5,667 knapweed plants and visited the 246 sites a minimum of three times.

Weed management benefits of a community based weed eradication program

Weed management benefits of a community based weed eradication program include community buy in, the presence of more "eyes on the ground," prevention and consistency in times of budget change:

Community "buy-in"



The initial proposal to use herbicides as a treatment method sparked intense social controversy. However, as a result of community involvement in the decision to pursue hand removal, the community has become galvanized, mobilizing a long term resource for weed eradication.

More "Eyes on the Ground"

The presence of large numbers of people who can identify knapweed and do not want it to spread means that they are able to keep there eyes out for knapweed and other invaisives as they drive and hike throughout the watershed. In the words of one active community member:

> "I can see spotted knapweed from 50 yards away now, when I'm driving in my truck. Even when I'm not even thinking about knapweed, if there is one on the side of the road, my spidie sense goes off. It's like whew, errk, stop the truck, jump out, everyone carries a tool, a knapweed tool in their car or truck around here. When the season is getting on, everyone has a ziplock bag and snippers."

Community Involvement helps for prevention

The presence of multiple people who are thinking about how weeds move helps to keep more material from coming into the watershed. The experimentation and innovation of many people may be included here. Community members also have ideas about prevention techniques:

> "We have this poster that we came up with, with noxious weeds that are here and on the other half of the poster is noxious weeds that are coming here. We're always looking for what's coming up."

Consistence in times of budget change

Committed volunteers have the vision, can provide buffer in times of budget cuts. Weed budgets in California and the West are not stable from year to year. While the SRRC program does require some funding to continue the large volunteer base makes this tool more consistent than programs dependent only on funded positions. Grass roots community involvement and buy in assures that many people participate in keeping knapweed out of the watershed whether or not they are paid.

Social Benefits for Participants

In addition to benefits in terms of weed management directly, community based programs may have a number of social benefits. These social benefits can be a big part of what motivates community participation. Three social benefits were highlighted by participants in the study: sense of attachment to place, development of community ties and a sense of empowerment.

Getting to know the place you live:

For all those involved looking and digging for knapweed taught them more about the place they lived.

> "Its so beautiful, I've never experienced anything like it. And there's no way I would be spending this much time down on the river if I wasn' t focused on doing something. That's what knapweed is all about. It's a tremendous opportunity."

> "This gave me a chance to walk these rivers, as if I was a kid just walking down the river with a fishing pole. I wasn't just hitting the good spots, I walked the whole thing and so I got to become fairly intimate with a lot of these areas on the river that I probably never would get to otherwise. Fish counting is like that too for me. I got to experience up and down the tributaries, especially with the steelhead, but with the spotted knapweed, I got to be on the river and walk places I never would go."

Getting to know other community members, stronger community ties . . .

Building social ties and networks has been another key positive outcome of the program.

> "I never spent so much time with some of these people. I had a great time getting to know them in a work atmosphere. Sure it was hot and we were wearing our big sun hats, but we made a party out of it."

Potential Employment

Although the program is largely volunteer based a number of community members have received part time employment. This modest income has been significant in a rural area with widespread poverty. The restoration council has made a point of employing youth when possible so as to retain younger community members.

> "I think it brings in jobs, instead of a few people working for the federal government coming in with sprayers, you could really hire a lot more people than that, and you don't have to pay them as much because it's not a dangerous; it's not dangerous. You're not handling dangerous chemicals, and it provides local support. Here a local

> economic support is really the biggest challenge of living out here. So, we had quite a number of people to come do this."

Sense of empowerment and responsibility

Community members report that seeing that they have made a difference feels good in daily life and transfers over to other projects and areas of work.

What makes this program a success?

Finally, community member shared a number of reflections about what made their program so successful. These included gaining cooperation and involvement of many partners, having fun, sharing responsibility e.g. "adopt a site" programs, creating a consistent time and routine, building on the experimentation and innovation of many people, being aware of the social benefits of volunteer work and communicating them, being appreciative of volunteered work and being ready to learn something new. A few examples in participant's own words:

Make work enjoyable

Making the work fun was key to attracting and maintaining volunteers:

> "We would sit around and sing songs about knapweed. We always talk about knapweed, all the time. It was just a constant thing. Sometimes you'd get sick of it, like' oh my god, we're talking about knapweed still' but otherwise, it was kind of funny. We'd always joke about it, like how the forest service, when they would check out, that was it, knapweed was off the day, but we would never check out. We were always talking about it. We always had maps out. We were making jokes about it, whatever. it was always a thing."

Creating a wide community base:

The Restoration Council has developed the cooperation and involvement of many partners both federal, state and county agencies and other watershed groups and Tribes. They suggest that it is key to listen to local concerns, find areas of common concern and build on these. Don't assume you know your "allies" or "enemies." Community volunteer emphasized the need to be curious about new people, reach out to find common ground between groups that may not seem like natural allies on other issues. Listen to local concerns, find areas of common concern and build on these.

> "It also has brought a lot of people that might not be so inclined to take part in the environmentalist movement out here, I think it's brought a few people in. We've always joked that I work in noxious weed eradication with loggers. Just factions of the community that normally probably wouldn't get together wouldn't get together on a sensitive environmental issue like this."

Contact the Salmon River Restoration Council for more information on their program: www.srrc.orgweeds@srrc.org , (530) 462-4665

Volunteer Exotic Removal Efforts and Success at Egdewood County Park and Preserve, San Mateo County, California

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Egdewood County Park and Preserve is a 467 acre plot of land underlain by a complex geology producing diverse soil types which support a rich diversity of plants including twelve rare species. It is located on the peninsula west of San Francisco Bay less than three miles from the urban corridor along the bay. It has a long history of human disturbances, cattle ranching, orchards, road and off road vehicle use and dumping. These disturbances have introduced many exotic plants which threaten the native flora.

In 1989 the first volunteer efforts to remove exotic plants began when a single person noticed the buildup of teasel (Dipsacus fullonum) in an area of the park. From her initial efforts and with the help of some others, this effort has grown both in number of volunteers and in the scope of the exotics removed. The strategy has evolved over time as new resources became available, the threat from different exotic species was evaluated and the best methods of treatment were established. Some of these treatment methods were researched from sources such as Cal-IPC, some were discovered by trial and error.

Keys to the success of this effort are many. They include a dedicated core of volunteers, a stable leadership over a period of years, the continuous recruitment of new volunteers from several sources and the involvement of local high school and business volunteers looking for community service during special weeding days. The program has sought to involve the County of San Mateo who owns the land in the effort. This involvement allowed the volunteers to approach San Mateo County when mowing was seen as the best way to control Yellow starthistle (Centaurea solstitialis). The volunteers also monitored the progression of the growing season to ensure the mowing would be timely for exotics removal. Volunteers were trained in monitoring techniques so that the county could be assured that the mowing had the desired results. Volunteers are encouraged to adopted areas they like to clear the invasive species giving them a feeling of ownership in the process. Finally, the effort is directed to exert a slow steady pressure on the populations of exotics, species and areas are chosen where the threat is the greatest and positive results are likely to occur using the resources at hand. These efforts over time have had some dramatic results in the reduction of exotics and there natural replacement by desirable native plants.

Session 6: Cutting Edge Research II

Out of the Frying Pan: Invasion of Exotic Perennial Grasses in Coastal Prairies

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The invasion of exotic annual grasses such as *Avena barbata*, *Bromus diandrus* and *Bromus hordeaceous* into California grasslands has been so complete that control and restoration efforts largely focus on maintaining or augmenting native components

in exotic-dominated stands. Annual grasses are afforded their own category in Cal-IPC's list of exotic pest plants, effectively acknowledging that they cannot be considered ongoing threats in the same way that species on the A or B list of most invasive plants are. In the last several decades, however, mesic California grasslands, particularly ones in coastal areas, are experiencing another compositional shift, as exotic perennial grasses invade annual-dominated or co-dominated grasslands. These European grasses, including *Dactylis glomerata*, *Festuca arundinacea*, *Holcus lanatus*, and *Phalaris aquatica*, are capable of developing monotypic stands that exclude both native perennial and even exotic annual grasses. They have high rates of growth, are generally fecund, and are successful competitors against both native bunchgrasses and Eurasian annual grasses. We discuss evidence from greenhouse and field experiments that exotic perennial grasses are strongly competitive with native perennial and exotic annual grasses. Relatively little is known about the long-term impacts of exotic perennial grasses on the grassland community or what strategies are effective in controlling them. Most alarming is evidence that traditional management techniques, including prescribed fire or grazing/mowing, may not be effective in controlling them. Their aggressive expansion in coastal habitats suggests that they may rival exotic annual grasses as a challenge to native biodiversity.

Reproductive Biology of Cape Ivy (*Delairea odorata*) in California

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Cape ivy (*Delairea odorata* syn *Senecio mikanioides*), originally from South Africa, is a wildland invader of California's coastal forests and scrublands. It is a brittle vine that is able to invade relatively undisturbed habitats—through fragments and wind-dispersed seed. Reproductive biology studies were initiated to better understand the potential spread of this species. The two areas investigated were self-compatibility and seed germination biology. Reciprocal crossing experiments were conducted to determine whether flowers from individual clones were self-incompatible. Seed biology studies were also conducted to determine germination requirements and seed production characteristics. Cape ivy was shown to be self-incompatible in California, and plants that were artificially cross pollinated produced a larger percentage of viable seed. Seeds from a geographic range of populations were sampled and only a few of the populations produced viable seed, suggesting that most infestations are clonal. Seed weights ranged from 0.02 mg to 0.39 mg, and the highest percentage of germination occurred in seeds weighing above 0.20 mg. Optimal germination occurred between 17 and 25ºC, and seeds were able to germinate in light or dark. Seeds germinated when planted on the soil surface or when buried 1 cm, but did not emerge when buried 2, 3, or 4 cm. Additionally, one and two-node stem fragments planted on the soil surface or buried 2 cm sprouted, but those buried at 4 or 6 cm did not. Experiments have shown that Cape ivy is self-incompatible and, contrary to previous reports, does produce viable seed in California.

Effects of Environment on Establishment of *Arundo donax* in Three Southern California Riparian Areas

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The initial stages of *Arundo donax* invasion are of critical importance for timely management. In order to understand and predict invasibility, it is important to quantify the environmental variables that correlate with the establishment of *A. donax* in the field. To that end, twenty-five plots were established in three southern California riparian areas. Four *A. donax* rhizomes were planted in each plot. Sites were visited weekly until all *A. donax* sprout emergence was complete. Environmental variables including soil temperature, PAR, and community composition were recorded at each site. Analyses of variance revealed that environmental conditions varied significantly across sites. Accordingly, *A. donax* performance also varied across sites. In an attempt to yield the list of variables that best explain the success of *A. donax* across all sites, multiple regression analysis was performed. Shoot emergence timing was slowed by cool soil temperatures and expedited by large initial rhizome volume; shoot height was negatively correlated with soil temperature and positively correlated with soil moisture; shoot survival was positively correlated with soil moisture. Destructive shoot herbivory by rodents for this species was observed in two sites, and negatively affected shoot survival in one site. Results from the first year of this experiment suggest that *A. donax* performance is highly dependent on site characteristics. It may be possible to determine sites of potential invasion by taking an inventory of environmental variables including soil variables and herbivory pressure, and by monitoring the size and apparent vigor of incoming rhizomes.

Creeping Water Primrose (*Ludwigia hexapetala*): The Ecology and Impacts of an Invasive Aquatic Plant in the Laguna de Santa Rosa

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The Laguna de Santa Rosa is a unique ecological system comprised of a mosaic of open water, wetland, riparian forest, oak woodland, grassland and vernal pools that has been negatively impacted by human encroachment over the last century. Within three years, the invasion and subsequent exponential growth of *Ludwigia hexapetala* has drastically altered the open water and riparian ecosystems of the Laguna de Santa Rosa. A freshwater vascular plant that thrives in nutrient rich water, *Ludwigia hexapetala*, has easily exploited the Laguna, forming dense, thick mats of vegetation in both aquatic and upland habitats, impacting native species and housing large mosquito populations.

Our study focuses on the ecological impacts of *Ludwigia hexapetala* as an aquatic invasive species and the relationships between *Ludwigia* and potential West Nile Virus mosquito vectors. The three primary objectives of our work are: 1) to asses the spatial extent of the *Ludwigia* invasion in aquatic and transitional zones using Geographic Information System (GIS); 2) to understand the ecology of *Ludwigia* through experimental investigations of mosquito populations, sedimentation, nutrient uptake, and recruitment and growth rates, and 3) to design and implicate experimental and large-scale management plans for *Ludwigia* in the Laguna de Santa Rosa. The results of this analysis will be applied to an extended restoration plan of the Laguna de Santa Rosa Watershed.

Invasion Dynamics of Perennial Pepperweed Along the Salinity Gradient

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Introduction

Perennial pepperweed, *Lepidium latifolium*, is one of the most threatening invasive plants in the San Francisco estuary. It is listed as a California Department of Food and Agriculture class B noxious weed, a species of known economic importance subject to county-level control; and as a California Invasive Plant Pest Council class A-1 weed, the most invasive plant pest category. It is a member of the mustard family (*Brassicaceae*), which is well-known for its weedy habit, numerous small and easily dispersed seed, and ability to reach large sizes. It initiates new growth early in the spring, grows rapidly, and has a large aggressive root system, enabling it to compete effectively with annuals and perennials, both above and belowground. *L. latifolium* shares vital attributes and a life history characteristic of prototypic exotics including the r-selected traits of small seeds, short generation time, and large annual seed crops (Baker, 1974; Rejmanek, 1996). Seed set can be as high as 16 billion seeds per hectare per year (Young *et al*., 1997) and seeds are highly viable (Miller et al., 1986). The species can spread by both seed and vegetative propagation (Trumbo, 1994). It establishes in a wide range of habitats, including rangelands, alkali sinks, riparian corridors, and tidal wetlands (Mark Renz, personal communication). *L. latifolium* poses a clear and serious threat to tidal marshes of the lower Delta and San Pablo Bay regions of the San Francisco Estuary, where populations continue to establish and spread along tidal creeks and channels.

Ecological analysis has been used to address site attributes governing invisibility by *L. latifolium* and to find vulnerabilities in its biology or life history that might facilitate control. Chen & Qualls (2003) found that perennial pepperweed was adapted to flooding, but displayed important limitations as well. Renz (2002) found that increased inundation period halted or reversed expansion in three seasonal wetland sites compared to abundance in previous years. He used discriminant analysis at the three sites to determine whether soil moisture, soil salinity, or species composition were strong predictors of *L. latifolium*, but did not find a significant correlation. Verdi *et al*., (unpublished data) failed to find a correlation between pepperweed distribution and elevation in a seasonal wetland in the Cosumnes River Preserve.

Our initial studies suggest *L. latifolium* is limited by a combination of poor drainage and higher salinities. However, the particular combinations of flooding and salinity conditions which favor or limit its growth are largely unstudied and remain unknown. These findings highlight two areas where knowledge is particularly inadequate: first, the limits and potential of *L. latifolium* in tidal wetlands, which are not predicted well by dynamics at the freshwater end of the spectrum; and second, an adequate understanding of the invasion dynamics of this species. The combination is particularly important for tidal wetlands, an ecosystem where pepperweed is especially problematic, but where a number of endangered floral and faunal species present serious barriers to research.

L. latifolium disperses via both seeds and root fragments. In germination trials Miller *et al.* (1986) found relatively short seed bank persistence, which suggests a potential for control for areas where seed is the dominant recruitment mode. However the primary source of recruitment into tidal habitats is unknown. The purpose of this research is to determine the importance of sexual

reproduction to *L. latifolium* expansion in two ways: first with seed quantification, as mediated by salinity and anoxia, and second by examining how competition with native streamside dominants further influences *L. latifolium* success. The central hypothesis is that the competitive relationships, in the context of prevailing salinity and flooding conditions, will determine the rate of *L. latifolium* growth and its long-term establishment capability. To examine this question, we evaluated the effect of salinity, flooding frequency, and presence or absence of vegetation on seed recruitment to various life stages over the course of a growing season. This allowed us to compare the relative importance of physical factors (flooding frequency and salinity) versus native vegetation cover on perennial pepperweed abundance and distribution.

Materials and Methods

In order to examine recruitment to various stage classes in perennial pepperweed, we divided the question into germination and post-germination success. We conducted the germination study in Petri dishes lined with tissue paper and wetted with one of seven salinity solutions: 0, 5, 10, 15, 20, 25, and 30 parts per thousand. There were four replicates per treatment. Trials were conducted over a one month period. Seeds were scored as germinated when a root emerged to a length of 1 mm or more.

We developed a tidal wetland mesocosm experiment to examine the question of post-germination success. The experimental design was a split plot, with salinity assigned to the main plots and flooding frequency assigned to the subplots. Within the subplots, *L. latifolium* seeds were sown into each pot either on bare soil, or into a native stand. The identity of the native was dictated by the salinity treatment so that pairing was representative of pairs found in nature. In fresh and low salinity conditions, *Scirpus acutus* would be a likely dominant streamside competitor; followed by *Potentilla anserina* at 10 ppt; *Scirpus americanus* at 20 ppt; and *Salicornia virginica* at 30 ppt. There were four levels of salinity (0, 10, 20, and 30 ppt) and two frequencies of flooding (daily and weekly). There were six replicates per treatment. One gram (approximately 800 seeds) of *L. latifolium* seed was sewn into the appropriate treatment for all experimental units. Seed rain rate was estimated from sampling in fresh water and brackish sites the season prior to commencement of this experiment. Response parameters of pepperweed growth included total number of recruits to the two-cotyledon, two-leaf, 4-leaf, small rosette, and large rosette stages.

Results

The results of the germination study showed a strong negative relationship between germination rate and increasing salinity. This negative relationship was well described by a linear function, r^2=0.76, or by a quadratic function, r^2=0.95 (Figure 1), where germination approached zero between 20 and 25 ppt. The number of days to germination varied along the salinity gradient, with low salinity (5 ppt) germinating first, followed by freshwater, followed by the higher salinity treatments (10, 15, 20, 25 ppt). Another facet of this relationship was borne out by an examination of the two salinity extremes in the wetland mesocosm recruitment experiment, 0 ppt (Figure 2) and 30 ppt (Figure 3). A comparison of these results illustrates that increased salinity level both inhibited and delayed germination.

An evaluation of flooding frequency and presence/absence of vegetation within each salinity level shows how these factors influenced recruitment to the early life stages (2 cotyledon, 2 leaf, and 4 leaf) (Figure 4); to small rosettes (Figure 5), and to large rosettes (Figure 6). For the 3 early recruitment stages (Figure 4), comparing daily flooding with and without vegetation, seedlings recruited into all treatments under daily flooding with vegetation and survived through the 4 leaf stage. If vegetation was absent, seedlings recruited in small numbers to the 2 cotyledon stage, but did

not survive beyond that in the highest salinity treatments. In the weekly flooding regime, early stage recruitment and survivorship was greater in 0 and 10 ppt treatments when vegetation was absent, but better at 20 ppt when vegetation was present. Between daily and weekly flooding, early recruitment was higher across the salinity gradient in pots that were flooded daily. At 0 and 10 ppt, recruitment rates were not significantly different between daily and weekly flooded unvegetated pots.

Comparing survival to the small rosette stage class with daily flooding with and without vegetation, small rosettes formed in the unvegetated pots in freshwater treatments, but in the vegetated pots only at 10 ppt (Figure 5). Weekly flooding without vegetation provided conditions under which small rosettes could survive across the most of the range of salinity treatments at 0-20 ppt, while vegetated pots had recruits only in the 10 ppt treatment (Figure 5). The qualitative pattern for recruitment to large rosettes was similar, except that *Potentilla anserina* prevented recruitment of large rosettes into the 10 ppt treatment under both daily and weekly flooding regimes (Figure 6).

These results were analyzed using ANOVA, and were divided into the same groupings of early recruitment, small rosettes, and large rosettes. ANOVA results were abbreviated to show significant results and non-significant results that show meaningful patterns (Table 1). The effect of salinity was evident across all of the life stages, as was the effect of vegetation. For recruitment to the three early stages, all main effects were significant ($p<0.0001$) with the exception of flood_regime at the 4 leaf stage ($p=0.108$). Additionally the interactions of salinity * flood_regime, salinity * month, flood_regime * month were also significant($p<0.0001$), except in the 2 leaf stage where flood_regime*salinity ($p=0.581$) and flood_regime*month ($p=0.548$). As illustrated above (figures 4-6), seedlings did not survive to the rosette stage in the high salinity treatments, leading to a non-normal distribution with heterogeneous variance. Therefore we analyzed the data using a logistic model based on whether at least one rosette was present; if so, we used a general linear model to determine the likelihood that there was more than one. The logistic model indicated that as seedlings matured to small and large rosette stages, salinity and vegetation continued to be significant determinants of recruitment ($p<0.005$), infrequent flooding was important for maturation of large rosettes ($p<0.05$) but not for small, and the interaction terms became non-significant. The general linear model showed that neither flood_regime nor vegetation were significant predictors for likelihood of more than 1 either small or large rosettes. For small rosettes, salinity significantly predicted whether more than one small rosette would be present. However in cases where there was at least one large rosette, salinity was not a good predictor for likelihood of more than one.

Discussion

Our findings show thatelevated salinity, increased flooding frequency, and presence of vegetation significantly reduced pepperweed seedling recruitment. Salinity was a key determinant of recruitment. It delayed and inhibited both germination and recruitment. Flooding frequency was an important covariate, and species' response to flooding frequency changed along the salinity gradient. For the freshwater end of the salinity gradient flooding frequency did not present an important limitation at either 0 or 10 ppt, at least across the range of flooding measured. Flooding frequency became a more important determinant of pepperweed seedling success as salinity increased. Vegetation had a facilitating effect at higher salinities in the early life stages, but inhibited or slowed stage progression across the salinity gradient. At this point it is unclear whether this is a delaying or inhibitory effect on balance, though the difference between the two is salient. This experiment is ongoing, and as of the last observation period, large rosettes had begun to senesce in some of the pots, but smaller rosettes had not. Whether these small rosettes can achieve the energy storage threshold to overwinter successfully will ultimately determine the vegetation effect. Either would

have important implications for restoration planning, particularly with respect to the importance of revegetation projects. It is important to note that native species cover was confounded with salinity level in that this was an incomplete block design with respect to vegetation. Despite this, the pattern of vegetation in delaying or inhibiting survivorship was consistent for much of the lower end of the salinity range.

Perennial pepperweed population demographics shift along salinity and flooding gradients. This is a common pattern for tidal wetland vegetation and appears to hold equally well for *L. latifolium* in the San Francisco Estuary. Zedler (1983) found that *Salicornia virginica* and *Spartina foliosa* productivity increased following freshwater events in the Tijuana estuary. Over a six-year study period Zedler *et al.* (1986) witnessed considerable temporal variability in *Spartina foliosa* abundance and distribution relative to amount and timing of streamflows.

Seed recruitment through the early life stages may be the most sensitive to harsh conditions and high salinities common to salt marshes. Shumway and Bertness (1992) found that seedling recruitment into bare patches of salt marsh was constrained by high soil salinities and released by fresh water additions, indicating that non-clonal plants may rely on episodic low salinity events. Beare and Zedler, (1987) studied cattail recruitment in various salinities and found that seeds and seedlings were salt sensitive, and were able to invade tidal marshes only during periods of prolonged low soil salinites. If low salinity levels persisted long enough that plants achieved a size threshold, then older, rhizome-bearing plants had much greater salt tolerance and were able to persist under hypersaline conditions. This pattern is qualitatively similar to the demographic patterns evinced by *L. latifolium.* Our results indicate that salinity has a consistently strong influence on recruitment, but that influence may begin to diminish as seedlings achieve a size threshold.

This experiment illustrates how competitive relationships, in the context of prevailing salinity and flooding conditions, will determine the rate of *L. latifolium* growth and its long-term establishment capability by seed. These findings are consistent with our other research along the salinity gradient in the San Francisco estuary. We are extending this research into tidal wetlands in the estuary by examining whether seed size and dispersal distance are likewise influenced by the salinity gradient by following seed production and dispersal from target plants at the extreme ends of the salinity gradient, fresh and hypersaline (Samuel Leininger, unpublished data). Both experiments are components of a larger project aimed toward determining life history characteristics and environmental variables influencing pepperweed success and control with a goal of providing information for enhancing management strategies.

For wetland management the findings of this research indicate that disturbed, freshwater wetlands present greatest risk for invasion. Pepperweed seedling recruitment into saline marshes is highly episodic and dependent on freshwater inputs. The most saline treatments were marked by low recruitment rates and no survivorship beyond the 4 leaf stage. This is consistent with field observations. No seedlings have been found at our most saline site, in Don Edwards National Wildlife Refuge in the south bay where salinities can become highly elevated over the summer months (unpublished data). Management efforts will be most effective when specifically tailored to the landscape, particularly with respect to dominant gradients such as salinity. Seeds probably play a much greater role in population establishment and expansion in freshwater and brackish wetlands. Plants at the freshwater end of spectrum will likely be healthier and more robust, with greater reproductive success. Therefore oligohaline and freshwater sites will require the greatest control efforts.

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Towards Eradication of *Lepidium latifolium* at Paramount Ranch: Control Methods and a Test of Restoration Treatments

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We initiated an eradication and restoration project in a 10 acre *Lepidium latifolium* infestation at Paramount Ranch in the Santa Monica Mountains National Recreation Area. This infestation occurs both along a perennial stream and its dry tributaries in exotic annual grass vegetation. The original plant community was most likely a mix of riparian, coastal sage scrub and perennial grassland vegetation types.

Within the total 10-acre infestation, a 1 acre test area was treated by cutting and then spraying re-growth of *Lepidium* at the flowering stage with 2% glyphosate. Within this treated area we performed a small-scale experiment to examine the efficacy of different restoration plantings in preventing both establishment and re-establishment of exotic species (specifically *Lepidium*).

In the restoration experiment, 50 one-meter square plots were installed. Restoration treatments were divided into four categories: control (no action), dig only (soil removed to a depth of 12 inches and then replaced), monoculture, five species mix, and ten species mix. Each plot type was replicated ten times. Plots were censused for species composition and cover six months after restoration plots were installed.

The initial treatment of cutting *Lepidium* followed by spraying re-sprouts at flowering stage with 2% glyphosate resulted in a 70% reduction in *Lepidium* cover.

In the restoration experiment, treatment plots had significantly more native cover and significantly less of both *Lepidium* cover and total exotic species cover than control plots. *Lepidium* cover was smallest in the ten species mix treatment but total *Lepidium* cover was not significantly less in planted plots than in dig only plots. Ten species mix plots had significantly more native cover and less exotic species cover than the monoculture plots. These experiments indicate that with small amounts of follow-up, both turning the soil and planting plants are effective means of combating

Lepidium. In addition, more diverse species mixes are more successful than monocultures in reducing exotic species establishment.

Fig. 1. Total exotic species cover by treatment

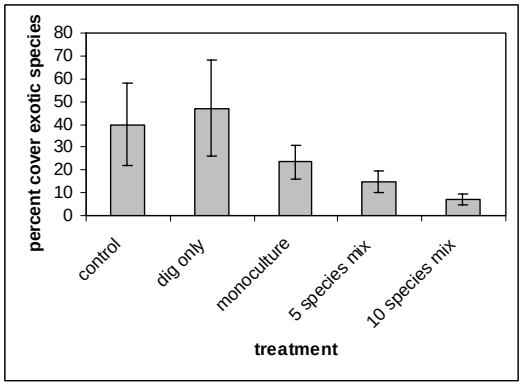
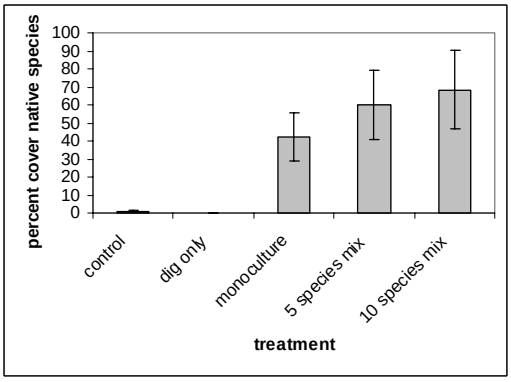


Fig. 2. Cover native species by treatment



Note the higher native cover and lower exotic species cover in high diversity treatments.

Fig. 4. Exotic species cover excluding

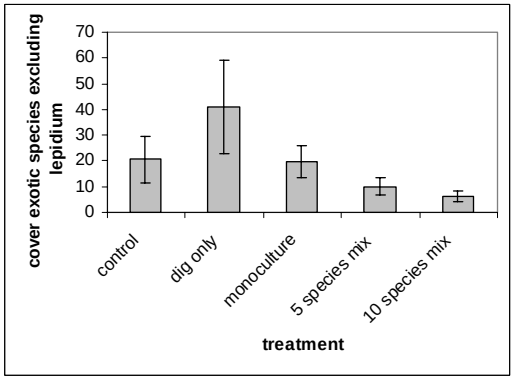
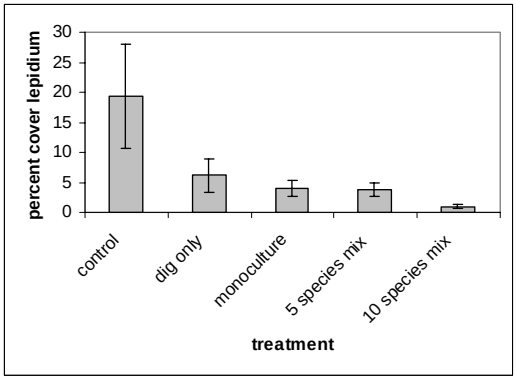


Fig. 5. Cover *Lepidium* by treatment *Lepidium.*



Note that *Lepidium* and other exotic species respond differently to treatments. *Lepidium* is regenerating primarily from rhizomes while other exotic species are regenerating by seed. Thus the dig only treatment encourages other exotic species to grow (exposes more seed to soil surface) while discouraging *Lepidium* growth (destroys rhizomes).

Fig. 6. Variability within treatments in exotic species cover

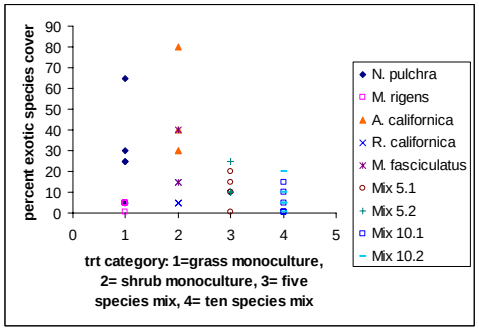
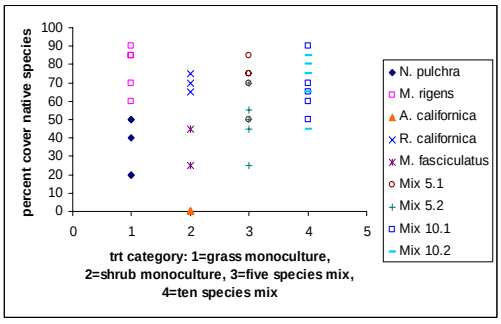


Fig. 7. Variability within treatments in native cover



Note the high variability within treatments. In the future we hope to analyze this data and determine whether the best monocultures perform equally as well as high diversity treatments. Also note that variability is reduced in high diversity plots. This may be due to the sampling effect.

Session 7: Migration of Ornamentals Across the Wildland/ Urban Interface

A Tale of Two Invaders: The Dynamic History of Pampas Grass and Jubata Grass in California

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Ever since Charles Elton first alerted us to the incipient biological invasions epidemic there has been a concerted effort to categorize the diversity of potential invaders and their impacts. It was hoped that predictive typologies could be developed that would allow for the efficient screening of likely invasives, the triage of susceptible ecosystems, and the establishment of generalized prescriptions for control. Although there have been a few notable successes over the past forty five years, the list of practical generalities is conspicuously short. One reason for this is that invasions are inherently dynamic. Both the invading species and the ecosystems into which they are invading can change. A number of processes such as the pattern of propagule supply, fluctuations in climate, physical disturbances, changes in landscape patterns, and evolutionary adjustments all work to confound static typological schemes. This is particularly the case along the wildland-urban interface where fundamental ecosystem properties are in rapid flux.

The invasion histories of pampas grass (*Cortaderia selloana*) and jubata grass (*C. jubata*) illustrate this dynamism. Both species were introduced to California in the horticulture trade during the mid eighteen hundreds. Their subsequent spread across California, and particularly across the wildland-urban interface, has been influenced as much by malleable external processes as by their intrinsic ecological traits. For instance, the dioecious *C. selloana* has spread at twice the rate of the asexual *C. jubata* probably because of its more widespread use in the horticulture trade. Although these contingent and often idiosyncratic histories make prediction difficult, it is possible to identify a number of key processes that influence the spread of invasive species across the wildland-urban interface. A better understanding of these processes and their interactions will allow for more comprehensive and adaptive management strategies.

Breeding Ornamentals is an Art and a Science But is it Breeding Invasives?

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Approximately half of the worst invasive plants in North America and greater than half of the most invasive plants of California's wildlands were introduced as ornamentals. Despite these alarming statistics, the sale of ornamentals continues to climb and the horticultural trade is currently the fastest growing segment of U.S. agriculture. California leads all states in nursery production. Of California's top ten commodities in terms of dollar values, nursery products rank third, valued at $2.35 billion in 2002.

The key to success of the horticultural trade, particularly the ornamentals industry, is novelty. Consumers are constantly on the lookout for novel ornamental species or cultivars. Breeding ornamentals differs from the breeding of major agricultural crops by being as much art as science. Many ornamental crops and cultivars sold today were originally discovered by nursery employees, staff or volunteers at botanical gardens, and individual plant enthusiasts belonging to garden or botanical clubs. Plants expressing novel phenotypes were often identified as "sports" or mutants among cultivated or wild plants, propagated vegetatively, and commercialized with little knowledge or concern for the genetic basis of the novel traits or whether genes for such traits would also promote invasiveness of wildlands.

The breeding of many high-value ornamental crops has involved sophisticated scientific methods. Breeders using scientific methods have selected numerous desired traits, including novel flower colors and forms, foliage color and form, timing of flowering, increased plant stature and vigor, pest and disease resistance, and tolerance of local environments. Sterility has been selected for and bred into several ornamentals but not for the purpose of reducing the probability of escape into wildlands.

Methods used in the scientific breeding of ornamentals can be classified into three basic approaches: traditional breeding methods, *in vitro* breeding, and molecular breeding using recombinant DNA techniques. Traditional breeding methods rely on sexual crosses between individuals of a single species. Hence, the creation of novel cultivars is limited by the amount of genetic variation for a desired trait that is present in the species. Development of *in vitro* breeding methods was an attempt to expand the available gene pool and introduce more variation for traits than nature offered. *In vitro* methods include mutagenesis, *in vitro* pollination, embryo rescue, and protoplast fusion. Several of the latter methods were developed to overcome barriers to interspecific hybridizations.

A major disadvantage common to both traditional and *in vitro* breeding methods is the need to carry out numerous backcrosses to isolate a novel trait in a desirable genetic background, which often takes many years. Development of novel cultivars is also limited to the traits and genes that occur within a few species. To continue producing novel crops and cultivars, ornamental breeders are now turning to molecular breeding using recombinant DNA techniques. Recombinant DNA methods allow the identification, isolation, and transfer of genes among different species, including species outside of the plant kingdom. Genes for certain novel traits, such as blue flower color in carnations, could not be obtained until the development of such methods.

Sterility is a trait that is highly desired by many horticulturalists and ornamental breeders. The concept of 'sterility' is generally well-defined. Cultivars referred to as 'sterile' produce no seed or produce inviable seed in cultivated plantings. 'Male sterile' cultivars produce no pollen or produce inviable pollen. Female sterile cultivars are desired because plants generally flower longer than fertile cultivars, seeds can be unattractive and 'messy', and/or spread of plants in the cultivated landscape is minimal. Male sterility is important for the production of hybrid cultivars and can be used to market cultivars to allergy sufferers.

In contrast, sterility has different implications for land managers and invasion biologists concerned with the escape and spread of ornamentals in wildlands. Male sterility implies that cultivars will not spread pollen with genes for adaptive traits and/or pollen that hybridizes with native or invasive plants in wildlands. Female sterility indicates that an ornamental will not escape into wildlands by seed. The dissimilar implications

that sterility has for ornamental breeders and nurseries, versus invasion biologists, has led to some miscommunication between the two groups. Recognizing these differences is essential for meaningful discussions between invasion biologists and the horticultural trade regarding means by which ornamental escapes and invasions into wildlands can be reduced.

Sterile cultivars can be suitable non-invasive alternatives for known ornamental invaders providing the genetic and/or molecular basis of sterility is known. Given knowledge of whether sterility is a result of a random point mutation, chromosomal imbalances or abnormalities arising from interspecific hybridizations and *in vitro* methods, or the transfer of genes for sterility using recombinant DNA techniques (biotechnology), it is possible to predict the stability of sterility and probability of reversion to fertility. Cultivars identified with stable forms of sterility can reasonably be promoted as non-invasive of wildlands.

Water Gardening: Pathway to Paradise or Plant Invasion?

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Water gardening is becoming increasingly popular in the United States. A recent survey conducted by the National Gardening Association found that 16 million American households have built water gardens. This figure is up from 4 million just five years ago. The total for water gardening retail sales reached 1.56 billion dollars in 2003.

In response to this trend, many nurseries, hardware/pet stores, and home and garden centers now sell aquatic plants for home aquascaping projects. Many of the plants commonly available through these avenues are also some of the worse offenders with respect to invasiveness. Plants such as water hyacinth (*Eichhornia crassipes*) and Brazilian waterweed (*Egeria densa*) are available to consumers, sometimes without any warning that they may cause considerable environmental and economic damage if they are released into a river or lake. In California, more than 45million dollars have been spent trying to manage these two plants in the Delta alone.

Preventing new aquatic plant introductions is by far the most environmentally sound and cost-effective way to approach this problem. It is imperative that scientists, natural resource managers and regulatory officials work together with nursery industry representatives, landscapers, water gardeners and other interested partners to exchange perspectives and develop best practice guidelines or codes of conduct that will eliminate or significantly reduce the introduction of invasive aquatic plants into California's waterways.

Partnering to Prevent Invasions of Plants of Horticultural Origin

Sarah Connick, Associate Director, Sustainable Conservation
Mike Gerel, Project Manager, Sustainable Conservation

http://www.centerforplantconservation.org/invasives/

Introduction

The sale of invasive plants through the horticulture industry has been an important pathway for invasive plant introductions in the United States, and a number of plants known to be invasive in California are widely available through nurseries and garden centers in the state. California's horticulture industry is the third largest agricultural industry in the state, with about $13.2 billion in annual sales (Hoy & Rodriguez 2003). While substantial headway has been made in the development of techniques for controlling and eradicating invasive plants, relatively little attention has been given to the development of effective strategies for preventing new and continuing invasions. Having researched the structure of the industry and efforts of others working in this area, Sustainable Conservation is establishing a multistakeholder partnership to develop and foster the implementation of strategies for preventing new and continuing introductions of invasive plants through the horticultural community in order to protect California's natural resources.

Environmental and Economic Impacts of Invasive Species

Invasive species, including plants and animals, have a tremendous impact on our environment along with a significant economic cost. Invasive species are the second most serious threat to biodiversity next to habitat destruction and play a critical role in worldwide loss of species (Wortman 2004). From a fiscal perspective, the costs associated with the direct impacts of invasive species amount to at least $137 billion per year nationally (Pimentel et al. 2000), not including the difficult to estimate costs of increased fire, flooding, erosion, and other adverse ecosystem changes.

Invasive Plants and the Horticulture Trade

The horticultural industry has been an important pathway for the introduction of many known invasive plants. Reichard (1997) determined that 85% of invasive woody plants in the United States were introduced for landscape trade, and estimated that there is the potential for more than 1000 new invasive plants to be introduced through this pathway (Reichard 2001). Stanton (2002) determined that 53% of California's most invasive plants have horticultural origins.

While there are numerous individual reports of invasive plants sold at individual stores, little comprehensive data have been available to understand fully the number of species and extent of the availability of plants known to be invasive through wholesale and retail trade. To better understand the situation, Sustainable Conservation and the California Invasive Plant Council (Cal-IPC) compiled information on the availability of known invasive plants through the review of wholesale catalogs and availability listings for 25 California-based nurseries. The 25 nurseries were selected to provide a representative cross-section of the industry based on size, specialty, and location. Cal-IPC identified 52 plants from the approximately 100 in its *List of Exotic Pest Plants of Greatest Ecological Concern in California* (Cal-IPC 1999) that have potential horticultural value. In reviewing the growers' plant catalogs and availability listings, Cal-IPC identified treated horticultural varieties separately.

Cal-IPC found that 32 of the 52 plants for which it looked were carried by at least one wholesaler; these plants are listed in Table 1. Thirteen of those 32 invasive plants also had varieties that were sold by at least one of the 25 growers surveyed. Cal-IPC found that 18 of the 25 growers carried at least one invasive plant and 22 carried at least one invasive plant or an invasive plant variety. The average number of invasive plants carried per wholesaler was 3.2 invasive plants, or 5.5 invasive plants including varieties. Of the 13 plants having varieties, each was sold by an average of 4.5 nurseries. One wholesaler carried 14 invasive plants. The most widely available wholesale plants found in this survey are listed in Table 2.

Cal-IPC also reported on a 2003 retail nursery survey conducted by University of California Cooperative Extension Master Gardeners in San Mateo and Santa Clara counties. The Master Gardeners surveyed 23 nurseries looking for 25 invasive plants included in the *List of Exotic Pest Plants of Greatest Ecological Concern in California* (Cal-IPC 1999), of which it found 23 on sale. The top five plants found in this survey are shown in Table 3.

California's Horticulture Industry

Horticulture is the third largest agricultural industry in California, next to dairy and grapes. In 2001, it accounted for $13.2 billion in sales, and provided approximately 169,000 jobs. Approximately 27% of California's nursery plant production takes place in San Diego County, and California produces 21% of the nursery plants sold nationwide (Hoy & Rodriguez 2003). On the consumption side, California is the largest nursery retailing state in the country, and sales have been trending upward.

California's horticulture industry is diverse and highly fragmented. The industry value chain shown in Figure 1 shows that at the wholesale level, plant material flows from a wide variety of seed and live plant propagators and growers to a wide range of retailers. The three main types of retail outlets are in-store retail, mail order, and landscape contractors. End customers vary widely from homeowners to commercial establishments and governmental purchasers, all of which have different needs.

There are 2,930 wholesale nursery producers in California (CDFA 2003), which accounted for $3.1 billion in sales in 2001 (Hoy & Rodriguez 2003). The wholesale side of this industry operates on low margins, with high competitive rivalry, and has low bargaining power relative to retailers. Although the industry has experienced a significant amount of consolidation in recent years, some sources say it is stabilizing, and it remains highly fragmented. Wholesale growers face several pressing issues in addition to concerns about invasive plants, including pathogen control and increased regulation of runoff water quality.

On the retail side, California's horticultural industry accounted for $10.1 billion in sales in 2001 (Hoy & Rodriguez 2003). There are many plant retailers in California, however, the greatest volume of plant sales is concentrated in the big chain stores. The hardware/home center market share has grown rapidly in recent years, and the relatively high bargaining power of the big chains allows these retailers to put pressure on margin and volume. At the same time that these retail outlets handle large volumes of plants, plants are only one of many types of products they sell.

Landscape firms are also an important retail outlet for plants. While no data are available for California, Americans spend approximately $11.2 billion on landscape construction and installation, and approximately 10.7 billion on landscape maintenance annually (First

Research 2003). It is estimated that landscape contractors constitute 7 to 14% of national nursery and grower sales (ANLA 2004).

Catalog sales account for $3.1 billion in annual sales value nationally (MGA 2003). Although catalogue sales represent a relatively small volume, they have the potential to play a significant role in the introduction of invasive plants because of the distributed nature of the business.

Existing Prevention Efforts

There is no comprehensive framework for regulating all pathways of invasive plant introductions, or for regulating all types of invasive plants sold through the horticultural trade. Federal authority for invasive plant regulation and control is fragmented across many agencies, and emphasizes control of plants that have an adverse impact on agriculture, as opposed to ecosystems. The U.S. Department of Agriculture has banned a small number of highly invasive plants from importation and trade nationally. At the state level, the California Department of Food and Agriculture maintains a list of noxious weeds, and is responsible for establishing appropriate levels of regulatory action. Thus, the listing of a plant as a noxious weed does not necessarily translate directly into a statewide sales ban. Until recently, this list also focused on plants that have an adverse impact on agriculture. In 1993, however, the listing authority was revised to include plants that have ecological impacts, as long as the listing would not have a detrimental impact on agriculture, and 11 new plants were added to the list in 2003, some of which have horticultural value. At the local level, there has been increasing interest in ordinances banning the sale of specific plant species.

Despite the attractiveness of regulation as a strong tool for controlling business practices, it is not clear that regulation alone is the most effective tool for preventing new and continuing introductions of invasive plants (Wortman 2004). The issue of plant invasiveness is complex and differs widely according to plant species and geography. As a result, a variety of organizations has sought nonregulatory means for preventing plant invasions. Invasive plant councils across the country are identifying and inventorying invasive plants to raise awareness of problems in their areas. Cal-IPC and other organizations have developed and disseminated educational brochures on alternatives to invasive plants.

In 2001, industry, academic, and nonprofit organizations concerned about invasive plants of horticultural origin came together to develop voluntary codes of conduct for nurseries, landscape architects, botanic gardens, and garden clubs. Since then, 35 organizations have voluntarily signed-on to the St. Louis Declaration Codes of Conduct.[1] The voluntary codes of conduct for nursery professionals are presented in Table 4. The Codes represent a significant step forward in addressing horticulture as a pathway for invasive plant introductions, and provide a solid foundation for developing practices throughout the horticultural community to prevent new and continuing introductions. At the same time, however, they provide broad direction and significant additional work is needed to translate them into action.

Partnering to Prevent Invasions of Plants of Horticultural Origin

Sustainable Conservation is a San Francisco based nonprofit organization that uses innovative partnerships to promote voluntary conservation in the private sector. In the summers of 2003 and 2004, Sustainable Conservation conducted research on the horticulture industry and the invasive plant issue. Based on our findings, we determined that an effective approach for

developing and fostering the implementation of strategies for preventing introductions of invasive plants of horticultural origin in California would be through a multistakeholder partnership that engages representatives of the industry, consumer, nonprofit, environmental, and academic communities concerned with these issues.

In June 2004, Sustainable Conservation convened a forum for stakeholders to share their perspectives on the nature of the problem and challenges in addressing it, and to assess the need for such an effort. Participants included representatives of the California Association of Nurseries and Garden Centers, Hines Horticulture, Mitsuwa Nursery, Monrovia, Master Gardeners, Cal-IPC, The Nature Conservancy, University of California Cooperative Extension, California Department of Food and Agriculture, and the Bay Area Open Space Council's Stewardship Committee.

Overall, the group concluded that a collaborative effort to develop and foster implementation of strategies for preventing invasive plant introductions through nurseries is needed in California. It identified several key challenges, especially the critical importance of bringing the right people to the table with respect to both the constituency an individual represents and the commitment of that person's organization to the process. In addition, the group saw coming to agreement on the definition and determination of "invasiveness" as a significant hurdle to be crossed. Other key challenges included consumer preferences for particular plants, the diverseness of the audiences that this effort would have to reach, and the need for high-quality scientific information.

At the conclusion of the forum, the group strongly supported the establishment of a Steering Committee to coordinate a collaborative effort. Among the initial tasks identified for the new Steering Committee were to: come up with a good name for the partnership effort, investigate and learn from voluntary efforts in other states, articulate a purpose statement and goals for the group, and develop operating procedures and a work plan using the St. Louis Declaration as a jumping off point. This work is now moving forward with leadership and coordination from Sustainable Conservation.

Epilogue

In December 2004, Sustainable Conservation convened the Steering Committee for this effort, which then named itself the California Partnership for the Preventing Invasive Plant Introductions through Horticulture or Cal-PPIPIH. The group developed and adopted a statement articulating its purpose:

> To develop and foster implementation of strategies for preventing new and continuing introductions of invasive plants through the horticultural community in order to protect California's natural resources.

It also adopted operating procedures and a work plan for moving forward. It then dove into the work of defining and evaluating plant invasiveness, with presentations on Cal-IPC's and NatureServe's criteria for assessing plant invasiveness. The group agreed to move forward with its work on two parallel tracks. One track will be to come to agreement on a definition of invasiveness and evaluation criteria using examples to inform this work, and then identify invasive plants that are used and propagated in the horticultural community. The other will be to develop the strategies needed to prevent new and continuing introductions of plants that are identified as invasive, including education and outreach approaches to industry and consumer communities. A list of the steering committee members is provided in Table 5.

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Session 9: Funding Invasive Plant Projects

Effective Invasive Control Programs in California's Coastal Watersheds

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The California State Coastal Conservancy and the Southern California Wetlands Recovery Project fund invasive plant control programs to protect or restore important coastal resources.

Characteristics of good control programs include:

- Mission – Address the entire infestation in defendable manner
    - Inventory to know where and how much
    - Strategy to eradicate in defendable manner

- Experience - Project manager and contractors have "been there, done that"
    - Knowledge of recent advances in methods
    - Trained contractors
    - If newcomer to invasive plant control, then get a mentor

- Capacity – Stick with program for long-haul
    - Conduct long-term monitoring and maintenance
    - Raise funds

  - Build relationships with public and regulators
  - Share lessons learned

- Support - Resource agencies and local stakeholders buy-in to program
  - Compliance with environmental regulations
  - Landowner permission

- Budget - Realistic yet Frugal
  - Demos & experiments ONLY if necessary
  - Minimize handling biomass
  - Use effective treatments to minimize repeat applications

- Funding – Secure funds from MULTIPLE sources

Our Grant Particulars:

- Coastal Conservancy
  - Demonstrate statewide significance
  - CEQA and permits approved for eradication grant
- Wetlands Recovery Project Work Plan
- Wetlands Recovery Project Small Grants
  - $30,000 maximum
  - Community involvement

Coastal Conservancy Programs

Since its establishment in 1976, the Conservancy has completed over 600 projects, with over 300 projects currently active. These projects include construction of trails and other public access facilities, restoration and enhancement of wetlands and other wildlife habitat, restoration of public piers and urban waterfronts, preservation of farmland, and other projects in line with the goals of California's Coastal Act, the San Francisco Bay Plan, and the San Francisco Bay Area Conservancy.

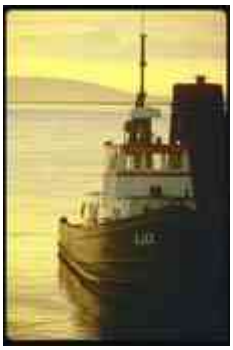
Public Access

The public access program provides capital funds and technical assistance for the construction of public access stairs, trails, limited-mobility-access projects, hostels, interpretive signs and other facilities that serve state and regional coastal access needs, and for the acquisition of interests in land necessary to enable the provision of access facilities. The Conservancy has helped build more than 300 accessways and trails, including major portions of the California Coastal Trail and the San Francisco Bay Trail, thus opening more than 80 miles of coastal and bay lands for public use.

Resource Enhancement

The resource enhancement program provides capital funds and technical assistance for the preservation, enhancement and restoration of wetlands, watersheds, riparian corridors, and other wildlife habitat lands, including, where necessary, acquisition of interests in land, and for technical and scientific services necessary to design and implement such projects. The Conservancy has helped

to design and implement such projects. The Conservancy has helped preserve more than 90,000 acres of wetlands, dunes, wildlife habitat, recreational lands, farmland, and scenic open space.



Urban Waterfronts

The urban waterfront program provides capital funds and technical assistance to protect, restore and expand coastal-dependent recreational, commercial and industrial facilities and to expand opportunities for public access and use of urban waterfronts in conjunction with new development, including the provision of technical assistance to landowners and local governments and through land acquisition and the construction and restoration of facilities. The Conservancy has assisted in the completion of more than 100 urban waterfront projects.

Nonprofit Assistance

The nonprofit organization assistance program provides capital funds and technical assistance to nonprofit land conservation organizations to aid them in implementing Conservancy projects and in developing cost-effective local management of resource land and public access facilities. The Conservancy has joined in partnership endeavors with more than 100 local land trusts and other nonprofit groups, making local community involvement an integral part of the Coastal Conservancy's work. Read about how the Conservancy can help your nonprofit organization.

Southern California Wetlands Recovery Project
www.coastalconservancy.ca.gov/scwrp

The Wetlands Recovery Project (WRP) is a partnership of 17 state and federal agencies working in concert with local government, businesses, and the environmental community to implement a regional wetlands recovery strategy for coastal Southern California (stretching from Point Conception to the border with Mexico). The long-term vision of the WRP is to reestablish a mosaic of functioning wetland and riparian systems that supports a diversity of fish and wildlife species. The Coastal Conservancy serves as staff to the WRP and works with local partners to implement WRP projects.

What Does the Wetlands Recovery Project Fund?

The WRP funds acquisition, restoration, and enhancement projects in coastal wetlands and coastal watersheds in Southern California. The WRP will potentially fund all phases of project development and implementation including planning, environmental review, permitting, and construction. The WRP provides grants to government agencies or 501c(3) non-profit organizations. There is no maximum grant amount. High priorities for the WRP include:

- Acquisition and restoration of tidal wetlands and contiguous transitional and upland habitat.
- Acquisition and restoration of floodplain habitat.

- Acquisition and restoration of riparian areas that contribute significantly to watershed functioning
- Restoration of ecological functions in coastal watersheds (e.g., reconnection of stream corridor to floodplain, stream stabilization, invasive species management, etc.)

The WRP prefers to fund projects that have been identified as a priority either in a resource management plan or by a resource management agency.

How Do You Get Funding From the WRP?

There are two ways to get funds from the Wetlands Recovery Project:

***WRP Work Plan*.** Each year the WRP adopts a list of candidate acquisition, restoration, and enhancement projects which is referred to as the Work Plan. A project must be on the Work Plan to be eligible for WRP funding; however, inclusion on the work plan does mean the project has been awarded a grant. Once a project is placed on the Work Plan, Coastal Conservancy staff will work with proponents of candidate projects to further develop and refine the project scope and identify additional funding sources. When the project is ready to be implemented, a recommendation will be made to the Coastal Conservancy board to award a grant to the project. The WRP solicits project proposals for the Work Plan approximately once a year. The next round of proposals will be solicited in Fall 2005.

Small Grants Program. The WRP Small Grants Program provides funding for community-based restoration projects in coastal wetlands and watersheds in the region. The purpose of the program is to further the goals of the WRP Regional Strategy; build local capacity to plan and implement wetland restoration projects; promote community involvement in wetlands restoration activities; and foster education about wetlands ecosystems. Grants of up to $30,000 are awarded. The program is administered by Environment Now. Nonprofit organizations and local agencies are eligible to apply. WRP Small Grants are awarded on an annual basis.

TABLE 1. Cal-IPC Listed Invasive Plants Available from 2004 Survey of 25 Wholesalers

Scientific name	Common name
Arctotheca calendula	cape weed
Arundo donax	giant reed
Cirsium vulgare	bull thistle
Cortaderia selloana	pampas grass
Cotoneaster lacteus	Parney's cotoneaster
Cotoneaster pannosa	cotoneaster
Cytisus scoparius	Scotch broom
Eichhornia crassipes	water hyacinth
Elaeagnus angustifolia	Russian olive
Ficus carica	edible fig
Foeniculum vulgare	fennel
Hedera helix	English ivy
Helichrysum petiolare	licorice plant
Hypericum perforatum	St. John's wort
Ilex aquifolium	English holly
Iris pseudacorus	yellow flag iris
Lupinus arboreus	bush lupine
Mentha pulegium	pennyroyal
Myoporum laetum	myoporum
Myriophyllum aquaticum	parrot's feather
Olea europaea	olive
Pennisetum setaceum	fountain grass
Retama monosperma	bridal broom
Ricinus communis	castor bean

Robinia pseudoacacia	black locust
Sapium sebiferum	Chinese tallow tree
Schinus molle	California pepper tree
Schinus terebinthifolius	Brazilian pepper tree
Sesbania punicea	scarlet wisteria
Spartium junceum	Spanish broom
Tamarix ramosissima	saltcedar
Vinca major	periwinkle

TABLE 2. Most Widely Available Invasive Plants from Survey of 25 Wholesalers

Cal-IPC Listed Plants

Hedera helix / English ivy (7 of 25)
Cortaderia selloana / Pampas grass (5 of 25)
Cotoneaster lacteus / Cotoneaster (5 of 25)
Schinus molle / California pepper tree or Peruvian pepper tree (5 of 25)

Varietals of Cal-IPC Listed Plants

Pennisetum setaceum var. / Fountain grass (12 of 25)
Hedera helix var. / English ivy (9 of 25)
Cortaderia selloana var. / Pampas grass (7 of 25)
Vinca major var. / Periwinkle (7 of 25)

TABLE 3. Most Widely Available Invasive Plants from Survey of 23 Retailers

Cal-IPC Listed Plants

Hedera helix / English ivy (23 of 23)
Pennisetum setaceum / Fountain grass (21 of 23)
Vinca major / Periwinkle (21 of 23)
Aptenia cordifolia / Red apple (19 of 23)
Helichrysum petiolare / Licorice plant (17 of 23)

TABLE 4. St. Louis Declaration Voluntary Codes of Conduct for Nursery Professionals

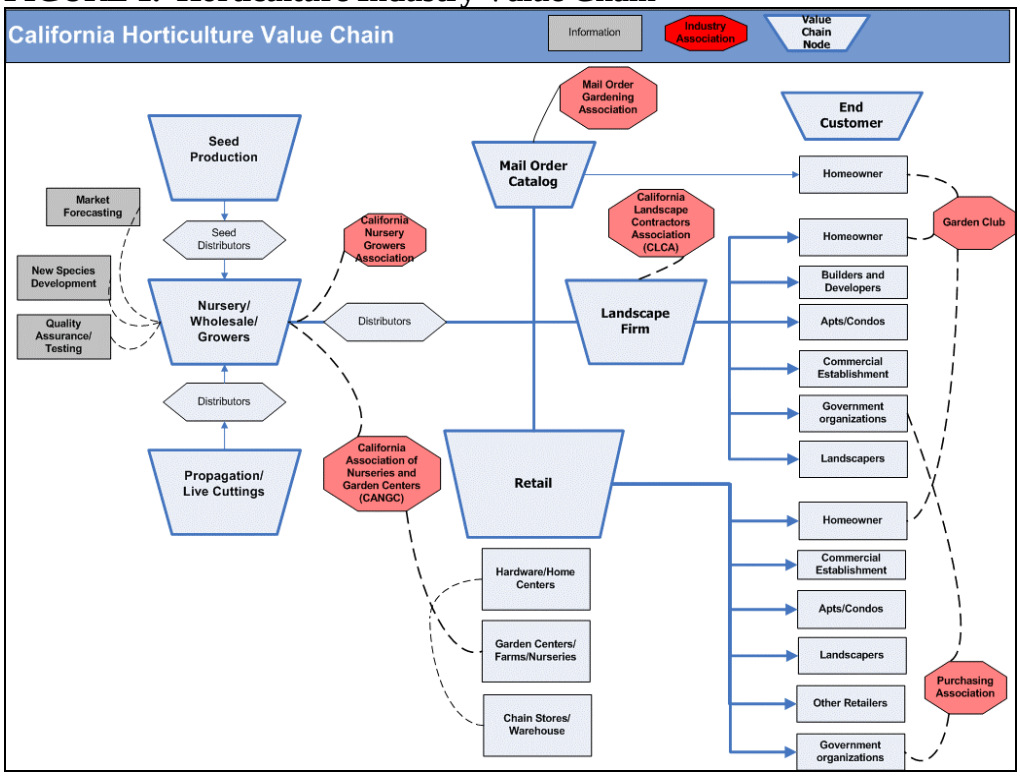
- Ensure that invasive potential is assessed prior to introducing and marketing plant species new to North America.
  - Invasive potential should be assessed by the introducer or qualified experts using emerging risk assessment methods that consider plant characteristics and prior observations or experience with the plant elsewhere in the world.
  - Additional insights may be gained through extensive monitoring on the nursery site prior to further distribution.
- Work with regional experts and stakeholders to determine which species in your region are either currently invasive or will become invasive.
  - Identify plants that could be suitable alternatives in your region.
- Develop and promote alternative plant material through plant selection and breeding.
- Where agreement has been reached among nursery associations, government, academia and ecology and conservation organizations,
  - Phase-out existing stocks of those specific invasive species in regions where they are considered to be a threat.
- Follow all laws on importation and quarantine of plant materials across political boundaries.
- Encourage customers to use, and garden writers to promote, non-invasive plants.

TABLE 5. California Partnership for the Preventing Invasive Plant Introductions through Horticulture Steering Committee

Name	Affiliation
Carl Bell	University of California Cooperative Extension, San Diego
Bethallyn Black	University of California Cooperative Extension, Contra Costa Master Gardeners Program
Sarah Connick	Sustainable Conservation
Holly Crosson	Reducing the Introduction and Distribution of Non-native Aquatic Invasive Species (RIDNIS), University of California at Davis
Jennifer Chandler	Landscape Architect, Northern California Chapter of the American Society of Landscape Architects
Bob Falconer	California Association of Nurseries and Garden Centers
Jim Folsom	Huntington Botanical Gardens

Jim Gilbert	Northwoods Nursery, Inc., Mail Order Gardening Association
Kent Gordon England	California Landscape Contractors Association
Angel Guerzon	Landscape Designer; University of California at Santa Cruz Arboretum; California Native Plant Society, Santa Cruz County Chapter
Doug Johnson	California Invasive Plant Council
Paul Nelson	Home Depot
Betsy Peterson	California State Floral Association
Mary Pfeiffer	Shasta County Agricultural Commission
John Randall	The Nature Conservancy
Craig Reggelbrugge	American Nursery and Landscape Association
Sarah Reichard	University of Washington
Nicholas Staddon	Monrovia
Pat Thalken	California Department of Food and Agriculture
Carolyn Villa-Scott	Yamagami's Nursery

FIGURE 1. Horticulture Industry Value Chain



Weeds/Watersheds/Words

Susan J. Woolam, State of California, Department of Water Resources, Southern District,
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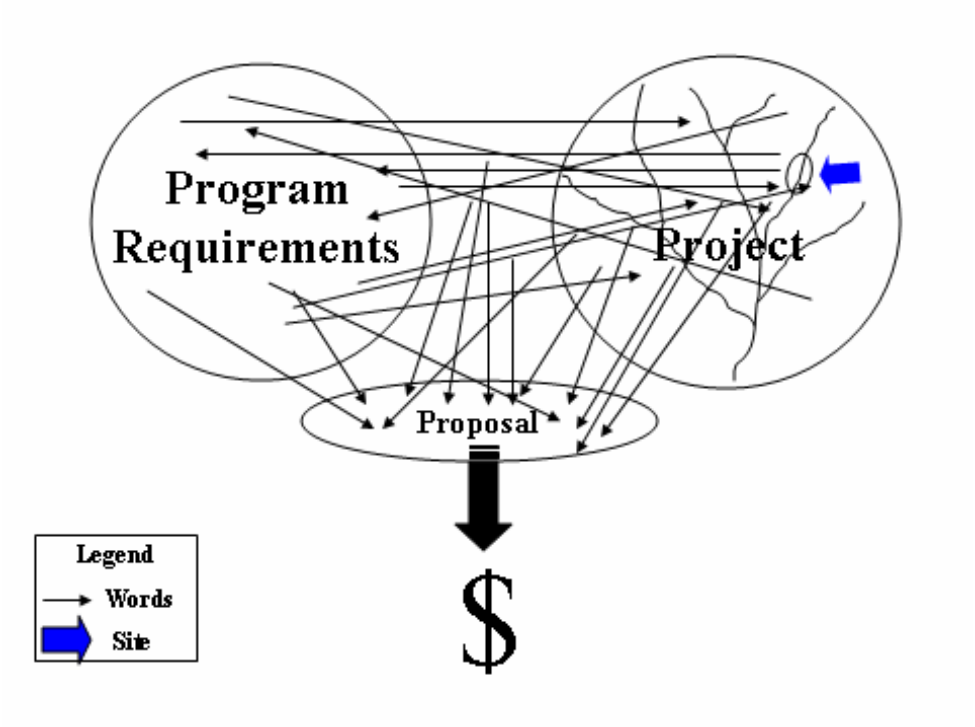
Department of Water Resources Website: http://wwwdwr.water.ca.gov/
Urban Streams Restoration Program Website:
http://www.watershedrestoration.water.ca.gov/urbanstreams/

The Urban Streams Restoration Program, administered by the California Department of Water Resources, has two main goals. One is to promote protection, restoration, and enhancement of urban stream channels by combining efficient and effective means of flood control protection with the preservation and enhancement of natural environmental values. The other is to promote community stewardship of local streams. Projects selected for funding tend to have multiple purposes that enhance the local watershed and community as well as the individual stream. Projects designed to remove exotic/invasive plant species from an urban stream channel for the purpose of controlling flooding and erosion, while also enhancing the local ecosystem, qualify for funding. For example, two large arundo-removal projects were funded in San Diego County, during the grant cycles of 2001-2002 and 2002-2003. Control of exotic/invasives can also be one of many components of a stream restoration project. The Urban Streams Restoration Program website has summaries of projects funded in recent years. http://www.watershedrestoration.water.ca.gov/urbanstreams/pastproj/

Specific program requirements include: 1) Co-sponsorship by at least one local government agency and at least one non-governmental organization. 2) Flood management or erosion control as a primary objective. 3) Maintenance or enhancement of the environmental characteristics of a stream or restoration of a stream to a more naturally functioning state. 4) Inclusion of the community in planning, implementing, monitoring or maintaining the stream to promote awareness and stewardship of streams. Prospective applicants should also be aware that this is a reimbursable grant program that pays for expenses *after* specific work tasks are completed. No funding is supplied in advance.

Obtaining grant funding through this and other programs requires that prospective applicants compete with others based on a written grant proposal. Each grant application package, issued at the opening of the grant cycle, contains instructions and the program requirements. These are primarily based on the California Water Code, Section 7048, and the California Code of Regulations, Title 23, Division 2, Chapter 2.4, Sections 451.1 through 451.6, often cited in the instructions. A copy of Section 451 is provided in the application package. All California codes (laws passed by the legislature) can be seen at http://www.leginfo.ca.gov/calaw.html and the California Code of Regulations (rules made by agencies based on laws) can be seen at http://www.calregs.com. The challenge in preparing a competitive grant proposal lies in being able to match complex project features to complex program requirements. (The diagram below attempts to illustrate the basic process of preparing a grant proposal.)



The circle on the right represents the project site, located on a stream, located within a watershed. The circle on the left represents all project requirements, including laws, regulations, and application instructions. The oval below the circles represents the project proposal. A thick arrow at the bottom of the proposal oval points toward a dollar sign and represents getting funded. The arrows between the project circle, or the requirements circle, and the proposal oval represent the words or language used to describe the project site and features or the requirements that apply to the project. The arrows between the requirements and the project show how they are interrelated. Other arrows toward the center go directly to the proposal, beginning from other arrows that connect the requirements and the project to each other. These represent language that describes the interrelationship between project features and project requirements. No arrows point outside the diagram into blank space. This represents a concise, effective proposal in which no words are wasted. The diagram is busy, even messy. This represents hard work in a complex verbal environment, the work of preparing a grant proposal.

In addition to the text portion of the proposal, it is also important to choose photos, maps, and drawings that best portray the site and the project. These should illustrate or supplement the descriptions or points made in the proposal text. Unfortunately, some photos are submitted with a proposal that do not convey the environmental values of the site. There are also times when diagrams or drawings are not submitted and the text alone does not clearly describe the project. Effective use of photos or diagrams, along with descriptive text, can help a project get funded.

While most applicants instinctively recognize the level of technical skill needed to design a project, some may not fully recognize the level of verbal skill needed to prepare a project proposal. However, finding team members with skills in preparing a project proposal can be just as important as finding team members with skills in designing a project. Most grant proposals that have been

funded by the Urban Streams Restoration Program were produced by project teams that had at least one person who had skills in writing and editing and also experience with restoration projects.

Funding Invasive Plant Projects Through the Farm Bill

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Yellow starthistle, Arundo, and other invasive weed projects may be funded by different programs within "The Farm Security and Rural Investment Act of 2002", commonly known as the Farm Bill. This presentation gave an overview of how these programs can work for funding invasive plant projects in California, as well as going over specific examples.

The Farm Bill is made up of over ten separate programs with different rules and procedures. In California, the program that has, by far, the most money is the Environmental Quality Incentives Program (EQIP) – over $31 million in 2004. This program is designed for private farms and ranches and can be used to cost-share (usually at 50%) specific practices as part of a Conservation Plan. Practices such as "Pest Management", "Prescribed Burning", "Prescribed Grazing", "Brush Management", "Critical Area Planting", and several others can be used for invasive weed projects through EQIP. This program is administered at the county level by NRCS. To find out more details of how this program works in your county and how to apply visit http://www.ca.nrcs.usda.gov/programs/eqip/ and click on "California 2004 State EQIP Sign-Up and Application Information –New!" (as of this writing the 2005 EQIP program has not been posted, although only subtle changes are expected from 2004). **The cut-off date for accepting applications for the 2005 EQIP funding cycle is January 28, 2005.**

Other programs that are sometimes used to fund invasive weed projects in California are the Wildlife Habitat Incentives Program (WHIP) and the Wetlands Reserve Program (WRP). Details on these and other programs in the Farm Bill can be found at http://www.nrcs.usda.gov/programs/farmbill/2002/products.html.

State and Federal Legislation Funding Initiatives

Wendy West
California Invasive Weed Awareness Coalition
El Dorado County Weed Management Area

The California Invasive Weed Awareness Coalition is a coalition of private sector groups and non-governmental organizations concerned with invasive weeds. The mission of the group is to support and enhance existing weed control efforts in California. The coalition supports legislation at the state and national levels to increase funding to groups in California to continue important weed projects. Efforts to lobby for new legislation and funding include:

Federal Efforts:

- Delegation to National Invasive Weed Awareness Week (NIWAW) in Washington, D.C. – February each year
- Meetings with Congress members and/or staff during NIWAW
- Produce a position paper and "leave behind" packet for Congress members
- Highlight the success of California Weed Management Areas (WMA) and "on the ground" projects
- Support Senate Bill 144 to provide $100 million funding to weed management entities
- Letters supporting legislation to Congress members and Committee Chairs

State Efforts:

- California Invasive Weed Day at the Capitol – March 24, 2004 and March 2005 (date to be announced) – meetings to educate legislators and staffers at the Capitol, including position paper and information packet
- California Weed Awareness Week – July 18-24, 2005; assist local WMA groups in highlighting projects, organizing weed tours, etc.
- New funding for Senate Bill 1740 (Leslie) – beginning process to introduce new legislation in 2005 to fund WMAs in California via the SB 1740 infrastructure

How can you help? Attend NIWAW and/or California Invasive Weed Day at the Capitol, be ready to write letters to legislative representatives when needed (and have your partners ready!), and educate, educate, educate! --- both state and federal staff members (at your district and at the Capitols) regarding the threat of invasive weeds!

Session 10: Field Techniques

Flaming: A New Tool for Wildland Weed Control

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The term 'flaming' as a method for killing plants would seem to indicate that plants are actually burned.. While a torch that produces a flame is indeed employed, the flame is passed over the plant so quickly that the only visible evidence is that the leaves deepen slightly in color, and wilt. At first, it's easy to doubt this slight change in appearance has produced mortality, but this will be easily confirmed by the next day when flamed plants will have turned brown.

The technique has been in use since the 1920's for controlling weeds in agriculture, and is now being applied to controlling weeds in wildlands. While it is not an efficient way to kill most weeds at later stages of growth, it is very effective for controlling most annual species and many perennial species if applied when the plants are in the seedling stage. In most parts of California, this occurs for many weedy species soon after the first rains of fall or winter. This coincides handily with the time that this technique can be safely employed, which is when the ground is too wet to carry fire. Since

wet soil transmits heat downward to roots more effectively than dry soil, the effectiveness of this technique is also enhanced in wet conditions. In addition, you can get an earlier start on the weed control season and kill weeds when they are very small, maximizing your efficiency.

I have been using flaming to control French broom for several years with great success. If properly done, mortality is close to 100%. The huge flush of seedlings which arises after the initial stand of parent plants is removed by hand pulling is not conducive to re-pulling by hand, so an alternative method must be employed at this time. Herbicides aren't always an option. Certifying workers to be herbicide applicators is time consuming, and many people don't like to spray. However, I have found most people are eager to flame, and it is very easy to train them to do it effectively.

Single Pass Flaming

The optimum time for flaming is when the plants are at the dicotyledon stage, and up until the plant has about 3-5 true leaves. At this stage, one pass of the torch produces mortality within seconds. I call this technique Single-Pass Flaming. Mortality is produced by a variety of physiological reactions to a surprisingly low level of heat. When the plant temperature reaches about 100 degrees C., cell walls burst, and other reactions to the heat which contribute to the plants mortality also occur. Carla Bossard is conducting a lab analysis of the many factors involved in mortality produced by single pass flaming, and her results will be published in a future CalIPC newsletter.

Although some annual species may succumb even at later stages of growth, most weedy species will require a greater expenditure of time and fuel to control with flaming if they have progressed significantly beyond he seedling stage. When flaming larger plants, concentrate the heat around the lower part of the stem. Some species develop resistance to flaming sooner in their growth stage than others, so experimentation may be required to determine the growth stage at which flaming is no longer the best option on a species by species basis.

Although my experience with single pass flaming is mostly with French broom, it has also been used to control many other species. Based on information I have gathered, here are some guidelines for determining what kinds of plants it may be effective on:

Candidate Species for Single-Pass Flaming

- Annual or perennial species which put most of their early growth into above ground vegetation, as opposed to developing significant underground reserves, deep roots, or rhizomes.
- Plants which have their growth centers above ground, where they are not well protected.

For species which meet these criteria, single-pass flaming can be an effective alternative to using herbicides.

Advantages of Flaming

- Can be done earlier in the year than other methods, extending the weed control season.
- Plants are killed when small, maximizing worker efficiency.
- No dead vegetation remains to hinder follow-up efforts.
- No ground disturbance
- Costs are comparable to using herbicides.
- Optimal conditions for use are in the rain, when workers would not otherwise be in the field.
- Flaming is more selective than spraying, allowing safer use in sensitive areas. There is no spray drift.

- Easier to use than herbicides. Less training is required for people to use the technique proficiently and safely, and licensing is not currently required.

Limitations of Flaming

- Slower than spraying, (but more precise)
- Less effective on most species when plants have emerged significantly beyond seedling stage.
- Dependant on suitable weather conditions, potentially limiting its usefulness in drier years
- Careless use of flaming equipment can result in personal injury or fire.

Repeat Flaming

Plants that produce rhizomes, runners, or extensive root systems are generally thought to be resistant to single pass flaming. Plants such as most perennial grasses which have their growth centers at or below ground, or protected by sheaths or other plant parts are also resistant. There is evidence that flaming can control these resistant species, but repeat applications must be used to exhaust the plants' reserves. If the applications are timed correctly, the plant will not be able to produce enough new stems and leaves to replenish the plants reserves. Eventually, the plant literally starves to death.

While this technique has been shown to be effective on grasses and other resistant species, it must be timed accurately to be successful. Most practitioners agree that follow-up applications should be about 2 to 3 weeks apart. Since flaming must be done in wet conditions, this may not always be possible in California winters. Also, enough applications would have to be administered to produce mortality within one flaming season, so the plant would not have time to regenerate.

There is very little definitive information available on repeat flaming, and none I could find specifically for wildland weeds we wish to control in California. Therefore, the technique may have to be tested on a species by species basis to determine its effectiveness. If many repeat applications are required, costs may be preclusive. However, repeat flaming may still prove a valuable tool where herbicides cannot be used.

FLAMING: THE TECHNIQUE

First, and most important, READ THE SAFETY PROCEDURES GIVEN HERE AND WITH THE EQUIPMENT BEFORE PROCEEDING. This equipment is soundly built with user safety in mind, but careless or improper use can result in serious injury.

Since this a new technique in wildlands, no regulations have as yet been set forth to control its' use, so practitioners must take the initiative to flame intelligently. To avoid the risk of fire, flame only when the site is too wet to carry fire or when you have employed appropriate prescribed burn procedures for containing any fire which may start. I prefer to flame when it is actually raining. Not only does this eliminate any chance of starting a fire, it will keep you warm and allow you to work when you might otherwise stay indoors. In addition to being safer, flaming when the ground is wet transmits heat deeper into the soil, helping to kill roots.

Follow correct procedures for assembly and use of all components. Check all connections for leaks before proceeding. To light, make sure the valve on the torch handle is closed, then SLOWLY open the valve on the tank. (If you open it too fast, the safety shut-off system will activate, preventing fuel from leaving the tank.)

Point the torch away from any objects, and slowly open the valve on the torch handle just enough to hear a little gas being released. Then light the torch from the back of the bell. I use a trigger activated butane lighter. Open the valve further until the flame is blue, with little or no trace of yellow. This is the optimum temperature.

Hold the torch 6“ to 12“ from the plant. This is where the flame is hottest. Torches vary in their output, and you will quickly learn the most efficient distance to keep the torch tip from the target. Keep the torch moving. The object is to use just enough heat to produce wilting. You should notice a slight deepening of the green on the leaves. If you burn the plant, you are wasting time and fuel, and may actually get less kill! A leaf pressed between the fingers will show a fingerprint when flamed properly.

Flaming is most effective from when plants are at the dicotyledon stage up to when they have produced about 5 or 6 true leaves. When flaming taller plants, concentrate heat on the lower portion of the stem. If the torch blows out frequently, you may be holding it too close to the ground. If it's windy, it helps to keep the torch pointed downwind. Do not flame under trees or shrubs with low overhanging branches, especially conifers!

The torch tip gets very hot, so be careful where you set it down. When you are through flaming, hold the lit torch in the air and shut off the gas first at the valve on the tank, letting all the gas in the hose burn off. Then shut off the valve on the torch, and disconnect the hose from the tank. Do not vent unburned fuel into the atmosphere. Never transport the equipment without first disconnecting the hose from the tank, and always transport cylinders in the vertical position (valve on top).

FLAMING: THE EQUIPMENT

There are two types of flaming equipment, based on the way fuel is delivered to the torch.

In **Vapor withdrawal systems** the fuel, liquid propane gas (LPG), is converted to a gas in the tank, and travels through the hose to the torch as a gas. When using the larger size vapor torches, the expansion of the liquid fuel to gas causes the tank and the torch handle to get very cold. Gloves are recommended. When flaming in wet or cold weather the torch handle and the cylinder may frost up over time. Since wet and cold conditions are conducive for flaming in wildlands, vapor systems are best suited for intermittent use. Icing can be reduced by using a smaller size torch, or by using a larger cylinder. (Fuel tanks are called cylinders.) Of course, larger cylinders are heavier and harder to handle. If the control valve on the handle freezes up to the point where you cannot operate it, you can shut off the fuel supply at the valve on the tank and let the fuel in the hose burn off.

In **Liquid withdrawal systems** the fuel is delivered as a liquid all the way to the tip of the torch, and is vaporized there. Liquid systems are not as susceptible to icing up, which makes them better suited for continuous use. Both the cylinder and the torch are made specifically for liquid withdrawal. (You cannot use a liquid cylinder with a vapor torch, or a vapor cylinder with a liquid torch.)

Small torches with capacities of 50,000 to 100,000 BTU are suitable for spot flaming or small jobs. They are usually used with a 10 or 20 lb cylinder which can be easily carried in one hand. A set-up is also available which incorporates a 10 lb cylinder into a backpack frame that I find very useful, especially in difficult terrain. It is currently available in 100,000 and 400,000 BTU sizes. Torches are available with capacities all the way up to 2,000,000 BTU., but torches with capacities over 750,000 BTU. are intended primarily for burning off areas of dense vegetation. If

you are flaming large areas on fairly level ground, a liquid system with a 40 lb cylinder mounted on a hand dolly is a good choice. Larger cylinders are available and can be mounted on trailers, tractors, or ATV's.

Large torches allow you to work faster, but are more difficult to control around non-target species. In addition, they use more fuel. A 100,000 BTU torch uses 2 to 3 lbs/hr, and a 500,000 BTU torch uses about 10 lbs/hr.

Flame Engineering www.flameengineering.com. offers a complete range of equipment. They have a toll free number where you can get a free catalog, information and technical support at 800-255-2469.

Summary

Flaming is an effective method for controlling many weed species, if done when plants are small.

Less susceptible species require repeat applications, timed to exhaust the plants' reserves.

Flaming is safe only when the site is too wet to support fire, possibly limiting its potential in drier areas and years.

Flaming is a new technique for controlling wildland weeds. Very little information is available. Your feedback will be valuable in determining species on which it may be effective here in California.

The Use of Heavy Machinery (Excavators) to Remove *Ammophila arenaria* (European beachgrass) from Native Sand Dunes at Point Reyes National Seashore

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Heavy machinery was used to remove 4 acres (1.6 hectares) of *Ammophila arenaria* (European beachgrass) at Abbott's Lagoon, Point Reyes National Seashore in February 2004. The process took 4 weeks and now, six months since removal, the results are very encouraging. This write-up will outline the history of *Ammophila arenaria* at Abbott's Lagoon, project preparation, removal method, removal results, and thoughts for the future.

Background

Functioning native coastal sand dune ecosystems are very rare in California. Point Reyes National Seashore is home to one of the last large, relatively intact dune ecosystems on the West Coast. Many listed species depend on functioning dune ecosystem for their survival including: the threatened Western snowy plover, the endangered Myrtle Silverspot butterfly, and the endangered plants *Layia carnosa and Lupinus tidestromii*. The purpose of this project is to restore coastal dune habitat for these species and restore natural dune processes.

The nonnative plant *Ammophila arenaria* has invaded significant portions of high quality coastal dune habitat all along the Pacific Coast, including over 800 acres at Point Reyes National Seashore. The perennial plant's dense stands can be over 1 meter tall and rhizomes can extend over 2.5 meters down; *Ammophila* sp. spreads primarily by rhizome. *Ammophila* sp., in addition to out-competing

native species, builds an unnaturally high, stable foredune at the front of the beach. This "sea wall" of *Ammophila* sp. prevents animals such as the Western Snowy Plover from nesting in all but a narrow, exposed strip of sand along the beachfront and prevents natural sand movement.

The 4-acre project site rests on a strip of dunes that separates the ocean from Abbott's Lagoon. The location of the removal was chosen because it would allow plovers to access the back dunes and beachgrass cover was nearly 100%.

Mechanical methods were used because of the dense nature of *Ammophila* sp., the lack of native plants, and the fact that hand removal methods have resulted in aggressive re-sprouting of beachgrass rhizomes. Using the hand removal method, roots and rhizomes of *Ammophila* sp. are dug to a depth of 1/2 to 1m deep. All plant material is carefully raked up and piled for composting. Re-sprouts, resulting from rhizomes that remain in the sand, must be removed 15 to over 20 times before complete removal is accomplished.

Project Preparation

Several compliance documents were prepared prior to the project beginning. These documents covered issues such as: California Coastal Commission notification, US Fish and Wildlife Service concurrence, and the park's internal Project Review (which included and exercise concerning mechanical tools in a wilderness area and archeological inspection of the site).

Prior to beginning the project background data that was gathered. This included a survey of all rare and native pants in the project area and surrounding areas. Two elevation transects were set up to determine the actual topographic change following removal. These transects ran across the project from the ocean to the lagoon with the elevation recorded every 3 meters. The intention is to monitor elevation changes due to actual removal and blowing sand movement following removal. Permanent photo-monitoring sites were established throughout the project site.

Removal Methods

Two excavators of 13 and 21 metric tons each were used. Each excavator was equipped with a four-foot bucket and thumb. The machine operators were two employees of PORE's roads and trails department; we paid their salaries for four weeks. The remoteness of the work site posed re-fueling logistic challenges. The machines could run for about 15 hours on a tank of gas (or about 2 days). An emergency spill kit was kept on site in case of a blown hydraulic line.

The actual burial of the beachgrass was a four-step process.

1. First an area of approximately 4 meters x 5 meters x 1-2 meter deep was cleared of *Ammophila* sp. Care was taken to dig deep and remove all the rhizomes and roots. This *Ammophila* sp. and "dirty sand" was piled on top of adjacent mature *Ammophila* sp.
2. Second the clean sand beneath was dug out and stockpiled in an adjacent clean sand area. In doing this, the pit was dug as deep as possible, 3+ meters deep. Final excavated pit size is usually about 4m x 5m x 3m deep (swimming pool size).
3. Third the large pit was filled with the recently removed *Ammophila* sp., the *Ammophila* sp. beneath, and all the dirty sand. The hole was filled to within about 1-1.5 meters of the surrounding elevation.

4. Finally the stockpiled clean sand was layer on top of the *Ammophila* sp. to a depth of about 1.5 meters. The clean sand was smoothed to grade. Actual burial depths at the project site varied from 0.5 to 1.5 meters due to poor communication with an equipment operator.

This process was completed in multiple adjacent pits, ultimately clearing a large area.

Removal Results

A 600 square meter area within the mechanical removal area contained a large amount of native and rare plants and almost no *Ammophila* sp., sort of a dune hollow. This native plant exclosure area was shown to the equipment operators and was clearly fagged off. The equipment operators were able to work with great precision right up to the edge of the exclosure without damaging the native plants. Nine native plants were found occurring in the native plant exclosure six months after removal including the endangered *Layia caranosa.*

The transect elevation monitoring show that there was large elevation change as a result of the actual burial process (up to two meters gain or loss). The elevation monitoring also show that there was very little change from one month after removal to six months after removal (up to 0.2 meters gain or loss). The most notable effect of removal was the laying back of the high foredune, making the dune profile more natural and less steep.

Mechanical removal methods resulted in fewer re-sprouts than hand removal methods. Re-sprouts of *Ammophila* sp. were monitored every two months following initial removal. Three separate categories were monitored; hand removal (down to 0.5 meters), shallow mechanical removal (*Ammophila* sp. was buried under 0.5-1.0 meters of sand), and deep mechanical removal (*Ammophila* sp. was buried under 1.0-1.5 meters of sand). Overall there were fewer re-sprouts/m^2 using shallow mechanical removal than using hand removal. There were still fewer re-sprouts/m^2 using deep mechanical removal than using shallow mechanical removal.

Mean *Ammophila* sp. stems/m^2

	2 months later	4 months later	6 months later
deep mech. removal	0.3 (95%C.I.=0.25)	0.7 (95%C.I.=0.58)	0.7 (95%C.I.=0.5)
shallow mech. removal	15 (95%C.I.=6.25)	6.8 (95%C.I.=2.76)	10.5 (95%C.I.=3.7)
hand removal	31.6 (95%C.I.=14.7)	35.6 (95%C.I.=14.8)	31.5 (95%C.I.=11.7)

A total of four Western snowy plover pairs and five plover chicks used the mechanical restoration area for chick rearing during the 2004 breeding season. This area is open enough for plovers to see approaching predators but also provides areas of cover, food, and reduced disturbance from humans. This is the first time plovers have used the back dunes area since research began in 1972. Normally plover nesting activity has been restricted to a narrow strip of sand between the *Ammophila* sp. formed sea wall and the high tide line. This project has opened up a whole new area of habitat for the birds.

A total of 9 species of native plants have appeared within the actual beachgrass burial part of the project 6 months after removal. This included two of the endangered *Lupinus tidestromii*. List of "volunteer" plants found within the mechanical removal area 6 months following beachgrass removal: *Abronia latifolia, Ambrosia chamissonis, Baccharis pilularis, Camissonia cheiranthifolia ssp. cheiranthifolia, Distichlis spicata, Lathyrus littoralis, Lupinus tidestromii, Plagiobothrys* sp., and *Rumex salicifolius var crassus*

Mechanical removal (burial) of *Ammophila* sp. proved to be more cost effective than hand removal. Mechanical removal cost us $5,363/acre (including equipment rental, operator salary, and fuel). Hand removal cost from $14,818/acre (for 0.5 meter deep removal) to $27,936/acre (for 1.0 meter deep removal). The hand removal figures are based on costs incurred during the 2003-2004 work years.

Several general lessons were learned through the project:
1. Bury *Ammophila* sp. deeper on windward slopes
2. Bury *Ammophila* sp. as deep as you can (at least 1.5m deep)
3. Establish clear communication with the equipment operator (to avoid shallow burial)
4. Pre-check mechanical condition of equipment (repair out at the dunes is more difficult)
5. Remove re-sprouts as soon as possible (it appears most of the re-sprouts are just sprouting from a small piece of rhizome and do not yet have well developed roots).

Thoughts for the Future

Ammophila sp. removal from California's remaining coastal sand dunes is a huge challenge. Tracking the invasion of *Ammophila* sp. into the Abbott's Lagoon area and its affect on native dune organisms and processes have provided the catalyst for removal. There are many situations in which manual removal might be preferred to mechanical; all alternatives should be evaluated for a given site. Some possible reasons that mechanical removal would not be feasible or desired include: relatively high presence of native plants, presence of endangered plants/animals, or significant cultural resources.

The mechanical removal method has produced encouraging results showing: fewer re-sprouts, removal of steep foredune, the ability to preserve native plant areas, the ability for the snowy plover to quickly utilize the area, the ability of rare and native plants to quickly re-colonize the area, and lower cost (compared to hand removal). With the knowledge gained from this project we plan on completing a similar project in 2007, treating 100-300 acres of *Ammophila* sp. near Abbott's Lagoon. It is our hope that these results and lessons learned will be useful to others facing similar challenges on their coastal sand dune restoration projects.

CRISISCat - An Online Invasive Species Information Clearinghouse for California

Allan D. Hollander
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The CRISISCat website is at http://cain.nbii.gov/crisis/crisiscat/

In conjunction with the California Legacy Project, the California Information Node (CAIN) of the National Biological Information Infrastructure has developed CRISISCat, a pilot Web-based clearinghouse for invasives resources in California. The aim of the CRISISCat project is to provide access to easily available information resources describing invasive species experts, projects, organizations, web resources, datasets, and distribution maps. We have initially catalogued information on 13 prominent invasive species, and also have included information from the CalWeeds database of noxious weed control projects, a bibliography of weed publications provided by Dr. Joseph DiTomaso, and references to weed distribution maps such as those in CAIN's earlier weed mapping web application, CRISISMaps.

The interface to CRISISCat is designed to let the user easily follow the interrelationships between resources, such as finding contact information for members of an invasive weed organization. CRISISCat supports both faceted navigation and full-text search, uses controlled vocabularies to facilitate navigation, and provides every information resource in the system with its own distinct catalog page. The backend of CRISISCat uses an RDF database to structure the links between resources and to facilitate aggregating catalog entries created by invasive weed experts. CAIN would like to expand the pilot CRISISCat catalogue to incorporate a more comprehensive set of weed resources, and use its underlying concepts of semantic networking to improve information sharing in the invasive weed community.

The New "JK Injection Tool" for Control of Knotweeds and Other Hollow-Stem Plants Growing in Sensitive Wetland Sites

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A new simple, effective, and easy-to-use tool has been developed for the control of Japanese knotweed (*Polygonum cuspidatum*), and giant knotweed (*Polygonum sachalinense*) using AquaMaster Herbicide. The tool may have utility for other hollow stem invasive plants, as well. The JK injection system is a patented tool, and has been developed primarily for the control of Japanese knotweed. This invasive weed family is a huge problem along water corridors and wetlands in the UK, and continental Europe, and across the northern-tier of the United States, and portions of southern Canada, as well. Infestations have also been found in areas outside its traditional range.

The presence of J. knotweed in California is unknown, but there are regions of the state that have similar site characteristics to infested sites in the Pacific Northwest. The biology and growth habit of J. knotweed pose special control challenges. An introduction to Japanese knotweed will be presented in addition to a description and use of the JK injection tool.

The Riparian Weed Management Program at Marine Corps Base Camp Pendleton: Past, Present, and Future

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Marine Corps Base, Camp Pendleton is 124,642 acres (50,462 ha) in size and has a diverse array of habitat types, including many different types of land uses. The Base covers an area with five major watersheds some of which are contained within the Base and some of which are shared by other neighboring landowners. Two types of weed projects occur in riparian areas on Pendleton: 1) stewardship and 2) mitigation banking. The Base uses ecologically-based adaptive weed management strategies with the goal being an increase in relative value of the riparian ecosystem and therefore more suitable habitats for listed species. Initial control efforts by the Base for arundo (*Arundo donax*) began in 1995 on Sandia Creek, a tributary of the Santa Margarita River watershed north of Camp Pendleton. Agreements were reached with neighboring agencies to treat portions of the upper watersheds to prevent the recurring

spread of arundo on Base. Since that time portions of all the major watersheds on Base have been treated primarily for arundo and tamarisk (*Tamarix* spp.). Fifteen of the 18 Santa Margarita River miles have been treated for arundo to date. Current efforts are focused on monitoring to determine riparian ecosystem recovery, data management, and planning strategy for the last remaining untreated section of the Santa Margarita River. A GIS-based tracking system is in development to integrate historical data and thus help track and guide future weed treatment planning.

Session 11: Invasive Plants and Fire at the Wildland/ Urban Interface

Benefits Versus Fire Risk of Native and Invasive Vegetation in the Wildland-Urban Interface

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Abstract
There is seemingly a paradox between the goals of the fire suppression community and those in urban forestry and landscape architecture. In general, the fire suppression community seeks to minimize vegetative cover in a community because it contributes to increased wildfire intensity and severity, whereas the latter often seek to maximize vegetation, both native and non-native, as it provides multiple benefits to a given community.

This paper discusses the challenges of managing vegetation in the wildland-urban interface. A hypothetical community was created to examine the tradeoffs between benefits and fire risk for various native and invasive plant communities. Two GIS-intensive software packages were utilized in the analysis. CITYgreen was used to quantify community benefits such as air pollution removal, carbon sequestration and storage, and stormwater runoff. FARSITE was simultaneously used to assess the potential wildfire behavior for each vegetation type. Results of this preliminary study indicate that both native and nonnative vegetation have associated benefits and risks. Fuel treatments in these plant communities can reduce the fire risk, but often subsequently reduce benefits derived from vegetative canopy cover. These same treatments can also result in unintended, negative consequences where both benefits are reduced and fire risk is elevated.

Introduction
There is often a great loss in canopy cover of oak woodlands and chaparral shrublands when new development occurs in the wildland-urban interface areas of California. This loss subsequently leads

to decreased social and environmental benefits such as carbon sequestration, stormwater absorption, and energy conservation. To counteract these losses, there has been a swell of recent interest to reclaim lost canopy cover by replanting both native and non-native vegetation. However, as millions in southern California experienced in October 2003, the same vegetation that supplies biological and social benefits also is prone to burn with great intensity and destruction. Therefore, there is a critical need to assess the tradeoffs in benefits derived from various types of vegetative cover versus its potential to facilitate destructive wildfires.

The type and structure of vegetative cover will influence both the benefits derived from that cover and also the rate of spread and intensity of a wildfire. For example, grasslands will likely burn with much less intensity than would a crown fire in timber or shrublands and would, therefore, be preferred by the fire community. However, grasslands provide limited cooling or air quality benefits compared to dense forested stands and is of lesser value to urban foresters.

An evaluation of benefits versus fire risk would be useful for community planners in the wildland-urban interface. Therefore, this paper investigates the potential benefits of various native and invasive plant communities versus the potential fire behavior of those plant communities in a hypothetical southern California interface community. Further, it examines the potential effects of fuel modification treatments in these same plant communities.

Methods

A hypothetical interface community was developed to mimic conditions that are prevalent throughout coastal southern California (Figure 1). The community consisted of a subdivision set in mountainous terrain, surrounded initially by various types of native vegetative cover, predominantly chaparral shrublands. A wildland fire was simulated in each of 5 scenarios of vegetative cover (discussed below). Each fire originated from a supposed bar and grill that was located at the base of a topographical “chimney” downslope of the subdivision, which would facilitate active fire spread toward the community.

Fire behavior was simulated for 4 hours using FARSITE (version 4.0.2), which utilizes GIS data to model surface and crown fire behavior across a landscape dependant on user-defined weather and wind data. All data that contributed to fire behavior (other than vegetation type) were held constant during all simulations and were intended to provide a typical weather scenario of an inland community in southern California (Table 1). For demonstration purposes, flame length was used to quantify potential fire behavior.

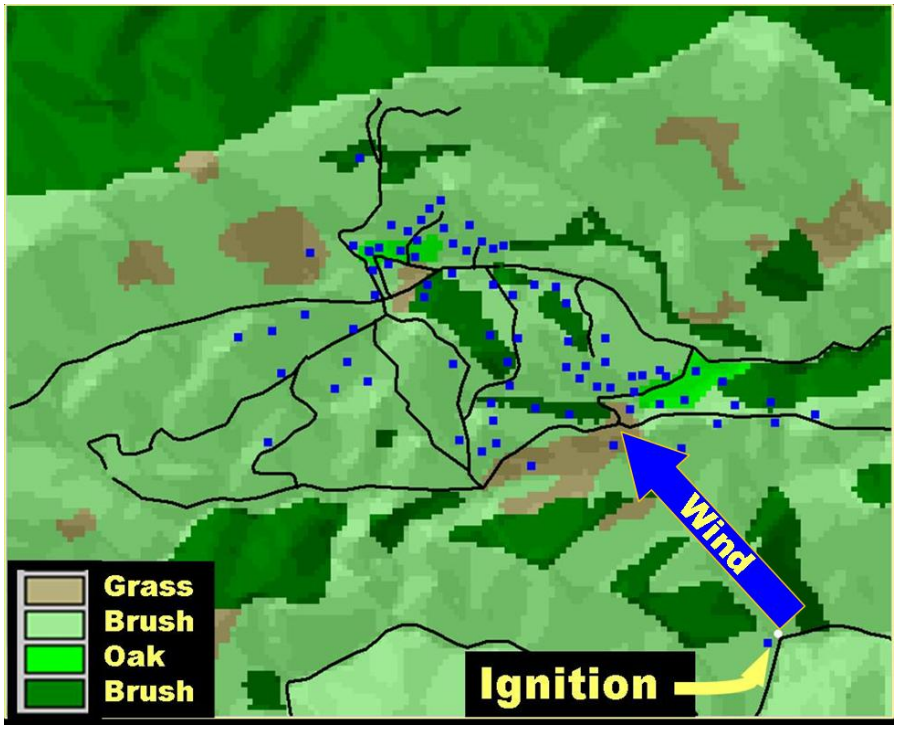

Figure 1. Hypothetical wildland-urban interface community in southern California. Blue squares and black lines represent homes and roads, respectively.

Table 1. Initial landscape characteristics at time of simulated wildland fire.

Weather

Temperature: 90°F
Relative humidity: 30%
Wind: 30 mph (SE)

Topography

Slope: 15-30%
Aligned with wind

Fuel moisture

Live: 90%
Dead: 4%

Community benefits were quantified using CITYgreen for ArcGIS, an extension to ArcGIS (ArcView 8.x and higher) that is used to aid city planners in managing urban forests. Benefits included air pollution removal (including carbon monoxide, ozone, nitrogen dioxide, particulate matter, and sulfur dioxide), carbon sequestration and removal, and additional infrastructure needed for stormwater runoff if vegetative canopy cover were not present.

Benefits and fire risk were quantified for 5 scenarios of vegetative cover. Scenario #1 included a typical vegetative community of older native brush, oaks, and grasslands. Within FARSITE, the most abundant fuel model on the landscape was fuel model 4, which represents old, decadent chaparral. Within CITYgreen, native brush communities for scenario #1 was modeled as "Shrub: Ground cover > 75%" and "Arid & Semi-Arid Rangeland: Sagebrush: Ground cover > 70%".

Scenario #2 was intended to modify the explosive conditions typical of fires burning in fuel model 4 above and was based on current regulations in the city of San Diego. Within FARSITE, a custom fuel model was created where 50% of the brush was removed and the remaining brush was pruned to remove ladder fuels. For simplicity, all brush across the landscape was treated in this manner even though this would likely be impractical and would not be necessary to reduce the rate of spread of a large wildland fire (Finney 2001). Within CITYgreen, the treated brush communities were modeled as "Impervious Surfaces: Unpaved: Dirt" and "Shrub: Ground cover > 75%".

Scenario #3 consisted of replacing all brush with invasive ice plant. Within FARSITE, a custom fuel model was created where only living herbaceous materials with a high live fuel moisture low fuel depth were present. Within CITYgreen, ice plant was modeled as "Arid & Semi-Arid Rangeland: Herbaceous: Ground cover > 70%".

Scenario #4 consisted of a closed eucalyptus stand with little understory fuels. Within FARSITE, the dominant fuel was fuel model 9, which represents hardwood stands. Within CITYgreen, these unthinned eucalyptus stands were modeled as "Trees: Forest litter understory: No grazing, forest litter and brush adequately cover soil".

Finally, Scenario #5 consisted of thinning the eucalyptus forest. Here, it was assumed that the opening of the overstory canopy would enable invasive grasses and brush to occupy the newly created growing space, an unexpected result of fuel reduction treatment that has been experienced in San Diego. Within FARSITE, a custom fuel model was created to simulate an open stand of trees with grass and brush in the understory. Within CITYgreen, the thinned eucalyptus stands were modeled as "Pasture/Range (Continuous forage for grazing): Ground cover > 75%".

Results & Discussion

Figure 2 illustrates the community benefits that were calculated by CITYgreen. In general, fuel reduction treatments resulted in lowered community benefits. Air pollution was negligible in all scenarios other than the closed eucalyptus stand. Similarly, C sequestration, and stormwater runoff was greatest in the closed eucalyptus stand. This reflects, in part, the inherent bias of trees in the algorithms used by CITYgreen. Indeed, there was no calculated air pollution removal or C sequestration in either the treated brush or the ice plant scenarios.

Of interest, the calculated stormwater runoff savings was 4 times as great in treated brush as untreated brush, even though ~75% of the treated area consisted of exposed soil. This and other anomalies led to diminished confidence in the analysis of benefits in this hypothetical community. CITYgreen is calibrated for eastern forests and at present may not meet the needs of western landscapes, particularly the Mediterranean ecosystems found in coastal California.

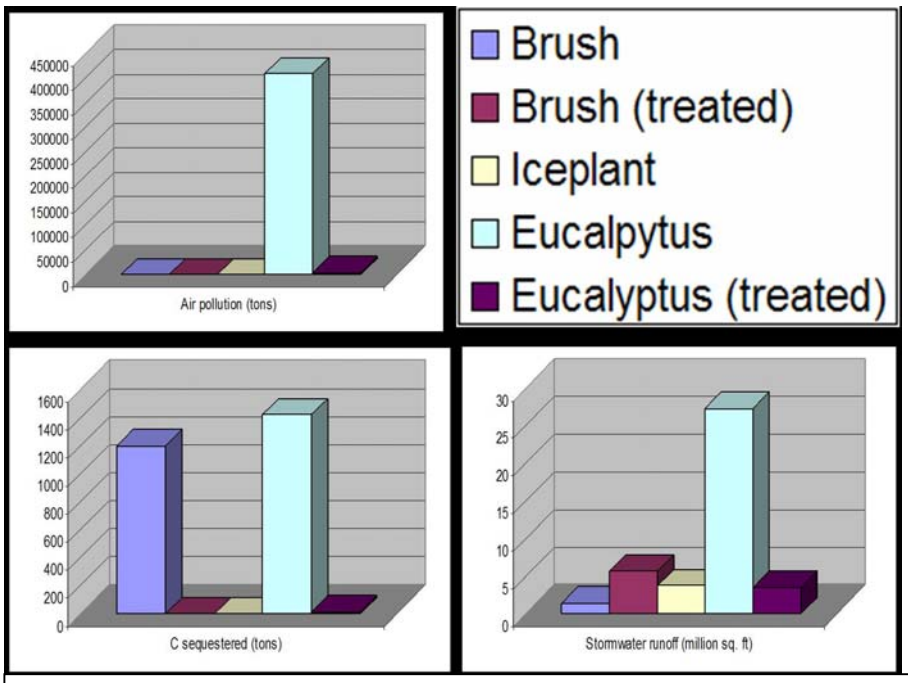

Figure 2. Various community benefits calculated by CITYgreen for 5 scenarios of vegetative canopy cover.

Figure 3 illustrates fire behavior as modeled by FARSITE. It does not include the ice plant scenario as this scenario did not support combustion. The native chaparral scenario (Figure 3.a) exemplifies the explosive fire conditions found there. Treatment of the chaparral per current regulations in San Diego resulted in a substantially smaller fire area and flame length (Figure 3.b). Thus, fuels treatments in wildland-urban interface areas should considerably reduce the fire risk to in southern California communities. However, it should be noted that the strategy to reduce risks must not be too complicated nor too simplistic. To simply require removal of all vegetation to a certain distance would certainly reduce the fire risk, but would also reduce the community benefits of that vegetation as well as contribute to unintended environmental damage such as landslides. Similarly, ordinances that are too complicated for the average landowner (such is a criticism of the San Diego model presented here) may not adequately reduce the risk. Further, it may serve to frustrate not only the landowner, but also those charged with enforcing the ordinances.

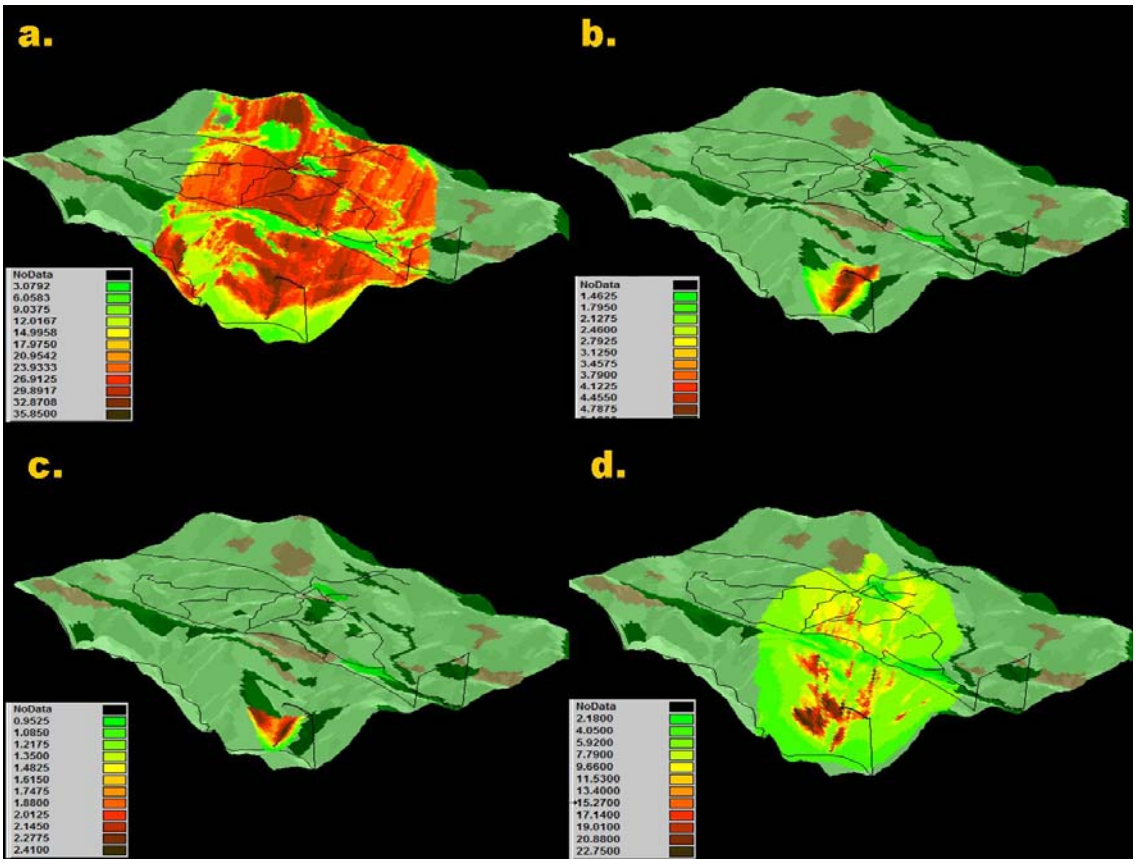

Figure 3. Simulated fire extent and flame length (ft) after 4 hours in (a) native chaparral, (b) thinned and pruned chaparral, (c) eucalyptus forest, and (d) thinned eucalyptus forest.

Vegetation managers must utilize treatments appropriate for local conditions and must not take a one-size-fits-all approach to land management because unintentional results often occur. For example, a fire burning in the closed eucalyptus scenario (Figure 3.c) could burn with a low rate of spread and low fire intensity if few fine fuels existed in the understory and there were no ladder fuels to promote crown fires. However, opening the canopy might promote an invasion of exotic grasses and brush in the understory, which would promote both greater rate of spread and also fire intensity (Figure 3.d), thereby increasing the risk.

The scenarios presented here exemplify that a community must consider many factors when attempting to reduce the fire risk in an area. For the hypothetical community examined here, untreated native chaparral would likely lead to a catastrophic wildfire. Treating the chaparral would reduce the fire risk, but would also reduce the benefits that the native vegetation provides to the community. For example, replacing the entire landscape with invasive ice plant would eliminate the fire risk entirely, but would also provide negligible environmental benefits to the area and might also contribute to slope instability (Radtke 2004). In the same vain, not all types of fuels treatments are effective and may even exacerbate the fire risk as illustrated in the thinned eucalyptus example.

Also, it should be noted that flames are not the only source of home ignitions during a wildland fires (Cohen 1997). Often, homes combust due to embers landing on flammable roofs or entering attics via unprotected vents, even if the fire is effectively stopped blocks away from a given home. Thus, to fully attack the fire problem in the wildland-urban interface, stakeholders from many worldviews and perspectives (fire personnel, urban foresters, landscape architects, home builders, developers, etc.) must work together. Fortunately, this integrated approach is increasingly being realized, especially in California with the advent of local FireSafe Councils.

Conclusions

There are benefits and fire risks for all vegetation, both native and exotic. Communities must weigh many options when creating a fuels management program in the wildland-urban interface. All treatments must first be examined thoroughly as there might be unintended consequences from those treatments (replacement of brush with ice plant reduces fire risk, but may cause slope instability; thinning eucalyptus may contribute to invasion of exotic grasses and shrubs, thereby exacerbating fire behavior). Wildland fire management in the wildland-urban interface is complex at best and must be assessed from a wide array of stakeholders to be most effective.

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Fire Management Impacts on Invasive Species at the Wildland/Urban Interface in California

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The wildla/urban interface is a complex mosaic of boundaries between human habitations and wildland fuels. In southern California this interface zone is largely centered between foothill chaparral and the growing urban sprawl, a mix that poses substantial fire hazard for a huge population. Communities have also sprung up throughout the mountains, with fairly high density housing in the coniferous dominated ecosystems, creating an equally hazardous but somewhat different set of fire issues. In California one of the major impacts of fire and fire management practices is on the balance between native to non-native species. At the wildland / interface the problems between fire and aliens are intensified. Here I consider the impact of fire management practices (Table 1) on alien invasions.

Table 1. Fire management actions that have documented impacts on alien plant species invasion of natural ecosystems in California.

Fire suppression action
Prefire fuel manipulations to reduce fire hazard
Mechanical thinning or logging
Prescription burning
Prescription burning to target noxious aliens
Fuel breaks
Postfire rehabilitation

Fire Suppression Policy

For much of the past century a policy of suppressing all wildfires has ruled fire management in the U.S. In mixed conifer forests such as those that dominate the plateaus around Lake Arrowhead and Big Bear in the San Bernardino Mountains, this policy has been extremely effective and resulted in near total fire exclusion over much of this landscape (Everett 2003). From a fire hazard perspective this policy has been disastrous due to the extraordinary fuel accumulation in these forests, with levels of 15 – 150 metric tons per hectare of just dead surface fuels (Stephens 1998, 2004). From an alien plant perspective this has not been particularly bad since the dense shading and litter layer have generally discouraged alien invasion (Keeley et al. 2003). However, this is not a sustainable means of controlling aliens because the increased fuels will almost certainly lead to large high intensity crown fires (Agee 1993), which will create ideal conditions for alien plant invasion. In the southern California mountains, particularly along the immediate wildland/urban interface, the situation is very critical because of massive tree dieback (Fig. 1a), particularly ponderosa pine (*Pinus ponderosa*).

Due to the extreme fire hazard these forests are being aggressively logged in order to removed the dead material (Fig. 1b). The

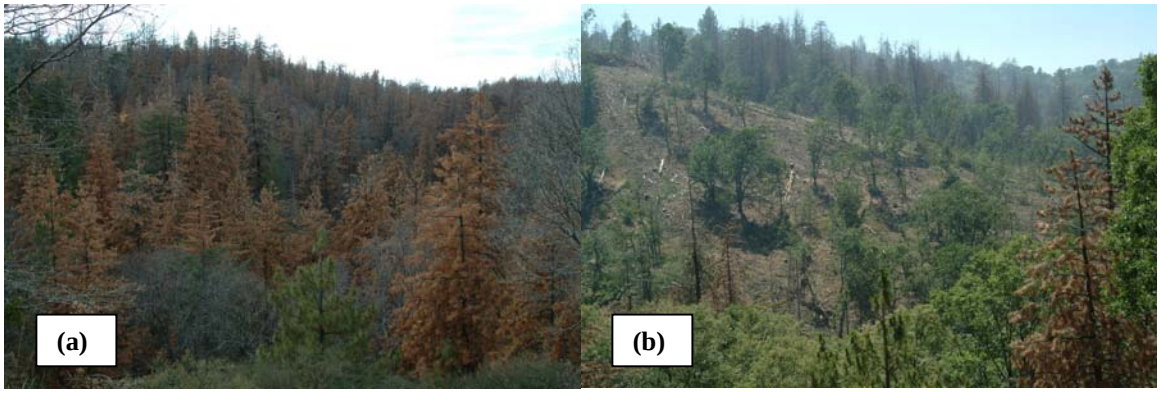

Figure 1. Ponderosa pine dominated forest at the wildland/urban interface in the community of Lake Arrowhead, San Bernardino County California. (a) Extensive pine mortality evident in the autumn of 2003, following severe drought and bark beetle attack, presumably exacerbated by the high tree density resulting from a century of fire exclusion. (b) The same forest 6 months later after dead trees removed, reflecting sites that are likely to become rapidly invaded by alien plants such as cheatgrass, which currently occupies most disturbed forests in the region (photos by J. Keeley).

resultant ecological vacuum created by these removal operations will almost certainly create a sink for alien species in the neighborhood. The most likely species to invade these perturbed forests is cheatgrass (*Bromus tectorum*), which presently is very widespread in disturbed forests in the San Bernardino Mtns. (Keeley, personal observations).

The situation, however, is somewhat different at the lower elevation foothill wildland/urban interface. In this zone a century of fire suppression has succeeded in maintaining relatively constant average levels of burning in the face of a massive onslaught of anthropogenic fires (Keeley et al 1999). Although the average fire rotation has not changed substantively, what has changed is the fire frequency along the densely populated wildland/urban interface.

Here high fire frequency has stressed the natural chaparral and sage scrub ecosystems to the point of a major state-change. Specifically, the ever increasing anthropogenic fire frequency has displaced many native shrublands with alien-dominated annual grasslands (Keeley 2001, 2004a). Within just a few years the dense postfire regrowth, particularly of fast growing suffrutescents such as *Lotus scoparius, Helianthemum scoparium* and *Calystegia macrostegia* produce massive fuel loads of fine fuels. In one study this ranged from 10 -24 metric tons per hectare, a value comparable to young sage scrub or productive grasslands (Keeley and Halsey in review).

Studies of postfire chaparral and sage scrub have shown that the major determinants of alien invasion are tied to the proximity of alien seed sources and the rate at which native shrub canopies recover (Keeley et al. 2003). When fire frequency increases to unnaturally high levels, e.g., once a decade in chaparral or several times a decade in sage scrub, native species are lost and alien annuals fill the void. These aliens alter the fire regime from a crown fire regime to a

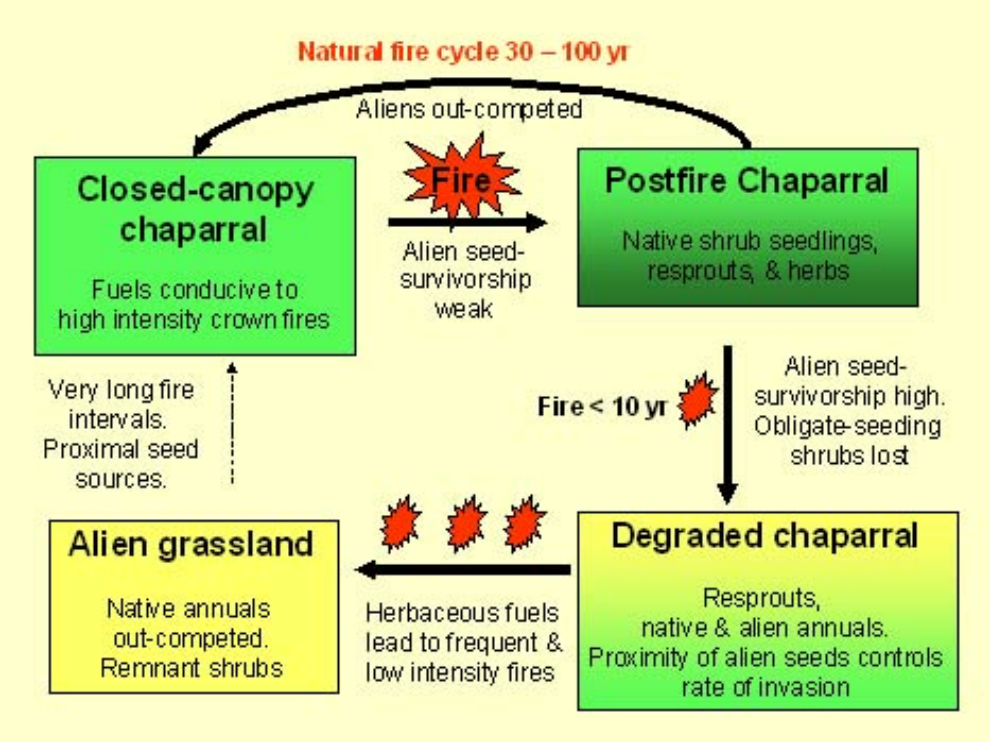

Figure 2. Model of interaction between fire regime and alien invasion in California chaparral.

mixed crown and surface fire regime, as a consequence fires can carry through these mixed shrubland/grasslands under a far greater range of weather conditions than are required to carry fire in young chaparral. In addition, the early curing of the alien grasses greatly expands the length of the fire season (Keeley and Fotheringham 2003). Lastly, the lower temperatures resulting from fires in grass/shrub mixtures means much greater alien seed survivorship, which
in turn enhances conditions for aliens in a feedback process that often ends in alien dominated annual grasslands.

Fuel Reduction Practices

Prescription burning and other fuel reduction treatments (e.g., Fig. 1b) are a necessity for life at the wildland/urban interface in conifer forests. Prescription burning is feasible because it is directed at burning understory fuels and produces low flame lengths and lower severity fires.. However, regardless of the method, any treatment that reduces canopy cover of native trees in these forests appears to enhance alien plant invasion (Griffis et al. 2001, Keeley et al. 2003). It may be a necessity of life that we are forced to choose between restoring "natural" fire regimes or altering fire regimes to less frequent fires that will favor communities of native species.

Prescription burning crown-fire shrubland ecosystems is a very different proposition than in forests. There are three main reasons. First, such treatments in chaparral are problematical because there is not an unnatural accumulation of fuels that is responsible for catastrophic fires (Mortiz et al. 2004), and thus fuel reduction is of limited value during severe fire storms that are responsible for most of the catastrophic fires in southern California (Keeley 2002). Secondly, these lower elevation chaparral landscapes are already challenged with an unnaturally high load of fires and further prescribed

application of fire potentially stresses these ecosystems. Lastly, controlling fires in these crown fire ecosystems is difficult and as a result there is strong motivation for burning during the cool winter wet season. However, there is increasing evidence that these out of season burns have potentially lethal effects on the native ecosystems, sometimes largely displacing them with a single ill-timed burn (Keeley in review).

Prescription Burning to Target Noxious Weeds

Targeting noxious aliens with prescription burning has shown some promise, specifically, repeated fires have been demonstrated to nearly eliminate yellow star thistle (*Centaurea solstitialis*) in field studies (DiTomaso et al. 1999). However, follow up studies indicate this apparent control is not sustainable and within a few years this alien weed returns with a vengeance (Kyser and DiTomaso 2002). From an ecological perspective this is perhaps not too surprising since this weed and most alien herbs are opportunistic species that capitalize on disturbance. Control of these opportunistic aliens is likely not to come about by further application of disturbances such as fire. Community restoration of the native perennial flora, bunchgrasses on some sites, shrublands on other sites, is likely the only means of restoring some quasi-equilibrium with natives as the dominants in the community.

Fuel Breaks

Fuel breaks: Fuel breaks pose a special invasive plant risk because they promote alien invasion along corridors into wildland areas (Fig. 3) and the lower fuel loads lower temperatures during wildfires generate “safe sites” for alien propagules. As a consequence, following fires these fuel breaks represent a major seed pool capable of providing a seed bank for invasion of adjacent wildlands (Merriam et al. in review).

Figure 3. Recently graded fuel break through chaparral and sage scrub in the Santa Ana Mountains, Orange County, California.

Postfire Rehabilitation

Rather than solving postfire watershed problems, aerial seeding of alien species appears to be the cause of a many ecosystem problems and potentially enhances alien invasion. Historically this practice is responsible for widespread dispersion of noxious aliens such as *Brassica nigra* and related

taxa. Today those fire management practices have left a legacy on the landscape in that some of these mustards have deeply dormant seed banks that allow them to dominate postfire sites. Other less noxious species have replaced mustard, however, these species are of concern because they have the potential to out-compete native plants and inhibit the natural ecosystem recovery (Keeley et al. 1981, Barclay et al. 2004). Recently these projects have moved towards use of "sterile" or "non-persistent" varieties of cereal grains. While these species apparently do not persist on a site or spread, they do inhibit the native recovery and pose a special risk for alien invasion (Keeley 2004b). Often these grasses are seeded very densely and then their sterile or non-persistent character means they disappear in subsequent years, leaving an ecological vacuum potentially exploited by alien invaders.

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Weeds in Wildland/Urban Interface Fuelbreaks: Challenges and Opportunities

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The Mt Tamalpais Watershed fuelbreak system presents a textbook example of invasives spread after fuelbreak construction. Following expansion of the Kent Woodlands Fuelbreak, *Genista monspessulana* expanded at a rate 10 times greater than that found outside the fuelbreak system. The Marin Municipal Water District (MMWD) estimates 50% of its 600-acre fuelbreak system are infested with invasive brooms, resulting in added maintenance costs of $500,000 to $1,000,000 over a ten-year period. There is also a biological cost: nascent weed populations are allowed to expand in interior, intact wildlands as crews are redirected to the already degraded perimeter in order to maintain fuelbreak function. At the same time, wildland/urban interface fuelbreaks provide opportunities to expand weed control programs and increase public support for them. Weeds in fuelbreaks are highly visible, accessible and treatable. The general public is often more supportive of grazing, brush cutting, and herbicide applications in the name "wildfire risk reduction" than they are for identical actions intended to protect biological diversity. Every wildfire season brings additional public dollars for reducing future wildfire risk, which can increase resource availability for weed control. The challenge now is designing, constructing and maintaining fuelbreaks that enhance rather than counteract weed control efforts. This necessitates (1) the incorporation of adjacent weed stands into fuelbreak design; (2) the inclusion of 2 to 3 years of aggressive weed suppression in and adjacent to fuelbreaks as part of the initial construction phase; and (3) provisions for on-going maintenance of a weed-free fuelbreak well into the future.

California's Fading Wildflower Legacy

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Vast fields of native annual wildflowers dominating the plains and valleys of historic California have been insidiously displaced by European invaders over the past two centuries. California wildflowers flush in spring and set seed that may store in seed banks but commonly germinate with the first winter rains. Most wildflowers disarticulate and leave little fuel as summer landscapes were barren, except along the coast where livestock grazing was concentrated from the Spanish period to the Gold Rush. European grasses, including ripgut (*Bromus diandrus*), red brome (*B. madritensis* spp. *rubens*), wild oats (*Avena fatua*), and slender wild oats (*Avena barbata*), grow quickly after fall germinating rains, displacing native forbs. Non-native grasses leave a bank of short-lived seed, and remain cured in summer, producing greater fire hazard than indigeous herbaceous vegetation. This transformation from wild explosions of spring color of native wildflower fields to solid green/beige fields of oat grassland, and later brome grassland is documented through the diaries and newspapers of early California missionaries, explorers and journalists. Attempts to control exotic grasses through prescribed burns have been partially successful depending on the season of burns relative to the seed shatter of exotic grass species. Time-series sampling in the Box Springs Mountains (1989-2003), in Riverside California, shows that late-spring burns (before shatter) reduce non-native annual grasses and most exotic

forbs, while increasing native wildflowers. Summer burns (during shatter) increase *Erodium cicutarium*, *Schismus barbatis*, and mustards (*Brassica geniculata*, *B. tournefortii*) but still reduce exotic grasses. Wildflowers are rare. Autumn burns increase *Bromus* and *Avena* over exotic and native forbs.

Working Groups

Session 4: Working Groups I

Riparian Working Group

Discussion leaders: Jason Giessow, Mark Newhowser

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Species: *Arundo*, tamarisk, Lepidium, Cape ivy, and others
Total people attending session: 68

The session began with everyone meeting together for a general discussion for 40 minutes and then people broke into four species-based groups (*Arundo*, Lepidium, tamarisk, and Cape ivy).

General Session:
A poll was conducted of what issue constitutes the single most important 'road block' to project execution. Each person was allowed one vote. The list of 'road blocks' was drafted by the group. Voting results were as follows:

Maintenance after completion of project	18
Funding:	14
Control methods:	10
Property access/obtaining permission	5
Public perception/support	5
People to do work	2
Permitting	1
No vote	3

Session leaders and many in the group were surprised that maintenance beyond the scope of the project constituted the most significant road block in the group. This seems to be partially tied to the limited timeline that most funding sources operate under (typically 3-5 yrs). This may indicate a greater need of involving and/or creating groups which can work beyond funding timelines, such as WMAs, conservancies, land management groups and other organizations that have a longer time line and institutional memory. The importance of developing funding resources that last beyond the 3-5 year period was discussed, but opportunities are scarce. Funding through mitigation typically has a 5 to 10 year time horizon and was proposed as a mechanism for carrying out long-term maintenance. This led into further discussion of funding. Some plant species receive more funding support than others. *Arundo* receives significant resource commitment, while species such as cape ivy receive less direct funding. Individuals were encouraged to attend the funding session the following day.

Obtaining permission and property access was addressed through citing specific program examples in the audience that have successful programs – Riverside Corona RCD/SAWA and SMSLR WMA. Difficulty in obtaining permission falls into two groups – individual owners who are difficult to persuade and large institutions which can be difficult to interface with, such as transit authorities. Public perception as a road block appears to be a localized phenomenon, but one that poses significant effort to remedy through education. Permitting as road block was not considered a serious issue by the work group. Regulators (FWS, CA DFG, ACOE, RWQCBs) appear to be more involved and comfortable with the type of invasive plant control occurring in riparian habitats than in the past.

Additional votes were taken on the general structure of programs/projects. The results are as follows:

Is your program single species oriented (17 votes) or multiple species focused (41)?

Is your program watershed based (26 votes), scattered parcels (9 votes), or an individual parcel (27 votes)?

Does your program have a control method (27 votes) or is your program searching/studying methods (35 votes)?

Does your program re-vegetate after invasive species control (45 votes) or just carry out control (17 votes)?

The majority of programs/projects treat multiple plant species within their project areas. Even the programs that focus on a single species, such as *Arundo*, still carried out control of other species.

Several of the worst invasive species in riparian habitat are spread by flood action. For this reason, many people are proponents of watershed based control. A large number projects and programs appear to be adopting a watershed based approach. Some discussion was given to the constraints that certain organizations have in carrying out treatments beyond their property boundaries. Additionally, some organizations found as watershed or regional based approach daunting. Again, WMAs and watershed based groups appear to be a good base from which to execute more comprehensive programs. A brief discussion of the importance and power of mapping was also carried out. Although many groups appear to have settled on methods of control that they use in the field, a majority of groups are still exploring control options. This discussion was left to individual species based groups to go over. Re-vegetation after control is usually carried out by most programs. It seemed to be that most programs wanted native vegetation to recover at control sites as quickly as possible. Some programs, particularly *Arundo*

ones, wanted to establish new root systems on the site to reduce erosion and make the sites as visually appealing to property owners as quickly as possible.

Arundo *Work Group:*

The group spent the majority of its time discussing details about methods used to control Arundo. A quick tabulation of methods used by those in the group was taken to start the discussion. Individuals voted based on the method that they used most often, with the understanding that some situations may dictate using a different method.

Initial: Cut & paint, Regrowth: foliar spray	17
Initial: Foliar spray (no cutting), Regrowth: foliar spray	3
Initial: Mow, Regrowth: foliar spray	3
Initial: Cut & paint, Regrowth: Paint	2
Initial: Tarp	1

All the methods were discussed by work group participants. The most discussed topic was when is the optimal time to spray Arundo. This is fairly universally understood to be in the Fall, but seasonal variation within California and the onset of rain seem to create some variation between northern, central and southern California. Field cues on the condition of the Arundo can be used to help ascertain when the plant is beginning to go dormant or has gone too dormant to spray and achieve maximum herbicide efficacy. Arundo can be effectively sprayed using the foliar application method even when the plant has begun to show yellowing of the leaves, according to Jason Giessow. In southern California this may be mid December and the dormancy is triggered by near freezing temperatures at night. The tarping method has been used with several different types of tarps and on stands up to a quarter acre in size. The method could be particularly useful in situations where individual property owners will not allow the use of herbicide. Its practicality on river systems with large acreage infestations is uncertain.

Aquatic Working Group

Topic Leader: Lars Anderson
Group Facilitator: Katy Zaremba
Note Takers: Julie Owen and Holly Crosson

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Suggested Aquatics Discussion Topics:

1. State Aquatic Invasive Species Plan – Push to finalize
2. New species of concern
3. Implement Wolk's Invasive Species council legislation
4. Support of "Habitattitude" program – Cal-IPC as a partner?
5. West Nile Virus and aquatic weed management
6. New IR-4 initiative to expand to irrigation and lake/reservoir sites as "minor uses" – Cal-IPC support letter?
7. "CANIPIT" – a California Rapid Response Action Plan
    a. "CA Non-native Invasive Pest Intervention Team"
8. How can Cal-IPC get involved?

Meeting Notes:
Introductions

Other suggested meeting topics:

- Who are the regulatory agencies for aquatic weed control?
- How do we deal with native invasions?
    - Cal-IPC could help with outreach to private landowners
- Herbicides used for aquatics
    - Fluridone
    - Trilogy
    - Glyphosate
    - Acrolein – used in irrigation canals
    - Imazapyr – riparian systems, some aquatics
        i. Not registered yet. May be approved in California in near future.
    - Copper
    - Diquat
    - 2, 4-D
    - Endothall
    - Aquathall
    - Note: bio-control programs not discussed today
    - Lars suggested interested individual look to web for more information
- Species Discussed:
    - Eurasian watermilfoil
        a. Found all over California, including Lake Tahoe
        b. 200 acres in Lake Tahoe where the regulatory agencies are stopping treatment
        c. No herbicides in the lake, dredging is a possible form of control
    - *Spartina spp.*
        a. 4 species in the SF Bay
            i. *S. alterniflora*-hybrid spreading fastest
            ii. *S. densiflora* in Humboldt Bay
        b. Invasive Spartina Project
            i. Grant funded project based at the Coastal Conservancy
                1. discussing forming joint powers or non-profit
            ii. Large regional project
            iii. Coordinates *Spartina* control in San Francisco Bay
            iv. 2001 – mapped 500 net acres, 2000 estimated in 2004
            v. EIR finalized
            vi. 2004 first coordinated control season
                1. 16 demonstration projects
                2. 250 acres

a. Primarily spray treatments, other manual methods (covering, digging, excavation) at small infestation sites

- Ludwigia
    a. Aquatic shrub from Uruguay
    b. Yellow water primrose
    c. Perennial stem/runners
    d. Runner root at nodes
        i. Spreads easily by fragmentation
    e. Dense mat smothers
    f. Freshwater emergent
    g. Control methods:
        i. Primarily herbicides, mechanical methods may spread propagules
    h. 150 acre infestation within 14 mile watershed in Sonoma
        i. Became an issue 18 month ago due to mosquito related problems
        ii. Ludwigia task force convened: multiple landowners/managers/stakeholders
            e.g. CDFG, Sonoma Co. Water, NOAA, Water Board
            1. Still squabbling over jurisdiction and liability
            2. Public hysteria over West Nile Virus vs. the use of herbicides to control the weed
    i. Working group suggests Cal-IPC could help educate the community on the relative impact of spreading invasive species and herbicides
- *Caluerpa*
    a. Example of a rapid response program
        i. $5 million program
        ii. Successful if they can declare eradication next year
        iii. 9 species banned in CA.
        iv. Cal-IPC could help with legislation, or encourage constituencies.

Topic Discussions:

1. State Aquatic Invasive Species Plan – Push to finalize
    - Plan is written and sitting at DFG
    - Draft AIS Management Plan was submitted to CDFG on schedule in September of 2003 where it is still under internal review. A release date for general public and broader agency review is not known.
        - Need to get a large number of groups to call the Governor to find out the status of the AIS Management Plan and put pressure on to get review.
        - Cal-IPC could help sponsor a letter writing campaign

2. New species of concern
    - Ludwigia

3. Implement Wolk's Invasive Species council legislation
    - What is the status of the Lois Wolk bill? Cal IPC follow up?
    - Note: Bill was vetoed - So no agency-"coordinating" mandate for all CA-invasive species.

4. Support of "Habitattitude" program – Cal-IPC as a partner?
- Holly Crosson attending national trade show for the nursery and aquarium industries
- Joint project with the USFWS, National Seagrant, and industry (Wal-Mart, Pet Co and others)
- Goal is to help prevent the spread of aquatic invasives
    - Create responsible consumers
- Message: "Don't Release"
    - Focus on proper disposal, alternatives to dumping
    - Doesn't define natives or invasives nor does it support restriction on sales
- Groups suggests that Cal-IPC could be a partner
- Cal-IPC could expand it into Alternatives Brochure???

5. West Nile Virus and aquatic weed management
- It was suggested that the public health agencies should broaden their spectrum.
- Weed control efforts should partner with mosquito abatement district for support.
- Cal-IPC may be able to assist with a letter educating public health agencies and mosquito abatement districts on the connection between aquatic weed control and mosquito prevention.

6. New IR-4 initiative to expand to irrigation and lake/reservoir sites as "minor uses" – Cal-IPC support letter?
    - IR 4 (Interregional Program- has four Regional Centers- including one at UC Davis): Traditionally has supported data-acquisition (primarily crop-tolerance) on herbicides for minor crops. The proposal is to include two new areas: (1) weed management in irrigation systems, and (2) weed management in lake/reservoir systems.
    - Cal-IPC should support this process for expansion of registrations for herbicide use to control aquatic and riparian weeds

- IR 4: Minor use herbicides for minor crops
- Cal-IPC may be able to use this process for minor agriculture weeds
    - Cal-IPC could write a support letter

7. "CANIPIT" – a California Rapid Response Action Plan
    "CA Non-native Invasive Pest Intervention Team"
- Have information before invasive species arrive
    - Modes of spread, modes of control
- Agencies should be primed for action
    - Run a "fire drill"
        - Identify:
            - Likely invaders
            - Required permits/authority
            - Action(s) to take

- Established monitoring plan

- USDA has a model with fruit fly and zebra mussel
- Lars Anderson and Mark Sytsma have a small grant to "pilot-test" this approach (NIPITS) for two weeds: *Trapa natans* (Water chestnut) and *Potamogeton crispus* (Curlyleaf pondweed) or *Lagarosiphon major* (Oxygen weed).
- Senate Bill 1573 – new invasive species council
    - The status of progress on the formation of an Aquatic Invasive Species Council pursuant to SB 1573, which passed in 2002, is not known at this time

8. How can Cal-IPC get involved?

- Create an online network of experts who are available and willing to assist and share information and experience,
    - List experts by topic
    - Perhaps Cal-IPC membership renewal form could ask for applicant's area of expertise and if the individual would allow CAL-IPC to post their name and contact information.
- Next Cal-IPC Symposium: more topics on aquatic weeds

Make sure Cal-IPC has a link to APMS and WAPMS on their website

Grasses Working Group

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Topic Leader: Joe DiTomaso
Note taker: Tanya Meyer
Notes edited and typed by: Joanna Clines

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First, we took a poll of the main grasses that people are having problems with to get a sense of where to focus the discussion (numbers in parentheses are number of people saying this grass is among their primary concerns):

Annuals
Taeniatherum caput-medusae - medusahead (6)
Aegilops triuncialis - barbed goatgrass (5)
B*romus tectorum* - cheatgrass (4)
Bromus diandrus - ripgut brome (6)
Avena spp. - wild oats (1)
Brachypodium distachylon - false brome (2)
Lolium multiflorum - Italian ryegrass (2)
Hordeum marinum ssp. *gussoneanum* – Mediterranean barley (1)
Schismus spp. – Mediterranean grass (1)
Bromus madritensis ssp. *rubens* - red brome (1)

Perennials
Cynodon dactylon – bermuda grass (3)
Brachypodium sylvaticum – slender false brome (2)
Pennisetum setaceum – crimson fountaingrass (2)
Piptatherum miliaceum – milo grass (2)
Sorghum halepense - Johnsongrass (1)
Festuca arundinacea – tall fescue (1)
Phalaris arundinacea (1) – reed canarygrass
Phalaris aquatica - hardinggrass (1)
Holcus lanatus – common velvetgrass (4)
Ehrharta erecta – upright veldtgrass (1)

Next, we asked people to share both their successful and unsuccessful management experiences:

- *Pennisetum:* Was planted as an ornamental in a shopping mall at Menlo Park, a woman was observed collecting seeds. When approached and asked whether she knew it was an invasive

pest plant, she said yes, and that she also intended to plant seeds of pampasgrass. The point is that many people in California do not believe that invasive ornamental plants are truly a problem. More education is needed.

- The issue of "sterile" versions of invasive ornamentals was discussed. Joe said that when the ploidy level is different, they probably are truly sterile. Cultivars may be able to revert to the reproductive variety, and a study is underway at UC Riverside to determine how likely this is.
- Medusahead – Roundup was sprayed when plants were turning brown, Joe said this is too late, spraying must be done while plants are still green and seeds are not yet viable.
- Seed mixes often have many invasive species in them. An unnamed government agency recently eradicated *Schismus,* an invasive species, and then a different department within that agency planted the area with *Schismus.*
- *Brachypodium sylvaticum* (slender false brome) – a couple of handouts were distributed from John Beall showing photographs and reasons for concern about the spread of this invasive grass. This grass has recently been discovered in San Mateo County. It has spread over 10,000 acres in Oregon and is causing economic losses. It can grow in sun, partial shade, wet and dry conditions, and may prevent the survival of tree saplings in forested environments. In San Mateo county contact: Jonas Roddenberry (representing the County WMA and the Midpeninsula Regional Open Space District) at jroddenberry@openspace.org or (650) 691-1200 Ext. 531. The Open Space District has closed trails, sprayed roadsides with Roundup, and has started a public education program. They have found that flaming does not work under the redwood trees. Hand pulling seems to be ineffective – plants resprout. This grass occurs mainly on the coast but occurs inland in Oregon, so should be looked for inland in CA. The Waipuna steam machine has been tried (uses hot coconut oil), but is expensive, needs to be accessed by a service truck, and moves extremely slowly. It top-killed plants but doesn't kill roots, and may stimulate germination. This grass may be misidentified – apparently there are 2 growth forms, and possibly 2 species, an annual and a perennial. Joe D. will attempt to clarify some specimens he has collected but they are likely to be *Brachypodium distachyon* since they appeared not to be a clear population of bunchgrasses.
- "Landmark" herbicide has been tried on goatgrass. This is a combination of chorsulfuron (Telar) and sulfometuron (Oust). Joe D. found it to be very effective but also injures perennial grasses and most broadleaf species. Will generally give bare ground.
- *Ehrharta erecta* makes seeds all year around. Hand removal is not effective. Roundup only kills the plants but doesn't affect the large seed bank. Even when sprayed 5-10 times. The land manager is trying to outcompete it with native shrubs and *Calamagrostis* that are kind of bushy, and taller than the *Ehrharta*. It has a very hard seed so could last in the soil longer than the average grass seed. Jeff Corbin recommends establishing a dense cover of natives.
- Yellow bush lupine and other natives can be very aggressive and outcompete or shade out *Bromus* spp. in dunes (Use in South Coast only – it is invasive up north!!).
- Solarizing with plastic – only kills grasses but not seed bank. Use clear plastic rather than black plastic for best results.
- Joe D. used wicking treatments on *Ehrharta* in areas with very thick thatch and the thatch was too thick to allow seedlings to sprout.
- Plastic tarps around Stanford – black plastic can kill annuals (before rains) but the natives survived. Leave on for several weeks, then remove.
- Solarization with <u>clear</u> plastic – only native *Lotus* germinated. No weeds. Killed entire seed bank, including YST, medusahead, cheatgrass, *Avena*. Manager applied in summer to get soil

temperature to 140˚ F. Black plastic does not work. This was in Medford, Oregon where the summer is hot and it is sunny a lot.

- A study at UC Davis – drill seeded grasses with mix of natives. *Leymus triticoides* has outcompeted *Bromus diandrus* (ripgut). *Bromus hordeaceus* is still a competitive weed.
- *Bromus hordeaceus* in San Diego does not seem to be outcompeting rare plants there. *B. diandrus* may be more of a problem.
- Joe D. – monitoring water usage of weeds: *B. diandrus* is most water efficient, produces twice as much biomass from the same amount of water as other weeds. (Because it starts growing earlier in the season). Jeff Corbin says that it draws down water faster from the entire soil profile.
- Italian ryegrass and barley on a 200 acre site near at Moss Landing is growing with a rare clover. Land managers mow, which helps the *Trifolium*, but also helps the annual grasses. They also have native meadow barley that they are trying to encourage.
- Medushead in the Sierra National Forest: For small patches, crews hand pull and bag before seeds disperse. Medusahead now exists in several areas too large for hand-pulling, need advice on how to control it.
- Medusahead seed only lives 2 years. Burning reduces cover dramatically. Burn as early as possible, as soon as your area can carry a fire. May is good in the Central Valley.
- Joe D. says that just knocking back the thatch will reduce medusahead cover. Medusahead is unusual in that one seed can put out 2-3 radicals, so each seed has 2 -3 chances of getting established even if the first radical doesn't make it to the soil through the thatch. If you get rid of the thatch, you reduce its advantage over other species.??
- *Bromus diandrus* is very sensitive to heat, more so than many other weedy annual grasses. Burning is always successful with *B. diandrus* even after the seed has shattered.
- Cheatgrass – however, burning helps establish cheatgrass unless you burn very early.
- Rare forbs can co-exist with medusahead, but not with cheatgrass.
- When to burn to control these weedy grasses is very site-specific. In Southern California it can be as early as January.
- Filaree (*Erodium* sp.) is encouraged by burning. If you use fire to control weedy grasses, you have to use another method to control filaree (herbicide). Fire can convert systems from grass to filaree.
- Concern from Forest Service biologists and botanists that the huge increase in acres of fuels treatments resulting from National Fire Plan will result in cheatgrass and other invasives spreading exponentially. Some federal agencies cannot use herbicides without a huge time lag. Too time consuming (this may be changing).
- Bonnie Harper-Lore (Federal Highway Administration) said that Executive Order 13112 requires that if federal funds are used for invasive control, natives must be replanted. Information can be found on the web at: http://www.fhwa.dot.gov/environment/vegmgt/index.htm, click on Policy Guidelines. (There is other good information on this web site as well).
- Kyle Merriam's research on fuelbreaks and the spread of invasives should help with the argument for restoration (web address: http://www.werc.usgs.gov/fire/seki/ffm/).
- San Clemente Island is burned a lot by training operations – leads to good natives, no annual weeds. But perennials do decline here without fire and the annual weeds creep in. Need disturbance to maintain a healthy native community in some areas.

- Fire – how to use it to control weedy grasses? You can call CDF. Take California Native Grass Association (CNGA) burning class to learn more about how to get permits, plan a burn, etc.
- Gophers and ground squirrels – prefer natives with good roots. Someone has observed that when they revegetate with natives, the natives get eaten. Also, gopher mounds favor annual weeds. Richard Hobbs at Stanford looked at gopher mounds. Sean Wattas at UCSB is looking at gophers too.
- Plateau (imazapic) is about to be registered in CA for annual grasses. Good on *Bromus* species., it does not hurt composites or perennials. But, it gets tied up in thatch and binds more tightly to thatch than other herbicides. Imazapic is both a pre- and post-emergent herbicide. Does not hurt legumes. Pre-emergent liquid applied at a very low rate. Can be combined with burning.
- Use Roundup with medusahead in spring, but since it's not selective, it kills everything.
- Ranchers can't burn easily, but they can graze. Timing of grazing is key, in March it doesn't affect medusahead, but if you graze with sheep just as seedhead emerges, you reduce cover. Only use sheep on 100% cover of medusahead. Sheep probably lose feeding weight on it because of the low nutritive value. Goats might work
- De-thatching in San Diego was done by using a crew weed whacking and bagging. Well trained crews must recognize natives. Works well, but is expensive and time-consuming.
- A combination of Telar, Transline, and 2,4-D was used, this eliminated all native forbs from the study site, but also yellow starthistle. Didn't take out pepperweed, thistle, or mustard. Even grasses were hurt by this combination. Be careful using herbicides in areas with native forbs.
- Medusahead – mowing is an alternative to burning. If you mow, you should rake it up, just before the seedheads are turning. As long as inflorescence is totally green, mowing works. Collect all the seeds before they fall!
- Brent Johnson - Re-introducing Tule elk near the coast did increase coastal grassland community species richness. This is due to thatch reduction which allows for more diversity of natives, although the elk will not eliminate weeds.
- If you are considering using any herbicides (especially pre-emergents) along creeks, talk to the manufacturer <u>first!</u> Can be dangerous along creeks.
- Joe D. used Landmark herbicide in experimental plot that killed annuals, but perennials did not establish year 1, the herbicide killed them. Waited until year 2 and they did establish, but you have to live with a year of bare ground – which may not work for erosion problems.
- Hardinggrass – someone is tarping it for an entire year! We'll see if it works. Roundup or shovels are most effective for smaller sites.
- A recent study was done using different colors of plastic for mulching out weeds. Certain colors (red) are most effective. For more information contact major advisor Steve Fennimore (Fennimore@vegmail.ucdavis.edu). It was a MS Degree in the Vegetable Crops Department completed in either 2002 or 2003.
- Cardboard and leaves in layers have worked to kill reed canarygrass, but you have to let it sit for 3 years. Then you can plant riparian plants directly into the cardboard mulch. Can only be used over small areas.

ACTIONS THE WILDLAND COMMUNITY CAN WORK ON:
1. Provide guidance on how to burn more easily: permits, planning, how to streamline the planning process.

2. Education! The public needs to know how dangerous weeds (invasive grasses in this case) are to our state.

Forbs Working Group

Topic Leader and Moderator: Carri Pirosko

Note Taker: Steve Schoenig

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Goals of the working group:

1. To exchange information through varying expertise
2. To share resources
3. To make group email addresses available for post symposium questions and discussion

The first ten minutes of the session were spent brainstorming species specific questions and other issues for discussion. Our working group topic list included:

- ✓ yellow starthistle (without herbicides)
- ✓ tocolate
- ✓ Italian thistle
- ✓ bull thistle
- ✓ artichoke thistle
- ✓ dalmatian toadflax
- ✓ Sahara (Moroccan) mustard
- ✓ *chrysanthemum coronarium*
- ✓ spotted knapweed (without herbicides)
- ✓ Prioritizing sites (*discussed in general discussion of species specific control)*
- ✓ Education for Early Detection (*discussed in general discussion of species specific control)*
- ✓ Coordinating with private landowners
- ✓ Resources

- edible fig
- *Asparagus asparagoides*

Yellow starthistle (control without herbicides)

-Grazing (cattle, sheep, goats) can work if timed correctly; timing is also key with mowing. The first viable seed develop within 10-14 days of initial flowering (when you first see yellow). It is this narrow window that mowing can be successful. Site conditions and previous management practices must be taken into account as well.

-Mechanical methods like digging and pulling can be very successful with smaller infestations.

-Yellow starthistle is an annual with a relatively short-lived seed bank as compared to perennial weed species- All methods of weed control are available for yellow starthistle. Herbicides, mechanical methods (digging, etc.), mowing, grazing, controlled burning, tillage, biocontrol.

See a write-up by Extension Specialist, Joe DiTomaso at the Weed RIC website: http://wric.ucdavis.edu/yst/manage/management.html for a COMPREHENSIVE write-up on the management of yellow starthistle.

-You must determine what your management goals are before implementing control measures. Is your goal: eradication, suppression, or containment?

-Early detection is key.

-Prevention is key. Keep spread from expanding into uninfected areas. Clean equipment. Work with adjacent landowners to prevent spread.

-How do you prioritize for a single species, yellow starthistle as an example. Map, stop movement into new areas, focus on sensitive sites first.

Tocolate

- Tocolate was discussed in context with yellow starthistle control.

-The importance of knowing what species (weeds and natives) exist at your site, before implementing control measures was emphasized. Certain control measures can actually alter your site to a less desirable site and/or leave you with a more difficult to control species. You must know what you will be "taking out" and what will be "filling-in" those bare spaces created (will in be a secondary invasion of a different or worse weed? Will natives or desirable species naturally fill-in? Or will assistance through revegetation measures be necessary?).

Italian, Bull, and Artichoke thistles

- There were questions about Transline; namely what non-target impacts are there on composit species? Transline is a very selective, broadleaf herbicide- the label has a complete list of impacts on non-targets. Transline works well on many composite species; Transline does have impacts on some legume species as well.

- Bull thistle:

One strategy provided was mowing down the thicket and then treating the following year, this allows better access.

Hand removal by the Park Service has been effective, with repeated visits throughout the season. John Randall (as part of his PhD research, now with The Nature Conservancy) found that the less soil disturbance the better. Often grazing or other mechanical methods can create soil disturbance, resulting in a huge flush of seedlings from the seed bank. Preferably, cut the flowers off and bag to minimize the soil disturbance, while eliminating further additions of seed.

There was the question: Can you cut bull thistle plants and leave them (and get no seed production)? Many folks in the group have seen bull thistle plants that were cut have enough energy to go ahead and make viable seed. To be extra cautious, it was advised to cut even young, undeveloped buds/flower heads to avoid any chances of seed development from cut plants.

- Tarping with these thistles was also discussed. The question of clear versus black plastic was posed. Many have cut thistles, piled them in a central location and then tarped with black plastic, as a means to focus the population into islands that would then be targeted heavily for early treatment the following season.

- Another idea for helping battle non-native thistle seed load (or any undesirable thistle with small, FLUFFY seeds that collect at the base of the plant when released)--- USE an outdoor vacuum to clean them up. One can REALLY reduce seed load for the following year.

Dalmatian toadflax

- The question of available and effective herbicides for dalmatian toadflax was posed. Many group participants testified to limited success on dalmatian toadflax with herbicides. Some success has been noted in some areas with Telar.

- Mechanical methods were discussed. Dalmatian toadflax has an extensive root system that results in massive resprouting if any roots are left in the ground. Limited hand pulling will not be successful. Rather, REPEATED digging, in an attempt to remove as much of the extensive root system as possible was recommended. Some smaller infestations have been completing eradicated with frequent digging throughout the duration of the season, year after year- being careful to not allow seed set.

Spotted Knapweed

- The question of available non-chemical methods for spotted knapweed was posed. Many from the group reported used digging as a control measure for spotted knapweed. Spotted knapweed has a huge tap root/root ball that is prone to resprouting, if all of the root is not removed. Special digging bars have been used by the Salmon River Restoration Council in Siskiyou County- and have helped them tackle this resprouting problem (see next comment for their webpage).

- The Salmon River Restoration Council was recommended as a resource, as they have successfully reduced huge spotted knapweed infestations in their watershed and are working toward total eradication- with non-chemical methods. This group has tried all non-chemical methods, including: hand-pulling, digging, tarping, mowing, etc. The Salmon River group can be reached via their comprehensive webpage: www.srrc.org

Saharan Mustard

- This plant is simply taking over the Mojave Desert.

-Remedy (Tricloypr) has been effective. A cautionary statement was made that this weed is prone to herbicide resistance (resistance to Banvel in Australia is well documented).

- Hand pulling can also work; millions of plants have been pulled from Lake Meade

-Matt Brooks with the USGS was mentioned as a further contact for those interested in more on the control of Saharan mustard, including impacts from fire/burning.

Chrysanthemum coronarium

-This plant is a REAL problem in Rancho Palos Verdes, spreading like crazy.

-Originally thought to have been introduced by Japanese immigrants, as this plant is a food source.

-There was limited expertise on available control measures within the group. The group member asking about this species was redirected to resources (listed below).

Private Landowner Participation

-This question was posed: How does one get private landowners on board, especially if you are working as a governmental employee?

-The following contacts/leads were suggested:
*Getting involved with your local county Weed Management Area group. Often, other members of the group (including the County Agricultural Commissioner's Office) will know the private land owner(s) in question AND/OR if they do not can help you find out and make contact.

*Cattlemen's Association. Another group that is heavily tied-in with private land owners.

*Resource Conservation District (RCD) and Natural Resource Conservation Service (NRCS). Two groups that focus on working with private landowners; RCDs and NRCS are charged with creating a bridge between government types and private landowners.

Resources to Learn More

-It was important to brainstorm ways in which group participants could get answers to their specific questions that we did not have time to cover and/or questions that arise beyond the CalIPC Symposium.

The following resources were discussed:

- The CalIPC website: www.cal-ipc.org
- The CalIPC List Serve CalWeed Talk (to sign-on, contact Doug at the CalIPC headquarters office in Berkeley)
- The recently released CalIPC, Weed Worker Handbook (copies available from CalIPC headquarters Office in Berkeley)
- Weed RIC (Research and Information Center) out of UC Davis http://wric.ucdavis.edu/
- The Encycloweedia from the California Department of Food and Agriculture www.cdfa.ca.gov/weedinfo
- The Nature Conservancy (TNC) Webpage, WEALTH OF INFORMATION http://tncweeds.ucdavis.edu/handbook.html AND Other web resources!
- The Center for Invasive Plant Management website www.weedcenter.org

- PMIS (Plant Management Information System) through the Army Corps of Engineers, a CD and their resource web page: http://www.newfs.org/invasive/invasive.htm
- Your Local Weed Management Area Group, www.cdfa.ca.gov/wma

Trees and Shrubs Working Group

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Notes: S. Grove

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Dealing with community opposition to weed removal projects

- Start w/removing sapplings and young/small populations
-To avoid public upset, drilling around into tree buttress roots and injecting 25% glyphosate. Drill into roots every 2 or more inches if cambium layer is thick. Trees die slow and branches fall slowly, so won't pose an immediate hazard. Not appropriate method for near trails as limbs may fall unpredictably and become a human hazard.
- GGNRA example: inform public ahead of time; use threats of fire danger to help build support for invasive plant removal projects.

Specific Treatments for invasive tree/shrub species

- GarlonTM on Eucalyptus? Works comparably if not better than glyphosate.
- Tree of Heaven always come back with mechanical methods, can make it works because of enhanced seed dispersal. Girdling may be more apporpriate.
- ImazapyrTM effective but may leach from roots and travel in soil.
- What tool can inject herbicides into Eucalyptus?
- Garlon4TM in the form of PathfinderTM effective on broom applied basally on plants 3-4" in diameter.
- Weed WrenchesTM are great for volunteers but seems to disturb soil so greatly. Any ideas?
  1) Might as well keep flushing the seed bank up if you can follow up post germination.
  2) Leave the plants in place one killed - it will help limit germination.
  3) Cut and peel the stump like a banana.
  4) Flush out seed bank and mulch
  5) Seed won't remain viable when passed through chickens.
- Castor bean, any advise?
  1) GarlonTM is better than RoundupTM
  2) If using RoundupTM, need greater than 5% or it will take to long to die.
- Has anyone tried cutting and spraying boom with GarlonTM?
  1) Cutting can backfire. If it rains or if the plants are really robust (4-5 years old), you could make the problem worse.
- Encourage cutting and peeling broom bark back on rocky slopes. This method is also effective on Acacia species.

- Use an old can of Kiwi shoe polish w/dobber-type of applicator to dispense triclopyr. VineXTM is a more legal alternative sold by pesticide companies to accomplish the same thing.

-Rubus discolor hand removal:

—cut stumps back and use sharp shovel
—cut and cut and recut 3-5 times during a season
—cut leaves and stems 12" high with RoundupTM

-Does native blackberry ever hybridize with exotics? Jake Sigg has found evidence this may occur.

Community Support

- Are there any efforts in using revegetation after invasive tree removal projects and if so, how does the public react?
  Response: yes - public insists on revegetation with native trees but often they wish to see them grow faster.
- Public input: Eucalyptus being replaced by native trees that probably won't survive because they do not belong.
- Native grasslands are not always a realistic restoration goal.

How to start Outreach

- Stewardship first, very small number of people can build trust or even halt a project Education must be done ahead of time. Obstructionists are fearful of change. They sometimes advocate for less aesthetically pleasing work. People must be convinced of native restoration alternatives to invasive forests. Restorationists should consider better, graphic descriptions (visualizations) of what the predicted outcome should look like. Must be honest and describe that projects may look unsatisfying for quite some time.
- Education public on adverse effects on songbirds: i.e. Sticky Eucalyptus gum clogs native songbird bills.
- Don't be shady, be honest, especially if working for the government. Have informal meetings, negotiate.
- Imaging can be done in PhotoshopTM fairly easily to help prepare visualizations to help people see what a project will look like before it ever begins.
- Use any supporters to juxtapose the opposition within the supporters. Show the opposition that the public also supports your weed removal plans.
- Language is important. July/Aug issue of Sierra magazine has an article on language use to please or irritate the public.
- Monitoring. Use the bird angle. People love birds.

Fire and Invasive Trees and Shrubs

- People are afraid of fire. Help them understand Eucalyptus trees and other invasive plants are very fire hazardous.
- Is there any solid research about Eucalyptus and fire?
- Are Eucalyptus and brooms any greater fire danger than native chaparral?
- Try and get funding for long term maintenance. Push for long term funding. Otherwise you may exasperate the problem and henceforth the public.

- Brooms typically have 50 year seed bank. How does one get funding for the 49 years after the initial removal effort?

Monitoring
-Photomonitoring
-Percent cover - transects/point intercept
-define goals clearly

Dunes Working Group

Leader/Facilitator: Jane Rodgers
Technical Expert: Kim Cooper

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Minutes
Group had brief introductions and individuals discussed projects and issues. These notes summarize group discussions and future action items for this informal dune group.

Individual Reports and Comments
Peter Warner (state parks): working on AMAR/cachxed/cose/coju; plovers, rare wildflowers, herbicide opposition,; had money to initiate project on 60-acres, however funding ran out and no

follow-up occurred. Issues including dealing with iceplant piles, piling material on existing mats. Is doing a study.

Greg Nowell (All Seasons Weed Control Inc.): spraying has much less regeneration.

Kelly Rose (FBW): 8.5-acre project in backdune of a salt marsh, very removed from dune system by surrounding development. All volunteer project, hand pulling. Question—will leaving iceplant on site alter soil? Have huge volunteer force, have been sifting sand to remove weed propagules. Thinking about bringing in sand. Can't use mechanical treatment due to number of natives and rarities on site.

Peter Brastow/Lew Stringer: Presidio has successfully brought in sand to effectively bury weed propagules, in particular BRDI, under 2" of sand. Is the BRDI invasion climate related/temporary/long-term? May be simply the removal of iceplant allowing new invasions. Have used rice straw to successfully kick out Erharta at small scale if done early w/small populations.

Tim Doherty (GOGA) has oxalis up after iceplant removal. Tim Hyland has used 7% Roundup, Dan Glusenkamp's used 2% with success.

Kim Cooper: at PORE they prioritize sites based on surrounding exotic species. Look to remove iceplant at sites that are weedfree on adjacent sites (esp. BRDI). Some success w/mechanical burial method.

Tim Hyland—burn AMAR, spray roundup. Burning good to reduce biomass.

Dan Glusenkamp—uses 2% roundup for small patches of AMAR.

Group questions—What other species are coming in? RUAC, ERER, ERCA, CEME, OXPE, BRDI, BRTE, VUBR, TETE, MECR, EN, HRA, OTHER DYC's, SEEL, slender-leaved iceplant.

Scale is critical in technique, plus rare spp., number of volunteers, herbicide, etc.

Guadalupe – big area w/multiple jurisdiction, difficult to sort out/get all doing same or similar management. Has website? Dunescenter.org. Has organized "Dune Quest" which is meeting regularly to discuss dune issues (similar to Dune Guild?). Project funded through oil spill dollars. Using bulldozers to remove pampas grass. Iceplant last priority because it is so easy to remove; need to get other more difficult species out first. Spraying veldtgrass. Senecio elegans moving in. Treating all exotics, not just invasives. 2-4 month interval spraying for veldtgrass. If you can't follow up, don't bother starting. Humidicide & general (roundup?) and lots of surfactant for V.E; spot spray after first pass. Fusselade just forces dormancy. Local ranches still planting veldtgrass; some experimental grazing but probably won't stop invasion, just lowers seed production. Peter Warner encouraged folks to get stories like this to CDFA—notion that federal land managers are trying to discourage/eliminate weed populations while adjacent landowners are planting those same spp. UniCal spent lots of money to eradicate SEEL and has been successful at project site, except for adjacent populations that are providing a seedsource.

Group question: Has anyone published their experiences with dune restoration? Answer: NO.

Update on Dune Guild—has been around for a while, but communication is lacking, sharing and starting from scratch happens a lot. People interested in guild, and suggested meeting at PORE. There was group interest in having a joint Dune Guild/Dunequest meeting and also a joint SERCal/CalIPC meeting (2006!).

Herbicide comment—some situations have a narrow window of opportunity to get insipient populations, herbicides at right moment can nip in bud rather that having to use lots more herbicides later when pop's out of control. Examples include knapweed at Glacier NP and water hyacinth in California. There was a question about spraying effects on non-target species, and availability of data. Joe Ditomaso has website link for this info. Regina at Vandenberg is starting a study with pampas spraying and pitfall traps to look at effects of herbicides. Mixed response from USFWS on use of herbicides.

Peter Warner encouraged folks to write down observations, there is a serious lack of scientific projects/studies/publications. Interested in seed viability, other life history information.

Pampas treatment discussion: use 2% roundup? Higher concentration? At 2% some are seeing 50% resprout/no kill. No translocation between culms so complete coverage w/herbicide is essential. Cutting first helps, but can't always do this. Folks discussed feasibility/appropriateness of cutting plumes—is it worthwhile? Consensus was yes, depending on scale.

Folks discussed value of building in time and money for report writing, data collection, analysis, and sharing of information. Interns or partnerships could assist w/writing.

Discussions Summary: Projects have developed successful techniques for iceplant, AMAR, but main group issues are--- communication/sharing information, new invaders, project scale (varies from less than 10-acres to over 1800-acres), long-term project planning. There was interest in a listserve, but no one took the lead on this.

WORKING GROUP ACTION ITEMS!

Project Summary Briefs
Participants of working group agreed to send Jane Rodgers at a minimum a paragraph discussing current or past project details/results/planning and to include contact information. These are to be sent to her in the next 2-4 weeks. Participants can send more, including reports, informal notes, anything, as attached files or in email. Jane will compile and let group know where this info will be posted—tentatively at the Elkhorn Slough site but possibly other website with link through CalIPC. Elkhorn Slough/Coastal Education Program may be a web venue for storing and sharing dune restoration information. Kim Cooper will look into this w/the program director Gray Hayes.

Future Meetings to Share Info
Kim Cooper volunteered to be the liason between CalIPC and SERCal; Peter Brastow volunteered to assist her with this. She will be in touch with SERCal Dune Guild rep. Victor(?) and report back to the group. At a minimum there will be opportunities for a joint meeting at the 2006 CalIPC/SERCal

meeting. There may be a meeting venue in 2005 through Dunequest, Dunes Collaborative, or Dune Guild for a group meeting and field trip. Lauren Brown volunteered to help bring Dunequest and Dune Guild together and invited participants to come speak at the next Dunequest meeting(s).

Session 8:Working Groups II

Risk Assessment Working Group

Leader: Peter Warner
Facilitator: Alison Stanton

Attendees:

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Note: No formal notes were taken during this working group session, as this topic was not condusive to note taking.

Mapping Working Group

Topic Leaders: Steve Schoenig, California Department of Food & Agriculture
And Deanne DiPietro, Sonoma Ecology Center
Facilitator: Mark Newhouser, Sonoma Ecology Center

Attendees:

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The working group started with a recap of last year's working group discussion, followed by an overview of the objectives of Cal-IPC's Weed Mapping Committee, including a call for data. Various presentations were then given describing new **Data Tools**. The session ended with a discussion of these different Data Tools and applications they are useful for.

Recap and Overview: Last year's discussion concluded that mapping is necessary but there is a steep learning curve with current technologies. Several needs were identified for weed mapping in California. In response to these needs, Cal-IPC formed a Weed Mapping Committee with the following goals in mind:

- Develop online statewide maps of the known locations of California's worst weeds.

- Host an inventory of programs conducting weed mapping and any data they are willing to share.
- Create a clearinghouse of tools and methods used by weed mapping efforts in California and elsewhere.

To achieve these goals the following projects are being worked on and can be accessed from Cal-IPC's website (www.cal-ipc.org >> Projects >> Cal-IPC Weed Mapping Committee).

- *Statewide Maps*: Currently we are collecting data for Arundo donax and tamarisk spp. for compilation into statewide maps for those species. To contribute these and any other species map data quickly and easily, please visit the above website.
- *Weed Mapping Project Inventory*: A simple database is being built that will be made searchable on the Cal-IPC website. To contribute your project's name and focal species please visit the above website. Also, the CalWeed database is revamping their project inventory. These two resources will be combined.
- *Clearinghouse of Mapping Tools*: Information on the tools used in weed management and where to get them will soon be made available on the Cal-IPC Weed Mapping Committee website.
- *Networking*: A new listserv (CalWeedMapping@topica.org) has been created as a forum for discussing topics related to mapping weeds, monitoring invasion spread and treatment success, and managing and sharing data. You can subscribe to this listserv on the Cal-IPC Weed Mapping Committee website.

Presentations of Data Tools: Many people presented new data tools they are working on or that have proved useful in the field.

1. Mandy Tu (TNC) – The Nature Conservancy has been developing a new data management tool called **WIMS** (Weed Information Management System). In 1999 TNC started working on WIMS to aid their land managers in tracking weed related data. WIMS is built around a relational database (MS Access). It contains 3 components:

1. Occurrences of weeds (GPS points and area of infestation around that point)
2. Assessments (monitoring of the weed population over time)
3. Treatment activities

WIMS is easily imported and exported for sharing in EXCEL spreadsheets. The data format conforms to NAWMA (North American Weed Mapping Association) standards. Using WIMS, TNC land managers can automatically produce shapefiles for GIS. They can also produce 20 different types of reports related to their weed control and monitoring activities. WIMS can be used in the field on a handheld PC or Palm Pilot with an attached GPS unit. The desktop format of WIMS is similar on the handheld PC. WIMS will be made available for free to everyone. Information about WIMS, including a draft user's manual, can be found at: http://tncweeds.ucdavis.edu/wims.html. The application will be released to the public in a couple of months.

2. Deanne DiPietro (Sonoma Ecology Center): TAdN (Team Arundo Del Norte) has been working under 2 different CalFed grants. The work has involved coordinating in the Bay/Delta Region to map the invasive plant *Arundo donax*, plan eradication of *A. donax*, track treatments, monitor progress, and organize project management among partners. They were developing a data management system to accomplish these goals but have decided to partner with TNC on WIMS. The objective of the TNC/TAdN partnership is to continue upgrades and development together, making changes that benefit all WIMS users while maintaining version control, and to consolidate technical support. Steve Schoenig commented:

- WIMS can be extremely valuable for WMA's and County Ag offices.
- You don't need to adopt this system to share data.
- WIMS is ideal for someone starting from scratch.

3. Chris Rogers (ESA Consulting): Esa Consulting received a CalFed grant to update and give better quality data throughout the Bay/Delta Region for *Lepidium latifolium* (perennial pepperweed). Their approach is field mapping with Trimble GPS receivers. These receivers incorporate a "data dictionary" based on TAdN's online forms. This work will be in the spirit of a publicly available online GIS product. Chris has a request for quality point, polygon data with attributes to enrich this product. This is a 3 year project and they are approaching the end of their 1st year.

4. Ingrid Hogle (I.C.E): Ingrid has been working at the Cosumnes River Preserve to map *L. latifolium* areas of presence and absence. In the field they have had good success using a Garmin Rhino with a two-way radio feature. This unit takes points the whole time, which aids in tracking areas surveyed. They also use a Trimble backpack setup for more detailed locations. Data is managed using an ESRI personal geodatabase instead of shapefiles. This approach provides the ability to link tables from other databases and can keep track of metadata within the database. Spatial analysis is done using ArcMap.

5. Bobbi Simpson (National Parks Exotic Plant Management Team): The National Parks EPMT uses a management tool called APCAM. APCAM uses datasheets in which you can pick and choose necessary fields depending on the project. A field person brings the paper form and a GPS unit. This information is later input on computer in the office. They are migrating towards an Oracle setup to enter data online. Using this system EPMT puts out reports to the National Parks on exotic plants. To date APCAM has not been intended for use by other agencies.

6. Jason Giessow (SMSLRWMA): Jason described a method for mapping large acreages of an exotic plant (*A. donax*) with minimum resources expended.
Step 1: Acquire orthorectified imagery of infested area.
Step 2: Print maps from this for field survey.
Step 3: Use these maps to outline exotic plant infestation in the field.
Step 4: Transfer map to a clean sheet by tracing.
Step 5: Scan traced images and convert into polygon coverages using GIS software.
Step 6: Georeference each image using GIS software.
Step 7: Merge coverages and clean up.
Step 8: Proof final coverage compared to field survey maps.
Step 9: Distribute data; final GIS coverage and maps available to public at http://smslrwma.org.
This method sets up the information you need to do *A. donax* projects quickly. The final Arundo coverage is thought to be accurate to +/- 20% of the actual acreage at that date. If a more accurate acreage is required (eg. for mitigation projects) then ground-based GPSing can be carried out during the actual treatment effort. This ground-based mapping is however, much more expensive and is not generally warranted for large scale mapping projects.

7. Christy Brigham (Santa Monica Mountain National Recreation Area): Christy's organization has completed mapping of their 120,000 acre recreation area. Now they are trying to prioritize, using these maps. They are getting a volunteer effort together to keep the maps up to date.

8. Meghan Fitch (Anteon Corp.;MCB Camp Pendleton): AMEC has built them a geodatabase. They are impressed with the geodatabase system and see the benefits of having these linked databases. Megan said “geodatabases rock!”, and now we all want geodatabases.

Discussion: After various presentations it was emphasized, when mapping, to know your objectives. There are many different methods available and your objectives will dictate which method is best for you. These methods have different levels of complexity and money expenditure. For example, TAdN will use the “Giessow Method” for quick recon of an area and WIMS method for more treatment-specific data. When choosing your weed mapping method, try using at least the minimum NAWMA mapping standards. For sharing data one must be very careful with attribute names and what you mean by it. This is important when “cross walking” databases with different fields (“semantics”). The question was raised; how much attribute data do we want? The spatial data can be very minimal and still provide for spread and position data over time for science and research. This is also beneficial for bio-control releases where it’s important to show population level effects the cheapest and fastest way. Another question brought up dealt with mapping infestation levels that change over time. WIMS addresses this issue by taking a GPS point at the infestation location and drawing different polygons around that point representing the population perimeter in different years. This way you can compare that polygon from year to year. At the end a quick poll was taken. Out of 56 people in attendance:

- 10 people were looking for a new system to use.
- 5 people had existing systems not using NAWMA standards.
- 35 people would be interested in a free WIMS workshop/training sponsored by Cal-IPC.

Nurseries Working Group

Facilitator: Mona Robison
Notetaker: Bree Richardson

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The following background information was given:

Two approaches:

- Top-down: working directly with growers and sellers
- Bottom-up: working to change consumer demand, 'Don't Plant a Pest'

Cal-IPC has taken both approaches over the past few years.

Bottom up:

- Don't Plant has been very successful

- Tree version out by spring
- Alison Stanton did a Master Gardeners training this year, for the Bay Area MGs
- We've gotten numerous requests to address garden clubs around the state
- Had a booth at the San Francisco Flower and Garden Show, attendance of 20,000

Top-down:

- **Collaborated with a number of nurseries**, Monrovia, Sloat, Berkeley Horticultural nursery, on the Don't Plant a Pest brochure
    - This has been a way to open avenues of discussion about invasive plants
    - One limitation to this is that most of the nursery representatives that worked on this project were already of a like-mind with Cal-IPC
- Collaborating with **Sustainable Conservation** on creating a working group that includes representatives from several larger nurseries and producers, including Monrovia, Hines, and Mitsuwa
    - Had one meeting with a number of stakeholders, the results of which are that we will form a steering committee which will produce a mission statement and a list of objectives

Perspective I've developed as all of this has taken place:

- Nursery professionals like plants, they are our kind of people
- The issue of invasive plants is gaining recognition and understanding within the horticultural trade
- **The nursery trade is very willing to work with Cal-IPC** and other like-minded groups because they believe that self-regulation is both better for them and more effective at solving the problem, than government regulation, which is a view shared by Cal-IPC
- There are **obstacles for the trade in working on this issue**:
    - Professionals in the trade are often beset by much more pressing problems, sudden oak death, glassy winged sharpshooter, so it's often difficult for them to find the time and resources to really delve into the invasive plant issue
    - In many cases there is no clear answer on what is safe to sell and what isn't, particularly with regard to cultivars, varieties, sterile hybrids, etc. but also regionally
    - The California nursery and growing trade is not neatly contained within California. Many growers grow things to be shipped elsewhere. As one grower put it: we grow pampasgrass that's put in a truck and shipped to Wisconsin to die.
- **Cal-IPC also faces obstacles** when trying to articulate what we would like from the nursery trade.
    - We don't have the science to determine which cultivars, hybrids, varieties are safe or unsafe: for us, English ivy is English ivy and that's an oversimplification
    - We don't have a working risk assessment model for screening new introductions. Several have been developed, others are under development, but none have yet proved accurate enough to really ask the trade to use them.

A couple of questions that group addressed:

What ideas do we have for additional bottom-up projects? We've done the brochure…now what?

As Cal-IPC continues to work with professionals in the nursery trade, what should our goals be? In short, what do we want from them, and how do we provide them with the tools they need to fulfill our requests?

Group Discussion
There was a lot of **interest in the Southern California regional "Don't Plant a Pest" brochure**. We might find help from the group in distributing it through their organizations.

Big Box retailers: Carolyn Martus had luck with Wal-Mart, but no luck with Home Depot despite their being affiliated with the National Fish and Wildlife Federation at the national level. NFWF isn't aware of regional issues like invasive plants. On the whole, however, most nurseries are amenable to reducing sale of invasive plants when it's brought to their attention. Carolyn is also working with landscape architecture groups to educate them about invasive plants.

Having a corporate impact will require a lot of work. The profit margin is incredibly slim, and we must supply viable alternatives. The only negative impact for nurseries selling invasives is the potential for bad press. It helps to have someone on the inside, who can direct people away from the invasive plants.

Regulation is not set up to deal with this problem. Regulatory system with California Department of Food and Agriculture does not regulate most of the plants we are concerned with. It takes a long time to update the list and then it is up to the County Agriculture Commissioner to enforce it. Regulation is not generally effective due to local issues. Eradication is the best, but providing alternatives is also important.

Marie J: We have to be sure we **don't imply that we are against all non-natives**. Sometimes non-natives are much better than natives from a different location that may influence the genetic makeup of the wild natives.

Nicholas S: Currently, nurseries don't know what to do about this issue. There are three big issues address by the **American Nursery & Landscape Association (ANLA)**: Labor, on which much work is being done; Water, on which work is being done; and Invasive plants, on which little is being done because the members don't yet know what to do.

One thing that would help is for the **industry to develop closer ties to research institutions** like UC Davis that can help determine what to grow and what not to grow. If researchers could look at the top 20 percent of sales and identify what is invasive and what are we just learning is invasive, that would be helpful. Also if they could help develop sterile varieties. There is funding going into research in the industry and some of that is aimed at the issue of invasive plants.

Selling plants that are regionally **labeled as non-invasive** or native is very desirable for the industry, since it's a way to add value. Currently, regional labeling is a huge challenge, when plants are grown and shipped all over the nation, but Monrovia is working on a system where individual retailers can customize their labels, which will allow some regional identification information to be included.

In many ways, Monrovia and other **growers are self-regulating**. They treat their neighbors' land for snails, anthills, weeds, because no one else will do it, so they spend their own money to do so.

Becky W.: Nurseries and seed growers could collaborate on **certification programs** which would identify non-invasives and certify that seed is weed-free.

There was a seed certification program at UCD but it has been closed. There are a lot of seed mixes labeled "Native" which are not appropriate for our area or contain known weeds.

Information on the **sterility of different plants/varieties** is not readily available. Much of it is in the minds of uncommunicative horticulturalists, and no database exists. Some information is easier to find, some harder. There is a need to document the development of new plants and varieties. Researchers at the UCs could work with growers to develop standard documentation methods.

Prices for native plant seed have been coming down steadily as more of them are grown commercially and the demand has heightened.

Ways Cal-IPC can forward progress:

- Have a short column in the Farm Bureau newsletter every month
- Continue work on **top-down education**
- **Work with agricultural commissioners** to try to reach small growers. Also help educate the people in the Agriculture Department who work on nursery issues about invasive plants. Currently the nursery folks and the weed folks are entirely unrelated.
- Do **outreach at the California Association of Nurseries and Garden Centers (CANGC) Western Expo**—they host talks and we could get one of our nursery professional partners to conduct a talk.
- Also do **articles** in: International Erosion Control Association Western Chapter newsletter, and Pacific Coast Nurseryman magazine, Sunset magazine (have to go directly to the writers to ever get through there)
- Get our **link onto other websites** and on producers' websites (ex. www.bewaterwise.com)
- Get **brochures into nurseries**—they will then pass them along to customers and each other—the Ag Depts. can help with distribution
- Coordinate with the Department of Conservation Watershed Coordinators (Drew Ready can be a contact for them)
- Get more regional 'Don't Plant a Pest' brochures developed and distributed.
- Act as a conduit between ANLA and related groups and researchers. Look into funding for research projects through the Horticultural Research Institute.
  Note to group: I looked on the website of ANLA (www.anla.org) and they listed a project funded for $15,500 in 2004 called Developing Improved, Non-Invasive Nursery Crops.
- Some other groups to coordinate with: Trees for Green LA, Mediterranean Garden Society, PG&E Safe Street Tree program in Bay Area. Look into coverage on the California Gold television show.
- CalIPC could develop a **speakers bureau**, Karen had a talk she could share
- CalIPC could develop a **weed and alternatives calendar** (Francisco's suggestion).

Fire Working Group

Facilitator: Joanna Clines
Topic Leader: Joe DiTomaso
Note taker: Suzanne Goode
Notes edited and typed by: Joanna Clines

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Joe DiTomaso announced that a monograph should be available by next year's Cal-IPC symposium resulting from a workshop held in Las Vegas on the use of fire for control of invasive plants. The workshop was put on by the Center for Invasive Plant Management. There will be chapters on use of prescribed fire to control invasive plants based on life cycle, ecology, etc.; use of fire in an IPM strategy. A literature review on the use of fire for invasive plant control is being compiled by Peter Rice at the University of Montana.

Then we had people introduce themselves and briefly state their interest in use of fire in regard to weed control.

- Tom Dudley – biocontrol beetles have been used to defoliate tamarisk, then fire was used to finish off the job in Northern Nevada. However, if knapweed and *Lepidium* are in the understory, they may benefit.
- Would like to know how fire has been used for yellow starthistle (YST) and how this may relate to Sudden Oak Death.
- Concerned with good fuelbreak design to minimize spread of weeds.
- Preserve design in San Diego: use fire to replace grazing and use in habitat management to control non-native bromes.
- A fire management plan is being prepared for San Diego: which exotics follow fire? Concern about creation of fuelbreaks.
- Use of fire against YST and Italian thistle.
- CDF is proposing fuelbreaks in areas containing broom.
- Jo Kitz: in the Santa Monica Mountains, they are managing formerly disked areas by mowing. There is an MOU for Cold Creek Preserve with the Fire Dept. allowing not to clear 200 feet. Planted *Nassella pulchra* – using native grasses to manage fuelbreak. Urgent need for prompt response after fires, survey and remove invasive plants before it exploded in the burned area. Use volunteers perhaps. They removed red gum eucalyptus before they had a chance to spread too much.
- When you burn for broom and YST control and don't plan it well, fire can make the infestations worse. There is a lot of pressure currently for fuelbreak expansion, worried about seed bank explosion after prescribed burning of broom.
- Tony – MRCA – Piro Creek in Santa Clara watershed – fire damage and subsequent recovery. Interested in how to construct fuelbreaks.
- How fire suppression impacts habitat.

- How to step down to small burns for restoration.
- Italian rye near seasonal wetland.
- Promotion of non-natives, increasing fire frequencies – difference between pile and broadcast burning – invasions of cheatgrass in higher elevation forests after prescribed burns.
- Mastication good for preventing weeds because it results in thick mulch and few weeds. Not always good for fire prevention because fuels on ground have a higher surface/volume ratio and can burn more easily than with some other fuels treatments.
- Concern over post-fire weed invasions / spread.
- Fire and bull thistle, hemlock, French broom.
- Use of National Fire Plan funding for community fuelbreaks – potential for weed spread
- Kurt Schasker believes low elevation chaparral (< 4500 feet) can't tolerate fire, questions the idea that prescribed burning of chaparral helps make communities fire safe.
- Stephen's kangaroo rat habitat – they prefer open areas. A prescribed burn was carried out near a new airport where they couldn't use livestock to open up the habitat.
- Fire frequencies at Santa Monica Mountains National Recreation Area have been too high, result is type conversion to laurel sumac and annual grassland. A fire management plan for the SMNRA is available (Marti Witter).
- Witter: Burned Area Emergency Rehabilitation funds are available to control post-fire invasives.
- Robert (SMNRA): concerns about scale of burning. Stopped by Ventura County Air Quality office – he'd like to do mustard control. Fire District plans fires on NPS lands without consulting NPS.
- Fire used to reduce ripgut brome and encourage native annual forbs. Used on *Ammophila* and then sprayed. Also in old growth redwood forest to reduce litter depth.
- Concern about how invasives can spread fire: e.g. *Arundo* in riparian areas. Did herbicide treatment after fire and it didn't work. (Joe D. says timing is crucial for controlling resprouting *Arundo,* must not be done too early).

<u>There were 3 recurring themes brought up by the participants:</u>

- Fuelbreaks and the potential for spread of invasive plants
- Invasions caused or exacerbated by fire
- How to use fire to reduce invasives

CONTINUING TO TRACK THE DISCUSSION:
Need to work with fire and fuels staff so they understand the problem of invasive plants

Re: burning for weed control: Timing and logistics can be difficult. May not be able to count on burning because of weather, fire danger, personnel availability, etc. Especially a problem if counting on late season burns, e.g. for yellow starthistle.

Use of fire retardants for fuelbreaks results in soil enrichment. There was a discussion about this becoming more of a common practice and some concern was voiced about environmental impacts of using retardants as a preventive tool in addition to its use in extinguishing fires.

Question for group: Asked if anyone in the group knows of proven instances where prescribed burning of lowland chaparral has effectively reduced fuels and met resource enhancement objectives; where burning was clearly better than doing nothing? Some people answered yes, they have reduced fuel and now have the plants they wanted.

Pretreatment to create shaded fuelbreaks has worked to stop fires.

Kyle Merriam (USGS) – research was conducted at 14 sites around California on the effects of fuelbreaks on the spread of invasives. This study can be found on the web site for the Western Ecological Research Center: http://www.werc.usgs.gov/fire/seki/ffm/

IDEAS ON ACTIONS THE WILDLAND COMMUNITY CAN TAKE:

1. We should use this workshop to start a network; we couldn't discuss all the issues in this short time.

(If we had stuck to the topic in the title of the working group: "using prescribed burning as a management tool", the working group session would probably have been more focused and productive. At least there would have been more time for discussing solutions to the problems / questions people brought up. However, this seemed to be the forum for many people to express concerns about the potential for the spread of weeds as a result of fuels reduction treatments as well as after prescribed and wild fires. Perhaps next year, the working groups could be structured to include these topics. JC.)

Critical Habitats Working Group

Facilitator: Katy Zaremba
Topic Leader: Mark Heath

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Main themes/questions that came up during round of introductions:

1) Can we develop guidelines for restoration work in various sensitive species habitat types?
2) How to work with volunteer groups in sensitive habitats
3) Permitting process – costly and time consuming to get restoration projects permitted, especially with threatened and endangered (T&E) species
4) How to monitor impacts of restoration projects on T&E species
5) Current herbicide toxicity data for T&E species not readily available

TOPIC 1: Permitting Issues
COMMENTS

1) Is it possible to create a MOU with permitting agencies for various types of weed removal projects in different habitats so that we are not constantly re-inventing the wheel (e.g. LACDWP has a 10 year project permit for all maintenance vs. many single year permits)?

2) New revision in CEQA (just came out three weeks ago) stated that small restoration projects (< 5 acres) can apply for categorical exclusion
3) Sustainable Conservation and Santa Cruz County RCD working with SC County to set up county-wide permit process for erosion control/restoration projects. Ventura Endangered Species office (FWS) is not comfortable granting county-wide permits through RCDs, but it may be possible to work around this by ensuring that a qualified biologist will work on the projects.
4) Monterey County RCD working with CDFG to streamline permitting process for private landowners – maybe watch this process and see what happens
5) 10A 1A permit versus Section 7 permit?- many different permits required for HCPs and agencies are not coordinated so very long process so can't get an HCP approved in time for project.
6) Some inherent problems in regulatory offices (FWS ES offices): Understaffed, high turnover, permit requirements often depend on the specific agency biologist working on the proposal – Need to develop/acquire protocols for many T&E species/habitat types and ensure that these reside in agency files (not just minds of specific staff). BUT every restoration project has site-specific issues that must be addressed.
7) Tips for streamlining process:
    a. Building a good working relationship with regulators is the best way to facilitate the permitting process.
    b. Include as much detail as possible in permit application/proposal/consultation. This makes their job easier and shows that you have a good understanding of the system and the potential impacts that restoration work could have.
    c. Clearly communicate long term benefits of restoration to T&E species despite potential take
    d. Try to get regulators out to the field for a site visit.
    e. Clearly outline goals and objectives for herbicide use.
    f. Useful to have detailed monitoring plan in place
8) Mosquito Abatement Issues need to be incorporated into restoration plans for all wetland areas (West Nile virus). There is not a lot of information available on impacts of mosquito control. County mosquito abatement offices are often very willing to get involved / attend public meetings and re-assure public that wetland restoration projects are good and not a threat to health. Form a relationship with them at early stage in project.

9) FWS has certain accepted permitting rules for certain species that are often not based on current biological science, don't be afraid to challenge these "rules" (e.g. must spray at least 100 feet from elderberry – why?). Most regulating agencies have little to no field experience with herbicide, they simply see the word and say "buffer needed"
10) FWS doesn't authorize take for pesticide use – look up to find exact info.

WHAT CAN CAL-IPC DO TO HELP WITH THE PERMITING PROCESS?

1) Since Cal-IPC is respected by regulating agencies, can be part of county-wide MOUs
2) Create and distribute (website) contact list for various T&E species experts/agency biologists/ restorationists
3) Have more links on web site for permitting requirements/processes or set up a chat room to discuss permitting issues/ pool all restoration project plans/Section 7 Consultations that

have worked with T&E species so that others can use this information to facilitate permitting process and spread restoration techniques that work well in sensitive habitat

4) Provide information/examples on how to build a good working relationship with regulating agencies
5) Set up BMPs (Biological Monitoring Plan) for various habitat types, then layer in management practices for various species – can be used as a foundation for specific sites
6) Create and distribute (website) a list of research questions that need addressing. Encourage graduate students to take on projects that will provide more scientific evidence on treatment effects/impacts – make a list of the gaps in information/what research needs exist
7) PUBLIC OUTREACH: two constituencies 1) educate public as to benefits (lack of harm) of herbicide as a restoration tool, clarify differences between low-impact herbicide like glyphosate and the broader negative term "pesticide". 2) regulating agencies – provide good data, explain systems, include them in public outreach because the agencies respond to public comments and need to ensure that they are not sued by the public.
8) Organize workshops with restorationists, regulators, and biologists – perhaps at next year's symposium to work together and identify issues and what can be done to streamline the process
9) Work to get adequate staffing in regulatory agencies (e.g. a botanist that can come out to the field to see what you are proposing) – not sure how to do this.
10) Cal-IPC symposium session devoted entirely to permitting issues – presentations sharing what has been done before regarding permitting, what worked, what didn't work (anecdotal)
11) Lobby herbicide companies to demand more toxicity studies/provide all information (active and inactive ingredients, surfactant), special studies for CA T&E species
12) Encourage new products that register in California to report more than just the standard toxicity data – specify effects on T&E species
13) CAL-IPC can put toxicity information on website, because often hard to locate. Often can get this information through university research – at least for Garlon, Aquamaster, RndUP. Link to good website: http://extoxnet.orst.edu
14) Symposium session on the mechanisms by which various herbicides work – has been done in the past, but seems that it is time for a new cycle

TOPIC 2: Ways to minimize impacts of weed removal on T&E species
COMMENTS:

1) Timing of treatment (avoid nesting / blooming season)
2) Avoid high-impact treatments in sensitive habitat (e.g. carefully hand pull grass around certain sensitive areas such as butterfly host plants, but use tools/spot spray other areas)

Environmental/Social Issues Working Group

Facilitator: David Chang

Topic Leader: Peter Brastow, peter@natureinthecity.org

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Some Salient General Issues:

Is Cal-IPC too pesticide friendly? This is a question that Cal-IPC really needs to confront. While most of us believe in and see the utility of using herbicides as part of IPM, pesticides in general have a long history of creating awful social (environmental justice) and ecological problems. We need to more explicitly tackle this issue head-on. Have we fully convinced ourselves about the safety of pesticides?

Money. Public agencies are required to be good stewards of the public's money. What's more important? -saving money in the budget or doing what is best for society and the environment, e.g., herbicides versus community-based stewardship.

Specific Problems:

Pro-invasives - "Dispersal biology," that the anthropogenic dispersal of species increases biodiversity and is an essential strategy to spur evolution. *Specific solution*: Cal-IPC/Academia/others publish articles in local papers with credible scientific refutation of this claim.

Opposition to the use of herbicides is increasing. *Specific solution*: 1.) We have to open up, listen to the opposition. 2.) Herbicide fact sheet including humility about its use and the harm pesticide use has caused in the environment – environmental justice. 3.) Cal-IPC could study external costs (from start to finish).

Lack of Funding to finance planning, including environmental justice, community involvement, education, and outreach. *Specific solutions*: 1.) Cal-IPC should promote/lobby for funding of more integrated approaches. 2.) CALFED has grants for outreach.

Pesticide companies lack environmental fate information.

General Problems:

Obstructionists going mainstream – politicization.
"Let nature take its course."
"All plants have a purpose."
"Everything is natural"

"Playing God"

Private Property rights
Big government
Fear

Contentious meetings
Hostility
Lack of receptivity
Power struggle
Lack of trust
Feeling of powerlessness

California is an (ecological) island, and thus vulnerable to invasion.

General Solutions:

Education –

1.) about how government does do good things.
2.) Take the public to view the worst infestations - the monocultures that dominate and degrade a habitat. Create partnerships
3.) use the environmental groups, CNPS, Sierra Club, to carry your message.
4.) Work with Botanical gardens

Facts. Publicize the facts. Have a clear statement of benefits.
Plan. Early buy-in -- if planning is done right, controversy should be dealt with.

***Working with the community*:**

Be wary of exuding the ***government expert syndrome*** – self righteousness.
Give power to the powerless. Humility. Respect. Go slow. Do projects incrementally. Flexibility.
Be democratic. Inclusive. Diversify. Be Open-minded.
Work with people. Find the common/middle ground/*quid pro quo*.
Give some people what they want/an egg.
Tolerate venting. Don't take it personally. Detach emotion.
(Simultaneously) Personalize by having friendly meetings face-to-face with people, perhaps on neutral ground. Create those lasting and sustainable relationships.

During actual meetings:
Use a talking stick. Meet in a circle. Work on consensus building. Active listening.
If necessary, formal *conflict resolution* with skilled mediator (***most important***).
Agree to disagree.

Additional Notes from Al Sattler

cynthia @ wildworks.org (sp?): Book review on book opposed to invasive plants removal
Maybe same as man promoting dispersal idea "speeding up evolution," writing books, actively and personally dispersing invasive plants.

NEED reputable academic to counter his arguments.

One possible counter argument could be that the resulting monocultures would undo evolution. California has been an island of high diversity. We would be losing genetic diversity, losing "information."

(Added later, in compiling these notes: Also point out that the reason why many invasive species are so successful is that they have arrived without their biological controls. If, through complete "dispersal" those animals/bacteria/fungi were also present, the invasive species would probably not be as overwhelmingly successful. Another counter argument would be that if just a few invasives take over, the resulting monocultures might not be very pleasant. On the animal side, we might be left with humans, rats, cockroaches, and Argentine Ants.)

Problem: Park inholdings with ornamental plants escaping. Possible solution would be to offer free replacement of invasive ornamentals.

Problem: Some park staff in GGNRA philosophically opposed to differentiating between native and non-native plants.

Problem: Dealing with vehement opposition, whether to removal of non-native plants/trees or to herbicide spraying, etc.

Let individuals vent. Listen carefully to what they are saying...their opposition on this issue may be part of a larger set of issues that they are concerned about.

Build personal relationships, but sometimes agree to disagree.

Be there for a while before starting a project. Most people are resistant to change. One project did education and outreach for a year before starting the project. If people are involved after plans are already done and money acquired, there will be more opposition than if people are involved early.
Find common ground. If you help opponents with a problem, then maybe they will help you.
Take people on hikes, show them native plants, show them problems with non-natives excluding native plants and wildlife, effects of non-native plants on wildlife (eucalyptus gumming up bills of birds, for example).
Formal conflict resolution can be very successful. In one case people were threatening to kill each other, but eventually became much less hostile. Conflict resolution works when people respect the process. It includes active listening...slow down the process a lot so people really listen to each other.

There is a "Magic" group in the Palo Alto hills active in native plant restoration which is also good at conflict resolution.

There is a need to lobby the funders to include funding and time for outreach, education, and planning before action. This is done in the area of health care.

(Added later, in compiling these notes: When this issue was raised as a question in the session on funding, one reply was to start small with a pilot project first, then come back with a grant request for a larger project later.)

There need to be displays at botanical gardens of invasive plants to avoid: "Quarantine Zone"
There needs to be a clear statement of the benefits of habitat restoration.
Are weeds really a problem?

Government Expert Syndrome
Some people are suspicious of anything coming from a governmental body. Maybe have a non-profit organization, non-government organization (NGO) be an ambassador?

Herbicides issues:
Cal-IPC needs to promote more research in Integrated Pest Management, instead of just herbicides.

Some grant applications, instead of applying to use herbicides to improve habitat for natives, maybe even replanting with natives, are just being written to use herbicides.

A theme from several speakers was opposition by environmentalists to use of herbicides to control invasive plants. One speaker (yours truly, a long-time Sierra Club activist) objected to this dichotomy, saying that hopefully all those fighting invasive plants are environmentalists, whether using herbicides or not. There needs to be an effort to reach out to groups such as the Sierra Club, trying to have articles in their newsletters, etc.

One speaker said that he had carefully investigated glyphosate and concluded that it was quite safe to humans (and other animals), that it was poisonous to plants because it interrupted a key biochemical process present only in plants. He referred to ExToxNet as a source of information.

(Added later, in compiling these notes: For many chemicals, the only information available on toxicity comes from the manufacturer. Another source of information would be more trusted.)

One speaker told of a project to remove Arundo from Topanga Creek, fought bitterly by residents who did not want the creek to be poisoned. The residents asked for a year to eradicate the Arundo by hand, cutting it, but have not been successful. 89 local residents have worked on this project. Now they are asking for another year or two. The person working on the project said that they needed to get the project finished soon or funding would be lost, and asked what to do, whether to move ahead aggressively with herbicide in spite of community opposition. One speaker said definitely not, that it was great that they had so much community involvement, to give them more time to work at it in hopes that they would eventually get tired and give in to herbicide use. Another speaker commented that they need to dig down four feet to remove the roots. Yet another speaker suggested to give them some digging tools so they can get after the roots effectively.

Roadsides Working Group

Bonnie Harper-Lore, Federal Highway Administration – Topic Leader
Wendy West, El Dorado County Dept. of Agriculture – Facilitator/Notetaker

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Bonnie started the discussion by asking for good and bad examples of working with road maintenance agencies, including Caltrans. Discussion included:

- Difficulty between each Caltrans district and the way they issue encroachment permits for detection surveys; each district varies
- Concerns re: limited use of herbicides by Caltrans --- how can we support education about the advantage of judicious use of herbicides:
    - Get involved in the Caltrans advisory process
    - Educate the public regarding how difficult some species are to remove by hand (give "service" opportunities to understand the difficulty). This may win some over!
- How are Caltrans "sensitive areas" determined and who reviews?

Caltrans staff attending the working group session gave insight into some of the challenges that Caltrans faces:

- Need ideas for non-invasive, low ground covers to incorporate into landscapes
- It is challenging to meet all of the public's "needs" regarding what should be included in a roadside landscape i.e. fire safety, native plants, "pretty" plants, variations in climate, soils, etc.
- Caltrans is constantly challenged by lawsuits, endangered species issues and pushed to include habitat corridors within easements
- Budget constraints have affected Caltrans ability to utilize some weed control tools

How can CalIPC and individuals help change Caltrans invasive weed strategy?

- There is a need for roadside Best Management Practices (BMP)
- Weed identification training and BMP information are needed at the "on-the-ground" level for maintenance crews -- trainings video, CD and identification cards?
- The push to increase invasive weeds as a top department priority needs to come from outside Caltrans, i.e. calls from the public, letters or emails (www.dot.ca.gov has an email address for complaints) --- all of these communication methods are reviewed by staff and the issues addressed
- Caltrans upper management needs additional training to understand the issue
- New construction – monitoring period for invasive weeds needs to be longer than is commonly used in current contracts --- 5 years? 10 years?
- Encourage roadside management curriculum to be added to college courses in landscape architecture, etc. plus environmental training for engineers
- Currently there is no professional organization for roadside managers in California. A professional conference for roadside/right of way (roads, utility companies, railways, etc.) managers would be a great way to get invasive weed information disseminated and increase invasive weed training for Department of Pesticide Regulation (DPR) continuing education credits
- Increase invasive plant talks at PAPA seminars
- Promote the CalIPC annual symposium to more Caltrans employees – Bruce April with Caltrans offered to help get the word out for the 2005 Symposium in Chico
- Include a speaker session on roadside/right of way issues at the next CalIPC Symposium

Poster Abstracts

Approaches to assessment of cumulative economic impact of invasive plants. **Athan, Tara** Cal-IPC <tara_athan@safe-mail.net >

It is becoming increasingly important to effectively utilize scarce resources for invasive species control, and further to communicate the benefits of control to funding agencies, volunteers and stakeholders. Quantitative alternative assessment, such as cost:benefit analysis or multi-criteria optimization, can assist in determining the optimal strategy for control and in clarifying net benefits to society and stakeholder groups. There is a further need to consider the management of more than one invasive species at a time. Many locations have infestations of more than one species. In other cases, control of one invasive is followed by infestation of another. Quantitive alternative assessment for control of multiple invasive species requires the calculation of the cumulative economic impact. Most cumulative assessments assume a linear, independent response: the impact of each species is calculated separately and the results are added. This approach neglects synergistic effects, where the impact of several species is greater than the sum of the impacts of individual species, and saturation effects, where a plateau is reached and additional infestation has little or no additional impact. These effects can cause a linear model to over- or under-estimate the cumulative economic impact. Using structured analysis diagrams, a diagramming method useful in visualizing conceptual models, several existing studies are compared and contrasted. Sources of model and parameter uncertainty are identified in each approach. Finally, we propose a conceptual model for assessing the cumulative economic impact of invasive plants in California's wildlands.

Invasion of Arizona's natural areas: Plants that threaten wildlands. **Backer, Dana** and **John Hall** The Nature Conservancy, Southwest Vegetation Management Association <dbacker@tnc.org>

In 2001 Southwest Vegetation Management Association teamed up with colleagues from California Invasive Plant Council and University of Nevada Cooperative Extension to develop a set of assessment criteria to identify, evaluate, and rank non-native plants that are invasive in wildlands. The focus is on ecologically influential species that are already established in areas that support native ecosystems, such as parks, wildlife reserves, national forests and rangelands. For the past year, the Arizona Wildlands Invasive Plant Working Group has been using the Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands to evaluate and document the ecological impact, invasive potential, and extent of invasion of a given plant. The process from developing the Criteria to evaluating non-native plants and assigning a rank will be presented. In addition, potential outcomes, products, and subsequent projects will be addressed. An example of one product is to use the plant evaluations to produce a state-wide categorized list based on the relative degree of threat to biodiversity and ecosystem functions. This non-regulatory wildlands plant list and supporting documentation will complement the federal and state "noxious weed" lists that primarily address species of agricultural and economic concern.

Biological control of Cape ivy: Coming soon? **Balciunas, Joe** Exotic & Invasive Weed Research Unit; USDA-ARS Western Regional Research Center <joe@pw.usda.gov>

Cape ivy (also called German ivy) is a vine from South Africa, widely used as an ornamental, that has become weed in California, Hawaii, and at least a half-dozen other countries. In 1998, USDA's Agricultural Research Service, established a project in South Africa, the native home of this vine, to locate potential biological control agents that might be released in California to control to this pest. In South Africa, Cape ivy has many natural enemies that seem to tame its aggressive nature. Since 2001, we and ARS cooperators in South Africa have jointly been evaluating the host-specificity of three of the most promising insect species that attack Cape ivy. We have ruled out one, but the other two, a gall fly and a tiny moth whose caterpillars mine the leaves and bore into stems, appear to restrict their attack to only Cape ivy, while refusing to feed or develop on any of its relatives. Despite the recent funding problems, our tests of the latter two insect species are nearing completion. We anticipate seeking regulatory approval for release of these insects by the end of 2004, but securing the required approvals and permits will take at least an year after that.

*Finding effective herbicide treatments for fennel (*Foeniculum vulgare*).* **Bell, CarlE.[1], Kari Roesch[2],** and **Harry Smead[2]** [1]University of California Cooperative Extension, San Diego [2]Tierra Data Inc., Escondido

Fennel is an introduced perennial weed that infests a variety of low elevation habitats throughout California. It is on the Cal-IPC A-1 List and is particularly extensive on Marine Corps Base Camp Pendleton in San Diego County where this study is being conducted. The experimental objectives are to find effective rates of two commonly used herbicides: glyphosate and triclopyr, either singly or in combination, that also minimize damage to other plant species. In February of 2004 we treated small regrowing fennel plants, approximately 20-30 cm high that had been burned in the wildfires of October 2003. Treatments were applied as broadcast applications over the entire plot. In addition, each of the herbicides was applied as a spot spray to just the fennel to reduce effects on other plant species. The experiment was arranged as a completely randomized design with four replications. Broadcast treatments were applied with a CO2 pressurized sprayer while spot spraying used a hand pumped backpack sprayer. Both herbicides controlled fennel well at the application rates used in this experiment.

Status of Puccinea jacea var. solstitialis in 2004 for biological control of yellow starthistle in California.

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The California Department of Food and Agriculture's Biological Control Program, in a cooperative arrangement with the United States Department of Agriculture and The California Agriculture Commisioners and Sealers Association, has a long-term effort to achieve biological control of yellow starthistle through the introduction of the plant's natural enemies into California. Previously, the effort has focused on five species of insects all collected from yellow starthistle in its native range, the Mediterranean. The insects were all extensively tested to ensure that they were safe to our native and agricultural plant species, then imported to California, field released and widely spread throughout the yellow starthistle range in California. The

current group of insects destroys seeds or seed producing structures. Ongoing studies show that the insects destroy a large proportion of each year's seed production, however, the amount is not quite enough to control yellow starthistle. Additional biological control agents are needed.

The rust fungus, *Puccinia jaceae* var. *solstitalis*, a natural pathogen of yellow starthistle in its native range in the Mediteranean area of southern Europe, has now been released in several locations throughout California. The disease it causes, commonly called rust of yellow starthistle, is named for the rust colored pustules of spores produced on infected plants. The rust is an obligate parasite, and can survive only on its living host. Extensive greenhouse testing has shown that the rust is highly specific to yellow starthistle, and cannot infect the nearly 100 species of crop and native plants that were tested. Host specificity testing in the laboratory, as well as field observations in its native range, indicate that infection by this disease will be limited to yellow starthistle. The rust fungus was approved by USDA-APHIS for release in North America in 2003 and its first release was on a private ranch in Napa County. In 2004, releases of the rust occurred in 25 locations in 20 counties statewide. Hopefully, the rust will compliment the impact of the seed feeding insects and result in substantial control of yellow starthistle.

Reducing the introduction and distribution of non-native aquatic invasive species through outreach and education (RIDNIS Project). **Crosson, Holly A.** and **Dr. Edwin D. Grosholz** Department of Environmental Science and Policy, University of California Davis <hacrosson@ucdavis.edu>

One of the greatest threats to the San Francisco Bay - Sacramento/San Joaquin Delta (Bay-Delta) is the invasion of non-native aquatic invasive species (NIS). Introduction pathways include release of NIS through ballast water, the dumping of aquarium contents and live seafood or bait, and escapes from ornamental ponds, among others. NIS can significantly disrupt the balance of ecosystems by altering biogeochemical cycles and consuming or competing with native plants and animals, including threatened and endangered species. NIS can threaten commercial, industrial, recreational and agricultural activities by disrupting fisheries and agricultural production; clogging waterways, flood control/irrigation channels and intake pipes; and rendering water-based recreational activities such as swimming, boating and fishing, difficult or nearly impossible. NIS can also harbor parasites and diseases that can be disastrous to both native species and human health.

The most effective strategy for minimizing costs and maximizing ecosystem health is to prevent NIS introductions from occurring, rather than managing them after they have become widespread in an area. The goals of the RIDNIS Project are to: 1) educate industry representatives involved in the importation, cultivation, sale, and distribution of live aquatic plants and animals (aquarium/pet, live seafood/bait, and aquatic nursery/landscape trades) about the costs and consequences of unwanted NIS introductions, and to work with them to develop spread prevention strategies and guidelines, and 2) educate the public about the risks posed by NIS if they are released into the aquatic environment, and to encourage them to dispose of the unwanted plants and animals in their aquariums, bait buckets and water gardens responsibly.

RIDNIS Project tasks to be completed during 2004 and 2005 include: 1) holding cooperative workshops to develop industry Best Practices or Codes of Conduct, 2) developing educational materials (brochures, posters) in English, Spanish and Chinese, 3) publishing articles on aquatic invasive species in industry trade magazines, 4) creating a video/public service announcements for cable television, and 5) maintaining a project website.

The Cal-IPC Weed Mapping Committee's Statewide Weed Data Coordination Project
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This poster introduces the Cal-IPC Weed Mapping Committee and calls for existing data on Tamarisk and Arundo donax. The Cal-IPC Weed Mapping Committee is dedicated to the coordination of geographic data on weed invasions in California and assisting weed mappers in the work of collecting, managing, and sharing their data. Its goals include: * Online statewide maps of the known locations of the worst weeds of California, * Live inventories of programs conducting weed mapping and the data they are willing to share, and * A clearinghouse of tools and methods used by weed mapping efforts in California and elsewhere. The Cal-IPC Weed Mapping Committee and its projects may be found on the Cal-IPC website under Projects. The website features links to the CalWeedMapping listserv, data for download, and database and mapping tools that can be accessed.

Ecohelpers: Education and ecological restoration in Southern California.
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Solstice Canyon is a riparian habitat near Malibu, in Santa Monica Mountains National Recreation Area. Solstice Creek provides water year-round for the diverse plant and animal life found in the canyon. This site comprises only 0.3% of the land area in the Santa Monica Mountains, but contains 23% of the native plant species found in the mountains. This diversity is threatened due to invasion of many non-native plants, caused by human and grazing animal impacts over the past two centuries.

The main weeds in Solstice Canyon are *Euphorbia terracina* (Geraldton's carnation spurge), *Brassica nigra* (black mustard), *Ricinus communis* (castor bean) and *Foeniculum vulgare* (sweet fennel). *Euphorbia* in particular has displaced native species and created monocultures in many areas of the Canyon.

The Ecohelpers program of the National Park Service helps to combat the weed problem through the cooperative efforts of a program coordinator, volunteers, NPS rangers, and high school science students. Field trips offer an educational lesson, interpretive hike, and planting and weeding stations. This school year, 1700 students weeded over 25,000ft^2 and planted 3109 natives during 2000 labor-hours. NPS staff and volunteers support the program through continued maintenance.

Although Ecohelpers has been funded through a number of different grants, continued funding is a challenge. Here we discuss the methods, results, and particular successes and challenges of this restoration program.

The effect of soil salinity and flooding on the growth Carpobrotus edulis *(L.) N.B. Br.: Implications for its spread into the Ballona Wetlands.*
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In the Ballona Wetlands of Los Angeles, *Carpobrotus edulis* extends into the upper salt grass (*Distichlis spicata*) zone but not the lower pickleweed (*Salicornia virginica*) zone where both soil water content and salinity were significantly higher. To investigate possible physiological limits to growth by salinity and flooding, rooted cuttings of *C. edulis* were subjected to salinity treatments of 0 ‰, 5 ‰, or 35 ‰ NaCl made up in a Hoagland's nutrient solution and used to irrigate freely-draining pots or to permanently flood pots. Plant growth (estimated to date through leaf biomass, dimensions, and number) was

greatest at 5 ‰ NaCl and was significantly reduced across all salinities by flooding. Plants in all flooded treatments exhibited evidence of flooding stress including leaf yellowing and increased stomatal densities. The plants grown in non-flooded conditions had higher leaf water and Na+ contents than flooded plants. Poor growth of C. edulis in flooded conditions possibly limits the spread of this invasive species into the lower reaches of the wetlands.

A watershed approach to giant reed removal:
An economic and environmental win:win for the Russian River. **Heckert, Kara** Sotoyome Resource Conservation District

Arundo donax (giant reed) is an invasive grass that is degrading streamside systems throughout California. The Arundo invasion in the Russian River watershed is in its early stages. The Russian River Team Arundo, which is comprised of Circuit Rider Productions, Inc. (CRP), the Sotoyome Resource Conservation District (SRCD), and the Mendocino County Resource Conservation District (MRCD), is working with private landowners and public agencies to remove giant reed from the Russian River watershed and restore native streamside habitat. The program is characterized by its adaptive approach to removal of an invasive species, and includes many diverse tools and strategies: GIS, research, landowner outreach, community education, monitoring, riparian restoration, permitting, and the collaboration with multiple groups. All removal efforts are voluntary, and are taking place with the leadership and participation of interested landowners. This voluntary program is funded by a variety of public agencies, and covers the costs of permitting, removal and follow-up revegetation. All work is implemented based on the landowner's preferred approach to removal. The Russian River Team Arundo is taking an efficient, common sense approach to giant reed removal – because the plant spreads only in a downstream direction, we are focusing first on the upstream reaches of the watershed, including the mainstem of the Russian River in Mendocino County and the tributaries to the Russian River in Sonoma County.

Floodplain invasion: Tracking pepperweed expansion in the Cosumnes River. **Hogle, I.H., J.H. Viers, J.F. Quinn, M.W. Schwartz** Information Center for the Environment, UC Davis <ibhogle@mindspring.com>

Measuring success of restoration efforts is a challenge for land managers, especially when determining what level of weed control will be considered a "success." Models of weed range expansion can guide management effort priorities and offer a null model of infestation rates against which to compare weed control results. By developing models of weed population growth, with and without active control methods, empirical measures of control and success can be set to reflect realistic, expected outcomes of future management scenarios.

We tracked population densities of established *Lepidium latifolium* patches on a restored floodplain at the Cosumnes River Preserve over three years. From these data, we are able to model intrinsic population trajectories at this site and the effects of extrinsic factors on these trajectories. Integration of population monitoring in a GIS framework allowed characterization of spatial patterns of dispersal, analysis of the importance of various potential vector sources (roads, levee breaches, existing populations) and assessment of expected dispersal distances. Other factors evaluated for their potential impact on *L. latifolium* growth rates include over-story shading and degree of flood inundation.

Our modeling results, in turn, inform the experimental design of an adaptive management program. We are blocking our sampling sites for future control efforts by

significant extrinsic factors that affect *L. latifolium* population dynamics. We will then be able to evaluate the effects of our control methods against modeled populations trajectories and help guide future management of *L. latifolium* invasions.

A gardener's dream, a land manager's nightmare: The spread of horticultural invasive plants into the wildlands of Santa Catalina Island. **Knapp, John** Santa Catalina Island Conservancy <jknapp@catalinaconservancy.org>

Sixty-two of 240 non-native plants are known to have been planted for landscaping on Catalina Island for over the last 150 years, and while some have remained in their garden bed, 31 species have found freedom invading the wildlands of Catalina Island. In 2003, the Santa Catalina Island Conservancy (Conservancy), which owns and manages 88% of the Island, developed an Invasive Plant Ranking Plan which entailed mapping 35,000 populations of 76 invasive plant species over 600 miles of transects. This data enabled them to prioritize each species for control and to build a solid foundation from which to develop a management program. The following species are known to have a horticultural origin, and were ranked as either Medium or High for control utilizing a modified Cal-IPC Plant Assessment Form: *Asparagus asparagoides*—High, *Cortaderia selloana*—Medium, *Cynodon dactylon*—Medium, *Delairea odorata*—High, *Ficus carica*—Medium, *Genista linifolia*—High, *Genista monspessulana*—High, *Pennisetum clandestinum*—Medium, *Pittosporum undulatum*—High, *Senna didymobotrya*—Medium, and *Vinca major*—High. All species were assessed for location, primary and secondary community types invaded, population size and cover. The present distribution and abundance of five of the eleven species were compared with the dates of introductions recorded in two floras, published in 1923 and 1967. Six species were not listed in either flora, including one that had never been documented before on Catalina Island. The level of invasiveness of the five species documented in the floras was estimated by comparing the first record of naturalization to their present distribution and abundance.

Seed and seedbank dynamics of the highly invasive weed yellow starthistle. **Lortie, C.J.[1], J. Hierro[2],** and **D. Villarreal[3]** [1]University of Nevada Reno <lortie@cabnr.unr.edu> [2]Division of Biological Sciences, The University of Montana, Missoula <jhierro@selway.umt.edu> [3]Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa, Argentina <dvillarreal@exactas.unlpam.edu.ar>

In a recent report by The Royal Society, 'Measuring biodiversity for conservation', unprecedented rates of introduction of non-native species and change in global climate are identified as two key processes impacting natural ecosystems primarily through loss of biodiversity. Every ecosystem worldwide is now subject to both processes, often simultaneously, and the success of native and invasive plant species is highly context dependent. To this end, it is crucial that we begin to address various ecological aspects of invasion in the context of variation between geographical regions. For instance, why is it that an introduced species is successful in one region and not another? More importantly, why is it that the same species is often not dominant in its place of origin? Yellow starthistle (Yst) is a highly successful invader in many regions including California and Argentina. The success of Yst is likely influenced by a suite of factors, yet seedbank dynamics, one of the least studied aspects of invasion ecology may be the key to understanding invasion dynamics for this species. An explicitly biogeographical approach was used to (i) compare properties of the local seed banks being invaded; (ii) compare ecological attributes of Yst seeds and plants in each

region; and (iii) experimentally test for seed-seed interactions. Seeds and seedbank from within its home range (the Republic of Georgia) were also tested. There was significant variation between Yst plant density and seed density between regions with California having the highest density of both seeds and plants. Interestingly, California also had the most diverse and dense local seedbanks yet was the most invaded by Yst. There was no significant relationship between the persistent seedbank of Yst and its emergent plant density which suggests that seedbank dynamics are decoupled from plant community interactions. Finally, in experimental tests for seed-seed interactions, Yst germination and establishment functioned in a density dependent manner which suggests there may negative interactions with other Yst seeds and plants but that these effects do not translate into reduced dominance within natural plant communities.

Behavioral responses of birds to invasive Spartina *in San Francisco Bay salt marshes.* **Nordby, J. Cully[1], Andrew N. Cohen[2],** and **Steven R. Beissinger[11]** Department of Environmental Science Policy and Management, UC Berkeley, [2] San Francisco Estuary Institute, Oakland

The invasion of an Atlantic cordgrass (*Spartina alterniflora*) into Pacific salt marshes provides an ideal model system in which to investigate ecosystem-wide ramifications of exotic invasions and how animals respond to these changes in their environment. The profound changes in habitat structure and composition that accompany the *S. alterniflora* invasion will likely have the greatest impact on species, such as birds, that are wholly dependent on the tidal salt marsh system. Alameda song sparrows (*Melospiza melodia pusillula*), a California Species of Special Concern, reside entirely within the salt marshes in the south portion of San Francisco Bay. These sparrows are affected not only by the *S. alterniflora* invasion directly, but also indirectly by new competitive interactions with marsh wrens (*Cistothorus palustris*) who are occupying the newly available habitat. In this study, we examined how the cordgrass invasion affected nesting habitat preferences, reproductive success, and breeding territory distribution of song sparrows. We also examined the breeding territory distribution of marsh wrens, territory overlap between the two species, and destruction of sparrow eggs by wrens. These measures are compared among three separate sites with varying degrees of invasion. Results from the first two years of this study suggest that invasive *Spartina* may be negatively impacting song sparrow populations.

Identifying origins and tracing spread of pampasgrass and jubatagrass in California by microsatellite markers. **Okada, Miki[1], Riaz Ahmad[2],** and **Marie Jasieniuk[3]**
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Pampasgrass, *Cortaderia selloana*, and jubatagrass, *C. jubata*, are native to South America but have become highly aggressive invaders of wildlands in California. Pampasgrass was first introduced into the state by the horticultural trade in the mid 1800's, and continues to be sold as a landscape ornamental. It was also used in forage trials and for erosion control in the 1940’s and 1950’s. Jubatagrass was introduced in the late 1800’s, probably as a horticultural contaminant. Since the 1950’s, both pampasgrass and jubatagrass have expanded spatially displacing native species and disrupting natural habitats. Heavy infestations of pampasgrass are found in coastal and inland areas of southern and northern California and jubatagrass in central to northern California. To identify the origins of recent invasions and trace the spread of pampasgrass and jubatagrass in

California, we sampled wild populations of both species, as well as ornamental plantings and cultivars of pampasgrass. We then used nuclear microsatellites to assess patterns of genetic variation and trace the spread of pampasgrass and jubatagrass in California.

*Control of tree tobacco (*Nicotiana glauca*).* **Oneto, Scott, Joseph M. DiTomaso, Guy B. Kyser, Sergio Garcia, and Sarah Hale** UC Davis, Cooperative Extension <sroneto@ucdavis.edu>

Tree tobacco is a native of Argentina. It is a slender, erect, 6-20 foot high shrub or small tree found in sandy or gravelly soils along riparian areas, roadsides, near cultivated areas, around old dwellings and ditch banks. It is a common weed throughout much of the southwest and is steadily expanding its range. During early October 2003 several herbicide application techniques were tested for its control in San Benito County, California. Treatments were made shortly before *Nicotiana* leaf drop. Herbicides tested included Chopper® (imazapyr), Garlon 4® (triclopyr ester), and Roundup Max® (glyphosate). Application methods included foliar, drizzle, cut stump and basal bark. Each treatment was replicated 10 times in a randomized block design with an individual trees serving as a replicate. A preliminary evaluation was performed in May 2004. Early results indicate that Roundup Max® appears to control tree tobacco either as a foliar spray, drizzle, or cut stump application. Chopper® also showed excellent control with all rates tested and application techniques employed. For Garlon 4®, only the basal bark and cut stump treatments provided excellent control. Trees will be re-evaluated in 2005 to confirm the effectiveness of the treatments. To determine if timing of application is significant to herbicide effectiveness, the trial was replicated in spring 2004 and will be evaluated this fall.

*Control of hedge parsley (*Torilis arvensis*).* **Oneto, Scott, Joseph M. DiTomaso,** and **Guy B. Kyser** UC Davis, Cooperative Extension <sroneto@ucdavis.edu>

Hedge parsley or beggar's tick is an upright annual weed that grows 6-18 inches tall. The white flowers are found in compound umbels 1/2 to 1 inch wide and the seed heads have coarse bristles with hooks. It flowers from April through July on most soil types and is a growing concern in many rangelands and natural ecosystems. In March 2004, we treated hedge parsley with six herbicides [Transline® (clopyralid), Arsenal® (imazapyr), Plateau® (imazapic), Garlon 4® (triclopyr), Roundup Max® (glyphosate), and Telar® (chlorsulfuron)], each at three rates. The trial was conducted in Amador County, California. Plots measured 10' x 20' and each treatment was replicated 4 times in a randomized block design. Treatments were applied using a CO2 backpack sprayer delivering 20 gal/A through four 8002 nozzles at 20 p.s.i. Treatments were evaluated on 3 June 2004. Hedge parsley was completely controlled at all rates of Plateau®, Garlon 4®, Roundup Max®, and Telar®. These four herbicides had different effects on other vegetation in the plots; for example, a native tarweed (*Madia* sp.) showed some tolerance to the Plateau® treatments, but was completely killed by Garlon 4®, Roundup Max®, and Telar® applications. Arsenal® gave partial control of hedge parsley and Transline® failed to effectively control hedge parsley even at the highest rates.

Distribution of perennial pepperweed in Bay-Delta wetlands: a CalFed Mapping Project. **Rogers, Chris** Environmental Science Associates <crogers@esassoc.com>

Under the CALFED Ecosystem Restoration Program, Environmental Science Associates (ESA) is undertaking a three-year study of the distribution of perennial

pepperweed (*Lepidium latifolium*), an aggressive invasive plant species in the San Francisco Bay-Delta. The study will include extensive region-wide inventory of the species, and development of GIS mapping and database. New field data and existing publicly-available information will be incorporated to create a spatial model of invaded habitats. The model will be a valuable asset to continuing monitoring of invaded habitats, and will provide a predictive tool to identify habitats at risk of invasion.

The study will develop a more current and complete understanding of perennial pepperweed distribution, invasion trends, habitats or areas at risk and ecological characteristics. This information will lead to developing better strategies for control, as well as anticipating and responding to invasions of restoration sites. This study will update documentation of current distribution of perennial pepperweed within the Bay-Delta region, and will identify conditions that place existing and restored habitats at greatest risk of invasion through a GIS-based analysis of extensive primary (field) and secondary data sources.

The proposed project will help CALFED meet key milestones for its Multi-Species Conservation Strategy and Ecosystem Restoration Program goals and objectives for At-Risk species and implement non-native species management. CALFED is a coalition of local, state, and federal agencies and other stakeholders organized to develop a long-term plan to restore the health of the San Francisco Bay/Sacramento-San Joaquin Delta estuary ecosystem, improve water supply and water quality, and improve levee stability.

Effects of Arundo *removal methods on revegetation: A conservation field trial.* **Rose, Peggy** and **Noreen Cabanting** Ventura County Resource Conservation District <prose_vcrcd@prodigy.net>

Ventura County Resource Conservation District, in conjunction with the Ventura County Watershed Protection District and the Ventura County Arundo Task Force have undertaken an *Arundo* Removal Demonstration Project in the Ventura River Watershed. Construction began in September, 2004. Once the removal is complete and a full season of retreatment has occurred, the USDA Natural Resources Conservation Service (NRCS) will begin a Conservation Field Trial on the same site. The goal of the Field Trial is to test the effects of the different removal methods on the revegetation efforts that may follow a removal project. Native species prevalent in the project area will be used for the revegetation. The Field Trial will be irrigated the first three years after planting to minimize the climatic and groundwater variables. Continued monitoring and evaluation will continue after the initial three year period.

*Invasive hybrid cordgrass (*Spartina alterniflora *x* S. foliosa*) recruitment dynamics in open mudflats of San Francisco Bay*. **Sloop, Christina M., Debra R. Ayres,** and **Donald R. Strong** University of California, Davis <cmsloop@ucdavis.edu>

Hybrid *Spartina* are currently expanding their range in the San Francisco Bay (SFB) at a rate exceeding exponential growth. A subset of transgressive hybrid *Spartina* plants that positively exceed the fitness trait values of their parents are competitively and reproductively superior to both parents and other hybrids and likely drive the invasion. In order to colonize the vast open SFB mudflats and found new populations hybrid cordgrass plants have to evolve self-compatibility and exhibit fast vegetative and rapid lateral growth. The mudflat tidal cycle covers or exposes plants for up to six hours, so new seedlings have to be robust and fast growing to survive and establish. A small number of hybrid and native *Spartina* have colonized the open mudflats along the

eastern shore of SFB. To discern mudflat seedling recruitment dynamics we investigated (1) the numbers and locations of recruiting seedlings at three SFB sites in 2003 and 2004 via GPS/GIS, and (2) the relationship of all established adult plants and parentage of seedlings using microsatellite markers. Our results identify all sampled seedlings as hybrids, and show a dramatic increase in seedling recruitment numbers in 2004. Molecular investigations reveal3-4 distinct family groups with inter-related adult clones as sires for most seedlings. Seedling recruitment is spatially heterogeneous, and in some cases in direct proximity to adult clones. Isolated plants on the outer edge of the mudflat produced more self-fertilized seedlings than more aggregated plants. These results give support to transgressive hybrid plants as the drivers of the invasion.

Funding urban projects. **Vona, Andrea** and **Dan Ryan** Palos Verdes Peninsula Land Conservancy <avona@pvplc.org>

White Point Nature Preserve is a 100-acre parcel of coastal open space in the City of Los Angeles dedicated as nature preserve in 2000. The funding matrix in support of this preserve was developed to control exotic plant species, restore 90 acres of coastal sage scrub habitat, and create land use improvements for the enjoyment of all visitors. This project is a work-in-progress, developed as a partnership between the City of Los Angeles, which owns the land, and the Palos Verdes Peninsula Land Conservancy (PVPLC), which has entered into a contractual management agreement to administer the project, and the local community, which has been integrated into the development and management process through the instrument of the White Point Steering Committee (WPSC). The myriad of funding for White Point Nature Preserve has been a product of master planning, volunteer support, and governmental support. Various strategies and collaborative efforts have been largely successful in achieving the goal of the PVPLC and of the surrounding community, in which it operates. This poster will depict the collaborative process of funding acquisition for this critical urban project.

English ivy removal at Redwood National and State Parks. **Williams, Andrea** National Park Service, Redwood National and State Parks <andrea_williams@nps.gov>

In 2000, Redwood National and State Parks was awarded a grant from Natural Resources Preservation Program (NRPP) in support of a three-year project to remove English ivy (*Hedera helix*) and other shade-tolerant exotics from the northern portion of the parks.

By the end of 2003, 100 acres of old-growth redwood forest and adjacent habitats were cleared of English ivy, cotoneaster, and English holly. Of these, approximately 85 acres were revisited for resprout removal one or more times. These forest habitats are well on their way toward recovery and restoration to a native-dominated understory.

A three-step process is recommended for other projects, based on this project's success. First, know your infestations: where, how big, and how heavy are they? Are any of them reproductive? Second, set your priorities: sever fruiting aerial vines from the ground to cut off reproduction, and begin removal at the lightest infestations in the most intact areas. Third, take small "bites" at the edge of an infestation and move toward the center. Move to another edge so the cleared area can recover. Then return to pick resprouts in a few months' time. Late winter/early spring removal yields the fastest native species recovery.

A total of 24,135 person-hours were spent in the field pulling exotics; the total budget for this project was $405,136. The National Park Service, California State Parks, California Conservation Corps, California Department of Corrections, and California

Department of Forestry and Fire Protection all contributed to the effort.

2003 Invasive Spartina *Project Monitoring Program*. **Zaremba, K.[1], M. McGowan[2],** and **D.R. Ayres[3]**
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The 2003 Invasive *Spartina* Project Monitoring Program was designed to provide (1) updated information on new-found populations of non-native *Spartina* in the Estuary; (2) information on the extent of spread since 2000-1; (3) a review of current field and aerial photo interpretation mapping and monitoring methods; and (4) determination of control efficacy at sites treated in 2002-3. Change in area of non-native *Spartina* was mapped at a subset of 28 sites stratified across the Estuary by Subregion (latitude) and Site Type (marsh type). The average increase in area between 2001 and 2003 for all species of non-native *Spartina* in the Estuary was 243%. S. alterniflora hybrids were found to be spreading at the greatest rate of 329%. Based on these results, the net acreage of *S. alterniflora* hybrids bay-wide may now be as high as 2,012 acres. The rate of spread greatest near the original introduction sites. We found greatest spread in Site Types I (e.g. tidal marshes or former diked baylands) and Site type II (e.g. mudflats) and less rapid in Site Types III e.g. creeks and sloughs and Site Types IV (e.g. urbanized marsh). *S. densiflora* spread only increased 25%. The field measurements were on average 170% higher than the aerial photo interpretation measurements. Genetic testing found no new invasion sites. Treatment site monitoring indicated that manual methods of *Spartina* control – digging or covering with geo-textile fabric – were effective at removing or killing the smaller populations of *Spartina* species.

2004 Cal-IPC Red Alert! New Invasions, Recent Expansions, and a Few Others to be on the Look-Out For....

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Weed Alerts represent potentially new species not previously reported to be invasive in California or species that have been here, but are now either expanding their range at a more rapid rate or moving into new areas of the state. It is critical that Cal-IPC members report potentially significant invasions of plants new to an area. Not only does this provide the society with an initial time frame for the invasion, but also alerts land managers in other regions of the state to the potential threat. Furthermore, rapid action on a new invader can potentially save millions of dollars with preventative control.

New reports should be made to the main office of Cal-IPC. This information will then be transferred to the individual presenting the New Alerts talk at the following symposium. The visual presentation of the talk will be included on the Cal-IPC website (cal-ipc.org) for future reference.

The 2004 red alerts include *Nassella tenuissima*, *Passiflora tarminiana, Dittrichia graveolens, Carthamus lanatus*, and *Asphodelus fistulosus*.

Needlegrass or Mexican feathergrass [*Nassella tenuissima* (=*Stipa tenuissima*)]. *Nassella tenuissima* is a fine textured clumping perennial grass native from Texas to New Mexico south through Central America to Chile. It is considered drought resistant and cold hardy. As a result, it has been widely planted throughout California as a landscape ornamental. Employees of various botanical gardens have anecdotally indicated that the plant quickly spreads within their gardens. They have predicted that it has the potential to move into wildland areas, although there are no reports of this yet in California. It has, however, escaped cultivation in urban environments in both Arizona and California and was placed on the California Department of Food and Agriculture (CDFA) Q-list in January 2004. This designation can give CDFA the authority to rapidly respond to control or eradication efforts without going through the long process of listing a plant on the A-list. Outside the United States, *Nassella tenuissima* has invaded Australia and New Zealand. A similar species, nassella tussock (*Nassella trichotoma*) has destroyed many hectares of good quality pasture, particular in New Zealand. The Auckland Regional Council considers *Nassella tenuissima* to have the same potential to invade pastures and has prohibited the sale, propagation and distribution of the plant. In California, this species should be watched carefully and any reports of its establishment in wildlands should be reported immediately.

Banana poka [*Passiflora tarminiana* (=*P. mollissima*)]. *Passiflora tarminiana* is a tropical vine in the Passifloraceae with a similar growth pattern as kudzu (*Pueraria lobata*). It is an aggressive climbing plant that can overtop other vegetation, including shrubs and trees, thereby blocking light penetration into the canopy. The pink flowers are large (>10 cm long). The fruit droops when mature

and somewhat resembles a solitary banana (hence the common name banana poka). The plant is well recognized as invasive in New Zealand and Hawaii. In these areas it has severely impacted the structure of forests and shaded out overstory trees. In California, this plant is occasionally grown as an ornamental. It was first discovered as an escape by Dr. Marcel Rejmanek (UC Davis) in California in 2003. He reported an infestation in about one hectare of coast woodland near the parking lot of Julia Pfeiffer Burns State Park in Monterey County. More recently, in 2004, another infestation of what appears to be a different species was discovered at the Mission Trails Park in Carmel. This species or relative may be a hybrid of *Passiflora tarminiana* and another ornamental *Passiflora*. It has a similar flower and fruit shape, but the flower is considerably redder with a more obvious crown above the throat. Currently, these species seem to be escaping from backyards between Santa Cruz to Monterey counties.

Stinkwort (*Dittrichia graveolens*). *Dittrichia graveolens* is native to the Mediterranean region and was first reported as a weed in California in 1995. It has also been reported as an invasive species in Australia. In 1995, the only reports were in Santa Clara County, but since this time it is spreading rapidly along highways and now can be found in many counties in both central and southern California, including Yolo, Alameda, Contra Costa, Solano, and San Diego counties. It is an erect, fall-flowering, aromatic annual to about 0.7 m tall, with sticky glandular-hairy foliage and flowerheads that consist of short yellow ray flowers and yellow to reddish disk flowers. The seeds are wind dispersed and can stick to hair, feathers, vehicles and equipment. Stinkwort is in the Asteraceae and closely resembles plants in the tarweed group (*Holocarpha, Hemizonia*), but from a distance can resemble Russian thistle. Stinkwort is not included in most California floras. It inhabits disturbed places, roadsides, pastures, fields, riparian woodlands, levees, washes, and margins of tidal marshes. It is considered unpalatable to livestock. Stinkwort can form dense infestations in disturbed sites and along highways. It is not known yet whether it will spread to undisturbed wildland and rangeland areas, but based on its invasion pattern in Australia, it is likely that it will over time.

Woolly distaff thistle (*Carthamus lanatus*). Woolly distaff thistle is native to the Mediterranean region. It is an erect winter annual with rigid stems and spiny leaves. Distaff thistles are very competitive with cereal crops and desirable rangeland species, and dense populations can develop. In addition, the spiny foliage and flowerheads can injure the eyes and mouths of livestock and wildlife grazing in distaff thistle infested areas. It is a CDFA B-listed noxious weed in California. Although Cal-IPC did not list woolly distaff thistle on the 1999 Plants of Greatest Ecological Concern list, it will undoubtedly be listed in the new revision scheduled to be in print in 2005 or 2006. In addition to being a problem in California, it is a government-listed noxious weed in some southern regions of Australia and has also been reported to be invasive in Texas and Oklahoma. In California, populations are rapidly expanding along coastal foothills north of San Francisco and more recently the plant appears to be spreading into the coastal regions of southern California, where it has been reported in San Luis Obispo County and probably elsewhere.

Onionweed (*Asphodelus fistulosus*). Onionweed is a short-lived perennial in the lily family. Plants have thick tuber-like stem bases, slender grass-like leaves that lack an onion or garlic scent when crushed, and openly branched flower stems. It is native to southern Europe and has escaped cultivation as an ornamental. In pastures and on rangeland, onionweed is avoided by livestock and can develop dense populations that exclude grasses and other desirable forage species. Oniongrass is a federally listed noxious weed and is also invasive in New Mexico and Texas. It is also a

government-listed noxious weed in Australia, where it is most problematic on pastureland in the southern areas. In the 1999 Cal-IPC Plants of Greatest Ecological Concern list, onionweed was listed under the category of "Needs More Information." However, since then it has spread over a greater area of southern California, particularly in coast bluffs and sandy area and is likely to receive a more serious listing in the new revision of the list.

Correction to Past Proceedings

CORRECTION to paragraphs 3.3 and 3.4 from: Neill, B. and J. Giessow, 2001, Distributions of Arundo Donax in Coastal Watersheds of Southern California. In, M. Kelly, (ed.). Proceedings of the California Exotic Pest Plant Council Symposium. Vol. 6: 2000-2002. pp. 77-85.

3.3 San Francisquito Creek: *Arundo* was introduced along the Los Angeles Aqueduct right-of-way with highest -- in elevation -- but not densest occurrences at Power Plant No. 1. Angeles National Forest started a removal program in 1995, employing Pestmaster Services (Bishop) to operate a tractor-size hammer-flail mower. The program was expanded in 1999 to include Los Angeles Dept. Water & Power property. During 2000-2001, Pestmaster Services mowed and treated *Arundo* along the lowest 2.5 miles of San Francisquito Creek as a mitigation project for Valencia Co. bridge construction and bank stabilization.

3.4 Soledad Canyon: The riparian corridor is free of *Arundo* through Acton and downstream for a distance of 7 miles, although *Arundo* is present in some of Acton's residential yards. In Soledad Canyon the primary introduction site is a rural residence next to the stream channel, 1 mile west of the conservation camp. Below the introduction site, Angeles National Forest hired Pestmaster Services to clear a one-mile length of the channel starting in 1995.

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