2016

NEWORLEANS

14th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles

Joint Annual Meeting of the Turtle Survival Alliance and IUCN Tortoise & Freshwater Turtle Specialist Group

Program and Abstracts

August 1 — 4, 2016
New Orleans, Louisiana

This year's Symposium is made possible by . . .

Title Sponsor

Additional Conference Support Generously Provided by:
Kristin Berry, Tonya Bryson, John Iverson, Robert Krause, Anders Rhodin, Stuart Salinger, Brett and Nancy Stearns, and Reid Taylor

Sound Science. Creative Solutions.®

Celebrating the Wonders of Nature

Funding for the 2016 Behler Turtle Conservation Award generously provided by:
Brett and Nancy Stearns, Chelonian Research Foundation, Deb Behler, George Meyer, IUCN Tortoise and Freshwater Turtle Specialist Group, Leigh Ann and Matt Frankel, and Turtle Survival Alliance

Turtle Survival Alliance
2016 Conference Highlights

TSA PROJECTS

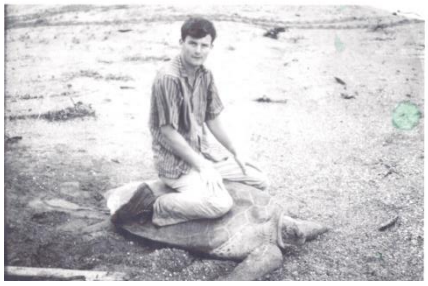
Confiscated endangered Malagasy tortoises were flown from Mumbai back to Madagascar in April with the support of a network of conservation organizations led by the Turtle Survival Alliance.

Along with the Asian Box Turtles of the genus Cuora, Batagur represent the TSA's most urgent conservation priority in Asia. The TSA now manages or supports programs for all six species of Batagur throughout south Asia.

It's been a busy breeding season at the Turtle Survival Center, highlighted by the hatching of three species never before bred at the TSC: Home's Hinge-back Tortoise (*Kinixys homeana*), Forest Hingeback Tortoise (*Kinixys erosa*, shown), and Sulawesi Tortoise (*Indotestudo forstenii*).

The TSA has always been an alliance, a melding of all people and groups with one common thread, turtles and tortoises. This year, we are inviting our friends and collaborators, to present on who they are, what they do, and any significant events in the past year.

Honoring Peter Pritchard



Words cannot begin to describe Peter. He is a true Renaissance man, an impeccable scholar, conservationist, a pioneer, and immersion traveler in the truest sense of the word. His friends range from the Turtle World's greats to those whose careers are just beginning. Please join us in honoring Peter on Monday, August 2nd during the afternoon session.

NEW ORLEANS

We hope everyone enjoys the festivities that this year's venue provides. Special thanks to the Aquarium of the Americas for helping us kick-off the festivities and the Audubon Zoo for helping us wrap up the celebration!

Audubon Nature Institute
Celebrating the Wonders of Nature

Table of Contents

From the Program Co-Chairs: WELCOME TO THE BIG EASY!

Many participants of this conference have requested we try a different venue from our regular Orlando-St.Louis-Tucson circuit. After much discussion it was decided that New Orleans would be equally hot in August to our past venues and we should give it a try. No heat has yet been able to squash our ability to have a great time at "the Turtle Conference." We are pleased to welcome you to New Orleans and The 14th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles at the Astor Crowne Plaza in New Orleans, LA. We are excited to see many of our old friends, and many new soon to be friends at the largest gathering of turtle biologists, zookeepers, husbandrists, and enthusiasts, anywhere in the world! While this is the 14th Annual Symposium, for many of the core group it represents our 10th Anniversary. In 2006, our good friend Chuck Shaffer guided the conference to new heights and put this gathering on the conference circuit for everyone studying chelonians. Since that St. Louis meeting in 2006, this has been THE conference to attend if you are serious about turtles and tortoises. Coincidentally, at that same meeting we celebrated Peter Pritchard and the release of the Alligator Snapping Turtle book, and this year we will be celebrating Peter and the Chelonian Research Institute. We look forward to a great series of talks, posters, and comraderie at the Joint Annual Meetings of the Turtle Survival Alliance and the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group.

We repeat this sentiment every year, but the growth and maturity of the TSA and this symposium is the result of continued student participation every year. Many of us first attended TSA symposia as students (in 2006!) and now we continue to support this group as working professionals. We truly hope to facilitate and encourage this level of continuity, which we do in part through Travel Grants and Student Presentation Awards. The generosity of our sponsors make Travel Grants a possibility, as well as our social events, so please take the time to visit the sponsor booths, buy their products, or just say thanks. The Student Presentation Awards are made possible through generous donations from Anders Rhodin and the Chelonian Research Foundation.

Trust us when we tell you that this year's program is as strong as ever. We have changed our traditional day 1 schedule a bit to highlight important functions and people within the TSA. Instead of the usual TSA Country reports in the morning, we are continuing to build capacity and cooperation by opening the floor to all of our friends and collegues who are working with other Turtle Groups. They will share with us who they are, what they do, and share any significant accomplishments. Later that day, as mentioned previously, we will be honoring Peter Pritchard and the Chelonian Research Institute. It is going to be a jam packed day, but should prove to be very entertaining. These important session are followed by additional sessions on Zoos and Chelonians, Diamondback Terrapins, Reproductive Ecology, Captive Husbandry, Turtles of Springs, Conservation and Policy in North American Chelonians, and Conservation Programs. There is also a session on Genetics highlighting two new species of chelonians. The symposium is bookended by two wonderful off-site events with the icebreaker at the Aquarium of the Americas, and the banquet and awards ceremony at the Audubon Zoo. We are certain you will thoroughly enjoy both of the beautiful venues.

As the "front" people who interact with the presenters, an impression that we "organize" the conference is created. Nothing could be further from the truth. This year Rick Hudson stepped in to help find the conference hotel as our normal hotel hunter Lonnie McCaskill was in the process of moving to New York. I think everyone is going to enjoy this venue. Robert Villa and Michael Hance will be running the AV and making sure your presentations run smoothly. Peter Miller will be taking your photos; smile! Nancy Reinert and Rose Tremblay will be here again to help run the hospitality suite and do a million other necessary jobs to keep the conference running smoothly behind the scenes. And, of course, Lonnie McCaskill will be around to help with all sorts of details, logistics, and to answer any of your questions. Ilze Astad, the TSA's Director of Development, will be helping to organize another fabulous silent auction. As many of you have heard, Heather Lowe, who for years has kept us all organized, is moving on to another job at the Fort Worth Zoo. We can't thank her enough for everything she has done for the TSA over the years. Stop by and wish her well, thank her for her service to turtles, it has been remarkable.

If you are interested in volunteering at next year's conference, please come and talk with us. We are always looking for session chairs, student paper and poster judges, Program editors, and additional hands to help behind the scenes. We also welcome your comments and suggestions on ways to make this conference more meaningful and enjoyable.

We look forward to visiting with all of you. On behalf of the Conference Committee and Volunteers:

Welcome! We hope you enjoy the conference!

Or, as they say in these parts: *Laissez les bons temps rouler!*

Andrew Walde and Daren Riedle, Program Co-Chairs

From the Hosts: WELCOME!

On behalf of the Board of Directors of the Turtle Survival Alliance (TSA), and the leadership of the IUCN SSC Tortoise and Freshwater Turtle Specialist Group (TFTSG), we welcome you to the 14th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. We decided to shake things up a bit this years and selected a venue that we knew would be fun and exciting, New Orleans. Famous for its cajun and creole food, party spirit and southern hospitality, the Big Easy offers superb opportunities for socializing and reconnecting with friends and colleagues. We selected the Astor Crowne Plaza Hotel for its promixity to a diversity of bars and restaurants and it is the gateway to the French Quarter.

Our local sponsor this year is the Audubon Institute, who are graciously hosting our two major evening events. The icebreaker will be on Monday, August 1, at the Audubon Aquarium of the Americas, which is a few blocks walk from the Crowne Plaza. The final awards banquet will be Thursday, August 4, at the Audubon Zoo. This will be an exceptional evening, starting with a visit to the Reptile and Amphibian House, followed by dinner in the exclusive Tea Room.

The highlight of this year's conference will be a special tribute to Dr. Peter Pritchard and the Chelonian Research Institute. This promises to be a moving and inspirational experience, as many of Peter and Sibille's long-time friends and collaborators will share their personal stories and memories of the Pritchards and the CRI. Be sure to join us in the Exhibit Hall immediately after, for a reception to honor the turtle community's own living legend, one who has meant so much to so many of us over the years. On Thursday night we wrap up with our Awards Banquet, where the student awards, Turtle Conservation Fund, and Behler Award winners will be announced.

We also offer a special thanks to the organizational skills of our experienced conference team of Heather Lowe and Andrew Walde who juggle and balance a multitude of details in the months leading up to conference. Theirs is a herculean task and we are grateful for their dedication to delivering a high quality conference at a bargain price.

We also pay tribute to our many sponsors, without whose support it would not be possible to provide a meeting of this caliber. Our longtime partner, Zoo Med Laboratories, whose support contributes so much to this event's success, is again the symposium's title sponsor. There are so many other costs associated with this conference - travel grants, coffee breaks, catering, transportation and the all-important hospitality suite. For their generosity we thank Brett and Nancy Stearns, John Iverson, SWCA Environmental Consultants, Mazuri, Kristin Berry, Tonya Bryson, the Desert Tortoise Council, Reid Taylor, Robert Krause, Anders Rhodin, the Chelonian Research Foundation, Stuart Salinger, and the Turtle Conservancy. Awards for the Best Student Presentations will again be presented and supported this year by Anders Rhodin and the Chelonian Research Foundation. And as a reminder please stop by and visit our vendors who have become an integral part of this conference.

We look forward to another great symposium and we thank you for being a part of it. This conference embodies the true spirit in which both the TSA and TFTSG were founded: that saving turtles would require a lot of like-minded people, from many backgrounds and professions, all working in synergy. We have said it before, but it is no less true this year: with the many people from diverse institutions and countries attending, this conference is a true microcosm of the global turtle conservation community, coming together once again to replenish and leverage our enthusiasm, find inspiration, and remind ourselves why we do what we do for turtles and tortoises.

Rick Hudson, TSA President/CEO
Peter Paul van Dijk and Brian D. Horne, Co- Chairs TFTSG

John L Behler Turtle Conservation Award

This year the 11th annual Behler Award for Turtle Conservation celebrates and honors Eric Goode, the founder and leader of Turtle Conservancy, a global conservation organization whose mission is to preserve and protect natural ecosystems, focusing on turtles and tortoises, other wildlife and their habitats, for the benefit of humanity and the Earth's biological diversity. With the initial help and inspiration of his good friend, John Behler, Eric created the Behler Chelonian Conservation Center and retreat in Ojai, California, an AZA-accredited captive-

breeding assurance colony for endangered turtles and tortoises. Eric is also the publisher and co-editor of *The Tortoise* magazine, a high-end conservation publication of the Turtle Conservancy. He also created the Turtle Ball, an annual fundraising event that brings together artists, celebrities, philanthropists, and conservationists for a festive evening that shines a light on the global turtle extinction crisis. Among other accomplishments, Eric and the Turtle Conservancy, in conjunction with other conservation organizations, have recently purchased and established a very large nature preserve in South Africa dedicated to the protection of the Critically Endangered Geometric Tortoise. In addition, he has organized and helped create support for the purchase of a new Sinaloan Nature Preserve for the protection of the Sinaloan Thornscrub Tortoise in Mexico, which was recently named after him (*Gopherus evgoodei*) in recognition of his passion for the smaller forgotten creatures on the planet. Most recently, the Turtle Conservancy has been awarded a large grant by the Leonardo DiCaprio Foundation to secure additional protected habitat for the Endangered Bolson Tortoise in Mexico, a testament to Eric's dedication to habitat protection for endangered tortoises and his amazing personal ability to energize and mobilize support for turtle conservation from previously untapped sources. Eric currently sits on the boards of Chelonian Research Institute and the Turtle Conservation Fund and the advisory council to Rainforest Trust, and is a member of the IUCN Tortoise and Freshwater Turtle Specialist Group.

The TFTSG and TSA are honored to be joined again this year by the Turtle Conservancy and the Turtle Conservation Fund as co-presenters of the prestigious Behler Turtle Conservation Award, bringing together the four turtle organizations most closely tied to John Behler's legacy. This award would not be possible without the following group of dedicated and generous co-sponsors: Global Wildlife Conservation, Conservation International, Turtle Conservancy, IUCN TFTSG, Chelonian Research Foundation, Wildlife Conservation Society, Turtle Conservation Fund, Surprise Spring Foundation, Turtle Survival Alliance, Chelonian Research Institute, George Meyer and Maria Semple, Brett and Nancy Stearns, and Deb Behler.

Congratulations Eric – most highly deserved!

Rick Hudson and Anders G.J. Rhodin,
Co-Chairs, Behler Turtle Conservation Award Committee

T-shirt Design Contest Winner!
Please join us in congratulating **Erin Shamley**. Erin submitted the winning entry in the t-shirt design contest for the 14th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. Be sure to purchase your own Conference t-shirt in the Exhibit Hall as a souvenir – supplies are limited!

Photo Policy
Photographers will be taking pictures at the conference, which may be used for promotional and educational purposes. Registration or participation in the meeting and other activities constitutes an agreement to allow TSA to use and distribute attendees' image or voice in photographs and recordings of the meeting — now and in the future.

If you are presenting…

Presenters, please plan on turning in your talk no later than the day **BEFORE** you present. No exceptions or last minute edits, please. To upload your talk online, please visit **http://bit.ly/TSANewOrleans**. Files should be named as Time_Day_LastName (ex: 1300_Fri_Smith). If that is not possible, talks will be accepted at the **Registration Desk** during the following times:

- August 1 – 3:00 PM – 5:00 PM
- August 2 – 8:00 AM – 4:00 PM
- August 3 – 8:00 AM – 4:30 PM

Contents of this Conference Program should be cited as:

Author. 2016. **Title**. In A.D. Walde, J.D. Riedle, and H. Lowe (Eds.). Program and Abstracts of the Fourteenth Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. Turtle Survival Alliance, New Orleans, Louisiana. pp.*xx–xx*.

Please visit the following vendors, sponsors, and non-profits in the Exhibit Hall (Grand Ballroom A&B):

- 4th Point Studios
- Asian Turtle Program
- Hector Sanchez
- Holohil
- Karumbe
- Mazuri
- New Mexico Museum of Natural History and Science
- Sonotronics
- Tiaro Landcare
- Turtle Conservancy
- Turtle Eye Productions
- the Turtle Room
- Turtle Survival Alliance
- Wildlife Materials, Inc.
- Zoo Med Laboratories

Conference Notes and Social Activities

Monday, August 1

- Registration 3:00 PM – 5:00 PM (Registration Desk)
- Auction Item Drop Off 3:00 PM – 5:00 PM (Grand Gallery)
- Poster Hanging 3:30 PM – 5:00 PM (Grand Ballroom A&B)
- Walk to the Aquarium of the Americas 5:30 (Meet in the lobby at 5:15)
- Icebreaker 6:00 PM – 9:00 PM (Aquarium of the Americas)

Tuesday, August 2

- Continental Breakfast 7:30 AM – 8:30 AM (Grand Ballroom A&B)
- Registration 8:00 AM – 4:00 PM (Registration Desk)
- Auction Item Drop Off 8:00 AM – 1:00 PM (Grand Gallery)
- Exhibit Hall Open 7:30 AM – 6:00 PM (Grand Ballroom A&B)
- Poster Viewing 7:30 AM – 6:00 PM (Grand Ballroom A&B)
- Silent Auction Opens 4:00 PM (Grand Ballroom A&B)
- Reception to honor Peter Pritchard 4:00 PM – 6:00 PM (Grand Ballroom A&B)
- Poster Session 4:00 PM – 6:00 PM (Grand Ballroom A&B)
- Purple Silent Auction Closes – 6:00 PM (Grand Ballroom A&B)

Wednesday, August 3

- Registration 8:00 AM – 4:00 PM (Registration Desk)
- Exhibit Hall Open 8:00 AM – 4:00 PM (Grand Ballroom A&B)
- Poster Viewing 8:00 AM – 4:00 PM (Grand Ballroom A&B)

- Continental Breakfast 10:00 AM – 11:00 AM (Grand Ballroom A&B)
- Tan Silent Auction Closes – 1:00 PM (Grand Ballroom A&B)
- Green Silent Auction Closes – 4:00 PM (Grand Ballroom A&B)

Thursday, August 4

- Registration 8:00 AM – 1:00 PM (Grand Ballroom A&B)
- Auction Payment / Pick-up 8:00 AM – 1:00 PM (Grand Ballroom A&B)
- Exhibit Hall Open 8:00 AM – 1:00 PM (Grand Ballroom A&B) ***Please note*** *– This is your last chance to purchase a TSA T-shirt or other conference souvenir!*
- Poster Viewing 8:00 AM – 12:00 PM (Grand Ballroom A&B)
- Continental Breakfast 10:00 AM – 11:00 AM (Grand Ballroom A&B)
- Poster Breakdown 12:00-1:00 PM (Authors, please take down your posters at this time. Any posters left behind will be discarded.)
- Meet in hotel lobby at 5:15 p.m. to Board buses to Audubon Zoo for Awards Banquet
- Awards Banquet at the Audubon Zoo: Tour of reptile house at 6:00 PM, followed by Dinner at 7:00 PM in the Tea Room.

Support the TSA!

Be sure to visit the TSA merchandise tables in the Exhibit Hall (Grand Ballroom A&B) while you are here! Purchases of t-shirts, prints, and other items benefit the TSA and its conservation programs. A cashier is available for TSA merchandise purchases anytime that the Registration Desk is open. Credit cards, debit cards, checks, or cash are accepted.

Auction Notes

The silent auction is always a fun part of the TSA Conference, plus they generate funds to help support the TSA's conservation programs. The silent auction will take place on Tuesday and Wednesday in the Exhibit Hall (Grand Ballroom A&B), in three segments. We will not be having a live auction this year.

Thanks to all of you who have items that you are donating to this cause. If you were not able to complete the auction form online prior to your arrival, you can do so at the auction drop-off table in the Exhibit Hall (Grand Ballroom A&B). Please note: no auction can be accepted without completing this process! Auction items will be accepted from 3:00-5:00 on Monday and from 8:00 AM-1:00 PM on Tuesday. **It is very important that you get your items turned in during this time!** This will allow our volunteers enough time to catalog each donation and make sure that everything runs smoothly.

To our lucky winners: auction items may be paid for and picked up in the Exhibit Hall from 8:00 AM – 1:00 PM on Thursday.

Social Media

Stay up to date on the latest in turtle conservation news by following us on social media.

http://www.facebook.com/TurtleSurvival
http://twitter.com/turtlesurvival
Join the conversation! Use #TSA2016 to post or tweet about the meeting.

Astor Crowne Plaza Conference Map

Conference Schedule Overview

<table>
<tr><th></th><th>Sunday July 31</th><th>Monday August 1</th><th>Tuesday August 2</th></tr>
<tr><td>8:00</td><td rowspan="10"><u>Turtle Conservancy</u>
(closed)</td><td rowspan="4"></td><td></td></tr>
<tr><td>8:30</td><td rowspan="4">Turtle Organization Reports</td></tr>
<tr><td>9:00</td></tr>
<tr><td>9:15</td></tr>
<tr><td>9:30</td><td rowspan="8"><u>TSA Board</u>
(closed)</td></tr>
<tr><td>10:00</td><td>Break/Posters</td></tr>
<tr><td>10:15</td><td rowspan="6">Turtle Organization Reports</td></tr>
<tr><td>11:00</td></tr>
<tr><td>11:15</td></tr>
<tr><td>11:30</td></tr>
<tr><td>11:45</td></tr>
<tr><td>12:00</td><td rowspan="2">Lunch</td><td rowspan="2">Lunch</td><td rowspan="2">Lunch</td></tr>
<tr><td>12:30</td></tr>
<tr><td>13:00</td><td rowspan="3"><u>IUCN - TFTSG</u>
Steering Committee</td><td rowspan="13"><u>TSA Board</u>
(closed)</td><td rowspan="7">Honoring Peter Pritchard/
Chelonian Research Institute</td></tr>
<tr><td>13:30</td></tr>
<tr><td>13:45</td></tr>
<tr><td>14:00</td><td rowspan="12"><u>TCF Board</u>
(closed)</td></tr>
<tr><td>14:15</td></tr>
<tr><td>14:30</td></tr>
<tr><td>14:45</td></tr>
<tr><td>15:00</td></tr>
<tr><td>15:15</td></tr>
<tr><td>15:30</td></tr>
<tr><td>15:45</td></tr>
<tr><td>16:00</td><td rowspan="4">Pritchard Reception and
Poster Session
in Exhibit Hall
(Grand Ballroom A&B)</td></tr>
<tr><td>16:15</td></tr>
<tr><td>17:00</td></tr>
<tr><td>17:30</td><td rowspan="6"></td><td>Walk to Aquarium</td></tr>
<tr><td>18:00</td><td rowspan="4">Icebreaker Social at
Aquarium of the Americas</td></tr>
<tr><td>18:30</td><td rowspan="3"></td></tr>
<tr><td>19:00</td></tr>
<tr><td>20:00</td></tr>
</table>

Conference Schedule Overview

<table>
<tr><th></th><th>Wednesday
August 3-A</th><th>Wednesday
August 3-B</th><th>Thursday
August 4-A</th><th>Thursday
August 4-B</th></tr>
<tr><td>8:30</td><td colspan="4">Morning Announcements</td></tr>
<tr><td>8:40</td><td rowspan="4">Origins, Patterns, and Changes</td><td rowspan="4">Turtles of Springs</td><td rowspan="4">Diamondback Terrapins</td><td rowspan="4">Zoos & Chelonians</td></tr>
<tr><td>9:00</td></tr>
<tr><td>9:20</td></tr>
<tr><td>9:40</td></tr>
<tr><td>10:00</td><td>Break/Posters</td><td>Break/Posters</td><td>Break/Posters</td><td>Break/Posters</td></tr>
<tr><td>10:20</td><td rowspan="4">Population/Status Surveys</td><td rowspan="4">Disease/Medical</td><td rowspan="4">Reproductive Ecology</td><td rowspan="4">Zoos & Chelonians (cont.)</td></tr>
<tr><td>10:40</td></tr>
<tr><td>11:00</td></tr>
<tr><td>11:20</td></tr>
<tr><td>11:40</td><td>Lunch</td><td>Lunch</td><td>Lunch</td><td>Lunch</td></tr>
<tr><td>12:00</td><td rowspan="4">Genetics</td><td rowspan="4">Conservation and Policy in North American Turtles</td><td colspan="2" rowspan="4">Conservation Programs</td></tr>
<tr><td>13:00</td></tr>
<tr><td>13:20</td></tr>
<tr><td>13:40</td></tr>
<tr><td>14:00</td><td>Break/Posters</td><td>Break/Posters</td><td>Break/Posters</td><td>Break/Posters</td></tr>
<tr><td>14:20</td><td rowspan="4">Turtle Ecology</td><td rowspan="4">Captive Husbandry - Collaborations & Conservation</td><td colspan="2" rowspan="4">Conservation Programs (cont.)</td></tr>
<tr><td>14:40</td></tr>
<tr><td>15:00</td></tr>
<tr><td>15:20</td></tr>
<tr><td>15:40</td><td rowspan="5" colspan="2"></td><td colspan="2">Load buses for Audubon Zoo</td></tr>
<tr><td>16:00</td></tr>
<tr><td>17:15</td></tr>
<tr><td>17:30</td><td rowspan="3" colspan="2">Banquet and Awards</td></tr>
<tr><td>18:00</td></tr>
<tr><td>18:30</td></tr>
<tr><td>21:30</td><td colspan="2"></td></tr>
</table>

	Sunday July 31	Monday August 1	Tuesday August 2
	Bourbon Room	St. Ann Room	Grand Ballroom C & D
8:00			***Turtle Organization Reports***
8:30			Opening Remarks
8:40			Turtle Survival Alliance
9:05			Wildlife Conservation Society Flagship Turtle Program
9:30			Tortoise & Freshwater Turtle Specialist Group
9:45			The Turtle Room
10:00			***Break & Posters***
10:15	**Turtle Conservancy** **(8:00 - 12:00)** **(Closed)**		Turtle Survival Center
10:35		**TSA Board** **(9:30 - 17:00)** **(Closed)**	Turtle Conservancy-Behler Chelonian Center
10:55			Le Village des Tortues (SOPTOM)
11:10			Turtle & Tortoise Preservation Group
11:25			American Turtle Observatory
11:40			Creative Conservation Alliance
11:45			
12:00	***Lunch***	***Lunch***	***Lunch***
			Honoring Peter Pritchard and the Chelonian Research Institute Chair: C. Schaffer
13:00	**TFTSG Steering Committee** **(13:00 - 14:00)** **(Closed)**	**TSA Board** ***(continued)*** **(9:30 - 17:00)** **(Closed)**	A Symposium to honor Peter Pritchard and the Chelonian Research Institute and the impacts they had on our careers with Special Guests: Ben Atkinson, Zack Burke, John Cann, Fred Caporaso, John Carr, Simona Ceriani, Bernard Devaux, Tomas Diagne, Eric Goode, John Iverson, Russ Mittermeier, Anders Rhodin, Chuck Schaffer, Kelly Stewart, Ian Swingland, Scott Thomson, Rob Truland, Dick Vogt, Tim Walsh, Roger Wood
14:00	**TCF Board** **(14:00 - 17:00)** **(Closed)**		
15:00			
16:00			Pritchard Reception and Poster Session in Exhibit Hall (Grand Ballroom A&B) 16:00-18:00
17:00			
17:30		**Leave for Aquarium of the Americas**	
18:00		**Icebreaker Social at Aquarium of the Americas**	
20:00			

Daily Schedule		
	Wednesday August 3 - Grand Ballroom C	**Wednesday August 3 - Grand Ballroom D**
8:30	**Morning Announcements**	**Morning Announcements**
	Origins, Patterns, &Changes Chairs: J. Lovich	***Turtles of Springs*** Chair: E. Munscher
8:40	*Chinlechelys*: Impact on Theories of Turtle Origins A LICHTIG	Turtles of Manatee Springs State Park, Florida W OSBORNE
9:00	Macroecological Patterns of Turtles at two Scales, Global & Continental J ENNEN	North American Freshwater Turtle Research Group - Springs J GRAY
9:20	Climate Change Effects on Two Species of Mud Turtles R MACIP-RIOS	Changes in Turtle Community in a Spring-fed River J JOHNSTON
9:40	Unusual Population Attributes of Red-eared Sliders in Japan M TANIGUCHI/J LOVICH	Growth of *Pseudemys* from a Spring System in Florida T STRATMANN*
10:00	***Break & Posters***	***Break & Posters***
	Population/Status Surveys Chair: D. Mifsud	***Disease/Medical*** Chair: J. Elbers
10:20	Relative Abundance of *Graptemys* in the Upper Pearl P LINDEMAN	Artificial Reproductive Techniques to Rescue the Giant Yangtze Softshell Turtle from Extinction G KUCHLING
10:40	Review of Status of the Alabama Red-bellied Turtle J GODWIN	An Algae Mediated Shell Disease of Yellow Mud Turtles J CHRISTIANSEN
11:00	Distribution and Status of Freshwater Turtles in Sindh and Khyber Pakhtunkhwa Provinces of Pakistan MZ KHAN	New Methods to Induce Egg Laying in Turtles M FELDMAN
11:20	Survey of the endemic Madagascar Hinge-backed Tortoise R WALKER	Turtle Associated Salmonella in the USA, 1960-2016 J WILSON
11:40		Genetic Variation Underlying Infectious Disease: Tortoises J ELBERS*
12:00	***Lunch***	***Lunch***
	Genetics Chair: T. Edwards	***Conservation & Policy in N.A.*** Chair: C.A. Jones
13:00	Goode's Thornscrub Tortoise, a new tortoise for N.A. T EDWARDS	Multi-Agency Approach to Conservation of Sonoran Desert Tortoise C JONES
13:20	Genetic Management of Captive Bolson Tortoise Program T EDWARDS	Regional State Wildlife Grants Partnership for the Conservation of Blanding's and Wood Turtles M JONES
13:40	New Species of Southeast Asian Snail-eating Turtle F IHLOW*	Conservation and Management of Alligator Snapping Turtles in Kansas and Oklahoma D RIEDLE
14:00	Inbred Populations of Dahl's Toad-headed Turtle N GALLEGO-GARCIA*	Gulf Coast Regional Planning for Diamondback Terrapins C MOHRMAN/W SELMAN
14:20	***Break & Posters***	***Break & Posters***
	Turtle Ecology Chair: J. Smith	***Captive Husbandry*** Chair: S. Enders
14:40	Sexual Size Dimporphism in Turtles: Implications for Management of Wild and Captive Populations M TUMA	Using Nature as a model for Captive Blanding's Turtles C LEONE
15:00	Ecology of *Testudo graeca nikolskii* in NW Caucasus, Russia O LEONTYEVA	Captive Husbandry of the Chinese Big-headed Turtle N SHELMIDINE
15:20	Ecology of Rough-footed Mud Turtles J SMITH	Husbandry and Breeding of Egyptian Tortoises R TILL
15:40	Raptor Predation of Chelonians in Central Florida T WALSH	Incubation Challenges of *Chelodina oblonga* S BAUER
16:00	Predation of Turtles by Bald Eagles in Alabama A COLEMAN	Breeding of Platysternon in Southern Anhui Province, China Y JIANG
16:20	Ecology of the Mexican Spotted Wood Turtle T BUTTERFIELD*	

*** Student Considered for Student Awards Competition**

Daily Schedule		
	Thursday August 4 - Grand Ballroom C	**Thursday August 4 - Grand Ballroom D**
8:30	**Morning Announcements**	**Morning Announcements**
	Diamondback Terrapins Chair: B. Atkinson	***Zoos and Chelonians*** Chair: B. Hughes/A. Stern
8:40	Ecology of Ornate Diamondback Terrapins B ATKINSON	Captive Husbandry and Reproduction of Eyed Turtles (Sacalia) B HUGHES
9:00	Observations on Juvenile Diamondback Terrapins W SELMAN	Husbandry, Reproduction, and Rearing of McCord's Box Turtles at the Saint Louis Zoo J DAWSON
9:20	Reproductive Physiology of Diamondback Terrapins J DONINI*	Breeding of Madagascar Big Head Turtles at Houston Zoo C BEDNARSKI
9:40	Citizen Science and Traditional Research Reveal Regional Declines of Diamondback Terrapins in Northeast S EGGER/R BURKE	A Gut Feeling: Summary of Commensal and pathogenic GI parasites and organisms J LIU
10:00	***Break & Posters***	***Break & Posters***
	Reproductive Ecology Chair: D. Thompson	***Zoos and Chelonians (cont.)***
10:20	Reproductive Investment Patterns - Alligator Snapping Turtles D THOMPSON*	Confiscation Management: Receipt, Husbandry, and Dispersal N ABELN
10:40	Olfaction as Cue for Nest-site Choice in Painted Turtles J IVERSON	The Ploughshare Tortoise: Battle on Multiple Fronts P GIBBONS
11:00	Estimating Age and Size at Sexual Maturity of the *Dermatemy mawii* N BISHOP*	Growing Pains: Tips for providing natural browse and forage for large collections J LIU
11:20	Assessment of ATV Impacts on Softshell Turtle Nests C GODWIN*	An Overview of Chelonian Operations at Zoo Knoxville S NELSON
11:40	Maternal Identity Influences Hatch Rates in Wood Turtles T DUCHAK*	Update, 15y after the Malaysian Giant Pond Turtles Rescued and Maintained at Zoo Miami A STERN
12:00	***Lunch***	***Lunch***
	Conservation Programs Chair: M. Tuma	
13:00	New Reserve for the South African Geometric Tortoise J JUVIK	
13:20	Community-lead Nest Protection and Pagoda-based Headstarting of Cantor's Giant Softshell Turtle in Cambodia Y SUN	
13:40	Conservation Efforts for Swinhoe's Softshell Turtle in Vietnam T MCCORMACK	
14:00	Measuring Population Impacts Resulting from a 14 year Turtle Conservation Program in Australia M CONNELL*	
14:20	***Break & Posters***	
	Conservation Programs (cont.)	
14:40	Turtle Conservation in Myanmar: Program Update S PLATT	
15:00	Chelonian Conservation in India S SINGH	
15:20	The Use of Traditional Protection and Community Involvement in the Full Protection of Hingeback Tortoises in Southern Ghana A AGYEKUMHENE	
15:40	Conservation Actions of Continental Turtles of Uruguay A ESTRADES	
16:00		

*** Student Considered for Student Awards Competition**

Poster Presentations *Exhibit Hall (Grand Ballroom A&B)*	
Poster Session Tuesday, August 2nd at 1600 h	
You ARE the Fathers: Parentage Analysis Reveals Extensive Occurrences of Multiple Paternity in Wood Turtles C BOUCHARD*	Population Genetics of the Razorback Musk Turtle (*Sternotherus carinatus*) and the Implications for its Conservation G BROWN*
Home Range of the Texas Tortoise (*Gopherus berlandieri*) on a Landscape Managed for Recreational Hunting R COUVILLON*	Preliminary Results from Two Alligator Snapping Turtle (*Macrochelys temminckii*) Projects in West Tennessee J ENNEN
Red List Assessment: Local Status of Turtles Species in Uruguay, South America A ESTRADES	Seasonal Changes in Box Turtle Diets M FIGUERAS*
Demography of *Terrapene carolina major* in Coastal Mississippi A HEATON	Unexpected Lack of Genetic and Morphological Divergence in a Widespread Tortoise: Phylogeography of *Indotestudo elongata* F IHLOW*
The Protection and Artificial Breeding of *Cuora flavomarginata* in Dabie Shan Mountain Area, China Y JIANG	Growth of the Early North American Tortoise *Stylemys nebrascensis* A LICHTIG
Habitat Selection and Movement Patterns by the Gulf Coast Box Turtle (*Terrapene carolina major)* on the Florida Panhandle J MECK*	Conserving Freshwater Turtles Requires Assessing Resource Use at the Appropriate Spatiotemporal Scale M MICHELI-CAMPBELL
Thirteen Years of Keeping and Breeding the Madagascar Flat-tailed Tortoise (*Pyxis planicauda*) V MISLIN/F IHLOW	The First Turtle Surveys of Weeki Wachee Springs State Park Reveals More than Mermaids E MUNSCHER/C MCCAVINCHEY
Influence of Microhabitat on Body Temperature Variation in *Kinosternon integrum* A PEREZ*	Citizen Science: Accuracy in Collecting *Terrapene* Coloration Data A PETRILLA*
Road Mortality of Turtles: a Comparison Between Highway, Undeveloped, Suburban and Urban Areas A PETRILLA*	Temperature Sex Determination in the Española tortoise (*Chelonoidis hoodensis*) A SANCHO/R BURKE
Fall Activity Patterns of Hatchling Alligator Snapping Turtles (*Macrochelys temminckii)* S SPANGLER*	Use of Basking Objects by Turtles in Louisiana A TRIPLETT*
The Relationship Between Incubation Temperatures and Male Rate of Hatching Softshell Turtles, *Pelodiscus sinensis* F WANG	The Spatial Ecology of the Eastern Box Turtle (*Terrapene carolina carolina*) in an Isolated Urban Landscape of Southeast Tennessee T WILSON
Road Ecology and Freshwater Turtle Protection: Case Study from Toronto, Ontario, Canada M DUPUIS-DESORMEAUX	
***Student Considered for Student Awards Competition**	
TURTLE SURVIVAL ALLIANCE	

Confiscation Management: Receipt, Husbandry and Dispersal

NICOLE ABELN
Anchorage Museum, Anchorage, Alaska
[nabeln@anchoragemuseum.org]

The Anchorage International Airport is the second busiest airport by cargo traffic in the nation, and is a hub for flights to and from Asia. In September 2014, inspectors with the U.S. Fish and Wildlife Service (USFWS) and the U.S. Customs and Border Protection Service discovered more than 200 hatchling turtles in a pair of snow boots being shipped to Asia. Inside were 6 species of turtle: diamondback terrapin, Eastern box turtle, loggerhead musk turtle, Blanding's turtle, North American wood turtle, and Kwangtung River turtle. The USFWS contacted the Anchorage Museum for assistance with the turtles' care. The Anchorage Museum houses a small collection of reptiles and marine life for educational purposes; it is not readily equipped to handle such a large number of temporary animals, especially ones in need of delicate care. From the initial intake, husbandry and medical issues, to finding new homes across the United States, staff at the Museum learned a lot about turtle confiscation management and what to prepare for should this happen again.
Zoos and Chelonians: Oral

The Use of Traditional Protection and Community Involvement in the Full Protection of Hingeback Tortoises in Southern Ghana

PHIL ALLMAN[1] AND ANDREWS AGYEKUMHENE[2]
[1]Department of Biological Sciences, Florida Gulf Coast University, Fort Myers, Florida
[2]Wildlife Division, Forestry Commission, Winneba, Ghana
[andyaohene@yahoo.com]

Hingeback tortoises (*Kinixys spp.*) are a unique group of turtles endemic to Africa. Although there is a paucity of population data for the group, many species are most likely declining due to the increased threats of habitat loss, direct harvest for food, and collection for the pet trade. Recent work in Ghana suggests remaining populations of Home's hingeback tortoises (*Kinixys homeana*) are immediately threatened with extirpation, and some populations may have already been lost. To prevent further population declines, the authors developed an intensive community involvement program that included educational workshops, stake-holder meetings, school activities, and a durbar (formal ceremony). Community members came together at these events to discuss the value of tortoises in the pet trade, as a food source, in the natural environment (ecological value), and for ecotourism. These activities led a community Chief to dedicate land as a tortoise sanctuary in hopes of maintaining a healthy population to attract ecotourism. A group of women from a different community who have historically collected tortoises for the pet trade took an oath of promise to no longer collect tortoises, but instead to help promote their protection and the health of the rainforest. A durbar was then organized with the Paramount Chief of the south-central region of Ghana to bring community members and Chiefs together for an afternoon of discussions about tortoise conservation. The Paramount Chief formally announced his support to protect tortoises in the region, which effectively gives traditional protection for all tortoises in the area. Because traditional rule is an important component of Ghanaian culture, this pronouncement affords the tortoises complete protection from collecting for the pet trade or harvesting for consumption. Similar forms of traditional protection in Ghana have prevented the extirpation of primates, trees, crocodiles, and critically endangered sea turtles. Nonetheless, the long-term success of traditional protection will be influenced by the amount of public support, tourism, and community interest for continued protection. It is therefore crucially important that the conservation community continues to engage the Paramount Chief and community members in additional tortoise activities and ecotourism.
Conservation Programs: Oral

Ornate Diamondback Terrapin (*Malaclemys terrapin macrospilota*) Ecology and Population Monitoring in Cedar Keys National Wildlife Refuge, Florida

BENJAMIN K. ATKINSON[1], COLEMAN M. SHEEHY III[2], STEVEN A. JOHNSON[3], AND EDWARD J. MCGINLEY[1]
[1]Department of Natural Sciences, Flagler College, St. Augustine, FL 32084
[2]Department of Biology & Seahorse Key Marine Laboratory, University of Florida, Gainesville, FL 32611
[3]Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611
[BAtkinson@flagler.edu]

The ornate diamondback terrapin (*Malaclemys terrapin macrospilota*) is endemic to coastal salt marsh and estuarine habitats of Florida's Gulf coast. In 2013, *Malaclemys* was added to CITES Appendix II due to concern over extensive habitat loss, road mortality, incidental drowning in fishing gear, and trade for food and pets. Following a distributional survey completed by colleagues in 2009, we initiated a mark-recapture and ecological investigation of *M. t. macrospilota* in Florida's "Big Bend" region. The Big Bend covers roughly 350 kilometers along Florida's least developed stretch of coastline. Prior to our study, little was known about the population of this species in the region. We are conducting our study within the Cedar Keys National Wildlife Refuge (CKNWR), located south of the Suwannee River mouth on Florida's Gulf Coast. We have permanently marked terrapins with PIT tags, and are collecting data on population size and demographic structure, habitat use, and dietary preferences. Preliminary results suggest that terrapins exhibit considerable site fidelity, recruitment, and heterogeneity in habitat use within the region. Due in part to our ongoing study, the CKNWR population was deemed one of three statewide "Sentinel Populations" by the Florida Fish and Wildlife Conservation Commission, which is reviewing diamondback terrapins for state listing. Herein, we present a current overview on reproductive phenology, dietary analyses, demographic structure, and estimated population size for our initial area of focus. Our longer-term goals include using genetic and mark-recapture methods to investigate metapopulation dynamics, inter-island movements and to determine significant threats to terrapin survival in the Big Bend.
Diamondback Terrapins: Oral

***Chelodina oblonga*: A Complex Incubation Challenge**

SAUL BAUER
Herp Keeper-The Shores Region, Columbus Zoo and Aquarium, Columbus, Ohio
[saul.bauer@columbuszoo.org]

The Northern Snake-Necked Turtle (*C. oblonga)* has a convoluted taxonomic history, having changed multiple times since its original description in 1841. Some still resort to *C. rugosa* and *C. siebenrocki,* however, *C. oblonga* is currently recognized and has been upheld by the ICZN since 2000, despite multiple contestations. The Columbus Zoo and Aquarium has raised and housed this species for many decades yet successful hatching has not occurred since 1998 despite dozens of attempts. With the collection becoming increasingly aged the decision was made to attempt incubation to sustain our group. Information on breeding this particular species is limited so multiple incubation scenarios were attempted including: multiple parameters, nest flooding and various media. Most information on related species conveyed a 60-80 day incubation period, however our clutch did not see a successful hatch until day 110. Our hypothesis is diapause was induced when the temperature was lowered from 86° to 81° due to the need to incubate a clutch of *H. horridum* eggs. The clutch may have suspended development until the temperature was raised to an eventual 88° once the eggs were able to be housed in a separate incubator. Hatching was sporadic, with only three successful emergences occurring over a 40 day span. When the remaining eggs were culled, multiple cases of fully formed, yet deceased, neonates were found. Multiple questions remain: why such an extraordinary incubation period, why did the only three survivors hatch over a bizarre stretch of time and why was there a low hatch percentage when many made it to late term development?
Captive Husbandry: Oral

Successful Breeding of the Madagascar Big Head Turtle (*Erymnochelys madagascariensis*) at The Houston Zoo

Christopher B. Bednarski
Department of Herpetology, Houston Zoo, Houston TX, USA
[cbednarski@houstonzoo.org]

The Houston Zoo received a confiscation of 2.5 *Erymnochelys madagascariensis* in 2005. A lack of space in the Herpetology department caused a need for an alternative option for housing these animals. This lead not only to being able to exhibit the animals, but also establish breeding due to collaboration between the primate and herpetology departments. The Houston Zoo primate department's heated lemur moat found to be a proper exhibit for these animals to be housed. The Herpetology and Primate departments collaboration proved to be a successful one when we found our first hatchlings in 2012. This presentation will discuss our husbandry techniques including diet, enclosure, incubation, hatchling rearing and utilizing other department's empty space to house and breed chelonians.
Zoos and Chelonians: Oral

Estimating Age and Size at Sexual Maturity in the Critically Endangered Central American River Turtle, *Dermatemys mawii*

NICHOLE D. BISHOP[1], RICK HUDSON[2,3], JACOB MARLIN[3,4], THOMAS POP[3,4], SHANE BOYLAN[5] , BENJAMIN K. ATKINSON[6], RAYMOND R. CARTHY[7]

[1]*School of Natural Resources & Environment, University of Florida, Gainesville, FL USA;*
[2]*Turtle Survival Alliance, Forth Worth, TX USA;*
[3]*Belize Foundation for Research and Environmental Education, Toledo District, Belize;*
[4]*Hicatee Conservation Research Center, Toledo District, Belize;*
[5]*South Carolina Aquarium, Charleston, SC USA;*
[6]*Department of Natural Sciences, Flagler College, St. Augustine, FL USA;*
[7]*U.S. Geological Survey, Florida Coop Fish and Wildlife Unit, University of Florida, Gainesville, FL USA*
[*n00051891@ufl.edu*]

Captive rearing of juvenile turtles for release into protected areas (i.e. "head-starting") has been identified as a means of restoring wild populations of some species. However, knowledge of the target species' life history traits is important in determining feasibility of conservation efforts. *Dermatemys mawii* is a critically endangered freshwater turtle endemic to Central America that has incurred substantial population losses due to habitat decline and overhunting for human consumption. It is now being considered for head-starting programs. However, relatively little is known about *D. mawii* life history, especially its growth patterns and reproductive ecology. The purpose of this study was to quantify growth parameters, size, and age at sexual maturity in *D. mawii*. We investigated a captive population in Belize housed at the Hicatee Conservation Research Center of the Belize Foundation for Research and Environmental Education. Growth rates based on morphometric data from adult males and juveniles of unknown sex (n=26) were used to calculate growth parameters. These data were used to estimate age and size at onset of sexual maturity. We generated a von Bertalanffy growth curve using a modified Fabens equation, which utilizes capture/recapture data to estimate age. Segmented linear regression analysis ($p<0.001$) suggested that *D. mawii* undergo onset of sexual maturity at approximately 33.6 cm straight carapace length. Our von Bertalanffy growth model estimated age of maturity at approximately 8 years. Rearing turtles until they are large enough to be "safely" released into the wild is often not practical due to slow growth rates. However, our *D. mawii* sample demonstrated relatively rapid growth and achieved sexually maturity in less than a decade. Head-starting may be a valuable component of *D. mawii* restoration projects, if they are raised in captivity for several years, released into managed areas, and adult populations are protected.

Reproductive Ecology: Oral (Student)

You ARE the Fathers: Parentage Analysis Reveals Extensive Occurrences of Multiple Paternity in Wood Turtles

CINDY BOUCHARD[1], NATHALIE TESSIER[2] AND FRANÇOIS-JOSEPH LAPOINTE[1]

[1]*Département de Sciences biologiques, Université de Montréal, Montréal, Québec, H3C 3J7, Canada*
[2]*Ministère des Forêts, de la Faune et des Parcs, Longueuil, Québec, J4K 2T5, Canada*
[cindy.bouchard.1@umontreal.ca]

Mating system is a primordial component for the elaboration of conservation strategies and long-term survival of threatened species. Namely, promiscuity and sperm storage may favor the survival of long-lived organisms by increasing genetic diversity in offspring and delaying the impact of a bottleneck. Considering the conservation status of the Wood Turtles (*Glyptemys insculpta*), we deemed necessary to study multiple paternity of one of the largest populations in Canada. Basic knowledge of the mating system of Wood Turtles will provide a better understanding of ecological requirements for population conservation, such as successful and continued recruitment. To do so, we used microsatellite analysis to study the mating system and parentage of Wood Turtles over two nesting seasons. We sampled 38 clutches in the Shawinigan River (Québec) over two nesting seasons (2006 and 2007), and genotyped 253 offspring and 84 candidate parents using seven microsatellite loci. The frequency of multiple paternity in all clutches was estimated at 37% for both seasons, by a consensus of three methods (allele count, GERUD and COLONY). The reconstructed genotypes of the fathers revealed that reproductive success varies greatly among males, with offspring numbers ranging from to 1 to 32. Repeat paternity was observed for 88% of the females under study. This important percentage may suggest either a frequent use of sperm storage, or mating with the same partner in successive years. Finally, our analyses also identified small groups of individuals that exclusively reproduce with each other. The implications of these results will be discussed with respect to a conservation strategy of Wood Turtle populations in Québec.

Presentation type: Poster (Student)

Population Genetics of the Razorback Musk Turtle (*Sternotherus carinatus*) and the Implications for its Conservation

GROVER BROWN[1], BRIAN KREISER[1], CARL QUALLS[1]
[1]Department of Biological Sciences, The University of Southern Mississippi, Hattiesburg, Mississippi, USA
[*Grover.Brown@usm.edu*]

The Southeastern United States is an evolutionary theater known for its rich biodiversity of aquatic species, and turtles are no exception. This is thanks in part due to particularly high levels of endemism across river systems in the Gulf Coastal Plains. The razorback musk turtle (*Sternotherus carinatus*) is a small to medium-sized, inconspicuous inhabitant of a number of Gulf Coast drainages that has received a lack of attention and research, perhaps because it is mainly treated as by-catch. For this study, we have collected a number of tissue samples from across the species' range from Texas to Mississippi and developed a set of microsatellite loci to determine 1) the levels of inter-drainage population structure and 2) to use this data to determine whether the species should be managed as distinct units or as a single entity. Though not currently listed as threatened or endangered by IUCN, there are disturbing levels of exploitation of this species for the Asian pet trade, with hundreds of thousands of *S. carinatus* reportedly being exported from the state of Louisiana alone in 2014. Ultimately this study aims to use population structure in *S. carinatus* to fingerprint individuals from Asian markets to help identify source populations and to help state agencies make informed management decisions.
Presentation type: Poster (Student)

Ecology of a Terrestrial Turtle (*Rhinoclemmys rubida perixantha*) in a Tropical Dry Forest

TAGGERT G. BUTTERFIELD[1], DANIEL D. BECK[1], AND ALISON SCOVILLE[1]
Department of Biological Sciences, Central Washington University, Ellensburg, Washington 98926, United States.
[butterft@cwu.edu]

Turtles are in trouble worldwide, with nearly half recognized by the International Union for Conservation of Nature (IUCN) as needing special protection. The Eurasian pond and Neotropical wood turtles of the family Geoemydidae are the most diverse turtles and comprise ¼ of all turtle species yet basic information on their natural history is lacking. Moreover, seasonal tropical dry forest (SDTF), where many geoemydids exist, is considered the most endangered ecosystem in the world. We investigated the activity patterns, home range size, and microhabitat selection of the Mexican Spotted Wood Turtle (*Rhinoclemmys rubida perixantha*) in its SDTF habitat by tracking turtles with trail spools and radio telemetry. Our data show activity of *R. r. perixantha* was strongly associated with the intense dry season in the tropical deciduous forest, where turtles made fewer movements and walked significantly shorter distances (wet=46.8±3.6m, dry=21.4± 4m, $P<0.05$). With the onset of the wet season, turtle activity peaked from 1100-1400hr. Male turtles moved significantly farther ($P=0.02$), and more frequently ($X^2=48.5$, $P<0.001$) than females, and had larger home ranges (males=1.26±.61; females 0.55±.19 ha, $P<0.001$). These differences reflect a reproductive strategy where males travel more in search of females, which maximizes fecundity. Furthermore, results from a generalized linear model reveal that specific habitat features within the SDTF selected by turtles include leaf litter ($F=13.7$, $P=0.0003$), bare ground ($F=33.3$, $P=5.1x10-8$), vine-like shrubs ($F=10.2$, $P=0.002$), and hillslopes ($F=35.0$, $P=2.5x10-8$). This was the first field study ever conducted on the near threatened Mexican Spotted Wood Turtle in its native habitat.
Turtle Ecology: Oral (Student)

An Algae Mediated Shell Disease of Yellow Mud Turtles, *Kinosternon flavescens,* Confirmed

JAMES L. CHRISTIANSEN[1], ELLIOT JACOBSON[2], AND TRAVIS LADUC[1]
[1]Univertsity of Texas, Biodiversity Collections, Austin TX
[2]University of Florida, College of Veterinary Medicine, Gainsville, FL, USA
[*jlchristiansen@drake.edu*]

Recent histological work and ongoing longitudinal studies of a population of *Kinosternon flavescens* in Presidio and Jeff Davis counties in West Texas has confirmed algae associated shell lesions. While we can not be certain of all aspects of the cause, light microscopy showed that the common filamentous algae *Basicladia chelonium* was present in all stages of the shell lesions. The algae had invaded and disrupted the lamellae of the keratinized portion of the shell with erosion leading to complete loss of the scute and exposure of underlying bone. Four stages of progression of the shell lesion were identified and are easily recognized in the field. We provide data on prevalence of this shell disease among the marked population,

association of the algal infection with aquatic tendency of individual turtles, progression of the disease in individual turtles, and typical ages of turtles with onset of the disease and more advanced stages. Our data are consistent with the concept that the most arid-adapted populations of this species may have lost defenses against this common turtle epiphyte. We are examining other populations to determine the distribution of the disease over the range of *K. flavescens.*
Disease and Medical: Oral

Predation of Aquatic Turtles by Bald Eagles (*Haliaeetus leucocephalus*) in Alabama

ANDREW T COLEMAN
Birmingham Audubon Society, Birmingham, Alabama 35222
[andycoleman@birminghamaudubon.org]

Documenting predator-prey relationships are necessary to fully appreciate the complete ecological roles of species as well as to properly manage them. Avian predators have been shown to be a conservation concern for numerous chelonian species. Bald eagles (*Haliaeetus leucocephalus*) prey on a variety of aquatic turtles in portions of the species' range, but this behavior has not been reported in Alabama. The current project evaluated occurrences of bald eagle predation of turtles in a variety of aquatic habitats throughout the state. The ground below eagle nests was surveyed to observe prey remains, and any turtle shell matter was collected and identified to species, if possible. Additionally, if the shell allowed, carapace length and width and plastron length were measured. These data indicated a potential size limit for predation. Identified species included Eastern musk turtle (*Sternotherus odoratus*), stripe-necked musk turtle (*Sternotherus minor peltifer*), Eastern snapping turtle (*Chelydra serpentina*), Northern map turtle (*Graptemys geographica*), and Ouachita map turtle (*Graptemys ouachitensis*). As the bald eagle nesting population rebounds in Alabama, quantifying the prevalence of predation will aid in understanding the potential impact of these apex predators on turtle populations.
Turtle Ecology: Oral

Measuring Population Impacts Resulting from an Australian 14 Year River Turtle Conservation Program

MARILYN CONNELL[1,2], DR. HAMISH CAMPBELL[2], ANDREW MCDOUGALL[3]
[1]Tiaro & District Landcare Group Inc, P O Box 6, Tiaro 4650 Qld, Australia
[2]Charles Darwin University, Northern Territory, Australia
[3]Department of Natural Resources and Mines, Bundaberg, Australia
[connellmarilyn@gmail.com]

The IUCN strongly advocates in-situ nest protection as an approach to improve recruitment for marine and freshwater turtles. Recruitment has long been considered a major threat for the endangered Mary River turtle (*Elusor macrurus*), with estimates of a 95% decline in the nesting population since the 1970's due to egg harvesting for the pet trade. In response, the local community initiated a Mary River turtle conservation program and for the past 14 years, this in-situ nest protection program has resulted in approximately 4,700 hatchlings entering the river. This study aimed to assess if nest protection was an effective conservation strategy for this turtle. Mark/recapture was used to estimate the population size/structure at twenty sites over four sampling reaches of the Mary River. Standardised capture methods were developed to reduce any biases by survey method and ensure changes to the population structure could be detected over multiple trapping episodes and be replicated in years to come. Results were compared between areas where nest protection was implemented against those areas where it was not. We found that size distribution at all sample sites was biased towards large adults. There was a complete absence of immature turtles from the nest protection reach whereas immature turtles were captured the other three reaches. The methodology used in this study is suitable for assessing population size and dynamics in other river turtle populations. Initial results of this study suggest that while the nest protection program has been very successful in improving nest survivorship, there are threats other than egg and hatchling survival affecting the recovery of the freshwater turtle population in this reach and throughout the Mary River.
Conservation Programs: Oral (student)

Home Range of the Texas Tortoise (*Gopherus berlandieri*) on a Landscape Managed for Recreational Hunting

ROSS O. COUVILLON AND LEONARD A. BRENNAN
Caesar Kleberg Wildlife Research Institute, Texas A&M University–Kingsville, Kingsville, TX, 78363, USA
[ross.couvillon@gmail.com]

The Texas tortoise (*Gopherus berlandieri*), the smallest North American tortoise species, is chiefly associated with the Tamaulipan Biotic Province of southern Texas and northern Mexico, and its distribution appears limited to thorn-scrub communities. The biology of this species remains poorly understood. Knowledge of Texas populations remains very localized, as most literature covers research conducted on coastal populations in Cameron and Willacy counties and an inland population in Dimmit and La Salle counties. Intraspecific variability in life history characteristics necessitates thorough knowledge of a species across its range to guide conservation and management decisions. This species is distributed over a portion of Texas that is characterized by large, private land holdings utilized for cattle grazing and recreational hunting. Habitat management for game species in south Texas involves maintenance of a patchwork of woody cover, herbaceous cover, and bare ground. In 2015, ten adult tortoises (4 males, 6 females) were followed through radio-telemetry to determine how they utilize a landscape managed for game species. Home range sizes were quite variable within sexes and the largest home ranges were maintained by males. In this small sample, home range size did not differ between male and female tortoises. Research has continued in 2016 with a larger sample size. Research conducted on this population will fill in natural and life history data in an area of Texas tortoise distribution that has not been studied. Our goal is to determine the compatibility of managing for recreational hunting while maintaining landscape characteristics important to Texas tortoises.
Presentation Type: Poster

Husbandry, Reproduction, and Rearing of McCord's Box Turtle (*Cuora mccordi*) at the Saint Louis Zoo

JEFFREY E. DAWSON
Charles H. Hoessle Herpetarium, Saint Louis Zoo, St. Louis, Missouri USA 63110
[jdawson@stlzoo.org]

First described in 1988, the critically endangered McCord's Box Turtle (*Cuora mccordi*) is considered to be one of the most threatened chelonian species. Originally, the species was probably endemic to China, but the species is now likely extirpated from the wild and little is known about its natural history. Fortunately, *C. mccordi* appears to do well in captivity. The Saint Louis Zoo first acquired a group of *C. mccordi* in 1995. The Zoo has continuously housed the species since that time and several of the founder animals are still alive. In 1997, the Zoo produced a single offspring, thus becoming the first zoological institution in North America to breed *C. mccordi*. After that initial success, an additional XX offspring have been propagated during the subsequent years. The Zoo continues to hold 25 specimens, the most of any North American zoo, and is a participant in the AZA Species Survival Plan® for *C. mccordi*. Recently, efforts have been made at the Zoo to increase capacity for the rearing of *C. mccordi* and strengthen the commitment to the long-term *ex situ* sustainability of the species. Details on these efforts, as well as an overview of current husbandry techniques and summary of reproduction to-date, at the Saint Louis Zoo will be presented.
Zoos and Chelonians: Oral

Reproductive Physiology of Diamondback Terrapins (*Malaclemys terrapin*) at Two Latitudes in the Gulf of Mexico

JORDAN DONINI, CHRIS LECHOWICZ, WILL SELMAN, AND ROLDAN VALVERDE[1]
[*Jordan.donini@selu.edu*]

The reproductive physiology of diamondback terrapins has been poorly studied, especially in Gulf of Mexico populations. The seasonal cycles of terrapins are thought to follow temperate reproductive patterns. However, the temperature regimen in southern latitudes are different than those experienced by northern terrapins. This could facilitate an extended reproductive period in terrapins in the southernmost extent of their range. Enzyme linked immunosorbent assays (ELISA) were used to quantify concentrations of plasma sex hormones estradiol (E_2) and testosterone (T), and the egg yolk protein vitellogenin (Vtg) in terrapins from two distinct latitudinal regions, south Florida, and Louisiana. Radiography and ultrasonography were used to monitor the ovarian status and egg development in females. Male terrapins in Florida showed a peak in T during winter months corresponding with postnuptial spermatogenesis periods, while Louisiana males showed a similar increase in the fall. Our results suggest that in Florida terrapins may have continuous vitellogensis with preovulatory follicles existing in every sampling period, along with multiple clutches of eggs. In Florida, Vtg showed peak concentrations in June with other months

showing lower but detectable concentrations; E_2 showed equivalent peaks until a significant decrease in winter, and T showed no significant changes across sampling months. Louisiana female terrapins exhibited large preovulatory follicles in 3 of the 5 months sampled, suggesting that these individuals followed a different vitellogenic cycle. Vtg in Louisiana showed no significant differences from May–July before a significant decrease in concentration occurred in August, followed by an increase in the fall months. E_2 concentrations were minimal in the periods they were sampled with no significant differences observed. T showed no significant differences across sampling periods. Vtg showed a significant positive relationship with plastron length (PL) in Louisiana terrapins, but no such relationship existed in Florida. A possible life history modification exists between these two regions, with terrapins in Louisiana exhibiting greater mean PL than in Florida, supporting the idea that terrapins in south Florida mature earlier and are able to allocate more energy to reproductive output given the difference in climate.
Diamondback Terrapins: Oral

The "Good" the "Bad" and the "Variable:" Hatch Rates in a Wood Turtle (*Glyptemys insculpta*) Population are influenced by Maternal Identity as much as Random Environmental Factors

THOMAS J. DUCHAK AND RUSSELL L. BURKE
Department of Biology, Hofstra University, Hempstead NY 11549, U.S.A. [Thomas.J.Duchak@hofstra.edu]

Wood turtles (*Glyptemys insculpta*) have been suffering a range-wide decline since the mid-1900's and life history studies are needed to determine major reasons for local population declines. Monitoring efforts of these turtles usually involve mark-recapture surveys to assess population size but seldom investigate rates of reproductive success. We collected three consecutive years (2013-2015) of wood turtle nests at a "communal" turtle nesting site in northwestern New Jersey and found the hatching success of this population to be unusually low. Furthermore, annual, intra-individual hatch rates and comparisons between in-situ and artificial incubation revealed that many females consistently produced clutches with low (<50%) hatch rates, regardless of incubation treatment. Additionally, the annual hatch rates of other females were either consistently high (>50%) or highly variable, ranging from as low as 0% in some years to as much as 100% during others. Repeatability analysis indicated that approximately 50% of the hatch rate variability observed in this population can be attributed to maternal identity, while 50% can be attributed to the random environmental factors that are often cited as primary causes of hatching failure in turtle populations (e.g., unsuitable incubation conditions, flooding, desiccation, egg infertility attributed to male defects, egg damage due to improper handling, root and insect predation, and microbial infection). The reasons for these findings are unclear, but maternally-linked hatching failure in wild turtle populations may be associated with poor quality maternal diets, inbreeding, or environmental contamination. Additional studies are necessary to test these hypotheses and reveal the true causes of hatching failure in many turtle populations. The present study indicates that the commonly suggested hypotheses for hatching failure are unlikely to explain all of the hatch rate variability in some populations. This study also reveals an important conservation implication for declining turtle populations: that the presence of many nesting females may not necessarily guarantee sustainable reproductive rates. When coupled with the high rates of nest predation and low juvenile survival rates that are common in most turtle populations, the exceedingly low hatch rates we observed suggest that this, and perhaps other wood turtle populations, may not persist past the 21st century.
Reproductive Ecology: Oral (Student)

Road Ecology and Freshwater Turtle Protection: Case Study from Toronto, Ontario, Canada

MARC DUPUIS-DESORMEAUX
York University Post Doctoral Fellow, York University, Toronto, Ontario, Canada
Toronto Regional Conservation Authority

A description of road ecology efforts in Toronto, including the Toronto Region Conservation Authority's road ecology citizen science project I am leading, the results of turtle population surveys at Heart Lake (a high traffic/high mortality site) and at Tommy Thompson Park (low road mortality), and some of the remediation efforts (drift fencing, ecopassages, road awareness, signage, lane narrowing, turtle nesting beaches, etc..) as well as the monitoring efforts post remediation (camera-traps surveys, and road monitoring) and habitat creation projects.
Presentation Type: Poster

Goode's Thornscrub Tortoise (*Gopherus evgoodei*); A New Model for Using Genetic Research to Inform Characterization of Species and Promote Conservation

TAYLOR EDWARDS[1], ALICE E. KARL[2], MERCY VAUGHN[3], ERIC GOODE[4], PAUL GIBBONS[4], JENNIFER MACKAY[5], LYDIA LOZANO[5], PETER PAUL VAN DIJK[6], RUSSELL A. MITTERMEIER[7], ROBERT W. MURPHY[8]

[1]*University of Arizona Genetics Core, University of Arizona, Tucson, AZ 85721 USA.*

[2]*P.O. Box 74006, Davis, CA 95617 USA*

[3]*Paso Robles, CA 93446 USA*

[4]*Turtle Conservancy, 49 Bleecker Street, Suite 601, New York, NY 10012 USA*

[5]*Naturaleza y Cultura Internacional, Cjon Dif #6, Calle Palma Real, Col. Las Palmas, Alamos, Sonora, Mexico, CP 85760*

[6]*Global Wildlife Conservation, PO Box 129, Austin, TX 78767 USA*

[7]*Conservation International, 2011 Crystal Drive, Suite 500, Arlington, Virginia 22202 USA*

[8]*Royal Ontario Museum, Toronto M5S 2C6, Canada*

[taylore@email.arizona.edu]

For decades, herpetologists have noted the distinctiveness of Mexican populations of desert tortoises (*Gopherus morafkai*) in the southern part of their range, particularly where they occur in thornscrub and tropical deciduous forest environments. A team of scientists from Mexico, the U.S. and Canada investigated the ecology, morphology and genetics of these southern populations and have characterized this "Sinaloan" lineage of desert tortoise as the new species; *Gopherus evgoodei*. Researchers and performed multi-locus phylogenetic analyses and employed RNA-seq next-generation sequencing methods to characterize variants throughout the *Gopherus* genome and modeled evolutionary scenarios of divergence. These detailed genetic analyses validate species-level differentiation among the three lineages of desert tortoise. Anticipating the immediate need for habitat conservation for this new species of tortoise, before concluding their description the authors reached out to the Turtle Conservancy with the suggestion to raise funds at the Turtle Ball for the protection of this new species. A partnership was created by the Andrew Sabin Family Foundation, Global Wildlife Conservation, the Rainforest Trust and the Turtle Conservancy to name the species for Eric Goode, founder of the Turtle Conservancy, with each organization contributing funds to protect habitat in Mexico for this tortoise. The group purchased 1000 acres of prime tortoise habitat that adjoins an existing nature reserve, the *Reserva Monte Mojino*, managed by local NGO *Naturaleza y Cultura Sierra Madre,* representing Nature and Culture International in Mexico. The property will be integrated into the reserve to protect in perpetuity its tortoises and their ecosystem. Furthermore, preserving this habitat not only contributes to the survival of a unique tortoise but also the rich biodiversity associated with this ecosystem. This protected area will safeguard the globally endangered tropical deciduous forest ecosystem supporting 36 families of tropical trees, 48 species of orchids, the highest diversity of birds in Sonora, 5 species of wild cats, and 79 species of amphibians and reptiles. This effort sets an important precedent for conservation by complimenting this taxonomic description with a tangible action that contributes to the preservation of the new species in its native habitat.

Genetics: Oral

Genetic Management of the Bolson Tortoise (*Gopherus flavomarginatus*) Captive Breeding & Reintroduction Program

TAYLOR EDWARDS[1], ELIZABETH CANTY COX[1], VANESSA BUZZARD[2], CHRISTIANE WIESE[3], L. SCOTT HILLARD[3,4], ROBERT W. MURPHY[5]

[1]*University of Arizona Genetics Core, University of Arizona, Tucson, AZ USA*

[2]*Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, AZ USA*

[3]*Turner Endangered Species Fund, Ladder Ranch, Caballo, NM USA*

[4]*Department of Ecology and Evolutionary Biology, University of California, Los Angeles, CA USA*

[5]*Centre for Biodiversity and Conservation Biology, Royal Ontario Museum, Toronto, Canada*

[taylore@email.arizona.edu]

The Turner Endangered Species Fund is facilitating the repatriation of Bolson tortoise (*Gopherus flavomarginatus*) into their former range in New Mexico through a captive breeding program. In September 2006, 30 individuals were translocated from the Appleton Ranch near Elgin, Arizona to the Armendaris Ranch in New Mexico with the long-term objective of restoring wild populations via captive propagation. We examined both mtDNA and 11 autosomal microsatellite loci from the captive population and 28 archived samples collected from wild individuals in Durango, Mexico to help inform management decisions for the captive population. In addition, we tested 26 additional individuals housed in private collections and zoological institutions to determine if they are suitable for inclusion in the captive breeding program. Although both the captive population and the wild populations exhibited very low genetic diversity, the captive population captured roughly 97.5% of the

total wild diversity, making it a promising founder population. Genetic screening of other captive animals uncovered multiple hybrid *G. flavomarginatus* x *G. polyphemus*, which are ineligible for the captive breeding program, however, three individuals were verified as purebred *G. flavomarginatus*. We are using these genetic data to inform mate pairing, reduce the potential for inbreeding and to monitor the maintenance of genetic diversity in the captive population. Finally, we analyzed the parentage of 241 hatchlings produced over six years of successful propagation. We observed that not all adults contributed equally to successive generations and most yearly cohorts of hatchlings failed to capture the diversity of the parental population. However, overlapping generations of tortoises helped to alleviate genetic loss because the entire six-year cohort of hatchlings contained the allelic diversity of the parental population. We also document the occurrence of polyandry and sperm storage which helps inform our management strategies. Although captive breeding and reintroduction programs face challenges on many levels, including animal behavior, health, and diet, we demonstrate that genetic data can be an important component in a program's success. Our experience can hopefully help to inform strategies for captive breeding or reintroduction efforts of other species of turtles, tortoises and other organisms that share similar life history traits.
Genetics: Oral

Combining Citizen Science and Traditional Research Reveals Regional Declines in Diamondback Terrapin Populations in the Northeast

STEPHANIE EGGER[1], A. BRETT BRAGIN[2], BARBARA BRENNESSEL[3], MICHAEL FARINA[4], ALEXANDRA KANONIK[5], DREW P. MCQUADE[2], NOGA NEEMAN[7], CHARLOTTE B. SORNBORGER[8], JOHN WNEK[9], RUSSELL L. BURKE[7]
[1]Conserve Wildlife Foundation of New Jersey, PO Box 420, Trenton, New Jersey 08625 USA
[2]New Jersey Sports & Exposition Authority, One DeKorte Park Plaza, P.O. Box 640, Lyndhurst, NJ 07071 USA
[3]Wheaton College, Norton, MA 02667 USA
[4]Marine Nature Study Area, Department of Conservation & Waterways, Town of Hempstead, NY, 11569 USA
[5]WildMetro, P.O. Box 4220, Grand Central Station, New York NY 10163 USA
[7]Department of Biology, Hofstra University, Hempstead NY, 11549 USA
[noga.noga@gmail.com]
[8]Barrington Land Conservation Trust, P.O. Box 324, Barrington, RI 02806 USA
[9]Marine Academy of Technology and Environmental Science, 195 Cedar Bridge Road, Manahawkin, NJ 08050 USA
[biorlb@hofstra.edu]

Conservation of wide-ranging species is especially difficult because the necessary population trend data are usually very difficult to collect in a robust manner. Thus, it is possible for species to undergo dramatic declines before region-wide or range-wide changes are detected. The diamondback terrapin (*Malaclemys terrapin*) is North America's only estuarine turtle; it inhabits ca. 6000 km of U.S. Atlantic and Gulf salt marshes and mangrove ecosystems from Massachusetts to Texas. Despite increased scientific and conservation interest in this species, terrapin population trend data are only available from a few small scale analyses and from qualitative surveys. Here we combine long term mark-recapture data collected by citizen science and more traditional academically-based projects from six terrapin populations in the northern portion of the terrapin range, spanning 16% of the species' range. The sites differ in terms of conservation issues, primarily nest protection and local habitat loss. We detected significant declines in two populations and more moderate declines at two more. There were overall significant increases in the number of nesting adults at two sites, but even these experienced dramatic declines in the last decade. We conclude that diamondback terrapins are extremely vulnerable in the northern portion of their range.
Diamondback Terrapins: Oral

Tortoise Immunomes Shed Light on Genetic Variation Underlying Infectious Disease

JEAN P. ELBERS[1], MARY B. BROWN[2], SABRINA S. TAYLOR[1]
[1]School of Renewable Natural Resources, 227 RNR Bldg., Louisiana State University and AgCenter, Baton Rouge, Louisiana, 70803, USA
[2]Department of Infectious Diseases and Pathology, College of Veterinary Medicine, University of Florida, Gainesville, Florida, 32611, USA
[jean.elbers@gmail.com]

Immune response genes control the immune system's response to pathogens and because changes in these genes can alter disease susceptibility, they are likely to be influenced by selection. Populations of threatened species generally possess low levels of genetic variation, and genetically depauperate hosts may be at greater risk of infectious disease contributing to extirpations. To better understand the genetic basis of infectious disease susceptibility in a species of conservation concern, we

sequenced the immune response genes (i.e., immunomes) in 16 free-ranging gopher tortoises *Gopherus polyphemus* from 3 Florida populations (CF, FC, and OLD) with (n=10) or without (n=6) clinical signs and that produced antibodies against *Mycoplasma agassizii*, an etiologic agent of infectious upper respiratory tract disease (URTD). We found several synonymous and non-synonymous SNPs and indels associated with URTD phenotypes. Genetic diversity was lowest in CF followed by OLD and FC. Population differentiation and admixture were as expected based on geographic proximity of populations. There were two SNPs putatively under selection according to F_{ST} outlier tests, and there were 35 genes that deviated from neutrality according to Tajima's *D*. These results demonstrate that immunome sequencing of individuals with symptomatic and asymptomatic phenotypes from several populations may be conducive to better understanding the genetic basis of infectious disease by elucidating what genetic variation is associated with disease susceptibility. Immunome sequencing can also provide valuable information on levels of population genetic diversity, how populations are genetically differentiated, and what genetic variation may be under selection or deviating from neutrality.
Disease and Medical: Oral (Student)

Macroecological Patterns of Turtles at Two Scales, Global and Continental

JOSHUA R. ENNEN[1], MICKEY AGHA[2], JEFFREY E. LOVICH[3], WILFREDO A. MATAMOROS[4], BARRY SINERVO[5], JUSTIN NOWAKOWSKI[2], BRIAN D. TODD[2], STEVEN J. PRICE[6], CHRISTOPHER W. HOAGSTROM[7], AND SARAH HAZZARD[1]
[1]Tennessee Aquarium Conservation Institute, Tennessee Aquarium, Chattanooga, Tennessee, 37402, USA; [E-mail: jre@tnaqua.org]
[2]Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, Davis, CA 95616, USA
[3]U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona 86001, USA
[4]Facultad de Ciencias Biológicas, Universidad de Ciencias y Artes de Chiapas, Museo de Zoología, Tuxtla Gutiérrez, Chiapas, México Apartado Postal 29000, México.
[5]Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, Santa Cruz, CA 95064, USA
[6]Department of Forestry, University of Kentucky, Lexington, Kentucky 40546, USA
[7]Department of Zoology, Weber State University, Ogden, Utah 84408-2505, USA.

We sought to explore macroecological patterns of turtles in North America but also globally. For North American species, we demarcated unique regional biota (i.e., biogeographical province) boundaries using species presence/absence data. Additionally, we constructed spatial regression models testing the effect of geographic, climate, topography, and stream channel variables on turtle species richness. At the global scale, we tested well-known biogeographic patterns and hypotheses, such as the latitudinal diversity gradient, Bergmann's and Rapoport's rules. Our investigation recovered 16 turtle-faunal provinces in North America, which were influenced by a variety of geological events (e.g., paleo-stream rearrangements, paleo-climates, glacial cycles, and valley incisions). Our spatial models provided support for multiple hypotheses related to species richness patterns, such as climate, productivity, water availability, topography, and latitude. North American turtle species richness was positively associated with temperature, precipitation, diversity of streams, coefficient of variation of elevation, and net primary productivity. At the global scale, turtle species richness increased towards the equator, with a second peak in the Northern Hemisphere around 25° N. Turtles adhered to Rapoport's rule, where range sizes increased with latitude. However, turtles displayed the opposite pattern of Bergmann's rule, where body sizes decreased with latitude.
Origins, Patterns, and Changes: Oral

Preliminary Results from Two Alligator Snapping Turtle (*Macrochelys temminckii*) Projects in West Tennessee

JOSHUA R. ENNEN[1], DUSTIN GARIG[2], MADISON HERRBOLDT[2], ROB COLVIN[3], JEREMY DENNISON[3], AND JON DAVENPORT[2]
[1]Tennessee Aquarium Conservation Institute, Tennessee Aquarium, Chattanooga, Tennessee, 37402, USA [jre@tnaqua.org]
[2]Department of Biology, Southeast Missouri State University, Cape Girardeau, Missouri 63701, USA
[3]Tennessee Wildlife Resource Agency, Jackson, Tennessee 38301, USA

Populations of Alligator Snapping Turtle (*Macrochelys temminckii*) have declined throughout the species' range and have been extirpated in several states. In Tennessee, *M. temminckii* is a species of greatest conservation need, but little research has been conducted on assessing the state-wide distribution and population status of the species. Our projects aim to understand the distribution, population status, and mercury contamination of *M. temminckii* in West Tennessee. To date, we have sampled 11 sites in southwestern Tennessee and captured 21 individuals; most of which were immature. The mean carapace length was 27.44 cm (standard deviation [SD] = 6.4), and the largest individual captured was 39.40 cm. One specific site was a release

location of 90 hatchlings in 2005, where 9 immature individuals were captured. The mean carapace length for these 9 individuals was 21.66 cm (SD = 1.82). The mercury contamination analysis is forthcoming.
Presentation type: Poster

Conservation Actions Update Regarding Continental Turtles in Uruguay

ANDRES ESTRADES, VIRGINIA FERRANDO, AND ALEJANDRO FALLABRINO
Karumbé. Av Rivera 3245, Montevideo, 11200, Uruguay
[tortuguayo@gmail.com]

In this presentation we discuss the activities carried out by the NGO Karumbe regarding the conservation of the five freshwaters turtle of Uruguay as well as the introduced tortoise *Chelonoidis chilensis*. Four species of Chelidae and one Emydidae, are present in the territory of Uruguay, South America. Karumbé has worked for 17 years in the field of turtle preservation including research, environmental education and conservation. Two conservation centers have been developed due to the demand of the public regarding pet turtles. Every year we receive more than 100 calls of turtle concern. Half are due to consultations on the health of turtles in captivity. We also receive turtles that people encounter on domestic routes. After a period of quarantine, wild turtles are reintroduced back into their natural habitats. An interesting aspect of such actions is that they have managed to detect turtle populations that were believed missing due to habitat loss. This is the case of specimens of *Acanthochelys spixii* found in urbanized areas of the Uruguayan coast. More than half of the turtles donated by people are pets that have lived since hatchlings in small terrariums or glass pools. These animals cannot be returned to the wild and so we keep them in big open enclosures. These turtles, consisting mostly of *Trachemys dorbigni*, *Trachemys scripta,* and *Chelonoidis chilensis* are used in our educational programs and students training workshops. We conduct annual training courses focused on young university students. We have conducted three workshops already and have trained more than 50 students, mostly from Biology and Veterinary careers of the Universidad de la Republica (National University). Recently we completed a working agreement with a local wildlife reserve, located in Flores Department. A total of 50 *T. dorbigni* specimens were transferred and relocated to open enclosures, in a system of semi captivity. Karumbé work on the development of posters of information, and the training of officials of the wildlife reserve. We recently assisted with analysis of all species of amphibians and reptiles for IUCN. *Phrynops williamsi* was categorized as Near Threatened. The other four species no show conservation problems according to IUCN criteria.
Conservation Programs: Oral

Red List Assessment: Local Status of Turtles Species in Uruguay, South America

ANDRÉS ESTRADES[1], ALEJANDRO FALLABRINO[1], RAUL MANEYRO[2] & SANTIAGO CARREIRA[2,3]
[1]Karumbe, Av. Rivera 3245, Montevideo, Uruguay
[2]Laboratorio de Sistemática e Historia Natural de Vertebrados, Facultad de Ciencias, Universidad de la República, Montevideo, Uruguay
[3]Museo Nacional de Historia Natural y Antropología, Montevideo, Uruguay
[tortuguayo@gmail.com]

Turtle populations around the world currently face numerous threats that have already resulted in the extinction of substantial number of species and are responsible for the threatened status of many others. In order to establish effective conservation and management measures, it is very important to determine which species are more susceptible to these problems, and thus, face a higher extinction risk. The objective of this paper was to evaluate all the turtles of Uruguay against the Red List categories and criteria of the International Union for Conservation of Nature (IUCN). This resulted in a systematic classification of the conservation status of Uruguayan Turtles trough the application of international standardized methods that are widely used in the field of biodiversity conservation. In the present work we present the evaluation of the status of the five freshwaters turtles and five marine turtles species present in Uruguay. This is a particular presentation of the Global Red List Assessment of Amphibians and Reptiles of Uruguay. These criteria applied to all of the wild species belonging to these zoological groups with a confirmed presence in the country. Due to their biological characteristics, reptiles are groups that can be used as good indicators of environmental quality. Many of these species are significantly affected by the changes that occur at all scales, particularly at mesoscale. Into categories of threat, only is observed leatherback turtle (*Dermochelys coriacea*) as the only taxon considered "critically endangered". Among the "vulnerable" two species of sea turtles (*Chelonia mydas* and *Caretta caretta*) are observed. Some species are presented in a near-income status within the above categories and therefore are

considered "near threatened" (NT), such as turtle *Phrynops williamsi*. This work aims to be a useful and simple application tool for decision makers, and at the same time the beginning of an orderly and permanent evaluation of our herpetofauna.
Presentation type: Poster

New Methods to Induce Egg Laying in Turtles

MARK FELDMAN AND ELIZABETH FELDMAN
PO Box 285, Kerikeri, New Zealand 0230
[nz.feldman@yahoo.com]

This year we returned to the Concordia Turtle Farm in Louisiana for our sixth season to experiment with new agents to induce egg laying in various species of aquatic, North American turtles.
We have completed a quantitative evaluation of carbetocin, a long acting congener of oxytocin designed for humans. Although we were very hopeful it would be a major improvement it proved to be ineffective in both sliders and map turtles. On the other hand, quantitative experiments with an alpha 2 adrenergic agent, romifidine (Sedivet), have proved very successful when used with stressed or diseased animals. When combined with prostaglandin F2 alpha (Luyalyse) the success rate increased to 88% from 70% when using Lutalyse alone. In contrast, with healthy animals Lutalyse alone has a 94% success rate with a variety of sliders and map turtles. Lutalyse must be used carefully because it migrates through mammalian skin and can cause diarrhea/abdominal cramps in everyone and abortion in pregnant women. By the time of the conference we will be able to report on the effects of Sedivet plus Lutalyse in softshell turtles. In previous years we established that xylazine or Dexdomitor (both are shorter acting, alpha 2 adrenergic agents) plus Lutalyse increases the success rate in softshells to 75% from 44% when using Lutalyse alone. Sedivet is longer acting and has a slightly different structure than xylazine or Dexdomitor so hopefully it will prove even more effective. In addition, we will have completed experiments with Tramadol, a drug that dilates the cervix in humans and hopefully will do the same in softshell turtles. We will also trial a new preparation of propranolol, a beta-blocker used in humans to reduce the peripheral symptoms of stress. It appears that Lutalyse initiates most of the cascade of natural events that leads to egg laying. Oxytocin is not as effective because its action is further along the cascade. We no longer believe that oxytocin has a role as a primary agent to induce egg laying in turtles.
Disease and Medical: Oral

Seasonal Changes in Box Turtle Diets

MIRANDA FIGUERAS, RUSSELL BURKE, AND TIM GREEN
Department of Biology, Hofstra University, Hempstead NY
[m.figueras@outlook.com]

Terrapene Carolina (eastern box turtles) are omnivorous reptiles that are commonly found in mesic forests throughout the Eastern United States. As opportunistic omnivores, they consume fruit, plant matter, invertebrates, carrion, and mushrooms. They regularly consume entire fruits which has led them to be thought of as important seed and fungal spore dispersers. Time spent in the guts of turtles has also shown to increase germination rates of certain fruit seeds, including may-apple, grape, and black cherry. Small home ranges also potentially increase turtles' efficacy as a disperser, box turtles generally deposit seeds and spores similar microclimates increasing the chances of favorable conditions. Seeds can be deposited, on average between 2 and 20 days after being ingested. Box turtles at Brookhaven National Laboratory were collected through radio-telemetry or random encounters during their active season, in June, July, August and October. Turtles were soaked overnight in about 1 cm of water in order to encourage defecation. Fecal samples were brought back to the lab and seeds were separated and identified using a dissecting microscope. Mushroom fruiting body fragments were identified by staining structures using black ink. Seasonal availability of fruit and mushrooms affected the frequency that they were found in fecal samples. Grape seeds were not part of fecal samples from June, but were being distributed by the box turtles until October.
Presentation type: Poster

Evidence of Small, Isolated, and Inbred Populations in Dahl´s Toad-headed Turtle (*Mesoclemmys dahli*)

NATALIA GALLEGO-GARCÍA[1], GERMÁN FORERO-MEDINA[2], AND MARIO VARGAS-RAMÍREZ[3]

[1] Laboratorio de Ecología Molecular de Vertebrados Acuáticos LEMVA, Departamento de Ciencias Biológicas, Universidad de los Andes, Carrera 1 No. 18A-10, Bogotá, Colombia. [natagalle@gmail.com]
[2] Wildlife Conservation Society, Turtle Survival Alliance. Avenida 5N # 22n -11, Cali, Colombia. [gforero@wcs.org]
[3] Biodiversidad y Conservación Genética, Instituto de Genética, Universidad Nacional de Colombia, Ciudad Universitaria, Edificio 423, Bogotá, Colombia [mavargas@yahoo.com]

The effects of habitat loss in conservation of endangered species has received great attention, since it is now widely recognized that small and fragmented populations are more vulnerable to extinction due to random fluctuations of allele frequencies (genetic drift), and increased inbreeding. This is especially important in rare species with small distribution ranges that occur in transformed habitats such as Dahl´s toad-headed turtle (*Mesoclemmys dahli*). This species is endemic to the Caribbean region of Colombia, and inhabits the tropical dry forest, one of the most endangered ecosystems in the world. In this study we developed a panel of 15 microsatellite loci in order to perform the first genetic assessment of *M. dahli* across its distribution range, and evaluate possible genetic consequences of fragmented populations. We found that *M. dahli* has a marked genetic structure with at least four independent populations, with surprisingly moderate to high levels of genetic diversity. Despite its genetic diversity, we found that these populations have been isolated over the last several generations, with little to no gene flow among them, and that their effective population sizes are very small (Ne <50). As a consequence, mating among related individuals has been occurring, and all four populations are showing inbreeding coefficients that resemble those expected from a mating between second-degree relatives. It remains unknown if this level of inbreeding has had deleterious effects on the fitness of this species, but given its degree of isolation and small effective population sizes, we believe that *M. dahli* has a high chance of inbreeding depression in the short term. We recommend habitat restoration in all four populations and management actions that could increase functional connectivity among them, provided the risk of outbreeding depression is low. We also recommend the establishment of a monitoring program in all four populations to assess population viability.
Genetics: Oral (Student)

The Ploughshare Tortoise (*Astrochelys yniphora*): Battle on Multiple Fronts

PAUL GIBBONS[1], ANDREA CURRYLOW[2], RICHARD YOUNG[3], ANDREW TERRY[3], RICHARD LEWIS[3], MATTHIAS GOETZ[3], PETER PAUL VAN DIJK[1], JAMES LIU[1], CRAIG STANFORD[2], ERIC GOODE[1]

[1]Turtle Conservancy, Ojai, California, USA
[2]Department of Biological Sciences, University of Southern California, California, USA
[3]Durrell Wildlife Conservation Trust, Trinity, Jersey, UK
[paul@turtleconservancy.org]

The Ploughshare Tortoise (*Astrochelys yniphora*) is one of the most endangered species on the planet. Results from the 2016 field season indicate that the wild population, which had been relatively stable at about 300-500 adults/subadults for several years, has declined substantially. The primary cause of this decline is systematic poaching that has resulted from improved technology and international communication coupled with rising market prices and the poor socio-economic condition of the region. The entire range of the species is contained within a national park and in situ support has focused on protection of the remaining animals through community-based as well as military patrols, surveys, community development, tracking of individual animals and support to local judiciary. There has also been a long-term program of rural development support for local communities. However none of these approaches have been able to stem the tide of animals being poached for the pet trade. Animals are regularly being seized by Customs officials on their way to China and South-East Asia, and appear frequently for sale either online or in markets in countries including Indonesia, Malaysia, and Madagascar. The International Studbook contains a limited number of breeding adults and the only sustainable captive population is located at the Durrell conservation-breeding center in Madagascar. An international group, called the International Angonoka Working Group, was formed several years ago to provide expert guidance and support to conservation efforts. Recognizing the crisis, the IAWG has developed a response plan that will focus on securing the genetic viability of as many ploughshare tortoises as possible through increased collaboration with international and local partners. Continued support is needed to ensure the future viability of the core population in Baly Bay National Park, but through the emergency response strategy, the IAWG aims to ensure that the Ploughshare Tortoise does not go functionally extinct in the wild.
Zoos and Chelonians: Oral

Assessment of ATV Impacts on Softshell Turtle Nests

CODY D. GODWIN
Department of Biology, Southeastern Louisiana University, Hammond LA 70402
[cody.godwin@selu.edu]

Recreational vehicle use (e.g., all terrain vehicles or ATV's) has become increasingly popular in recent years, and is particularly prevalent in the southeastern U.S. Numerous studies have indicated negative effects of ATV's on the environment, especially in and around wetlands, including wetland degradation, soil erosion, destruction of vegetative communities, and direct animal mortality via impact. However, the impact of ATV's on nest success of fresh water turtles has not been documented. The beaches of the Comite River in southeastern Louisiana bring into close contact ATVs and the nesting sites for two species of softshell turtles (*Apalone mutica* and *Apalone spinifera).* The present study aims to understand the impacts of the ATVs on softshell turtle nests and thus the turtle populations. A study performed in 1993-1994, when ATVs were absent, provides a baseline for assessing the current impacts. Preliminary analyses from the 2015 field season show that ATV's impacted 35% of nests including 25% entirely destroyed. The 2016 field season is under way and nest destruction shows a similar trend.
Turtle Ecology: Oral (Student)

Review of the Status of the Federally Endangered Alabama Red-bellied Turtle (*Pseudemys alabamensis*)

JAMES GODWIN
Alabama Natural Heritage Program, Museum of Natural History, Auburn University, AL 36849
[jcg0001@auburn.edu]

Southeastern Turtle Priority Area USA is known as a globally significant region with high freshwater turtle species richness and endemism. One of the major river drainages of this region is the Mobile River Basin. The terminus of the Mobile River Basin is Mobile Bay and the core of the distribution of the Alabama Red-bellied Turtle (*Pseudemys alabamensis*), an endemic to coastal Alabama and Mississippi, is centered around Mobile Bay. The Alabama Red-bellied Turtle has been listed as federally endangered since 1987 yet remains one of the least studied freshwater turtles in North America. Populations of the species have been considered to be in decline due to high nest mortality, collection for pet trade, by-catch from commercial fisheries, and road mortality of nesting females and hatchlings. Recent studies have filled information gaps and an analysis of trap data spanning ca. 30 years indicate that the status of the Alabama Red-bellied turtle is more stable than thought at time of listing as an endangered species. A review of current information and data on the status of the Alabama Red-bellied turtle will be presented.
Population/Status Surveys: Oral

NAFTRG Collaborations: The Key Constituent to Chelonian Conservation Success

JORDAN GRAY AND ERIC MUNSCHER
North American Freshwater Turtle Research Group, Turtle Survival Alliance,
1989 Colonial Parkway, Fort Worth, TX 76110
[jgray@turtlesurvival.org]

The North American Freshwater Turtle Research Group (NAFTRG) is a citizen-science based constituent of the Turtle Survival Alliance. Currently, the NAFTRG has a multitude of long-term mark-recapture studies taking place in Texas, Florida, Tennessee, and with the addition of a new site(s) proposed to begin in Pennsylvania in 2017. With the addition of Pennsylvania, NAFTRG will effectively manage up to fourteen long-term population-monitoring projects across the four states. Due to the fact that the NAFTRG specializes in efforts that include community associations of multiple sympatric species, large numbers of turtles are captured during each survey. To date, more than 8,500 individual specimens and > 17,000 recaptures have been captured, processed and PIT tagged across the sites. These sites are monitored up to four-times per year, making scheduling, prioritizing and most importantly collaborating, of critical importance to the viability of the effort. Being a citizen-science based group, these collaborations have included a multitude of Colleges and Universities, public and private organizations and interest groups, and citizen naturalists, hobbyists and conservationists. In addition, to perform these studies, the NAFTRG works with various stakeholders such as State agencies and Governmental Departments, and public and private

landowners. Now in its 17th year, the NAFTRG has proven that the multitude of collaborations that make up the core of the effort has created a vast community of chelonian research, outreach and conservation.
Turtles of Springs: Oral

Demography of *Terrapene carolina major* in Coastal Mississippi

ANDREW J. HEATON[1] AND ANDREW T. COLEMAN[2]
[1]Institute for Marine Mammal Studies, Gulfport, Mississippi, USA
[2]Birmingham Audubon Society, Birmingham, Alabama, USA
[aheaton@imms.org]

Due to their longevity, chelonian population dynamics require long-term data for context. While many factors can influence change, population trends are often exacerbated by the time required for replacing mature individuals within a population. This study aimed to report on the demography of Gulf Coast Box Turtles (*Terrapene carolina major*) in an understudied portion of their range. Individuals in this study were captured from March 2012 – May 2016 in the coastal counties of Mississippi. All turtles received standard morphological measurements, and a subset of turtles captured in a smaller study site within Gulfport, Mississippi were marked for future identification. Additionally, females received radiographs for analysis of clutch size. A total of 162 turtles were sampled. Of these, 15 were recaptured at later dates. Recaptured turtles displayed some degree of intra- and inter-annual site fidelity, and one was found crossing the same road at roughly the same area once a year for four years. Our sample was 51.23% female, 36.42% male, and 12.35% juvenile, with a 1:1.41 male to female sex ratio. Mean carapace length of mature individuals was 16.53 ± 1.48 cm for males and 14.53 ± 1.94 cm for females. Eggs were detected on radiograph from the last week of May through July, and clutch size was 1-6, with an average of 4.25. Information from this study can be used to examine differences in demography and morphology among separate populations and subspecies while also providing baseline data to examine trends in the study area.
Presentation type: Poster

Captive Husbandry and Reproduction of Eyed Turtles (*Sacalia quadriocellata* and *Sacalia bealei)*

BILL HUGHES
Tennessee Aquarium, Chattanooga TN
[bhh@tnaqua.org]

Four-eyed turtles (*Sacalia quadriocellata*) are classified as Endangered by IUCN while Beal's eyed turtles (*Sacalia bealei*) are classified as Critically Endangered. Despite this, the current zoo populations of these turtles in the U.S. are still fairly small. Both species have been successfully breeding at the Tennessee Aquarium since 2007. Since the initial hatchings, the husbandry protocols used with these species have been refined and in subsequent years, the number of viable hatchlings has increased. Information on the husbandry techniques successfully used with these two species will be presented with comments on some issues that need further work.
Zoos and Chelonians: Oral

Integrative Taxonomy of Southeast Asian Snail-eating Turtles (Geoemydidae: *Malayemys*) Reveals a New Species and Mitochondrial Introgression

FLORA IHLOW[1], MELITA VAMBERGER[2], MORRIS FLECKS[1], TIMO HARTMANN[1], MICHAEL COTA[3,4], SUNCHAI MAKCHAI[3], PRATHEEP MEEWATTANA[4], JEFFREY E. DAWSON[5], LONG KHENG[6], DENNIS RÖDDER[1], UWE FRITZ[2]
[1]Herpetology Section, Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany. [F.Ihlow@ZFMK.de] [M.Flecks@ZFMK.de] [T.Hartmann@ZFMK.de]
[2]Museum of Zoology, Senckenberg Dresden, Dresden, Germany. [Melita.Vamberger@senckenberg.de] [Uwe.Fritz@senckenberg.de]
[3]Thailand Natural History Museum, National Science Museum, Khlong Luang, Pathum Thani, Thailand. [herpetologe@gmail.com] [sunchaimakchai@yahoo.com]
[4]Phranakhon Rajabhat University, Bang Khen, Bangkok, Thailand. [drpratheep@gmail.com]
[5]Charles H. Hoessle Herpetarium, Saint Louis Zoo, St. Louis, Missouri, United States of America. [jeffrey.e.dawson@gmail.com]

[6]*General Department of Administration for Nature Conservation and Protection, Ministry of Environment, Chamkar Mon, Phnom Penh, Cambodia.*
[moe.tonlesap@gmail.com]

Based on an integrative taxonomic approach, we examine the differentiation of Southeast Asian Snail-eating Turtles using information from 1863 bp of mitochondrial DNA, 12 microsatellite loci, morphology and a correlative species distribution model. Our analyses reveal three genetically distinct groups with limited mitochondrial introgression in one group. All three groups exhibit distinct nuclear gene pools and distinct morphology. Two of these groups correspond to the previously recognized species *Malayemys macrocephala* (Chao Phraya Basin) and *M. subtrijuga* (Lower Mekong Basin). The third and genetically most divergent group from the Khorat Basin represents a previously unrecognized species. Historic fluctuations in potential distributions were assessed using species distribution models (SDMs). The Last Glacial Maximum (LGM) projection of the predictive SDMs suggests two distinct glacial distribution ranges, implying that the divergence of *M. macrocephala* and *M. subtrijuga* occurred in allopatry and was triggered by Pleistocene climate fluctuations. Only the projection derived from the global circulation model MIROC reveals a distinct third glacial distribution range for the newly discovered *Malayemys* species.
Genetics: Oral (Student)

Unexpected Lack of Genetic and Morphological Divergence in a Widespread Tortoise: Phylogeography of *Indotestudo elongata*

FLORA IHLOW[1], CÄCILIA SPITZWEG[2], MORRIS FLECKS[1], TIMO HARTMANN[1], UWE FRITZ[2]
[1] *Herpetology Section, Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany.*
[F.Ihlow@ZFMK.de] [M.Flecks@ZFMK.de] [T.Hartmann@ZFMK.de]
[2] *Museum of Zoology, Senckenberg Dresden, Dresden, Germany*. [*Caecilia.Spitzweg@senckenberg.de]*
[Uwe.Fritz@senckenberg.de]

The Elongated Tortoise *Indotestudo elongata* occupies a wide distributional range in Southeast Asia covering several well-known zoogeographic barriers. Across its range, the species shows a high variability in size, shape, and coloration. We examined 163 adult tortoises (76 males and 87 females) from Vietnam, Cambodia, Myanmar, and Thailand for morphometric and coloration-related characters. Multivariate statistical analyses were performed to quantify morphological variation and to identify potential underlying geographic patterns. Intraspecific genetic differentiation of 17 specimens of *I. elongata* was assessed by analyzing mitochondrial DNA (COI, ND4, and cyt *b*) obtained from fresh samples as well as from historic collection material from throughout the species' range. For historic samples PCR primers for the amplification of variable regions of the respective genes were developed using sequences from fresh samples and GenBank. Samples were subsequently amplified in series of short fragments of 160–270 bp and all precautions for aDNA work were taken (DNA extraction in a clean room, etc.). Morphological analyses revealed no differences between geographic groups. Concordantly, there was only minor genetic variation within the examined samples of *I. elongata*, lacking a clear geographic pattern. Although we found high morphological and moderate genetic variability, the Elongated Tortoise exhibits no variation that is correlated with the geographic origin of the samples. Considering its wide distributional range, it is surprising that none of the current zoogeographic barriers in Southeast Asia seems to have had a major influence on intraspecific variability.
Presentation type: Poster (Student)

Olfaction as Cue for Nest-Site Choice in Painted Turtles

JOHN B. IVERSON, HANNA KLONDARIS, CHRISTOPHER ANGELL, AND WENDY P. TORI
Department of Biology, Earlham College, Richmond, Indiana 47374 USA
[johni@earlham.edu]

Nest-site choice in turtles has a demonstrated impact on their fitness. Previous studies of nest-site choice have focused on environmental factors potentially affecting that choice (e.g., temperature, insolation, soil type or moisture, etc.). Observations of nesting of painted turtles (*Chrysemys picta*) at the Crescent Lake National Wildlife Refuge in the Nebraska Sandhills suggest that females might use olfactory cues (specifically odors of other nesting females) to choose nest sites. We tested this hypothesis indirectly by using the nearest neighbor (nest) distance algorithm in ArcMap 10.1. Our results for nests in 2012-2014 were mixed, with nesting at some sites, in some years, and by some turtles occurring non-randomly, in very close proximity to previous nests. Preliminary experimental data from 2015 using urine-treated sites in primary nesting areas also suggested that females showed more interest in those sites than sites moistened with equal amounts of water. These data

provide some support for the use of nest odor as an important cue for nest-site choice in turtles, but they are insufficient to reject the possibility of the simultaneous use of other fine-scale environmental cues.
Reproductive Ecology: Oral

The Protection and Artificial Breeding of *Platysternon megacephalum* in Southern Anhui Province, China

YELIN JIANG[1,2,3], FEN WANG[2,3], GUANJUN HOU[1,2,3], YUNSHENG CEHNG[1,2,3], JING ZHANG[1,2,3]
[1] Fishery Institute, AnHui Academy of Agricultural Science, HeFei, AnHui, China
[2] Anhui Engineering Research Center for turtle Farming Technology, HeFei, AnHui, China
[3] Fisheries Academician Workstation of Anhui Academy of Agricultural Sciences, HeFei, AnHui, China
[jiangyelin@qq.com]

The Bigheaded Turtle, *Platysternon megacephalum*, is primarily distributed in montane creeks of southern China. This species has relatively large head that can't be withdrawn into its shell and a long tail which aid in climbing over boulders or grasping rocks. In recent years, the habitat loss and over-fishing have impacted populations of *P. megacephalum*. Moreover, low fertility and high hatchling mortality have also contributed to the decreasing number of wild *P. megacephalum*. This species is critically endangered and was listed as appendix I of CITES in 2013. Conservation measures enacted to protect the species include *in situ* conservation and captive breeding. The *P. megacephalum* breeding facility is based in a broad flat valley of mountain area of Southern Anhui province. The monthly average maximum and minimum temperature is 27.9 and 3.7℃, respectively. The breeding pool is 3-6 m^2 and the wall is 40-50 cm high. One third of the sandy sediment bottom is land for activities and spawning, two third is immersed in water and the water is 15-30 cm deep. Stream water is diverted directly to the breeding tank. *Platysternon megacephalum* usually mate from Sep. to Oct., and lay eggs from June to mid-August in the following year. The long of eggs are in the range of 47.61-51.27 mm, the short diameters are 18.6-20.37 mm, and the weights are about 9.9-12.3 g. The juvenile is incubated by no media innovation patented technology at room temperature 25-30℃ and humidity 80-83%. Juveniles hatch after approximately 88 days.
Captive Husbandry: Oral

The Protection and Artificial Breeding of *Cuora flavomarginata* in Dabie shan Mountain Area, China

YELIN JIANG[1,2,3], FEN WANG[2,3], GUANJUN HOU[1,2,3], YUNSHENG CEHNG[1,2,3], JING ZHANG[1,2,3]
[1] Fishery Institute, AnHui Academy of Agricultural Science, HeFei, AnHui, China
[2] Anhui Engineering Research Center for turtle Farming Technology, HeFei, AnHui, China
[3] Fisheries Academician Workstation of Anhui Academy of Agricultural Sciences, HeFei, AnHui, China
[jiangyelin@qq.com]

Cuora flavomarginata (*Cistoclemmys flavomarginata*) primarily distributed in the hilly landscape of Dabie shan mountain area in central and southern China. In recent years, the nature habitat loss and over-exploitation caused great threats to *C. flavomarginata*, which has been list in International Union for Conservation of Nature (IUCN) and Convention on International Trade in Endangered Species (CITES). This species usually mate from mid-April to October and spawn from May to September in the following year. During the breeding season, *C. flavomarginata* (about 500 g) are put into the breeding pool at a density of turtles/m^2 and a male and female ratio of 1:2. One female may breed several times in a year and producing 2-4 eggs for every successful breeding event. The eggs are oblong, 42-47 mm in length, and e 42-47 mm in width with a mass of 8.5-20 g. It's worthy to mention that the white patch (animal pole) must always keep upward during incubation, and the eggs should be moved as little as possible. The juvenile is incubated in the sand (diameter 0.5-0.6mm) at room temperature 28-32℃, the air humidity 80-85% and the sand humidity 7%-9%. Incubation lasts approximately 85 days.
Presentation type: Poster

Changes in Turtle Density and Assemblage Structure in a Florida Spring-fed River

GERALD R. JOHNSTON[1], JOSEPH C. MITCHELL[2], AND ERIC MUNSCHER[3,4]
[1]Department of Natural Sciences, Santa Fe College, Gainesville, Florida, 32606, USA [jerry.johnston@sfcollege.edu]
[2]Florida Museum of Natural History, University of Florida, Gainesville, Florida, 32611, USA [dr.joe.mitchell@gmail.com]
[3]SWCA Environmental Consultants, Bridgeville, Pennsylvania, 15017, USA [emunscher@swca.com]
[4]Turtle Survival Alliance - North American Freshwater Turtle Research Group, Fort Worth, 76110, Texas, USA

The Ichetucknee River (IR) is a spring-fed ecosystem in northern Florida that harbors a rich turtle assemblage within one of Florida's most heavily visited state parks. To inform management decisions in Ichetucknee Springs State Park, an initial survey of the resident turtle populations was conducted in 2007. We conducted a follow-up survey in 2014 using the same protocols that were used in 2007 to determine whether turtle density and assemblage structure had remained the same. Within the same 5.16 km section of the river, similar numbers of snorkelers hand-captured more species in 2014 (n = 9) than in 2007 (n = 7) and revealed a shift in the numerically dominant species from *Sternotherus minor* to *Pseudemys suwanniensis*. This shift was primarily attributed to a 450 % increase in *P. suwanniensis* density from 2007 to 2014. We hypothesize that this increase may be related to changing ecological conditions in the Santa Fe River (SFR) which receives flow from the IR. During 2013 and 2014, we witnessed a decrease in submerged aquatic macrophyte abundance in the SFR. With less available food in the SFR, the herbivorous *P. suwanniensis* apparently shifted to using heavily vegetated spring habitats such as the IR more than in previous years. Evidence of movement from the SFR to the IR comes from 15 individuals that had been captured and marked in the SFR in previous years but appeared in the IR in 2014. Furthermore, 55 individuals in the 2014 survey had propeller scars on their shells, a type of damage that must have occurred when the turtles were in the SFR or Suwannee River. Motorized boats are prohibited in the IR. Continued annual surveys of the turtle assemblages in the Ichetucknee, Santa Fe, and Suwannee Rivers and associated springs will enhance our emerging understanding of the interconnectedness of these ecosystems.
Turtles of Springs: Oral

A Cooperative Multi-Agency Approach to Provide Conservation for the Sonoran Desert Tortoise

CRISTINA A. JONES[1], JON COOLEY[1], TIM HUGHES[2], SHAULA HEDWALL[3], AND BRIAN J. WOOLDRIDGE[3]
[1]Wildlife Management Division, Arizona Game and Fish Department, Phoenix, Arizona 85086
Arizona State Office, [2]Bureau of Land Management, Phoenix, Arizona 85004
[3]Arizona Ecological Services Office, U.S. Fish and Wildlife Service, Flagstaff, Arizona 86005 [cajones@azgfd.gov]

Since the 1980s, the Arizona Game and Fish Department has actively monitored Sonoran Desert Tortoise (SDT) (*Gopherus morafkai*) populations throughout their range in Arizona. Analyses of the capture-recapture data on 17 long-term monitoring plots suggest that survivorship is high (>90% in most locations). However, while there is no evidence for a declining trend in survival, we recognize that populations face a number of serious threats, including habitat destruction and fragmentation, degradation caused by invasive nonnative plant establishment, altered fire regime, urbanization and development, and human-constructed barriers to movement. The U.S. Fish and Wildlife Service found in 2010 that listing the SDT as threatened was warranted due in part to these and other threats identified in a petition. Due to a subsequent lawsuit and settlement agreement, the Service was required to make a final listing decision by October 2015. In September 2014, biologists from the Department, Bureau of Land Management and the Service met to build the framework for a Candidate Conservation Agreement (CCA) for the SDT. CCAs are formal, voluntary agreements between the Service and one or more parties to address the conservation needs for candidate species. In the CCA, participants voluntarily commit to implement specific actions designed to remove or reduce threats, so that listing may not be necessary. The SDT CCA was developed as a cooperative effort among 14 federal and 2 state agencies to provide a comprehensive conservation framework to implement effective conservation and management of the SDT in Arizona. The CCA is designed to encourage, facilitate, and direct conservation actions across multiple agencies that have the ability to influence the species' conservation in Arizona. This coordinated approach allows for a uniform reporting, integrates monitoring and research efforts with management, and supports ongoing conservation partnership formation. The CCA was routed for signature in March 2015, and the implementation of the conservation measures was considered in the Species Status Assessment and subsequent not warranted listing decision. To expand the collaborative success of the CCA, the Department and Service are developing a CCA with Assurances (CCAA), engaging non-traditional partners in voluntary proactive conservation through assurances that preclude the possibility of incurring additional obligations.
Conservation & Policy in North American Chelonians: Oral

Blanding's Turtle and Wood Turtle Conservation in the Northeastern USA: Examples of Regional State Wildlife Grants (SWG) Partnerships for the Conservation of Petitioned Turtles

MICHAEL T. JONES*, LISABETH L. WILLEY*, MICHAEL MARCHAND, PAUL SIEVERT, THOMAS S. B. AKRE, GLENN JOHNSON, LORI ERB, ANGELENA ROSS, DEREK YORKS, PHILLIP DEMAYNADIER, ELLERY RUTHER, JEFF DRAGON, LORIEN LEMMON, JONATHAN MAYS, KATHY GIPE, J.D. KLEOPFER, CHRIS URBAN, SCOTT ANGUS, STEVE PARREN, JAMES DRASHER, STEPHANIE KOCH, ANTHONY TUR, BRIAN ZARATE, EDWARD THOMPSON, PATRICK ROBERTS, DANA SHEEDY, ANDREW WHITELEY, BARRY WICKLOW, KIERAN O'MALLEY, JENNY DICKSON, DENNIS QUINN

**Corresponding authors: Mass. Division of Fisheries and Wildlife, Westborough, MA 01581 [michael.t.jones@state.ma.us] American Turtle Observatory, New Salem, MA 01355 [lisabeth.willey@gmail.com]*

Regional conservation planning programs are currently underway in the Northeastern USA for two long-lived, semi-terrestrial freshwater turtles: *Emydoidea blandingii* (Blanding's Turtle) and *Glyptemys insculpta* (Wood Turtle). Both species rely seasonally on wetland and upland habitats, have life history characteristics that make populations especially vulnerable to adult mortality due to habitat fragmentation, are of conservation concern throughout the region, are listed as "Endangered" by the IUCN, and have been petitioned for listing under the ESA. The Northeast Blanding's Turtle Working Group, composed of representatives from wildlife agencies, universities, and NGOs from five northeastern states, initially collaborated on the development of a regional status assessment in 2007 and finalized a comprehensive Blanding's Turtle Conservation Plan and monitoring program in 2014 with funds from the U.S. Fish and Wildlife Service Competitive State Wildlife Grants (SWG) Program. Our hierarchical monitoring framework resulted in standardized sampling across 148 sites, allowing us to assess the species' distribution and genetic structure, develop a conservation area network and demographic baselines to evaluate change over time, and to adaptively assess the effectiveness of conservation actions. Based on empirical survey data and habitat suitability models, we mapped the highest priority sites in the region, developed site-specific management plans, and identified "site leaders" to advance conservation objectives at each site. In 2016, the five states were awarded a second Competitive SWG grant to implement necessary conservation actions at priority sites. The Northeast Blanding's Turtle effort has served as a model for a parallel conservation program for *G. insculpta* from Maine to Virginia. The Northeast Wood Turtle Working Group also received a Competitive SWG award and has implemented a standardized, hierarchical monitoring protocol since 2012, conducting >1600 surveys of >350 sites throughout the Northeast, yielding more than 3300 individual wood turtle detections. We are currently finalizing a conservation plan, conservation area network, and implementation plan for the species that incorporates genetic and landscape information and empirical survey data. We will give a brief overview of the Northeast Blanding's Turtle and Wood Turtle Conservation Plans, describe the process and lessons learned, and outline our implementation framework and future directions.

Conservation & Policy in North American Chelonians: Oral

A New Reserve for the Critically Endangered South African Geometric Tortoise (*Psammobates geometricus*)

JAMES O. JUVIK, A. ROSS KIESTER & ERIC GOODE

Turtle Conservancy, 49 Bleecker St. Suite 601, New York City New York 10012 [jim@turtleconservancy.org]

The Turtle Conservancy and partners are excited to announce that over the past twelve months we have been able to purchase a total of 812 acres of Alluvial Fynbos tortoise habitat in the Breede River Valley near Cape Town. This is one of the largest remaining fragments of this rapidly disappearing endemic vegetation biomes in the unique Cape Floral region, and is home to the last significant, sustainable population (more than 500 individuals) of what is considered one of the world's most endangered tortoise species, the Geometric Tortoise *(Psammobates geometricus.)* The new reserve presents significant management challenges due to a range of incompatible adjacent land uses including industrial and agricultural activities, as well as major highways and rail lines. The provincial conservation agency CapeNature, and other South African conservationists and scientists are partnering in reserve management. Although the Fynbos ecosystem in this summer-dry Mediterranean climate is naturally fire adapted, fire frequency in the area is greatly increased by anthropogenic activities which ultimately kill tortoises and degrade habitat, encouraging invasion by alien plant species such as the Australian wattle (*Acacia saligna*). Suppression of wild fires, but the judicious use of controlled small burns (with temporary prior relocation of tortoises) is essential to creating a mosaic of successional vegetation units critical to the sustainability of tortoise population. Natural tortoise predators (e.g. the African Pied Crow *Corvus albus*) are heavily subsidized by surrounding human activities in the region and their elevated abundance severely threaten juvenile tortoise survivorship. Fencing and predator control are key components of reserve management

Conservation Programs: Oral

A Review of Distribution and Status of Freshwater Turtles in Sindh and Khyber Pakhtunkhwa Provinces of Pakistan

M ZAHEER KHAN, AMTYAZ SAFI, FARINA FATIMA, AND SYED ALI GHALIB
Department of Zoology, University of Karachi, Karachi-75270, Pakistan
[zaheer@scspkarachi.org]

Studies on the distribution and status of freshwater turtles were conducted in Sindh and Khyber Pakhtunkhwa (KPK) Provinces of Pakistan. The objective of this study was to determine the population distribution, status and abundance of freshwater turtle species in two provinces. Several survey techniques like Transact Method, Capture through Nets, Boat Surveys, Presence of Signs etc were employed for observation and census of turtles. Eight species - *Lissemys punctata, Pangshura smithii, Pangshura tectum, Chitra indica, Nilssonia gangeticus*, *Nilssonia hurum, Hardella thurjii,* and *Geoclemys hamiltonii* were recorded. In Sindh, *Geoclemys hamiltonii* was recorded as rare in Badin, Sanghar and Sukkur districts, while other species were abundant, common or uncommon. *Pangshura tectum* was recorded only from Sukkur district, while *Chitra indica* was recorded in all the four selected districts of Sindh. *Geoclemys hamiltonii* was recorded only in D.I. Khan district of KPK. *Lissemys punctata* was the most abundant and most widely distributed species in Khyber Pakhtunkhwa. Population of freshwater turtles in Sindh is much higher than that in Khyber Pakhtunkhwa Province. It is concluded that due to anthropogenic activities like agricultural farming, habitat destruction, and eutrophication population of *Geoclemys hamiltonii* has also decreased in Sindh.

Population/Status Surveys: Oral

Artificial Reproductive Techniques to Rescue the Critically Endangered Giant Yangtze Softshell Turtle *Rafetus swinhoei* from Extinction

GERALD KUCHLING[1], LU SHUNQING[2], YAN XIAHUI[3], CHEN DAQING[4], BARBARA DURRANT[5], PAUL CALLE[2], DI MIN[4], EMILY KING[1], YANG JUNLONG[3], LU QINGTAO[3], AND SUN AIGUO[4]
[1]Turtle Survival Alliance
[2]Wildlife Conservation Society
[3]Changsha Zoo
[4]Suzhou Zoo
[5]San Diego Zoo Institute for Conservation Research
[Gerald.Kuchling@uwa.edu.au]

The critically endangered Giant Yangtze Softshell Turtle *Rafetus swinhoei* is the world's most endangered chelonian, with only two specimens known to be alive in China and one in Vietnam. Despite eight years of captive breeding attempts in China, all eggs produced so far were infertile. The examination of Suzhou Zoo's last old *Rafetus swinhoei* male in May 2015 revealed a heavily damaged and scarred penis without any traces of the appendices with seminal grooves typical for softshell turtles, suggesting he is unable to successfully inseminate Changsha Zoo's last known female of the world. However, a low volume of semen collected by electroejaculation contained a low density of partly motile sperm, demonstrating that he was still producing sperm. The semen was inseminated by cloacoscopy into the urodeum of the female. Both the male and the female had to be tranquilized for these procedures. Although none of the eggs of the subsequently laid three clutches showed any development, the only perivitelline membrane which could be recovered from one egg in October 2015 showed an embedded sperm head. Since in a previous study no perivitelline sperm heads had been detected in 15 eggs examined in 2014, this finding demonstrated that the first artificial insemination in 2015 allowed some sperm to reach the upper oviduct area where fertilization has to take place. An attempt to collect semen again by electroejaculation in October 2015 was unsuccessful, but in early April 2016 a semen sample was collected with much higher sperm density than in May 2015. To increase the chances for sperm to reach the upper oviducts, the semen was surgically injected into the vaginal/uterine parts of both oviducts by coelioscopy (laparoscopy). Results regarding egg development were not yet available by mid-June 2016.

Disease and Medical: Oral

Using Nature as a Model: Successfully Maintaining Blanding's turtle (*Emydoidea blandingii*) in Captivity Through Replication of Wild Habitat

CHRIS LEONE
Garden State Tortoise, Freehold, NJ
theTurtleRoom, P.O. Box 521, Lititz, PA 17543
[chrisleone@gardenstatetortoise.com]

The Blanding's turtle *(Emydoidea blandingii)* is a medium to large sized North American emydid found in disjunct populations in New York and New England with its main strongholds located around the Great Lakes region. One population found in Minnesota is doing well despite the species' overall decline throughout its range. In June of 2015 I was fortunate enough to visit this location alongside the Division of Natural Resources which enabled me to learn quite a bit about the natural habitat and behavioral patterns the turtles exhibit. For more than a decade I have maintained Blanding's turtles in outdoor enclosures at my own facility with limited success until recent years. Being subjected to their wild home and absorbing the detail in everything from plant life, soil consistency, sun intensity and water has led to the creation of a much more suitable captive environment for my own turtles. In much of the literature available to enthusiasts worldwide, outdated information still exists pertaining to the construction of turtle habitats in human care including diet in captivity. Some of this information is simply too general while some is no longer accepted at all. *Emydoidea blandingii* is somewhat of a habitat specific species in that they seek out appropriate conditions often moving from one place to another several times during their active season. The general and all too broad way of building an aquatic turtle environment does not apply to this species. Being one of the few semi-aquatic chelonians that is capable of consuming food on land as well as in the water, the construction of an adequate terrestrial area within the designated enclosure is one focal point that is often left out. This results in overly stressed specimens and a severe drop in reproduction. Taking what I learned from the field and graciously administering it to my own captive habitat for the turtles has resulted in the evolving of a highly naturalistic setting which closely replicates where they occur. This in return has promoted normal behavioral patterns, healthier specimens and an increase in reproduction. Surveying the wild turtles and niches located within their main habitat as well as length of winter and sex ratio has also contributed to captive success here. This presentation will share tips and methods with those interested in properly housing *Emydoidea blandingii* in order to shed some light on an otherwise poorly understood yet truly remarkable freshwater turtle.
Captive Husbandry: Oral

Status of *Testudo graeca nikolskii* at the Abrau Peninsula (North-Western Caucasus, Russia)

OLGA LEONTYEVA[1] AND SOLOMON PERESHKOLNIK[2]
[1]Dep. Biogeography, Fac. Geography, Moscow State University, Moscow, Russia, 119991 [*leontolga@mail.ru*]
[2]Bolshaia Gruzinskaia str., Moscow Zoo, Moscow, Russia

The area of *Testudo graeca nikolskii* covers the narrow coastal part of the Black Sea from the Abrau Peninsula at the north-west down to the Petsunda Peninsula at the south-east. Up to 20-30% of the total number of the subspecies (near 5-6 thousand individuals) inhabits the low mountains of the North-Western Caucasus at the Abrau Peninsula with xerophytic forests of the Mediterranean type. The purpose of the study was to investigate the present day status of *T.g.nikolskii* population at the North-Western Caucasus. Research on the tortoises at the Abrau Peninsula have been conducted since 1991 at the sample squares and tracks using the standard methods. During 15 years near 900 individuals of the tortoises of different age-size categories were caught. The tortoises prefer to inhabit (>40 ind./km2) the gentle slopes of the southern aspect at the height 100 m above sea level covered with bushes, shiblyak, rock-oak forests and woodlands of juniper and pistachio. The main part of the population consists of the tortoises 25-30 years old with the carapace length 17,5-22,5 см (62 % of females and 72 % of males). The young males grow quicker than the females. But later their growth becomes slower. Because of that the picks of male and female carapace sizes are not the same: males – 17,5-20 sm., females – 20-22 sm. There are three times more females with size 25-30 sm than males. That was the characteristic for nearly all years of the researches. The small number of caught young tortoises (< 100 mm – 10%, 100-150 mm – 9%) can be as a result of difficulties in finding them in nature. Inozentsev and Pereshkolnik have got the same picture of sex-age structure for 96 tortoises in 1985. They prognosed that the population will disappear in 10-15 years. But till now the picture didn't change. So we can say that the tortoise population is more or less stable at the Abrau Peninsula. Utrish reserve was created in 2010 to protect *T.g. nikolskii* population and its habitats.
Population/Status Surveys: Oral

***Chinlechelys*: North America's Oldest Turtle and its Impact on Theories of Turtle Origins**

ASHER J. LICHTIG AND SPENCER G. LUCAS
New Mexico Museum of Natural History and Science, 1801 Mountain Rd. NW, Albuquerque, NM 87104
[ajlichtig@gmail.com]

The turtle *Chinlechelys* shows a stage in the development of the turtle shell prior to more derived turtles such as *Protochersis* and *Proganochelys*. While the preserved portions of the plastron are similar to those of *Odontochelys*, the carapace shows a

more advanced state. This carapace differs from all other turtles with the exception of *Dermochelys*, in that the ribs and overlying osteoderms are not nearly parallel, instead crossing at a 45° angle. Further, the morphology of these costals leads us to infer a terrestrial habit based on the occurrence of raised bosses perpendicular to the midline of the animal as well as the occurrence of near right angles in the costals, both of which would incur a significant hydrodynamic penalty. The carapace of *Chinlechelys* resembles that of *Dermochelys,* which has often been referred to as neonate in its morphology. We also suggest that this indicates some of the unique features of *Dermochelys* are reversals to the primitive state following the notion that ontogeny mirrors phylogeny. Based on this comparison we speculate that the carapace may not have been absent in *Odontochelys* but rather made up of a great many separate osteoderms that were disarticulated following death. Further, we suggest that *Odontochelys* represents a side branch of turtle evolution---likely an early sea turtle, as some have suggested--rather than the ancestor of all later turtles. This is primarily based on the derived state of lacking a bony attachment between the pelvis and the vertebral column, which is absent in all other uncontroversial stem turtles. *Pappochelys* is here disregarded as relevant to the origin of turtles based on our conclusion that the features linking it to turtles identify it as a basal placodont. Based on the presence of turtle footprints in the lower Middle Triassic true, turtle-like animals must have evolved by that time. These footprints are unlikely to have been made by *Odontochelys,* given its unique pelvis morphology.
Origins, Patterns, & Changes: Oral

Growth of the Early North American Tortoise *Stylemys nebrascensis*
ASHER J. LICHTIG AND SPENCER G. LUCAS
New Mexico Museum of Natural History and Science, 1801 Mountain Rd. NW, Albuquerque, NM 87104
[ajlichtig@gmail.com]

The early growth of the Eocene-Oligocene turtle *Stylemys* was preliminarily assessed based on a group of seven partial skeletons from a single locality in Nebraska. These seven shells were closely associated, meaning that they are from the same time and geographic area and thus are taken to represent a population sample. These skeletons range from 59 to 163 mm in plastron length and show remarkably linear growth changing little in shape over this time. Most change results from a relative widening of the shell over time. Attempting to estimate age based on plastron scute rings indicates that these turtles ranged from two to six years old with age and length correlating well. Using the equation of growth ($y = 32.524x^{0.7353}$) derived from this sample and other published *Stylemys* ages, an estimated age of 30 years is obtained for the 400 mm long plastral specimen examined. Further, from this the largest (~900 mm) specimens reported would be approximately 90 years old. Examining the variation in plastral sulci lengths, as with *Gopherus agassizii,* the gular scutes are the most variable in size relative to the total plastron length. There is less variation in the femoral, pectoral, anal, humeral measurements, and variation is lowest in the abdominal scutes.
Presentation Type: Poster

A Preliminary Examination of the Relative Abundance of *Graptemys pearlensis* and *Graptemys oculifera* in the Upper Pearl Drainage of Mississippi: Tributaries, Dam Effects, and New Distributional Records
PETER V. LINDEMAN
Department of Biology and Health Services, Edinboro University of Pennsylvania
[plindeman@edinboro.edu]

The Pearl map turtle (*Graptemys pearlensis*) and Pascagoula map turtle (*Graptemys gibbonsi*) are being considered by the U.S. Fish and Wildlife Service for listing under the Endangered Species Act. In 2015, the first year of a five-year assessment of populations, I surveyed basking turtles at a variety of bridge crossings and on boat surveys to ascertain the status of the *G. pearlensis* in the upper half of the Pearl River drainage. Counts of basking turtles were made both in density surveys from a jonboat or canoe and in counts from bridges, boat ramps, or other fixed access points. A congener federally listed as Threatened since 1986, the ringed sawback (*Graptemys oculifera*), predominated at sites on most of the mainstem Pearl River and reached its highest densities (to 83 turtles per river kilometer) in sluggish reaches leading into a large reservoir. The relative abundance of *G. pearlensis* increased in tributaries of the Pearl and in the river's uppermost portion, achieving predominance over *G. oculifera* in some reaches and being recorded substantially farther upstream. Additional turtle species observed at lower basking densities included *Pseudemys concinna*, *Trachemys scripta*, *Sternotherus carinatus*, *Apalone spinifera*, *Apalone mutica*, *Macrochelys temminckii*, *Chelydra serpentina*, *Sternotherus odoratus*, *Chrysemys picta*, and *Deirochelys reticularia*. Results were similar to findings for other sympatric species pairs of the genus *Graptemys* in Gulf Coastal drainages in the overall predominance of the narrower-headed, less molluscivorous species contrasting with increased

predominance and greater range extension of the broader-headed, more molluscivorous species at upstream and tributary localities. In addition, the high ratio of *G. oculifera* to *G. pearlensis* in regions where a major dam slows the flow of the Pearl River and a tributary resulted not only from increased density of the former, but also lowered density of the latter in these regions. Finally, new tributary records and range extensions within known tributaries were also recorded for both species of *Graptemys*.
Population/Status Surveys: Oral

Growing Pains: Tips for Providing Natural Browse and Forage for Large Collections

JAMES LIU
Turtle Conservancy, Ojai, California, USA

Turtles and tortoises inhabit a wide range of habitats and individual species can vary greatly in their food preferences. Whether herbivorous, carnivorous, or somewhere in between, all chelonians can benefit greatly from natural browse and forage in zoo collections. This dietary addition is useful both in providing balanced nutrition and micronutrients, but also in meeting basic behavioral enrichment needs for these animals. Natural plant or live forage and browse in zoo collections often cater towards mammalian species. Niche species, such as turtles and tortoises, are often overlooked. However, providing these additions to the diets to even large chelonian collections is possible with minimal investment and can greatly enhance the longevity of individuals and provide stimulation to animals and visitors alike. Raising live foods such as worms, snails, cockroaches and mosquitos can feed all life stages of carnivorous animals. Similarly, raising hardy, drought resistant and native plants both inside and outside enclosures are a way to provide nutrition and enrichment in a variety of climates. Micronutrients can also be provided through a variety of supplements. Examples of each of these food sources are illustrated through various zoo and private collections.
Zoos and Chelonians: Oral

A Gut Feeling: A brief summary of commensal and pathogenic GI organisms in Chelonians

JAMES LIU
Turtle Conservancy, Ojai, California, USA

Various studies have revealed complex bacterial, fungal, and protozoal communities in the gastrointestinal tract of chelonians. Bacterial composition is generally anaerobic and aerobic gram-positive and gram-negative bacteria. For many omnivorous and herbivorous chelonians, these commensal bacteria play an integral role in hindgut fermentation and nutrient extraction. Similarly, many fungal and protozoal colonies exist as a part of the natural gut ecosystem. However, dysbiosis of gut flora can be brought on by stress, improper diet, drug administration, and disease. In many instances, this can give rise to larger, uncontrolled populations of pathogenic organisms and parasites. Many common pathogenic gastrointestinal issues in zoological collections include bacteria (E. coli, Klebsiella spp., Salmonella spp., Enterococcus spp., Pseudomonas spp., Clostridium spp., Corynebacterium spp., Staphylococcus spp., Pasturella spp.), protozoa (coccidia, isospora, cryptosporidium), and parasites (nematodes, strongyloids, trematodes, etc). Diagnostic testing in reptiles is a relatively new field and a summary of techniques will be described to ensure accurate and cost-effective tools for collections. There is also growing evidence that probiotics, nutrition, and translocation of gut flora from adults to neonatal or juvenile chelonians may aid overall GI health.
Zoos and Chelonians: Oral

Spatial Niche Distribution and Forecast of Habitat Loss of Two Mexican Mud Turtles *Kinosternon hirtipes* and *Kinosternon integrum*: Climate Change Effects in Widespread Distributed Species

RODRIGO MACIP-RÍOS[1], ALEJANDRO MONTIEL[1], CHRISTIAN BERRIOZABAL[2], SAÚL LÓPEZ[2], AND OSCAR FLORES-VILLELA[3]
[1]Escuela Nacional de Estudios Superiores, Unidad Morelia, Universidad Nacional Autónoma de México, Morelia, Michoacán, México
[2]Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, Pachuca, México
[3]Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad de México, México
[rmacip@enesmorelia.unam.mx]

Climate change is an important factor in the biodiversity loss phenomenon. Climate change in ectotherms could potentially modify their distribution range due the reduction of preferred environmental characteristics (potential spatial niche). Wide distributed species have better chances to survive climate change effects, however, distinctive biological entities with limited distribution (subspecies or rare haplotypes) could be threatened by climate change. We modeled the potential and 2050 and 2070 broadcast distribution for the two widely distributed freshwater turtles in Mexico: *Kinosternon integrum* and *K. hirtipes*. To construct the potential spatial niche, we used records from collections, public, own, and shared data bases with WorldClim layers. We used three climate change scenarios from the IPCC: low (greenhouse gases falling after mid-century), middle (greenhouse gases increasing gradually but stabilizing by the end of century), and high (greenhouse emissions increasing all century-"Business as usual"). Models were performed in Maxent and validated with AUC. Potential distribution for both species overcome their known distribution. *K. integrum* models recognizes isothermality, precipitation, and temperature seasonality as main variables explaining its distribution (AUC = 0.983). *K. hirtipes* models identifies precipitation seasonality, isothermality, temperature, and precipitation of the driest and coldest quarters describing its potential distribution (AUC = 0.986). *K. integrum* 2050 forecast in the low, middle, and high scenarios, predicts an increase in its potential distribution, but a reduction in the Acapulco area (type locality). For *K. hirtipes,* in the 2050 forecast, low, middle, and high scenarios increase the potential distribution of the species, but important reduction occurs in the distribution area of the microendemic subspecies from Michoacan, Valley of Mexico, and Viesca Region in Coahuila. The 2070 forecast for *K. integrum* showed an increase in its potential distribution through Northwestern Mexico and a slight reduction in their actual distribution in Southern Mexico (Guerrero and Michoacan). For *K. hirtipes*, 2070 forecast, a severe loss was projected for southern subspecies and populations of *K. h. murrayi*. Potential distribution for *K. hirtipes* is projected to shift to Northeastern Mexico and Southern Texas. *K. hirtipes* seems to be more affected by climate change than *K. integrum*.
Origins, Patterns, & Changes: Oral

Habitat Selection and Movement Patterns by the Gulf Coast Box Turtle (*Terrapene carolina major)* on the Florida Panhandle

JESSICA MECK[1,2], MICHAEL JONES[2], AND LISABETH WILLEY[1,2]
[1]Department of Environmental Studies, Antioch University New England, 40 Avon Street Keene, New Hampshire 03431
[2]American Turtle Observatory, 90 Whitaker Road, New Salem, Massachusetts 01355
[jmeck@antioch.edu]

Habitat use and home range size of the Gulf Coast Box turtle (*Terrapene carolina major*) are not well understood. Although its phylogenetic placement within *T. carolina* is poorly resolved, *T. c. major* is thought to be more aquatic than most other *T. carolina* lineages. An improved understanding of *T. c. major's* behavior and movement patterns can inform management decisions to advance their conservation. Our objectives in the present study are to evaluate seasonal home range and habitat selection of *T. c major* in the Florida Panhandle, to compare their ecology, seasonal behavior, and demography to that of other *T. carolina* subspecies, and to assess the causative factors associated with road mortality. Twenty adults (11 male and 9 female) at five sites were captured and fitted with radio transmitters in March 2016. Locations of each individual were obtained twice a week from May to August 2016. Habitat type and turtle activity were noted at each location. Average home range size and structure for each *T. c. major* individual were estimated using a kernel density estimator and minimum convex polygons. Average daily movement distances were also calculated. Differences in movement patterns and habitat selection between males and females and the correlation between body size and movement distances were evaluated. We will continue to collect radiotelemetry data for four years in order to better understand the annual variability in home range and habitat use of *T. c. major* to adaptively guide conservation and management decisions.
Presentation Type: Poster (Student)

The Loss of a Legend and Conservation Efforts for Swinhoe's Softshell Turtle in Vietnam

TIMOTHY MCCORMACK[1], PHAM VAN THONG[1], AND HOANG VAN HA[1]
[1]Asian Turtle Program (ATP) of Indo-Myanmar Conservation (IMC), Room 1806CT1, Bac Ha C14 Building, To Huu Road, Nam Tu Liem District, Hanoi, Vietnam
[tmccormack@asianturtleprogram.org]

Swinhoe's Softshell Turtle (*Rafetus swinhoei*), the worlds most endangered turtle, was dealt a sad blow on the 19th of January 2016 when the body of the legendary Hoan Kiem Turtle was found in Hoan Kiem Lake in Hanoi, Vietnam. Reducing the global population of the species to only three living individuals. Yet hope may remain for the species, the creation of a new

national wildlife protection law in Vietnam in 2013, Decree 160/2013/ND-CP, listed the species as fully protected. Resulting from the new decree the Ministry of Natural Resources and the Environment (MoNRE) in Hanoi have been mandated to protected the species. In 2016 a national workshop is to be held in Vietnam to develop a 'Tortoise and Freshwater Turtle Conservation Plan' to review all 25 species occurring nationally. Importantly a focus will be made on developing a strategy for the conservation of *Rafetus swinhoei* in partnership with government agencies.
Conservation Programs: Oral

Conserving Freshwater Turtles Requires Assessing Resource Use at the Appropriate Spatiotemporal Scale

MARIANA A. MICHELI-CAMPBELL[1,4], MARILYN J. CONNELL[2,4], ROSS G. DWYER[1], CRAIG E. FRANKLIN[1], BRIAN FRY[3], MARK J. KENNARD[3], JUAN TAO[3], AND HAMISH A. CAMPBELL[1,4]

[1]School of Biological Sciences, The University of Queensland, St. Lucia, QLD 4072, Australia
[2]Tiaro & District Landcare Group, Tiaro, QLD 4650, Australia
[3]Australian Rivers Institute, Griffith University, Nathan, QLD 4111, Australia
[4]Research Institute for the Environment and Livelihoods, School of Environment, Charles Darwin University, Darwin, NT 0909, Australia
[hamish.campbell@cdu.edu.au]

Many threatened species of freshwater turtles are data-deficient in regards to critical habitat, information that is essential for effective conservation and management. Here we assessed long-term dietary acquisition in two threatened species of freshwater turtle (*Elseya albagula* – White-throated snapping turtle and *Elusor macrurus* – Mary River turtle). Carapace stable isotope values were compared with those of potential food items to determine dietary preferences over a broad temporal scale, whilst passive acoustic telemetry was used to understand precisely where individuals acquired those food items. The results showed that *E. macrurus* fed upon resources located in riffles, whilst *E. albagula* fed from the shallow margins of deep pools. Although these discrete areas occurred in close proximity, there was < 5% probability of inter-species overlap of the dietary niches. These sympatric species are currently reported to feed on similar resources, and consequently, are managed presuming similar habitat requirements. This study showed that the habitat critical for the survival of each of these species is segregated and disparate, and we recommend that listing and advice for conservation and management take this into consideration. It is logical that the difference in the findings from our study and that of previous studies on the same species were due to disparate spatiotemporal scale of the sampling regime. We believe this approach has the potential to greatly assist in the conservation and management of freshwater turtles worldwide.
Presentation type: Poster

Thirteen Years of Keeping and Breeding the Madagascar Flat-tailed Tortoise (*Pyxis planicauda*)

VIKTOR MISLIN[1] AND FLORA IHLOW[2]

[1] Zoology Institute, University of Basel, Basel, Switzerland.
[Viktor.mislin@unibas.ch]
[2] Herpetology Section, Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany.
[F.Ihlow@ZFMK.de]

The critically endangered Madagascar Flat-tailed Tortoise *Pyxis planicauda* is endemic to the Menabe region on the central western coast of Madagascar. Throughout its tiny range *P. planicauda* is threatened with extinction through habitat loss and multiple anthropogenic hazards. Although research increased in recent years knowledge on the endangered species' life history remains poor. To date no information regarding the species reproduction in the wild exist and despite several decades of considerable efforts by renowned zoos knowledge on the species' breeding biology is still very limited. Consequently breeding attempts widely remain unsuccessful and the number of captive bred individuals is very low. In the course of the past thirteen years we produced more than 50 hatchlings from a breeding stock of nine adult specimens (3, 6) using multiple different incubation conditions of which nine proofed successful. In here we summarize thirteen years of keeping *P. planicauda* and share our experiences with different incubation conditions.
Presentation type: Poster

Gulf Coast Regional Planning for Diamondback Terrapins (*Malaclemys terrapin*): Research, Management, & Education

CHRISTINA MOHRMAN[1], TOM MOHRMAN[2], AND WILL SELMAN[3,4]

[1]NOAA Environmental Cooperative Science Center and Grand Bay National Estuarine Research Reserve, Moss Point, MS 39562

[2]The Nature Conservancy, South Mississippi Field Office, Vancleave, MS 39565

[3]Rockefeller Wildlife Refuge, Louisiana Department of Wildlife and Fisheries, Grand Chenier, LA 70643

[4]Biology Department, Millsaps College, Jackson, MS 39210

[will.selman@millsaps.edu]

Diamondback Terrapins (*Malaclemys terrapin*) inhabit salt marsh and mangrove habitats along much of the Gulf and Atlantic coastlines, and are considered a "flagship species" for saltmarsh conservation. The Diamondback Terrapin Working Group (DTWG) is a non-profit organization formed in 2004 by individuals from academic, scientific, regulatory, and private organizations. The mission of the DTWG is to promote and support Diamondback Terrapin research, conservation, management, and education. The national DTWG is broken up into 5 regional working groups (Northeastern, Mid-Atlantic, Southeastern, Florida, Gulf Coast). The Gulf Coast region of the DTWG extends from the Alabama/Florida border to the western terminus of the terrapin's range in Texas (Texas, Louisiana, Mississippi, and Alabama). On 26 February 2015, the Gulf Coast region of the DTWG held a meeting to discuss the current status of terrapins in the western Gulf Coast. The meeting drew 37 attendees from all states within the regional working group, with the majority of attendees coming from state agencies or academic institutions. Because the Gulf Coast working group had not met since 2009, state updates on the status of terrapin research, conservation, and education were provided by state representatives. Following the state updates, breakout sessions were organized with attendees selecting one of three different sessions: research, conservation and management, and education. These sessions were very productive as a brainstorming exercise and are the primary focus of this presentation. Workshop evaluations indicated that attendees thought the workshop was a good use of their time and provided a better understanding of terrapin research, conservation, education activities in the Gulf Coast region; the workshop also provided an opportunity for improved collaboration with others attendees met at the workshop. Many of the "action items" or "brainstorming ideas" could be implemented in other regions of the DTWG and/or for other turtle species when developing species conservation plans.

Conservation & Policy in North American Chelonians: Oral

Turtle Surveys of Weeki Wachee Springs State Park reveals more than Mermaids

COLLIN MCAVINCHEY [1,9]*, ERIC C. MUNSCHER[2,9], ANDREW D. WALDE[3,9], ELIZABETH M. WALTON[4,9], NICOLE SALVATICO[5,9], BRIAN P. BUTTERFIELD[6,9], WAYNE OSBORNE[7,9], AND J. BRIAN HAUGE[8,9]

[1]Fairhaven College, Western Washington University, Bellingham, WA 98225, USA

[2]SWCA Environmental Consultants, 200 Bursca Drive, Suite 206, Bridgeville, Pennsylvania 15017, USA

[3]Walde Research & Environmental Consulting, 8000 San Gregorio Road, Atascadero, California 93422, USA

[4]School of Geosciences, University of South Florida, 4202 East Fowler Avenue, Tampa, Florida 33620, USA

[5]Department of Biology, University of Central Florida, 4110 Libra Drive, Orlando, Florida 32816, USA

[6]Freed-Hardeman University, 158 East Main Street, Henderson, Tennessee 38340, USA

[7]Pine Ridge High School, 926 Howland Boulevard, Deltona, Florida 32738, USA

[8]Department of Biology, Peninsula College, Port Angeles, Washington 98362, USA

[9]Turtle Survival Alliance, North American Freshwater Turtle Research Group, 1989 Colonial Pkwy, Fort Worth, Texas, 76110, USA

[collinmcavinchey@gmail.com]

Weeki Wachee Springs State Park boasts a significant diversity of chelonian herpetofauna. Many of Florida's turtle species are considered common or abundant and as such remain understudied. The Turtle Survival Alliance's North American Freshwater Turtle Research Group (TSA-NAFTRG) conducted mark-recapture population surveys of Weeki Wachee's Springs State park and ca. 2 km of the Weeki Wachee Run in March 2015, October 2015, and March 2016. Turtles were captured by hand while snorkeling, marked, and released. This work has established baseline assemblage composition and abundance data for a site where no previous population demography work has occurred. The surveys in March 2015, October 2015, and March 2016 netted 182, 117, and 172 turtles respectively. Species observed included Florida Softshell (*Apalone ferox*), Eastern Snapping Turtle (*Chelydra serpentina*), Florida Chicken Turtle (*Dierochelys reticularia*), Striped Mud Turtle (*Kinosternon baurii*), Suwannee River Cooter (*Pseudemys concinna suwanniensis*), Florida Red-bellied Cooter (*P. nelsoni*), Peninsula Cooter (*P.*

peninsularis), Loggerhead Musk Turtle (*S. minor*), Eastern Musk Turtle (*Sternotherus odoratus*), Red-eared Slider (*Trachemys scripta elegans*), and Yellow-bellied Slider (*T. s. scripta*). The most abundant species was *S. odoratus* with a total of 235 separate individuals marked to date. Attempts to calculate population estimates for the two most numerous species (*S. odoratus* and *P. peninsularis*) indicate that we do not yet have enough data for reliable estimates. Weeki Wachee had the highest taxa richness of any of the five Florida NAFTRG springs surveyed during the 2015-2016 survey seasons with 11 taxa observed.
Presentation type: Poster

An Overview of Chelonian Operations at Zoo Knoxville

STEPHEN NELSON AND MICHAEL OGLE
Herpetology Department, Zoo Knoxville, Knoxville, TN 37914
[snelson@zooknoxville.org]

Zoo Knoxville has been working with chelonians since September of 1974, when the zoo purchased 1.1 *Aldabrachelys gigantea*. The collection started to shape into what it is today in February 1975 when the zoo acquired 2.4 *Pyxis a. oblonga* and 1.1 *Pyxis planicauda*. The zoo currently works with over 200 turtles and tortoises representing 27 species. Of that, 177 individuals are considered critically endangered by the IUCN TFTSG and represent 17 species and sub-species. 27 individuals are considered endangered and represent 6 species. 24 individuals are considered vulnerable and represent 3 species. Here I will discuss the past, present, and future of chelonians at Zoo Knoxville.
Presentation type: Oral

Composition of an Aquatic Turtle Assemblage at Manatee Springs State Park, Florida

WAYNE OSBORNE[1], ERIC MUNSCHER[2], ANDREW WALDE[3], DAREN RIEDLE[4], TABITHA BARBREE[5], J. BRIAN HAUGE[6]
[1]Pine Ridge High School 926 Howland Blvd. Deltona, Florida 32738
[2]SWCA Environmental Consultants, 200 Bursca Drive, Suite 206, Bridgeville, PA 15017, USA
[3]Walde Research & Environmental Consulting, 8000 San Gregorio Rd., Atascadero, CA 93422, USA
[4]Kansas Department of Wildlife Parks and Tourism 512 SE 25th Ave., Pratt, KS 67124, USA
[5]Baptist Medical Center 800 Prudential Dr. Jacksonville Fl. 32207
[6]Peninsula College, Department of Biology, 1502 East Lauridsen Boulevard, Port Angeles, Washington 98362 USA
[wosborne@turtlesurvival.org]

Manatee Springs, located within Manatee Springs State Park, Chiefland, Florida, is a first magnitude spring within the Suwanee River drainage. The main spring flows approximately 366m to the Suwanee River and is further connected by a cave system to three additional sinkhole ponds found within the park. The North American Freshwater Turtle Research Group (NAFTRG) has been conducting a mark-recapture study at this site up to three times per year since June, 2010. To date we have captured and individually marked 798 turtles, including all three species of river cooter (*Pseudemys*) native to Florida, two species of musk turtle (*Sternotherus*), and yellow bellied sliders (*Trachemys scripta scripta*), as well as representatives of five other genera. We provide relative abundances for all species captured. Three of those species, Pseudemys *concinna* suwanniensis (n=261), *Sternotherus minor minor* (n=348), and *Trachemys scripta scripta* (n=94) were the most frequently captured species in our samples. For these three species we calculated population estimates, apparent survivorship, density, biomass, species richness and abundance, and sex ratios. Based on these initial samples, Manatee Springs appears to have a very rich turtle assemblage. Sampling will continue at Manatee Springs in order to track population trends over time and provide important information in regards to the general health of the spring allowing for the best practical management of this iconic ecosystem.
Turtles of Springs: Oral

Influence of Microhabitat on Body Temperature Variation in *Kinosternon integrum*

AILED PÉREZ PÉREZ, ORLANDO SUÁREZ RODRIGUEZ, GABRIEL SUÁREZ VARON, ANA ESTHELA LÓPEZ MORENO, AND OSWALDO HERNÁNDEZ GALLEGOS
Laboratorio de Hepetología, Facultad de Ciencias, Universidad Autónoma del Estado de México, Instituto Literario # 100 Centro, Toluca, Estado de México C. P. 50000, México.
[ailed_bio@hotmail.com]

The regulation of body temperature (Tb) in reptiles can be controlled by both behavioral and physiological mechanisms, in turtles habitat selection has been associated to the ability of thermoregulation. Currently the information about Tb of *Kinosternon integrum* is sparse. We evaluated the Tb of *Kinosternon integrum* and their variation according sex and microhabitat use, in Tonatico, Estado de México. Between October 2013-May 2016, 20 adult turtles (9 females, 11 males) were equipped with transmitters and iButton (Tb was recorded every 60 min). The Tb of *Kinosternon integrum* varies between 4.0 to 43.6 ºC. The Tb during basking events was (mean ± 1 EE) 26.84 ± 0.05 ºC (median=26.13ºC, range 17 – 43.6ºC), the number of hours of basking per day was 4.04 ± 0.06 (median= 4 hours, range 1-16 hours); the number of days of baking per month was 12.49 ± 0.8 days (median= 11 days, range 0 - 30 days). The habitat natural of *Kinosternon integrum* is the river, where their Tb is the lowest compared to other habitats (17.7 ± 0.01 ºC; median= 18.12ºC, range 4.04 – 24.65ºC). Some individuals leave the river for a few months, for different reasons, from June to November, some turtles migrate temporarily to artificial ponds, where they can reach high temperatures without basking (24.28 ± 0.05ºC; median=23.65ºC, range 10.11-39.12ºC). During dry season (December-April) some turtles estivate near the river, and the Tb was 19.9 ± 0.09 ºC (median=19.12ºC, range 10.0 – 36.61ºC); The Tb in *Kinosternon integrum* such as another species of freshwater turtles, present a high variation according to microhabitat, sex, individual, month, season and year. The selection of microhabitat directly influences the Tb in *Kinosternon integrum*.
Presentation type: Poster (Student)

Citizen Science: Accuracy in Collecting *Terrapene* Coloration Data

ARIEL PETRILLA
Department of Biology, University of Central Oklahoma, Edmond, Oklahoma
[apetrilla@uco.edu]

Researchers have limited time, manpower, and budget, narrowing the scope of their potential projects. Citizen scientists allow researchers to efficiently gather large amounts of data and cover large tracts of land and are especially useful for projects that have limited budgets. To test the effectiveness and accuracy of citizen scientists collecting coloration data on *Terrapene carolina* and *T. ornata*, a lamented color chart was used to assign intensity scores for six colors on five live juvenile *T. carolina* as well as 10 pictures of adult individuals. Averaged Kendall's concordance coefficient values were compared with my own scores to measure overall accuracy. Accuracy levels of volunteers, whether they have minimal or extensive experience with turtles, are too low to be dependable for this type of research. While *Terrapene* coloration is an understudied subject, especially in Oklahoma populations, using the proposed color chart as a technique to collect *Terrapene* coloration data is an unreliable method at this time.
Presentation: Poster (student)

Road Mortality of Turtles: a Comparison Between Highway, Undeveloped, Suburban and Urban Areas

ARIEL PETRILLA
Department of Biology, University of Central Oklahoma, Edmond, Oklahoma
[apetrilla@uco.edu]

As fragmentation due to human encroachment into wild lands continues, monitoring populations of wildlife is critical if we are to make management decisions in conservation biology. Because of low hatchling survival, slow recruitment into breeding populations, and delayed sexual maturity, turtles are highly susceptible to increases in mortality and have been extirpated from many areas. In Oklahoma, because of urbanization and associated increases in roads and traffic, areas that once supported robust turtle populations may now be experiencing declines in turtle abundance. I sampled four sets of sites (highway, rural, suburban, and urban) during May-July 2015 making a total of 7 trips that resulted in 135 individuals of 8 species. More individuals were found on highways and in rural areas and more females were found than males for all species present. For all species, 92 individuals (n=74 dead, n=18 alive) were located on highways connecting sampling sites. More individuals were present at rural sites (n=33) compared to suburban (n=6) or urban (n=4) sites. Excluding highways, more live turtles (n=35) were found than dead turtles (n=8), but all live turtles found in suburban and urban locations (n=8) had recent or past physical trauma while few live turtles in rural locations (n=27) showed such signs. Long term goals include further data analysis, habitat analysis, and repeated trips to the same sites during summer 2016 to give a better understanding of seasonal movements.
Presentation: Poster (student)

Turtle Conservation in Myanmar: TSA/WCS Program Update (2015-16)

STEVEN G. PLATT[1], KALYAR PLATT[2], WIN KO KO[1], TINT LWIN[1],ME ME SOE[2], KHIN MYO MYO[1], AND MYO MIN WIN[1]

[1]Wildlife Conservation Society, Aye Yeik Mon, 1st Street,Hlaing Township, Yangon, Myanmar.
[2]Turtle Survival Alliance, Aye Yeik Mon 1st Street, Hlaing Township, Yangon, Myanmar
[sgplatt@gmail.com]

The diverse turtle assemblage in Myanmar is threatened by habitat loss, poverty-driven subsistence harvesting, and rampant over-collection for wildlife markets in southern China. In response to these threats, Turtle Survival Alliance (TSA) and Wildlife Conservation Society (WCS) initiated a number of conservation projects in Myanmar. Focal species for conservation include the Burmese star tortoise (*Geochelone platynota*), Burmese roofed turtle (*Batagur trivittata*), Rakhine Forest Turtle (*Heosemys depressa*), and Asian Brown Tortoise (*Manouria emys*). A combination of *ex*- and *in-situ* conservation strategies have been successfully employed to halt and reverse population declines among these species. Captive assurance colonies and head-starting have bolstered numbers of critically endangered *G. platynota* and *B. trivittata*, creating a pool of animals that are now available for reintroduction. A 2011 survey identified two protected areas where reintroduction of captive-bred *G. platynota* was thought likely to succeed. At the first site, 150 subadult tortoises were liberated (2014-15), but further releases were suspended following the theft of 188 tortoises in late 2015. Releases are expected to resume upon completion of a security review by the Myanmar Forest Department. Holding pens have been constructed at a second site and 150 tortoises are awaiting release. An egg collection and head-starting program initiated in 2006 along the Chindwin River has staved off the near-certain extinction of *B. trivittata*. Two assurance colonies of these critically endangered turtles were also established, and almost 700 *B. trivittata* are now in captivity. The few remaining wild females (< 5) produced clutches of non-viable eggs during 2014 and 2015. In May 2016, 27 hatchlings emerged from a clutch of 30 viable eggs collected in late February. Additional hatchlings are being produced at an assurance colony at the Mandalay Zoo. A third assurance colony was established in Htamanthi Wildlife Sanctuary (HWS) and stocked with 100 head-started turtles. Two experimental reintroductions, each consisting of 30 head-started turtles undertaken in the Chindwin River and Nam Thalet Chaung in March 2015, continue to be monitored. Two assurance colonies of *Manouria emys* confiscated from illegal wildlife traffickers are now established; > 150 eggs are currently being incubated. Breeding groups of *Nilssonia formosa* and *Chitra vandijkii* are being assembled and facilities constructed at HWS. Efforts are currently underway to secure three *Batagur baska* found in a pagoda pond for conservation-breeding.

Conservation Programs: Oral

Conservation and Management of the Alligator Snapping Turtle in Kansas and Oklahoma

J. DAREN RIEDLE[1], DAY B. LIGON[2], MARK HOWERY[3], MATTHEW FULLERTON[3]

[1]Kansas Department of Wildlife, Parks, and Tourism, Ecological Services Section, 512 SE 25th Ave, Pratt, KS 67301 USA
[2]Department of Biology, Missouri State University, Springfield, MO 65897 USA
[3]Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln Blvd., Oklahoma City, OK USA
[daren.riedle@ksoutdoors.com]

The Alligator Snapping Turtle, *Macrochelys temminckii*, has long been a species of conservation concern throughout its range due to drastic declines in population resulting from overharvest, fragmentation of river systems, and declining water quality. In light of these declines, the alligator snapping turtle was included in a petition to federally list 53 species of amphibians and reptiles as Threatened or Endangered. The historical range of the Alligator Snapping Turtle included the Arkansas, Caney, Verdigris, Neosho, and Spring river drainages in northern Oklahoma and southern Kansas on the northwestern extent of its range. Results of surveys of conducted in both states revealed that Alligator Snapping Turtle populations were either greatly reduced or extirpated from some river segments. Oklahoma has made progress toward recovery of the species through the establishment of a translocated population in the Washita River in southern Oklahoma and reintroduction of head-started turtles on the Caney and Verdigris rivers near the Kansas border. A five-year review of post-release monitoring on the Caney River suggests that the early stages of the release efforts have been successful. Through the auspices of two State Wildlife Grants, one of which is a multi-state grant that includes both Kansas Department of Wildlife, Parks, and Tourism and the Oklahoma Department of Conservation, these conservation efforts will be expanded over the next three years. The new scopes of work include re-sampling the historic distribution of the species in Kansas through both environmental DNA methods and physical sampling with hoop nets, monitoring for reproductive success at the Caney River release site, and determining if released animals in Oklahoma have moved northward into Kansas in either the Caney or Verdigris river drainages. Both states will also

work closely together in data sharing and future planning for the conservation of the Alligator Snapping Turtle. It is our hope that proactive planning will provide positive steps toward to the recovery of this species.
Conservation & Policy in North American Chelonians: Oral

Temperature Sex Determination in the Española Tortoise (*Chelonoidis hoodensis*)

ANA SANCHO[1*], WILLIAM H. N. GUTZKE[2*], HOWARD L. SNELL[3], SOLANDA REA[4], MARSHA WILSON[4], EUGENIA M. DEL PINO[1], RUSSELL L. BURKE[5]
[1]Pontificia Universidad Católica del Ecuador, Escuela de Ciencias Biológicas, Apartado 17-01-2184, 170517 Quito, Ecuador.
[2]Memphis State University, Department of Biology, Memphis, Tennessee 38152, U.S.A.
[3]University of New Mexico, Biology Department, Museum of Southwestern Biology, Albuquerque, New Mexico 87131, U.S.A.
[4]Estación Científica Charles Darwin, Puerto Ayora, Isla Santa Cruz, Galápagos.
[5]Department of Biology, Hofstra University, Hempstead NY 11549, U.S.A.
** Deceased*
[biorlb@hofstra.edu]

Sex determination (SD) mode is only documented in 86 (26%) of the approximately 335 known turtle species; temperature sex determination (TSD) is common but is not ubiquitous. In family Testudinidae (ca. 52 extant species), SD mode is documented for only five species: *Testudo hermanni*, *T. greaca, Gopherus agassizii*, *G. polyphemus*, and *Malacocherus tornieri*; all of these have TSD. It is widely assumed that other tortoises also have TSD but this has not been verified. *Chelonoidis* is the largest tortoise genus (11-14 extant species), all South American, most of which are in the *C. nigra* complex (Galápagos giant tortoises). Although TSD was reported in this complex as "*Geochelone elephantopus*" in 1991, that was on the basis of a personal communication, and was never published. Here we report the details of TSD in *Chelonoidis hoodensis* (Española tortoise) based on experiments done in 1986. We found strong evidence for Type IA TSD, the threshold incubation temperature is 28.3ºC, and the range for transition temperatures is 25.4-31.5ºC. These results have important implications for incubation of eggs for head starting and for interpretation of data from natural nests. We caution against the assumption that all *C. nigra* complex species have similar threshold or transitional temperatures, and encourage evaluation of more species in this group.
Presentation type: Poster

The Thébaide

CHUCK SCHAFFER AND RICK SCHAFFER
Casa Tartaruga, Korona, FL USA
[Chelonian1@aol.com]

Tales from the Thébaide (2007) is a unique, arguably autobiographical tome which reads like a trip to Peter's sanctuary – his and Sibille's home and the Chelonian Research Institute. Despite being geographically separated by a busy street, it's exceedingly difficult to tell where one ends and the other begins. It is truly a Thébaïde, an intellectual retreat, far from the mundane outside world, and at the same time, a meeting place for travelers and knowledge seekers. The four houses and two storage buildings are an immense Cabinet of Curiosity, sometimes overwhelming through the sheer volume of incredible material, specimens, artwork, books, and certainly the myriad of folks visiting on a regular basis. Be it living turtles or preserved specimens (none of which were killed for science), chelonian artwork or artifacts - you are surrounded. But a visit, usually with the ever present good intentions of conducting a bit of research, often ends up as a pleasant morning or afternoon (or whole day) sitting with Peter (and often Sibille) in his office or walking the grounds in conversation – but mostly just listening. At first glance, the sum of parts which is the CRI appears to be put together in a chaotic and random fashion by some bizarre and disjointed committee, but there is a method to this madness. Connected only by the omnipresent chelonian theme (although not simply turtle related paraphernalia), it is a veritable bricolage of everything you can imagine. It is a cornucopia of all things Testudine, liberally touched with subtle, sublime humor and humanity. Worlds fail me in trying to describe Peter. He is a true Renaissance man, an impeccable scholar, conservationist, and immersion traveler in the truest sense of the word. If you have the chance to visit, it is an opportunity not to be missed. It really goes to show; it is turtles all the way down.
Honoring Peter Pritchard: Oral

Life in Skinny Water: Observations of Juvenile Diamondback Terrapins (*Malaclemys terrapin*) Utilizing Shallow Water Habitat

WILL SELMAN[1,2], WILLIAM STRONG[1], AND BRETT BACCIGALOPI[1]
[1]Rockefeller Wildlife Refuge, Louisiana Department of Wildlife and Fisheries, Grand Chenier, LA 70643
[2]Biology Department, Millsaps College, Jackson, MS 39210
[selmaww@millsaps.edu]

For many turtle species, relatively little is known about those years spent between hatching and adulthood, particularly the habitats used by juvenile turtles. Prior turtle ecological studies have found that juveniles use vastly different habitat than adults, and therefore, juveniles are typically undersampled in ecological or life history studies of turtles. Diamondback Terrapins (*Malaclemys terrapin*) inhabit salt marshes and mangrove habitats from Texas to Massachusetts, USA, with an isolated population existing on the island of Bermuda. Although much information is known about adult terrapin life history and ecology, little information exists to better understand the juvenile life stages. While sampling for terrapins in southwestern Louisiana from 2011 – 2016, we captured 18 and 19 juveniles (<9.5 cm PL) by fyke net and manual search via airboat, respectively. Juveniles made up only 2.8% of fyke net captures (0.06 per net day; 286 net days) and 8.1% of manual searching captures (0.53 per airboat search hour; 31.5 hours). The commonality of all observations is that juveniles were exclusively captured in shallow water habitats (<1 m), with many captured in <5 cm of water. Shallow water likely promotes better survival by having fewer predators and more cryptic habitats, while also promoting growth via better themoregulatory opportunities (i.e., shallow, warm water) and competitive avoidance with adult terrapins. Presumably the lack of juveniles in prior studies is due to a combination of improper sampling methodology, the location of habitats that are sampled, and crypsis of juveniles. Our observations further support previous descriptions that indicate "high marsh" as an important habitat for juvenile terrapins, and these habitats should be included into terrapin and/or coastal conservation planning.
Diamondback Terrapins: Oral

Captive Husbandry of the Chinese Big-headed Turtle (*Platysternon megacephalum megacephalum*) including Propagation, Incubation, Hatchling Care, and Development at WCS's Prospect Park Zoo

NICHOLE SHELMIDINE
Animal Department, Prospect Park Zoo, Brooklyn, NY
[nshelmidine@wcs.org]

In 2008, staff at Prospect Park Zoo (PPZ) began working with a pair of Chinese big-headed turtles (*Platysternon megacephalum*) with the intent of propagating via artificially controlled methods which in the future could be repeatable and utilized to breed additional pairs of this species. In order to accomplish this, staff simulated seasonal changes by fluctuating photoperiod, both ambient and water temperature as well as diet in an attempt to mimic conditions in the wild. Individuals are cooled down starting in November with full brumation during the months of January and February. Each May, the female is placed in the male's enclosure for at least 15 minutes a day for breeding introductions. In 2012, PPZ had our first successful breeding season with an ensuing clutch of eggs from this single breeding pair. We continued to have consecutive years of breeding and obtained eggs from this pair with successful hatchings in 2013-2015. The female laid her eggs during the months of July and August with clutch size range being 5-6 eggs. Eggs were incubated in a RCOM Juragon reptile incubator at 23.3°C with 90-95% humidity. Eggs were candled weekly and blood vessels were observable around Day 21-32. Incubation ranged from 84-105 days. Hatchling body mass range at day 1 was 8.11-10g. In addition to presenting on the above methods and results, information on hatchling care and development will also be discussed. The goal of this project is to contribute to the growing body of literature and eventually help to develop a future viable, sustainable North American captive population for this species as well as to adapt our techniques for future possible in-situ conservation needs.
Captive Husbandry: Oral

Understanding Growth Rates of *Pseudemys peninsularis* and *Pseudemys nelsoni* from a Spring System in Florida, U.S.A.

THERESA STRATMANN[1,2], **DOUG ARMSTRONG**[3], **ANDREW WALDE**[1,4], **AND ERIC MUNSCHER**[1,5]

[1]*Turtle Survival Alliance - North American Freshwater Turtle Research Group, 1989 Colonial Parkway, Fort Worth, TX, USA 76110*

[2] *Department of Biological Sciences, Goethe University and Senckenberg Biodiversity and Climate Research Centre, Senckenberg Gesellschaft für Naturforschung, Frankfurt (Main), Germany*

[3] *Wildlife Ecology Group, Massey University, PB 11222, Palmerston North, New Zealand*

[4]*Walde Research & Environmental Consulting, 8000 San Gregorio Rd., Atascadero, CA 93422, USA*

[5]*SWCA Environmental Consultants, 200 Bursca Drive, Suite 206, Bridgeville, PA 15017, USA*

[theresastrat@gmail.com]

For turtles, fitness is closely tied to size. Size is positively correlated with clutch size in females and competitive advantage in males, and is negatively correlated with predation risk. To understand turtle population dynamics it is therefore important to have a basic understanding of their growth. This understanding can only come from long-term data sets which track many individuals. The lack of such data sets paired with inadequate analysis techniques means that we know very little about growth rates in turtles, even for the most common species. Here we present a rare long-term mark-recapture dataset for *Pseudemys peninsularis* and *Pseudemys nelsoni* from a spring system in central Florida which we analyzed using a Bayesian hierarchical version of the classic von Bertalanffy growth model (VBGM). This method adds individual variation and a size-based change in growth rate at maturity to the standard VBGM. Our results show that individuals within these populations are growing much faster than has been previously recorded in the literature. We observed rapid growth in immature individuals, with *P. peninsularis* exhibiting annual increases in size of 23-104.6% and *P. nelsoni* of 14.6-42.2%. Rapid juvenile growth could explain our ability to identify the gender of females well before the size at maturity seen in the literature (*P. peninsularis*: 16.5 cm straight carapace length (SCL) vs. 24-30 cm in the literature; *P.nelsoni*: 16.1 cm vs. 27.5-29 cm in the literature). This fast growth is most likely due to spring environments sustaining constant temperatures (21-24°C) that are favorable for growth and foraging year-round. This ability of environment to dramatically influence growth demonstrates that it is insufficient to use one set of growth rates to characterize a species. Our work also shows that we still have much to refine when it comes to statistical growth models for turtles. We will discuss how sexual dimorphism, gender vs. sexual maturity, and dealing with a lack of known-age individuals are all still problems and what our potential solutions for these are. A better understanding of growth will ultimately help us better understand how resilient different populations are to detrimental events such as the poaching.

Turtles of Springs: Oral (Student)

Community-lead Nest Protection and Pagoda-based Head-starting of Cantor's Giant Soft-Shell Turtle in Cambodia

YOEUNG SUN

Conservation International's Mekong Turtle Project Manager

Conservation International - 4th floor, Building E, Phnom Penh Center, Sihanouk Boulevard, Phnom Penh, Kingdom of Cambodia

[syeoung@conservation.org]

Since 2007, Conservation International has been working with local villagers living along Mekong River in Cambodia to conserve the endangered Cantor's Giant Soft-shell Turtle, *Pelochelys cantorii.* The species had been considered extinct in Cambodia, and was only rediscovered in 2007. This species is listed as Endangered on the IUCN Red List. Through CI's program, turtle nests are protected from Sambor district in Kratie Province to upstream for about 40 kilometers. From 2007 to 2015, 285 nests were found and protected by villagers with 6,579 hatchlings produced successfully and released back into their habitat. CI has also collaborated with monks from the historic 100 Pillar Pagoda to construct a turtle 'head-starting' facility. This included the re-build an old pond and the construction of a turtle facility in the pagoda grounds in 2011, named the Mekong Turtle Conservation Center (MTCC). The MTCC is used for raising hatchlings for about 10 months before their release back into their habitat, combined with community education and eco-tourism. The monks are particularly involved in helping disseminate awareness of the turtle conservation program to tourists and local school students. The MTCC is also a good place to train community nest protectors on how to take care of the turtle hatchlings and other native turtle species. The MTCC attracted over 4,000 national and international tourists in 2015.

Conservation Programs: Oral

TSA's India Program: 12th Successful Year of Conserving Endangered Chelonians

SHAILENDRA SINGH*, BHASKER M DIXIT, NILADRI DASGUPTA, SNEHA DHARWADKAR, ARUNIMA SINGH, NEERAJ KUMAR PAL, AND RACHNA TIWARI

TSA India Program, D1/317, Sector F, Jankipuram, Lucknow, India 226021 [shai@turtlesurvival.org]

India Turtle Conservation Program has completed another successful year inspite of conservation and administrative challenges. ITCP has been targeting some of the endangered turtles, such as Northern River Terrapin (*Batagur baska*), Red-crowned Roofed Turtle (*B kachuga*), Indian Narrow-headed Turtle (*Chitra indica*), Black-softshell Turtle, (*Nilssonia nigricans*), Crowned River Turtle (*Hardella thurjii*) besides other species along six locations across 4 Turtle Priority Areas (TPAs)—North-central India, Tarai, Suderbans and Assam. This year's notable success include pilot release of 10 juvenile *B baska* and maximum hatching of *B baska* (n=95) in Sunderbans, scaling up protection of *B kachuga* nests on Chambal, investigating population and nesting ecology of *H thrujii*, opening the new community conservation centre and integrating alternate livelihood for fishermen and turtle poachers in *Tarai*, incorporating new temple for *N nigricans* recovery program in Assam. Moreover, we helped repatriating and rehabilitating over 1000 confiscated turtles of different species. We forged new partnerships with agencies like Centre for Wildlife Studies, Uttar Pradesh Government, Madhya Pradesh Biodiversity Board and Assam Tourism Development Corporation for long term administrative, financial and logistic support.

Conservation Programs: Oral

Movement, Habitat Preference and Growth Rate of the Rough-footed Mud Turtle, *Kinosternon hirtipes murrayi*

JENNIFER SMITH

[*jsmith77@nmsu.edu*]

STEVEN PLATT

[*sgplatt@gmail.com*]

WIEBKE BOEING

The Rough-footed mud turtle, *Kinosternon hirtipes*, is listed as Threatened on the Texas Parks and Wildlife Departments' nongame list and Decling on the UICN red list. Four of the known seven populations have disappeared over the past four years, leaving only two viable populations and one with only males present. Without understanding the natural history of this species, conservation efforts would yield little success for species survival in its harsh and declining environment. The purpose of this on-going study is to investigate the habitat preferences, migration patterns, movement within and outside of the pond and specific niche preferences of males, females and juveniles. Turtles were collected by traditional trapping methods using double throat wire mesh traps and a 3.6 g. transmitter attached for a telemetry study. In addition, a comparison with other Kinosternids is made with this Texas population on growth rate and movement. General size distribution of carapace length, width, plastron length width, body depth and mass was calculated and a growth model was produced showing increased growth rate of juveniles until approximately 100 mm then a slowing trend with growth rate faster than other Kinosternids, including *Kinosternon hirtipes murrayi* from Mexico, with a size reaching 190 mm in carapace length. A significant sexual dimorphism emerged from the data, with males quite larger than females and the *K. hirtipes murrayi* in Texas having a significantly different size than those found in Mexico. The telemetry study has revealed a much greater affinity to water than other Kinosternids with movement during active season restricted to their aquatic habitats. Detailed observations of preferred habitats for juveniles in comparison to adult males and females will also be discussed. A population was re-discovered in an area of Big Bend Ranch State Park recently that had not been documented in over 30 years. This information is invaluable in determining what habitat is most successful which will be used when implementing a strategic management plan of this Threatened species. Funding for the telemetry study was provided by the Texas Parks and Wildlife Conservation License Plate Grant.

Turtle Ecology: Oral

Fall Activity Patterns of Hatchling Alligator Snapping Turtles (*Macrochelys temminckii)*

SARAH J. SPANGLER[1], DENISE M. THOMPSON[2], BRIAN M. FILLMORE[3], AND DAY B. LIGON[1]

[1]*Department of Biology, Missouri State University, Springfield, MO 65897 [sspangler5@yahoo.com; day.ligon@missouristate.edu]*

[2]*Department of Integrative Biology, Oklahoma State University, Stillwater, OK 74078 [denise.thompson17@gmail.com]*

[3]*Tishomingo National Fish Hatchery, Tishomingo, OK 73460 [brian_fillmore@fws.gov]*

The Alligator Snapping Turtle (*Macrochelys temminckii)* is a rare species that is protected throughout its range. It was petitioned for and denied protection under the Endangered Species Act (1973) because data on it's life history and ecology was insufficient. Since then, there has been a focus on research, yet there is still much that has not been determined and is not understood. One area in which there has been little examination is hatchling ecology post nest dispersal. Hatchlings are especially challenging to study because of low survival rates and low detectability. The intent of our study was to examine whether there are correlations between activity, day length, and temperature for hatchling alligator snapping turtles. Activity patterns of 13 hatchlings was monitored from September to November 2015 with the aid of automated telemetry. Activity (minutes of activity per hour) decreased with a decrease in temperature and day length, but at a low of 7.6ºC in late November there were still bouts of minimal activity. Activity patterns were variable, but tended to fit a diurnal pattern.
Presentation type: Poster (Student)

15 years after the Malaysian Giant Pond Turtles *(Orlitia borneensis)* rescued and maintained at Zoo Miami

ADAM G. STERN
Senior Ectotherm keeper, Zoo Miami, Florida
[astern@miamidade.gov]

This update is to report the status and reproduction of Malaysian Giant Pond Turtles *(Orlitia borneensis)* held at Zoo Miami for the past 15 years after the 2001 TSA Asian turtle confiscation. This talk is going to be discussing the population growth over the past 15 years at Zoo Miami. This is going to be an update from a 2011 presentation. Zoo Miami, then Miami Metrozoo, acquired 53 *Orlitias* from the confiscation that underwent treatment upon arrival for a number of medical issues including parasites, open wounds on feet and legs, removal of fish hooks found lodged in the mouths and throats of some turtles, and the treatment of one gunshot wound. Three animals died within 17 months and 39 turtles were sent to other institutions and T.S.A. members in 2002 and 2003. Zoo Miami has 10 adults living in a moated exhibit housing gibbons and siamangs.
Zoos and Chelonians: Oral

Unusual Population Attributes of Invasive Red-eared Slider Turtles (*Trachemys scripta elegans*) in Japan: Do They Have a Performance Advantage?

MARI TANIGUCHI[1, 2], JEFFREY E. LOVICH[3]*, KANAKO MINE[1], SHINTARO UENO[4], ANDNAOKI KAMAZAKI[1, 5]
[1]Kobe-Suma Aquarium, 1-3-5, Wakamiya, Suma, Kobe, 654-0049, Japan
[2]Department of Safety Systems Construction Engineering, GraduateSchool of Engineering, Kagawa University, 2217-20 Hayashi-cho,Takamatsu, Kagawa, 761-0396, Japan
[3]USGS, Southwest Biological Science Center, 2255 N. Gemini Drive, MS-9394, Flagstaff, Arizona, USA 86001-1600
[4]Department of Ecosystem Studies, Graduate School of Agricultural andLife Sciences, The University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo113-8657, Japan
[5]Department of Biosphere-Geosphere Science, Okayama University ofScience, 1-1 Ridai-cho, Kita-ku, Okayama, 700-0005, Japan
[jeffrey_lovich@usgs.gov]

The slider turtle (*Trachemys scripta*) is native to the United States and Mexico. Due to their popularity as hatchlings, they have been exported worldwide and are now present on all continents, except Antarctica. Sliders are well-established in Japan and occupy aquatic habitats in urban and agricultural areas, to the detriment of native turtles with which they compete. We tested the hypothesis that slider turtles in Japan have a performance advantage since they are liberated from numerous competing turtle species in their native range and released from many of their natural enemies. Traits examined in a comparative fashion included maximum body size, mean body size, female size of maturity as measured by size of reproductive females, sex ratio, and sexual size dimorphism, the latter two a partial reflection of growth and maturity differences between the sexes. We sampled slider turtle populations in three habitats in Japan and compared population attributes with published data for the species from its native range in the USA. Mean male body size was small compared to the range of values reported from the USA but maximum size of Japanese males was at the high end. Females in Japan appear to mature at smaller body sizes and have mean clutch sizes only slightly smaller than sliders in the USA. Sex ratios are female-biased, the opposite of what is reported for natural populations in protected areas. Sexual size dimorphism was at the high end of values reported from the USA. In the absence of a full complement of native predators and diseases, slider turtles may have performance advantages in Japan including potentially smaller size of maturity in females and strongly female-biased sex ratios. These performance advantages, along with the adaptability and catholic diet of sliders, translate into dominance over native Japanese turtles in altered aquatic habitats.
Origins, Patterns, & Changes: Oral

Reproductive Investment Patterns in a Captive Population of Alligator Snapping Turtles (*Macrochelys temminckii*)

DENISE M. THOMPSON[1], REBECCA FILLMORE[2], BRIAN M. FILLMORE[3], AND DAY B. LIGON[4]
[1] Department of Integrative Biology, Oklahoma State University, Stillwater, OK 74078
[2] Durant Hatchery, Oklahoma Department of Wildlife Conservation, Caddo, OK 74729
[3] Tishomingo National Fish Hatchery, US Fish and Wildlife, Tishomingo, OK 73460
[4] Department of Biology, Missouri State University, Springfield, MO 65897
[denise.thompson17@gmail.com]

Identifying resource allocation patterns is fundamental to understanding reproductive investment strategies that maximize maternal fitness. Turtles are useful model organisms for such studies because most species do not invest in parental care; therefore, variation in maternal investment can be assessed primarily from variation in clutch characteristics (e.g., egg size and egg number). Maternal investment patterns in *Macrochelys temminckii* were examined by measuring reproductive output of captive turtles maintained under similar semi-natural conditions. Larger females tended to produce larger eggs ($r^2 = 0.420$, $p < 0.0001$), and hatchling size increased with increasing egg size ($r^2 = 0.162$, $p < 0.0001$); thus, larger females produced larger offspring ($r^2 = 0.284$, $p < 0.0001$). The number of eggs per clutch (mean = 34) did not correlate with female body size ($r^2 = 0.140$, $p = 0.1867$). Overall, however, larger females exhibited greater total reproductive effort as total clutch mass positively correlated with female size ($r^2 = 0.441$, $p = 0.0095$). Additionally, females with higher body condition produced hatchlings that were both larger ($r^2 = 0.1089$, $p < 0.0001$) and had higher body condition ($r^2 = 0.027$, $p = 0.0082$), but we found no effect of female body condition on clutch size nor total clutch mass. We also found that increased resource availability increased average annual reproductive output. These results suggest that *M. temminckii* primarily increase maternal investment by producing more eggs rather than larger eggs.

Reproductive Ecology: Oral (student)

An Overview of the Chelonian Research Institute (CRI) Collection. Its Unique Diversity and Importance to the study of Chelonians Worldwide

SCOTT THOMSON
Museu de Zoologia da Universidade de São Paulo, São Paulo, SP, Brasil

In April to May this year I was asked to examine for the CRI the size and diversity of the turtle collection that had been put together by the many years of dedication by Peter Pritchard. I have visited this collection on several occasions between 1997 and 2016, have often recommended it for other researchers and am very familiar with it.The collection of some 18000 turtles is one of the largest in the world and easily comparable for example to the collection of the Smithsonian Institute for numbers of specimens. However the Smithsonian is largely made up of North American species, whereas the CRI has species from all over the world, representing almost every genus and species of turtle. A large percentage is skeletonized, this is highly preferable as turtles are extremely conservative in external morphology, and it also makes it one of the few collections useful to the study of both living and fossil turtles. Among the species represented are a number of highly unique and important specimens such as the skull of a *Rafetus swinhoei* an extremely rare turtle and the only skull of the species in the USA. Another is the skull and several plastron pieces of a Réunion Giant Tortoise (*Cylindraspis indica*), yet another example is a skull of *Elseya irwini* from Australia this is the only skull of this species in existence. The collection in total consists of some 13 Families, 91, genera and 260 species of chelonians. Of these there are 11 Families, 73 genera and 195 species of Cryptodira and 2 families, 18 genera and 65 species of Pleurodira. All species of Sea Turtles are represented in the collection. Among the more exotic groups to the USA are for example 43 species of Chelidae from 13 genera, upon my examination of my own specialty group the *Elseya* I find all species except *Elseya schultzei*, and a probable new species also. There is also good within species diversity for example in *Phrynops geoffroanus*, specimens from multiple drainages throughout South America, or in *Elseya albagula*, all known populations are represented.

Honoring Peter Pritchard: Oral

Husbandry and Breeding Tips for the Egyptian Tortoise (*Testudo kleinmanni*)

RALPH J. TILL, JR.
Palm Harbor, FL 34683
[Rascal1843@aol.com]

The second smallest of all Testudo species, the Egyptian tortoise has long earned a reputation of being difficult to maintain and propagate in a captive environment. Combining this with a relatively low reproduction rate means every effort needs to be taken to ensure their survival. With deliberate husbandry techniques and a selective breeding program to safeguard the gene pool diversity, the future of this attractive species can be preserved. We will discuss indoor husbandry procedures designed to maintain a significantly sized but equally manageable breeding group. Diet is also a key aspect of success that warrants review. Juveniles, and especially amorous males, have voracious appetites and a mixed variety in their diet is a must. Reproduction of the species has always been a challenge. The author maintains all of his Egyptians in individual enclosures with "scheduled" pairings to easily track results and monitor parentage.
Captive Husbandry: Oral

Conservation Efforts in the Chittagong Hill Tracts, Bangladesh

SCOTT TRAGESER
Creative Conservation Alliance, House #1/4, Block #C, Lalmatia, Dhaka-1207, Bangladesh
[trageser.scott@gmail.com]

Ongoing conservation efforts in the Chittagong Hill Tracts, Bangladesh by our organization, the Creative Conservation Alliance, are successfully alleviating poaching pressures on five endangered and critically endangered testudines: *Manouria emys*, *Heosemys depressa, Pangshura sylhetensis*, *Cuora mouhotii*, and *Indotestudo elongata*. Ten other species including Asian elephant, tiger, clouded leopard, and Chinese pangolin are also protected by our initiatives. Through the utilization of traditional ecological knowledge and the empowerment of local tribesmen, we have successfully implemented conservation measures in a highly restricted region, otherwise fated to be lost within a decade. Four months after the initial intervention in April 2015 a 50% reduction in testudine poaching was observed within the community managed protected areas. With continued work, the forests of the Chittagong Hill Tracts could become a rare, safe haven for many endangered species within the Indo-Burma Biodiversity Hotspot.
Turtle Organizations: Oral

Use of Basking Objects by Turtles in Louisiana

ASHLEY TRIPLETT AND JOHN L. CARR
Department of Biology and Museum of Natural History, University of Louisiana at Monroe 700 University Drive, Monroe, LA 71209
[triplean@warhawks.ulm.edu]

Many aquatic turtles are known to use emergent objects for aerial basking; however, the detailed basking preferences of such species have been little studied. The goals of this study were to compare the use of basking objects among aquatic turtle species. Using a fixed-site spotting scope methodology, the assemblage of basking turtles was surveyed at 144 stream and lake sites across 27 parishes in northern Louisiana. Two-thousand ninety-nine turtles of nine species were observed on 1,034 basking objects between 1998 and 2002. For each observation, microhabitat data on object type and estimated angle of the basking turtle were recorded, as well as the demographic class (juvenile, male, female) and identification for each turtle. Ninety-six percent of basking objects consisted of dead tree material; other objects included live trees, manmade objects, and banks. For those with the largest samples (*Graptemys pseudogeographica kohnii, G. ouachitensis, Pseudemys concinna*, and *Trachemys scripta elegans*), we compared basking angle interspecifically and males to females intraspecifically. Average angle for the four species was 18.7°, 19.1°, 10.7°, and 12.2°, respectively. The basking angle in the two species of *Graptemys* was not different, but for *Graptemys* compared to *Trachemys* or *Pseudemys*, there was a significant difference between basking angles of adults ($p < 0.001$). There was no significant difference between the sexes within any of the four species. Juvenile age classes of *G. p. kohnii*, *G. ouachitensis* and *T. s. elegans* exhibited greater basking angles than adults of the same species; however, the difference was only significant within *Trachemys*. A variety of deadwood objects is vital to serve for basking by the widest assortment of demographic groups of the complete set of species in an assemblage of basking turtles.
Presentation type: Poster (Student)

Sexual Size Dimorphism in Turtles: Implications for Management of Wild and Captive Populations

MICHAEL W. TUMA

Department of Biological Sciences, University of Southern California, Los Angeles, California 90089, USA

Turtles exhibit sexual size dimorphism (SSD), with expressions of female-biased, male-biased, and equal sizes between the sexes in species. Female-biased SSD appears to be the ancestral condition and is the most commonly expressed within species and clades; however, male-biased SSD and lack of SSD have evolved several times in turtles. Like other morphological traits, SSD expression varies intraspecifically. The distribution and diversity of SSD expression in turtles has implications for management of both wild and captive populations. Using Agassiz's desert tortoise as an example, I argue for management of wild populations in a manner that considers SSD, its effect on local populations, and the phylogenetic and ecological factors that influence the trait. Agassiz's desert tortoise exhibits intraspecific variation in adult body size and degree of SSD across its range, which appears to be due to phylogenetic lineage affiliation rather than ecological differences. Female body size responds moreso to ecological differences than does male body size, possibly as a phenotypic response to local ecological conditions, and male body size responds to variability in sexual selection pressures. Thus, large-scale tortoise translocation efforts planned for military base expansions and solar energy projects should consider maintenance of SSD and the factors that influence variable the expressions of this trait between populations. SSD expression in turtles should also be an important consideration in the management of captive groups of turtles, especially for captive breeding programs. I advocate for consideration of SSD in balancing social behaviors within captive groups, achieving greater captive breeding success, and maintaining the genetic integrity and diversity of captive groups for reintroduction and reestablishment efforts.

Turtle Ecology: Oral

Baseline Population Assessment of the Recently Described, Endemic Madagascar Hinge-backed Tortoise (*Kinixys zombensis domerguei*)

RYAN WALKER[1,2], DAVID MIFSUD[3], RIANA RAKOTONDRAINY[4], ANDREA CURRYLOW[5], SOARY RANDRIANJAFIZANAKA[6], AND MIKE CUMMINGS[7]

[1]Nautilus Ecology, Oak House, Pond Lane, Greetham, Rutland, LE15 7NW, United Kingdom

[2]Department of Earth, Environment and Ecosytems, The Open University, Milton Keynes, MK7 6AA, UK

[3]Herpetological Resource and Management, 1101 S Main St #100, Chelsea, MI 48118, USA,

[4]Département de Biologie Animale, Université d'Antananarivo, BP 906, Antananarivo 101, Madagascar

[5]Integrative and Evolutionary Biology, University of Southern California, 3616 Trousdale Parkway, AHF 107, Los Angeles, California 90089, USA

[6]Département de Biologie Animale, Université de Toliara, B.P. 141, 601 Toliara, Madagascar

[7]Darwin Ecology Ltd. Unit 4, Old Dairy Buildings, Fonthill Bishop, Salisbury,SP3 5SH, United Kingdom

[ryan@nautilusecology.org]

Describing the area of occupancy, population size and density of a threatened species, or species supporting a limited distribution, is often imperative when establishing sound conservation management for such species. The recently re-described Madagascar Hinge-backed Tortoise (*Kinixys, Zombensis domerguei*), was historically recognized as a subspecies within *K. belliana.* However recent molecular phylogeny works suggest that *Kinixys zombensis* represents a distinct species, with the Madagascar *Kinixys* population recognized as a distinct subspecies. This population, to date has largely been ignored by the scientific community based on an assumption of introduction, however is thought to inhabit the small island of Nosy Faly and the adjacent Ambato peninsular in northwest Madagascar. Using distance sampling and developing a spatial dataset of the species' area of occupancy we undertook a comprehensive population assessment. Thirty eight transects, varying in length from 523m to 3960m were applied systematically across the populations suspected range, totalling 66,051m. Through line distance sampling and conversations with local communities a GIS model was created detailing the area of occupancy of the population. The area of occupancy of the island population totals 1,346.8 ha (13.5 km^2), while the area of occupancy of the mainland population totals 3,115.3 ha (31.1km^2). The resulting distance model established a mean density of 1.5 tortoises per ha. (95% CI of 0.8-2.9 per ha.) and a population estimate of 6,631 tortoises (95% CI 3,455-12,727). Population density appeared highest within the island population, most likely as a result of local cultural taboo (fady) preventing the local communities from collecting or touching the tortoises. This belief does not persist upon the Ambato peninsular, with levels of poaching reported within the local communities. The Nosy Faly population of tortoises most likely represents the highest density of *Kinixys* tortoises in the world, with this subspecies occupying the most restricted range of any population within this group. Both the mainland and island population appear to suffer threats from bush pig predation and bush fires to convert habitat to agricultural land. Conservation actions are warranted and necessary for this unique endemic tortoise.

Population/Status Surveys: Oral

When Turtles are on the Menu: Raptor Predation of Chelonians in Central Florida

TIMOTHY J. WALSH[1,2] AND GEORGE L. HEINRICH[2,3]
[1]Bruce Museum, Greenwich, Connecticut, USA;
[2]Florida Turtle Conservation Trust, St. Petersburg, Florida, USA;
[3]Heinrich Ecological Services, St. Petersburg, Florida, USA
[twalsh@brucemuseum.org]

Chelonians representing six of the seven families (Chelonidae, Chelydridae, Emydidae, Kinosternidae, Testudinidae, and Trionychidae) that occur in the United States are known in the diets of raptors. We report on two central Florida field studies, which document predation of turtles by Red-shouldered Hawks (*Buteo lineatus*), and Barred Owls (*Striyx varia*). We examined the remains of 37 turtles (ten species) adjacent to a Red-shouldered Hawk nest. Twelve shells representing two species were found at a Barred Owl nest site. In addition, twenty-five (15.7%) of 159 owl pellets contained the skeletal remains of turtles. Chelonian prey selection in these studies appears to be limited by species presence and abundance, prey size, and energetic costs. This research further documents chelonophagy by raptors and significantly expands the list of known prey species. These observations contribute to further understanding the importance of turtles within the dynamics of food webs. We also discuss the potential impacts of this underreported natural occurrence on turtle populations.
Presentation type: Oral

The Relationship Between Incubation Temperature and Male Rate of Hatching Soft-Shelled Turtles, *Pelodiscus sinensis*

FEN WANG[1,3], YELIN JIANG[1,2,3], GUANJUN HOU[1,2,3], YUNSHENG CEHNG[1,2,3], JING ZHANG[1,2,3]
[1] Anhui Engineering Research Center for turtle Farming Technology, HeFei, AnHui, CHINA
[2] Fishery Institute, AnHui Academy of Agricultural Science, HeFei, AnHui, CHINA
[3] Fisheries Academician Workstation of Anhui Academy of Agricultural Sciences, HeFei, AnHui, CHINA
[jiangyelin@qq.com]

The Chinese soft-shelled turtle (*Pelodiscus sinensis*) is an important and high-valued commercial aquaculture species, which is widely distributed in central and southern China and east and southeastern Asia. Because of the high nutritional and medicinal values, soft-shelled turtles are also a highly appreciated part of many dishes of people in Asia. To investigate the effect of incubation temperature on hatching sex ratios in the Chinese soft-shelled turtle, fertilized eggs were incubated at seven constant temperature regimes (25.5, 27.5, 29.5, 30.5, 31.5, 32.5 and 33.5℃). The range of relative humidity was 75-85%. Three samples of 120 eggs each were set up for each temperature. Male ratios increased as temperature increased, from 14% at 25.5℃ to 89.4% at 33.5℃, and the ratio of male is 49% at 29.5℃. The result indicated that soft-shelled turtle had a mechanism of temperature-dependent sex determination (TSD) with higher temperatures favoring males and lower temperatures females. In addition, hatching rate differed considerably among different temperature treatments, with eggs incubated at the lowest (25.5℃) and highest (33.5℃) temperatures exhibiting lower hatching rate (23℃: 89% and 33.5℃: 86%) than those incubated at intermediate temperatures (91-98%).
Presentation type: Poster

Explaining Variation in the Distribution of Turtle Associated Salmonella (TAS) in the United States, 1960-2016. A Clinical Perspective with Recommendations to Support Safe Husbandry

JASON W. WILSON, MD, MA, FAAEM
Division of Emergency Medicine, Department of Internal Medicine, Morsani College of Medicine, University of South Florida, Tampa, Florida
[tampaERdoc@gmail.com]

Turtle Associated Salmonella (TAS) is a recognized pathogenic source of human disease and has been linked to occasional large scale, multi-state, outbreaks in the United States. Estimates for reptile associated salmonella over the last 50 years have been estimated as high as 24% of all reported Salmonella cases. More recently, the proportion of salmonellosis attributed to TAS likely decreased in the late 20th century. However, the slope of the line of incidence rates may have become more steep over last decade. In Phase 1 of this investigation, I first searched the medical literature in order to document all reported cases of TAS beginning with in the 1960s (prior to the implementation of federal and widespread local laws limiting small pet turtle sales). Sources for the documentation and assessment of TAS included case reports, case series, review papers and, notifications found in the Morbidity and Mortality Weekly Report (MMWR) issued by the Centers for Disease Control (CDC)

found using documented MeSH terms in PubMed. In Phase 2, after creation of a TAS database (United States, 1960-2016), I examined the distribution of variation in TAS cases to generate specific, testable, hypotheses (i.e. taxa, origin, environmental factors) in order to ask the question if one variable explains more variation then might be expected (e.g. if a specific taxon only accounts for X% of pet turtles but represents X+Y% of TAS cases). AMVA data was also used to estimate pet turtle ownership rates over time in order create a model of testable expected TAS rates compared to overall reported rates of Salmonella infections each year. Finally, this author reviews the microbiology and pathophysiology of *Salmonella*, the clinical approach to Salmonellosis and then concludes with recommendations on how captive breeders and *Testudines* enthusiasts can safely continue safe husbandry practices.
Disease and Medical: Oral

The Spatial Ecology of the Eastern Box Turtle (*Terrapene carolina carolina*) in an Isolated Urban Landscape of Southeast Tennessee

THOMAS P. WILSON, MARK J. DILLARD, JEREMY HOOPER, AND TEAM SALAMANDER
Department of Biology, Geology, and Environmental Science, University of Tennessee at Chattanooga, Chattanooga, TN 37403
[thomas-wilson@utc.edu]

The landscape throughout the range of the Eastern Box Turtle (*Terrapene carolina carolina*) has been altered drastically since the time of the industrial revolution. Consequently, populations of Eastern Box Turtle now appear to be in an overall state of decline. Habitats become fragmented and the microclimates are altered when roads, utility-power lines transect them or when they are clear-cut. In this study, the spatial ecology and seasonal movement patterns of the Eastern Box Turtle in contrasting habitat and management types were investigated. Home range size, daily movement patterns, and habitat use areas were investigated to determine how box turtles use fragmented or anthropogenic disturbed habitats. We monitored a total of 15 radio-tagged turtles (3 males and 3 females) from August 2013 to November 2016 and (8 males and 1 female) from May 2014 to January 2015. Turtles were located at least two times per week throughout the active seasons and bi-weekly during the winter months. Turtles emerged from hibernation in late April each season and exhibited extensive movement through hardwood forests and early successional habitats. Home range sizes averaged 4.05 ± 3.18 ha using minimum convex polygon analysis. The average distance moved per relocation in a straight line distance was 59.43 ± 15.78 m. The average net distance moved throughout the season by all turtles in both study years was 2,163.60 ± 1,369.70 m. During both monitoring seasons, turtles were located more often at sites with moderate to heavy canopy cover and woody debris present at the microhabitat level, suggesting that canopy cover may be an important attribute for box turtles when selecting suitable habitat and thermoregulation or other life history needs. The findings from this study will be integrated into our university's biological field station plan as well as management plans of other local non-profits that focus on conservation. If area non-profits can embrace management strategies that promote landscape connectivity, habitat protection and restoration, then the Eastern Box Turtle would directly benefit from those management decisions.
Presentation type: Poster