15th 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 7 - 9 2017
Charleston, SC

Additional Conference Support Provided by:
Kristin Berry, Herpetologiccal Review, John Iverson, Robert Krause,George Meyer, David Shapiro, Anders Rhodin, Brett and Nancy Stearns, and Reid Taylor

Funding for the 2016 Behler Turtle Conservation Award 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 the Turtle Survival Alliance

TURTLE SURVIVAL ALLIANCE

2017 Conference Highlights

Keynote: Russell Mittermeier

Priorities and Opportunities in Biodiversity Conservation

Russell A. Mittermeier is Executive Vice Chair at Conservation International. He served as President of Conservation International from 1989 to 2014. Named a "Hero for the Planet" by *TIME* magazine, Mittermeier is regarded as a world leader in the field of biodiversity and tropical forest conservation. Trained as a primatologist and herpetologist, he has traveled widely in over 160 countries on seven continents, and has conducted field work in more than 30 − focusing particularly on Amazonia (especially Brazil and Suriname), the Atlantic forest region of Brazil, and Madagascar.

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

TABLE OF CONTENTS

TSA PROJECTS

In October 2016, the TSA opened the Tortoise Conservation Center in southern Madagascar that will provide long-term care for the burgeoning number of tortoises seized from the illegal trade. The TSA manages over 7,800 Radiated Tortoises in seven rescue facilities.

The TSA-Myanmar team and our veterinary and husbandry staff from the Turtle Survival Center teamed up with WCS to provide triage and husbandry for over 800 Big-headed Turtles confiscated from wildlife-traffickers in Myanmar.

The first international bloodline exchange of one of the world's most endangered species, Zhou's Box Turtle (*Cuora zhoui*) occurred in June through a cooperative agreement between the TSA and the International Centre for the Conservation of Turtles at the Allwetterzoo Münster in Germany. Exchanges like this are vital to global captive conservation efforts to save these critically endangered species.

From the Program Co-Chairs: WELCOME TO THE HOLY CITY!

From one historic city to another, the 15th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles serves up another suite of presentations on this amazing group of organisms. After a successful 2016 symposium in New Orleans, we are pleased to welcome you to the Turtle Survival Alliance's home turf, Charleston, South Carolina! This year's meeting, sponsored by Zoo Med Laboratories is being co-hosted by the Turtle Survival Alliance and the IUCN Tortoise and Freshwater Turtle Specialist Group at the DoubleTree by Hilton Hotel and Suites in Charleston's Historic District. We just hope Charleston is ready for the largest gathering of turtle biologists, zookeepers, husbandrists, and enthusiasts, anywhere in the world! This year's symposium includes special sessions on Headstarting, Zoos and Chelonians, Captive Husbandry, Road Ecology, Community Outreach and Partnerships, Freshwater Turtles of the Southeast USA, and Conservation and Policy in the United States. The latter session will focus on current funding and potential new funding initiatives that would have tremendous impacts on turtle conservation in the United States.

As always, we are excited to see many of our old friends, and make new connections in the turtle conservation world. As this symposium enters its 15th year of existence, its impact on the biology of chelonians is quite evident. The level of collaboration and cross-pollination amongst the attendees is tremendous. Many of the projects you will hear about at this year's meeting started out as ideas and conversations in banquet rooms and barstools at previous symposia. This level of interaction amongst your peers in concert with the information presented during our paper sessions is what makes this symposium so successful. Many of us attended our first symposium in 2006 as students, and now have become collaborators and co-authors on many papers and presentations! We 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 vendors and sponsors make Travel Grants and our social events a possibility, so please take the time to visit the sponsor booths, buy their products, or just say thanks.

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. Cristina Jones jumped in to help get the program pulled together. Robert Villa and Michael Hance will be running the AV and making sure your presentations run smoothly. Greg Brashear, Adventure Steve, and Zachary Walde 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, has put together our offsite events at the Turtle Survival Center, SC Aquarium, and the soon to be famous, Henry's. While Chris Clark has been busy working the site logistics and the never ending details and emails! 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 to the Holy City!

Andrew Walde and Daren Riedle, Program Co-Chairs

T-shirt Design Contest Winner!
Please join us in congratulating **Miranda McCleaf**. Miranda submitted the winning entry in the t-shirt design contest for the 15th 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!

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 15th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. We decided to keep things southern this year and selected another venue that we knew would be fun and exciting, Charleston, South Carolina. Famous for its historic beauty and unsurpassed southern charm and hospitality, the Holy City provides ample opportunities for socializing and reconnecting with friends and colleagues. We selected the DoubleTree by Hilton Hotel and Suites for its proximity to a diversity of bars and restaurants and is located in the heart of old downtown Charleston.

And while Charleston is a charming tourist destination, widely recognized as one of the top foodie destinations in the U.S, fine dining is not the reason we selected this venue. We wanted to offer conference attendees an opportunity to see the TSA's Turtle Survival Center in nearby Cross, SC. The tour is Sunday, August 6, and is fully booked. Please be ready to board the busses by 8:00 AM sharp as this will be the only way to get there. Because of security concerns and lack of parking space, we must insist that you arrive on the scheduled bus transportation. Lunch will be served after the tour and we will have you back to the hotel by early afternoon with plenty of time to chill out before the icebreaker. Our local sponsor this year is the South Carolina Aquarium which is graciously hosting our icebreaker Sunday evening, August 6. The Aquarium is roughly a 20-minute stroll from the conference hotel but for those of you who prefer less strenuous options, you can Uber/Lyft or hire a pedicab.

The highlight of this year's conference will be a special plenary session on the pros and cons of headstarting turtles for reintroduction, in the afternoon of Day 1, August 7. The debate over whether headstarting in an effective conservation tool is a contentious one, and this session will attempt to illustrate successful examples of headstarting, based on survival, but will also highlight some programs that have not proved successful. A series of presentations, both on tortoises and freshwater turtles, will be followed by two roundtable discussions that will encourage audience input and questions. Overall this session is intended to showcase examples of success, as well as point the way for improved monitoring techniques. Also early in the evening of Day 1, IUCN TFTSG Chair Craig Stanford will host a review of the Top 25+ Turtles in Trouble in an open forum session.

On Wednesday night, August 9, we wrap up with our Awards Banquet, where the student awards, Turtle Conservation Fund, and Behler Award winners will be announced. The banquet will be at the conference hotel, the DoubleTree.

We offer special thanks to the organizational skills of our conference team - Andrew Walde, Chris Clark, and Ilze Astad - who managed to balance a multitude of details in the months leading up to the conference. Theirs is a demanding and often all-consuming 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 Adventure Steve, Kristin Berry, Desert Tortoise Council, Herpetological Review, John Iverson, Robert Krause, Mazuri, George Meyer, David Shapiro, Brett and Nancy Stearns, the Surprise Spring Foundation, SWCA Environmental Consultants, and Reid Taylor (in memory of Charlie Green). 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
Craig Stanford, Chair, TFTSG

John L Behler Turtle Conservation Award

This year the 12th annual Behler Award for Turtle Conservation celebrates and honors Peter Paul van Dijk for his quarter-century of dedication to turtle science and conservation. Peter Paul spent many years studying tortoise and freshwater turtle conservation biology and surveying their population status in Thailand, with some early forays into Myanmar but came to prominence by co-editing the *Asian Turtle Trade* monograph, published by Chelonian Research Foundation in 2000. This monograph brought the Asian turtle crisis to the attention of CITES and the rest of the world, also leading to the formation of both the Turtle Survival Alliance and the Turtle Conservation Fund. Combined with his work at TRAFFIC Southeast Asia, these efforts started the symbiotic relationship between Peter Paul and CITES. Over the years, he has written many proposals to include freshwater turtle species under the international trade supervision provided by CITES, seen those proposals through to adoption and implementation, and has worked tirelessly to make the best of existing legislative protection opportunities for turtles. His working years at Conservation International were focused on expanding Red List coverage of tortoises and freshwater turtles, identifying priority species and priority areas for conservation action, and partnering with country programs and like-minded NGOs and governments to design and deliver conservation action for turtle populations in the wild, almost worldwide. His current work at Global Wildlife Conservation and the Turtle Conservancy is focused even more on in-situ conservation through securing and restoring native habitat. Along the way, Peter Paul has been a core contributor to the TTWG Turtle Checklists, to conservation strategies in various countries, and to a wide range of publications. Peter Paul has been deputy chair of the TFTSG since 2000, with a co-chairing stint from 2012 to early 2017, sits on the review board of the Turtle Conservation Fund, and has been a mentor, mediator and partnership builder for many in the turtle research and conservation community. Nevertheless, Peter Paul is happiest when sloshing through a wetland or hiking through a desert in search of turtles, and is proud to have seen over 80 species in the wild.

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, George Meyer and Maria Semple, Brett and Nancy Stearns, and Deb Behler.

Congratulations Peter Paul--extremely well deserved!

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

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/2017TSA**. 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 6 – 3:00 PM – 5:00 PM
- August 7 – 8:00 AM – 4:00 PM
- August 8 – 8:00 AM – 4:30 PM

Contents of this Conference Program should be cited as:
Author. 2017. **Title**. In A.D. Walde, J.D. Riedle, and C.A. Jones (Eds.). Program and Abstracts of the Fifteenth Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. Turtle Survival Alliance, Charleston, South Carolina. pp.*xx–xx*.

Please visit the following vendors, sponsors, and non-profits in the Exhibit Hall (Ansonborough Ballroom):

- Allen Press
- ECO Publishing
- Holohil
- Mazuri
- Paul Gritis Books
- Sonotronics
- Stoneridge Art Studios
- Turtle Conservancy
- Turtle Eye Productions
- the Turtle Room
- Turtle Survival Alliance
- Zoo Med Laboratories

Conference Notes and Social Activities

Saturday, August 5

- Registration 3:00 PM – 6:00 PM (Registration Desk)

Sunday, August 6

- Registration 1:00 PM – 5:30 PM (Registration Desk)
- Auction Item Drop Off 3:00 PM – 5:30 PM (Ansonborough Ballroom)
- Poster Hanging 3:30 PM – 5:30 PM (Ansonborough/Hayne Street Gallery)
- Walk to the South Carolina Aquarium 5:30 PM (Meet in the lobby at 5:15)
- Icebreaker 6:30 PM – 8:30 PM (SC Aquarium)

Monday, August 7

- Registration 8:00 AM – 4:00 PM (Registration Desk)
- Auction Item Drop Off 8:00 AM – 1:00 PM (Ansonborough Ballroom)
- Exhibit Hall Open 7:30 AM – 6:00 PM (Ansonborough Ballroom)
- Poster Viewing 7:30 AM – 6:00 PM (Ansonborough/Hayne Street Gallery)
- Silent Auction Opens 4:00 PM (Ansonborough Ballroom)
- Silent Auction #1 Closes – 6:00 PM (Ansonborough Ballroom)

Tuesday, August 8

- Registration 8:00 AM – 4:00 PM (Registration Desk)
- Exhibit Hall Open 8:00 AM – 4:00 PM (Ansonborough Ballroom)
- Poster Viewing 8:00 AM – 4:00 PM (Ansonborough/ Hayne Street Gallery)
- Silent Auction #2 Closes – 1:00 PM (Ansonborough Ballroom)
- Poster Session 3:30 PM – 5:30 PM (Ansonborough/Hayne Street Gallery)
- Silent Auction #3 Closes – 5:00 PM (Ansonborough Ballroom)

Wednesday, August 9

- Registration 8:00 AM – 1:00 PM (Ansonborough Ballroom)
- Auction Payment / Pick-up 8:00 AM – 1:00 PM (Ansonborough Ballroom)
- Exhibit Hall Open 8:00 AM – 1:00 PM (Ansonborough Ballroom) ***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 (Ansonborough/Hayne Street Gallery)
- Poster Breakdown 12:00-1:00 PM (Authors, please take down your posters at this time. Any posters left behind will be discarded.)
- Awards Banquet (Charlestonian Ballroom) at the DoubleTree: 6:00 PM.

Support the TSA!

Be sure to visit the TSA merchandise tables in the Exhibit Hall (Ansonborough Ballroom) 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 Monday and Tuesday in the Exhibit Hall (Ansonborough Ballroom), in three segments.

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 (Ansonborough Ballroom). Please note: no auction can be accepted without completing this process! Auction items will be accepted from 3:00-5:30 on Sunday and from 8:00 AM-1:00 PM on Monday. **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 Wednesday.

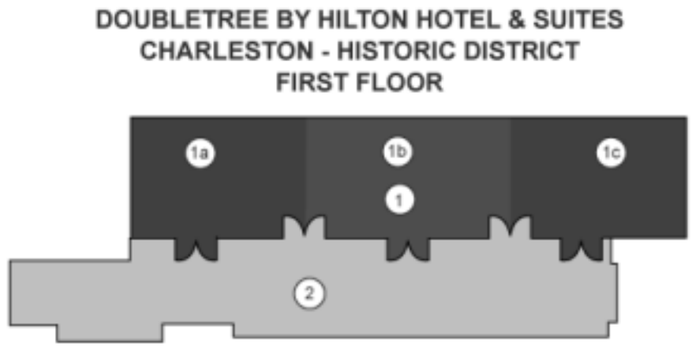
Social Media

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

On Facebook: http://www.facebook.com/TurtleSurvival
Twitter: @TurtleSurvival
Instagram: @turtlesurvial

Join the conversation! Use #TSA2017 when you post or tweet about the meeting or to follow along!

DoubleTree by Hilton Hotel & Suites Charleston - Historic District



SECOND FLOOR

Conference Schedule Overview

<table>
<tr><th colspan="2">Saturday
August 5</th><th>Sunday
August 6</th><th>Monday
August 7</th></tr>
<tr><td>8:00</td><td rowspan="6"><u>TSA Governance</u>
(closed)
Kiawah Room</td><td><u>Turtle Survival Center</u>
<u>Field Trip</u>
Buses depart</td><td></td></tr>
<tr><td>8:30</td><td rowspan="11"><u>TSC Tour</u></td><td>Opening Address and Welcome</td></tr>
<tr><td>9:00</td><td>TFTSG</td></tr>
<tr><td>9:15</td><td rowspan="3">Keynote Address
Russ Mittermeier</td></tr>
<tr><td>9:30</td></tr>
<tr><td>9:45</td></tr>
<tr><td>10:00</td><td rowspan="2"></td></tr>
<tr><td>10:15</td><td>Break/Posters</td></tr>
<tr><td>10:30</td><td rowspan="5"><u>TSA Board</u>
(closed)
Cooper Room</td><td rowspan="2">Sex, Shells, and Weaponry</td></tr>
<tr><td></td></tr>
<tr><td>11:00</td><td>Update on Palawan</td></tr>
<tr><td>11:15</td><td>IUCN - Redlisting Process</td></tr>
<tr><td>11:30</td><td rowspan="2">Introduction to Headstarting</td></tr>
<tr><td></td></tr>
<tr><td>12:00</td><td colspan="2" rowspan="2">Lunch</td><td>Lunch
BBQ at the TSC</td><td>Lunch</td></tr>
<tr><td>12:30</td></tr>
<tr><td>13:00</td><td colspan="2" rowspan="8"><u>TSA Board</u>
(closed)</td><td rowspan="2"><u>Buses return from TSC</u></td><td rowspan="6">Headstarting</td></tr>
<tr><td>13:30</td></tr>
<tr><td>13:45</td><td rowspan="2"><u>Registration</u>
<u>(open until 17:30)</u></td></tr>
<tr><td>14:00</td></tr>
<tr><td>14:15</td><td rowspan="5"><u>TCF Board</u>
(closed)
Cooper Room</td></tr>
<tr><td>14:30</td></tr>
<tr><td>14:45</td></tr>
<tr><td>15:00</td><td rowspan="2">Headstarting Discussion</td></tr>
<tr><td>15:15</td></tr>
<tr><td>15:30</td><td rowspan="5"><u>TSA Board</u>
(closed)</td><td rowspan="6"><u>Registration</u></td><td rowspan="2"></td></tr>
<tr><td>15:45</td></tr>
<tr><td>16:00</td><td rowspan="3">Icebreaker Social</td><td rowspan="3">IUCN - TFTSG Top 25 Discussion</td></tr>
<tr><td>16:15</td></tr>
<tr><td>17:00</td></tr>
<tr><td>17:30</td><td rowspan="4"></td><td></td></tr>
<tr><td>18:00</td><td rowspan="3"></td></tr>
<tr><td>18:30</td></tr>
<tr><td>19:30</td><td colspan="2"></td></tr>
<tr><td>20:00</td><td></td><td></td></tr>
</table>

Conference Schedule Overview

<table>
<tr><th></th><th>Tuesday
August 8-A</th><th>Tuesday
August 8-B</th><th>Wednesday
August 9-A</th><th>Wednesday
August 9-B</th></tr>
<tr><td>8:45</td><td colspan="4">Morning Announcements</td></tr>
<tr><td>9:00</td><td rowspan="5">Road Ecology</td><td rowspan="5">Growth/Morphology</td><td rowspan="5">Conservation Projects</td><td rowspan="5">Tortoises</td></tr>
<tr><td>9:15</td></tr>
<tr><td>9:30</td></tr>
<tr><td>9:45</td></tr>
<tr><td>10:00</td></tr>
<tr><td>10:15</td><td>Break/Posters</td><td>Break/Posters</td><td>Break/Posters</td><td>Break/Posters</td></tr>
<tr><td>10:30</td><td rowspan="5">Community Outreach and Partnerships</td><td rowspan="5">Zoos & Chelonians</td><td rowspan="5">Conservation Projects</td><td rowspan="5">Genetics</td></tr>
<tr><td>10:45</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><td rowspan="2">Lunch</td><td rowspan="2">Lunch</td><td rowspan="2">Lunch</td><td rowspan="2">Lunch</td></tr>
<tr><td>12:00</td></tr>
<tr><td>13:00</td><td rowspan="5">Reproductive Ecology</td><td rowspan="5">Geography Matters</td><td rowspan="5">Ecology/Field Studies</td><td rowspan="5">Freshwater Turtles of the Southeast: a Marriage of Conservation and Education</td></tr>
<tr><td>13:15</td></tr>
<tr><td>13:30</td></tr>
<tr><td>13:45</td></tr>
<tr><td>14:00</td></tr>
<tr><td>14:15</td><td>Break/Posters</td><td>Break/Posters</td><td>Break/Posters</td><td>Break/Posters</td></tr>
<tr><td>14:30</td><td rowspan="4">Physiology/Health</td><td rowspan="4">Conservation and Policy in North American Turtles</td><td rowspan="5">Ecology/Field Studies</td><td rowspan="5">Captive Husbandry</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><td colspan="2" rowspan="4">Poster Session</td></tr>
<tr><td>16:00</td></tr>
<tr><td>17:00</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>17:30</td></tr>
<tr><td>18:00</td><td rowspan="2"></td><td rowspan="2"></td><td colspan="2" rowspan="2">Banquet and Awards</td></tr>
<tr><td>18:30</td></tr>
<tr><td>21:30</td><td colspan="2"></td></tr>
</table>

Daily Schedule			
	Saturday, August 5	Sunday, August 6	Monday, August 7
	Cooper Room	Lobby/Cooper Room	Stono Ballroom
8:00	**TSA Governance (8:00 - 10:00) (Closed) Kiawah Room**	**Turtle Survival Center Field Trip Buses depart 08:00**	
8:30			Turtle Survival Alliance - Opening Address
9:00		**TSC Tour**	TFTSG - Update
9:15			KEYNOTE ADDRESS Priorities and Opportunities in Biodiversity Conservation Russ Mittermeier
9:30			
9:45			
10:00			
10:15			***Break & Posters***
10:30	**TSA Board (9:00 - 17:00) (Closed)**		Sex, Shells, and Weaponry P MOLDOWAN*
11:00			Update on Palawan S SHOPPE
11:15			How IUCN Red Listing Works R KIESTER
11:30			Headstarting: the Panacea for Freshwater Turtle Conservation? R-J SPENCER
12:00	***Lunch***	***Lunch at TSC***	***Lunch***
			Headstarting: What we know, what we don't know, and future directions Chair: R. Hudson
13:00	**TSA Board (9:00 - 17:00) (Closed)**	**Buses return from TSC**	"Does it work?" Evaluating Success in Headstarting A BENNETT (S CARSTAIRS)
13:15			Head-starting that works: Growing a Colony of Bolson Tortoise S HILLARD
13:30			Captive Breeding and Reintroduction of Burmese Star Tortoises K PLATT
13:45			Developing Head-starting Strategies that work for Gopher Tortoises and Desert Tortoises: an Iterative Process T TUBERVILLE
14:15		**Registration (Open until 17:30)**	***Headstarting Tortoises Discussion***
14:30			***Break***
14:45			Restoring *Batagur trivittata* to the Chindwin River in Myanmar S PLATT
15:00	**Registration In Lobby (15:00-19:00)**	**TCF Board (15:00 - 17:00) (Closed)**	Captive Breeding and Headstarting Increase the Wild Population of the Critically Endangered Western Swamp Turtle G KUCHLING
15:15			Genomic Assessment Reveals Increase in Genetic Diversity Following Bog Turtle Translocation Program C DRESSER*
15:30			Tracking Headstarted Giant South American River Turtles V BERNARDES (R VOGT)
15:45			Fifteen Years of Headstarting Alligator Snapping Turtles D LIGON
16:00			Behavior, Body Condition, and Survivorship among Three Cohorts of Headstarted Wood Turtles D MULLIN*
16:15			Headstart Methodology and Post-release Survivorship and Movements in Head-started Wood and Blanding's turtles K BUHLMANN
16:30			***Headstarting Freshwater Turtles Discussion***

***Indicates Student Presentation for Student Awards Competition**

Daily Schedule		
	Tuesday, August 8 - Stono Ballroom	Tuesday, August 8- Charlestonian Ballroom
8:45	**Morning Announcements**	**Morning Announcements**
	Road Ecology Chairs: M. Dupuis-Desormeaux	***Growth/Morphology*** Chair: T. Stratman
9:00	Blood Along Heart Lake Road: Mortality and Mitigation M DUPUIS-DESORMEAUX	Exceptional Growth Rates in the Genus Pseudemys T STRATMAN*
9:15	Sex-biased Turtle Road Mortality with an Unbiased Dataset S CARSTAIRS	Growth and Activity of Alligator Snapping Turtle Hatchlings S SPANGLER*
9:30	Road Effects on Painted and Snapping Turtle Demographics S KELL*	Glacial Growth Rates of Alligator Snapping Turtles B FOLT
9:45	One of the World's Worst Turtle Road Mortality Hotspots now has 89% Fewer Turtle Deaths S GILLINGWATER	Is Coprophagy an Important Management Consideration for the Captive Breeding of Herbivorous Turtles? N BISHOP*
10:00	Evaluating Mojave Desert Tortoise Underpass Designs K HOLCOMB	Interspecific Variation and Ecological Correlations in Skull Characters of *Kinosternon* and *Sternotherus* J BERRY
10:15	***Break & Posters***	***Break & Posters***
	Community Outreach and Partnerships Chair: J. Gray	***Zoos and Chelonians*** Chair: B. Hughes & A. Stern
10:30	Coming Full Circle: How an Education Program has Translated into Conservation Action D GASBARRINI	Integration of Extrinsic Partners with AZA Species Survival Plans: There's More Than One Way to Breed a Turtle B HUGHES
10:45	Aquatic Turtles - The Perfect Critters for Teaching Students and Promoting Community Conservation J BYRD	Constraints and Solutions to Managing Chelonians in a Small Institution Z BYRNE
11:00	Education and Outreach Tools for the Modern World S ENDERS	Overview of Turtle Research at the Tennessee Aquarium J ENNEN
11:15	Turtle Marketing 101: Making Turtles the New Panda J LIU	A Cupulatta, France: an Unique European Turtle Park P MOISSON
11:30	Country-wide Efforts to Promote the Conservation of the Critically Endangered Central American River Turtle H BARRETT	Thinking Outside the Shell for Conservation: Training Behaviors in Tortoises for Public Encounters L ETZKORN
11:45	Hope for Belize's Hicatee: Central American River Turtle VIDEO Presentation	Small Steps Towards BIG Conservation K LAMMERING
12:00	***Lunch***	***Lunch***
	Reproductive Ecology Chair: J. Ennen	***Geographic Variables*** Chair: Ben Atkinson
13:00	Habitat-associated Morphology Divergence Physically Constrains Reproductive Output in a Mud Turtle J ENNEN	Understanding the Geographic Distribution of Turtles is Fundamental to Conservation and Management G HEINRICH
13:15	Nest Survivorship and Demographic Trends of Bog Turtles M KNOERR*	The Southwestern Pond Turtle (*Actinemys pallida*) in the Mojave River of California: Past, Present and Future J LOVICH
13:30	The Effects of Climate on Annual Variation in Reproductive Output in Snapping Turtles A. HEDRICK (J IVERSON)	Immigrants Welcomed: Colonization of an Artificial Urban Wetland Complex by Various Turtle Species M DUPUIS-DESORMEAUX
13:45	Reproductive Ecology of Desert Tortoises S PUFFER	Explaining Unusual Distributions of Northern Map Turtles K BUHLMANN
14:00	Research of Beal's Eyed Turtle (*Sacalia bealei*) in China L LIN	Population Dynamics in an Wood Turtle Population E RUTHER*
14:15	***Break & Posters***	***Break & Posters***
	Physiology/Health Chair: M. Feldman	***Conservation & Policy in N.A.*** Chair: C.A. Jones
14:30	Differences Among Three Southeastern US Semi-aquatic Turtle Species in Their Metabolic Responses to Temperatures D HASKINS*	South Carolina's State Wildlife Action Plan and Associated State Wildlife Grants Program A SMITH
14:45	Health Threats to Urban and Rural Box Turtles in Missouri J PALMER	State Wildlife Action Plan and State Wildlife Grants – Directing and Funding Conservation of Arizona's Turtles C JONES
15:00	Refining the Techniques Used to Induce Egg Laying in Turtles M FELDMAN	Status and Spatial Ecology of the Spotted Turtle in Florida J MAYS
15:15	Overview of the Intranuclear Coccidian Parasite of Testudines N STILWELL	Turtle Conservation and the Kansas State Wildlife Action Plan D RIEDLE
15:30-17:30	***POSTER SESSION***	

*** Student Considered for Student Awards Competition**

Daily Schedule		
	Wednesday, August 9 - Stono Ballroom	**Wednesday, August 9 - Charlestonian Ballroom**
8:45	**Morning Announcements**	**Morning Announcements**
	Conservation & Management Chair: B. Horne	***Tortoises*** Chair: A. Walde
9:00	Learning from Success in Chelonian Conservation P GIBBONS	Reintroducing Bolson Tortoises into Prehistoric Habitat C WIESE
9:15	Western Megacephalic Map Turtles - Federal Protection? P LINDEMAN	Detection of Ranavirus in Translocated Gopher Tortoises R COZAD*
9:30	Conservation and Private Industry: Tailoring Management Plans to fit Industry Objectives and Expectations B DURKIN*	Use of Modified GPS Logger and Radio-Telemetry Methodologies for Studying Resident and Translocated Gopher tortoises L PADEN*
9:45	Semicaptive Management - Central American River Turtle G GONZALEZ-PORTER	Home Range of Texas Tortoises in Jim Hogg County, Texas R COUVILLON*
10:00	A Soft-release Repatriation Trial of Radiated Tortoises A CURRYLOW	Phylogeny of the Enigmatic Eocene Testudinoid Turtle *Echmatemys* and the North American Origin of the Testudinidae A LICHTIG
10:15	***Break & Posters***	***Break & Posters***
	Conservation& Management (cont.)	***Genetics*** Chair: F. Ihlow
10:30	Conservation of the Southern River Terrapin in Cambodia S SOM	Male Body Size Effects on Siring Success in the Gopher Tortoise N WHITE*
10:45	Management Strategies for the Geometric Tortoise J JUVIK	Diversity of North American Map and Sawback Turtles F IHLOW*
11:00	Recovery and Protection of the Hogei Sideneck Turtle M COUTINHO	Actual genetics situation of the box turtle in Cuatrociénegas México X CORTES-RODRÍGUEZ*
11:15	Conservation of the Endemic Chelonians of Sulawesi: Forsten's Tortoise and Sulawesi Forest Turtle C LIGHT/A CURRYLOW	Genetic Evidence of Fragmented Populations and Inbreeding in the Endemic Dahl's Toad-headed Turtle N GALLEGO-GARCIA*
11:30	Program Update: Conservation Efforts in Bangladesh S TRAGESER	The Population Genetics of the Razorback Musk Turtle G BROWN*
11:45	Five Years of Turtle Conservation in Colombia G FORERO	Molecular Analyzes Reveal Conservation Potential for the Critically Endangered *Mesoclemmys hogei* L GOMES*
12:00	***Lunch***	***Lunch***
	Ecology/Field Studies Chair: A. Currylow	***Freshwater Turtles of the Southeast*** Chair: T. Wilson
13:00	Spatial Relationships and Anthropogenic Effects on River Turtle Assemblages in Kansas and Oklahoma D RIEDLE	Design Process Thinking and Structured Decision Making to the Conservation of Freshwater Turtles in the Thrive 2055 Region T WILSON
13:15	Eastern Musk Turtle Predation on Invasive Snails M MORRISON*	Using Citizen Scientists - Spatial Ecology the Eastern Box Turtle M DILLARD* (P-E BAKLAND*)
13:30	Tenacious Site Fidelity of Ornate Diamondback Terrapins B ATKINSON	An Iconic Freshwater Turtle Species, Hidden in Plain Site E MUNSCHER
13:45	Building A Better Crab Trap Bycatch Reduction Device J SCHWENTER	Clean Water and River Health Education Using Freshwater Turtles S MADSEN
14:00	Ecology and Trade of the Black-breasted Leaf Turtle (*Geoemyda spengleri*) on Hainan Island, China D GAILLARD (J DAWSON)	A Study of an Aquatic Turtle Assemblage in a Northwest Georgia Lake and Wetland Prior to Restoration T HENDRICKS*
14:15	***Break & Posters***	***Break & Posters***
	Ecology/Field Studies (cont.)	***Captive Husbandry*** Chair: S. Enders
14:30	Microbiomes of the Krefft's River Turtle D MCKNIGHT*	Naturalistic Keeping: Design and Construction of Captive Habitats C LEONE
14:45	Ecology of Breeding Females of Hogei Sideneck Turtle G DRUMMOND	Captive Management and Reproductive Biology of the Hicatee J MARLIN
15:00	Population Ecology and Movements of two Kinosternon Species from Mexico R MACIP-RIOS	Tiny Tortoises: Captive Care and Breeding of the Parrot-beaked Tortoise (*Homopus areolatus*) J LIU
15:15	An Evaluation of Culturing Carolina Diamondback Terrapins A GROSSE	If You Build it They Will Come, the Success and Strategies of the TSC C DOAK
15:30		The Albera Turtle and Tortoise Captive Breeding Centre: results of twenty five years of protecting the local species of turtles R MASCORT
15:45		The State of the Art of Captive Raising Turtles in China D VOGT

*** Student Considered for Student Awards Competition**

Poster Presentations *(Ansonborough/Hayne Street Gallery/Ashley)*	
Poster Session Tuesday, August 8th at 1530 h	
Riverine Turtle Distribution and Abundance within the Pascagoula River Drainage, Mississippi G BERRY*	A Yankee Turtle Invading the Deep South: Discovery of the Northern Map Turtle (*Graptemys geographica*) in Mississippi G BROWN*
Sex and Clutch Effects on Growth Rates of Gopher Tortoises J COBB*	Bald Eagle Predation of Aquatic Turtles in Alabama A COLEMAN
Effects of Health Status and Enclosure Density on Home Ranges of Translocated Gopher Tortoises in Florida, USA R COZAD*	Comparing Unmanned Aerial Vehicles (UAVs) to Traditional Field Methods in Surveying of Basking Riverine Turtles K DANIELS*
The Greenhouse for Culturing Juvenile Soft-shelled Turtles, *Pelodiscus sinensis* W FEN	The Growth and Movement of *Gopherus polyphemus* J FLOYD*
Preliminary geometric morphometric analysis of the North American genus Pseudemys J GODWIN	Motor Boat Injury Rates and Patterns in Aquatic Turtle Communities E HOLLENDER*
Nesting in Close Quarters: Causes and Benefits of High Density Nesting in Painted Turtles S KELL*	3rd Attempt at Artificially Inseminating the last female Yangtze Giant Softshell Turtle, *Rafetus swinhoei* G KUCHLING
Triassic Turtle Tracks Provide New Age Constraints on the Origin of Turtles A LICHTIG	An Island of Misfit Tortoises: Using Waif Animals to Recover Populations on the Brink R MCKEE*
Estivation Site Selection of Western Chicken Turtles MCKNIGHT*	Salinity Tolerance and Osmoregulation in Red-eared Sliders H MEILING
Sex Determining Morphometric Trait Analysis in Diamondback Terrapins C MILES	Evaluating the Effectiveness of Headstarting for Wood Turtle (*Glyptemys insculpta*) Recovery from a Suspected Poaching Event D MULLIN*
Use of Prescribed Fire to Increase Detectability of Gopher Tortoise Burrows Prior to Relocation L PADEN*	Distribution and Size Classes of Alligator Snapping Turtles in the Pascagoula River Drainage of Mississippi L PEARSON*
A Preliminary Look at Declines in Capture Rates of Sternotherus Species at Wekiwa Springs State Park, Florida R PHILLIPS*	Estimates of Relative Preferred Temperatures in Turtles A RAY
Movements of Loggerhead Musk Turtles (*Sternotherus minor*) in a Central Florida Spring A ROSS*	Evaluating Turtle Passage Gates using Remote Camera Traps and Visual Encounter Surveys J ROSS
Hypomelanism Rates in a Captive Population of Alligator Snapping Turtles K SARDINA*	Growth and Survival of Head-started Alligator Snapping Turtles (*Macrochelys temminckii*) in Northeastern Louisiana N SCHWARTZ*
A Major Field Experience: New Millsaps College Turtle Research Projects in Mississippi W SELMAN	Spatial, Seasonal, and Sexual Variation in the Diet of *Graptemys flavimaculata* of the Pascagoula River System, Mississippi, USA W SELMAN
Body Condition and Body Composition of Captive and Reintroduced Alligator Snapping Turtles (Macrochelys temminckii) B TAPPMEYER*	Ecomorphological Correlates of Microhabitat Selection in Two Sympatric Asian Box Turtle Species (Geoemydidae: *Cuora*) F XIAO
The Investigation on the Habitat and Resources Conservation of Golden-headed Box Turtle, *Cuora aurocapitata* C YUNSHENG (J YELIN)	
***Student Considered for Student Awards Competition**	

Tenacious Site Fidelity of an Insular Population of Ornate Diamondback Terrapins (*Malaclemys terrapin macrospilota*) Following Hurricane Hermine

Benjamin K. Atkinson[1], Coleman M. Sheehy iii[2,3], and Laura C. Sánchez[3]
[1]Department of Natural Sciences, Flagler College, St. Augustine, FL 32084
[2]Division of Herpetology, Florida Museum of Natural History, University of Florida, Gainesville, FL 32611
[3]Department of Biology, University of Florida, Gainesville, FL 32611
[BAtkinson@flagler.edu]

Ornate Diamondback Terrapins (*Malaclemys terrapin macrospilota*) are obligate estuarine emydids, with a range restricted to Florida's Gulf coast. Despite being sought after in the (legal and illegal) pet trades, little is known about the biology and ecology of this "ornate" subspecies. Nonetheless, this genus faces many threats. 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. Since 2014, we have been investigating a metapopulation of *M. t. macrospilota* in the Cedar Keys National Wildlife Refuge, which is located on Florida's Big Bend, just south of the Suwannee River's outflow. We used mark-recapture data from 65 recaptures of 57 individual terrapins to examine site fidelity on a continental island during a three-year period that included pre- and post-Category 1 Hurricane conditions. During the high point of Hurricane Hermine's storm surge, the island was under ~4 meters of water for several hours. Of terrapins marked in the year prior to the hurricane, 56% were recaptured after the storm. There was no significant difference in mass between females captured before and after the hurricane. However, males recaptured after the storm had larger mass than males captured prior to the storm. We are unable to determine whether terrapins hunkered down and remained on the island during the storm surge, or whether they left and returned. Overall, there was no significant difference between terrapin sex and frequency of recapture. In 2016, prior to the hurricane, we observed 48 young-of-the-year terrapins on the island. Following the hurricane, we encountered only a solitary post-hatchling at this site, suggesting the storm may have nearly wiped out an entire recruitment cohort. However, gravid females are returning to the island, presumably to nest. We have also observed evidence of multiple clutching, by palpating these recaptures for eggs. Terrapins are known to exhibit high site fidelity in many parts of their range. Multiple clutching and high site fidelity are life history traits that may allow terrapins to persist in insular habitats where they are periodically exposed to extremely harsh environmental conditions.

Geographic Variables: Oral

Country-wide Efforts to Promote the Conservation of the Critically Endangered Central American River Turtle *(Dermatemys mawii)* in Belize, Central America

Heather Barrett
Belize Foundation for Research and Environmental Education (BFREE)
PO Box 129, Punta Gorda, Belize, Central America
[hbarrett@bfreebz.org]

Due to the rapidly declining population across its limited range of southern Mexico, northern Guatemala and Belize, the critically endangered Central American River Turtle, *Dermatemys mawii,* has elicited great concern. Recognizing that the stronghold for this dwindling population was likely in the small country of Belize, the Turtle Survival Alliance spearheaded a country-wide survey followed by a series of workshops to ignite interest and action. As a result of the first workshop in 2011, the National Hicatee Conservation and Monitoring Network (NHCMN) was established with membership including the Belize Fisheries Department, the University of Belize, conservation NGOs, scientists, and members of civil society throughout Belize. These partners have spearheaded independent and collaborative research, educational and monitoring activities. Over the past five years, various awareness and outreach events have been implemented throughout the country focusing in Districts with the highest populations of *Dermatemys*. Outreach materials including t-shirts, stickers, and activity books have been created and distributed during major events when it is typical to consume Hicatee meat as in the annual competitive canoe race, Ruta Maya. Press releases, articles, radio announcements, and creative raps have been published in national newspapers and broadcast using national media sources throughout the peak season for *Dermatemys* consumption. With the opening of the Hicatee Conservation and Research Center (HCRC) at the BFREE Field Station in 2013 and the arrival of its first captive-bred hatchlings in 2015, there was a new opportunity to engage Belizeans because finally they could see and even touch this reclusive and unusual turtle. Since the establishment of the HCRC, hundreds of visitors from Belize and abroad have been exposed to the Hicatee. Most recently, a film "Hope for Belize's Hicatee: Central American River Turtle," was produced by wildlife filmmakers, Richard and Carol Foster. This film is to be premiered at the 15th Annual Turtle

Survival Alliance Conference and will be launched both online and throughout Belize in a collaborative and strategic push by members of the NHCMN during the fall of 2017. Sustained messaging and ongoing awareness activities are essential in order to encourage stewardship and protection for the secure future of the species.

Community Outreach and Partnerships: Oral

"Does It Work?" Doesn't Work; Evaluating Success in Headstarting

Amanda Bennett[1,2], Jessica Steiner[2], Sue Carstairs[3], Andrea Gielens[2], and Christina Davy[1,2,3]
[1]Trent University, Peterborough ON, K9J 7B8; [2]Wildlife Preservation Canada, Guelph, ON N1H 6H2
[3]Ontario Turtle Conservation Centre Selwyn, ON, K9J 6X2
[suecarstairs@sympatico.ca]

It is challenging to scientifically evaluate conservation interventions such as headstarting because of case-by-case, species-specific approaches and small sample sizes inherent to species conservation. As a result, debates about whether a particular method is successful ("Does it work?") may become entrenched in an uninformative yes-no framework. Headstarting is a conservation tool that has attracted strong opinions but little robust data to either side of the argument. Logistical limitations such as the long-lived life history strategy of turtles have slowed experimental evaluation of turtle head-starting. Evaluations of success among headstarted individuals and populations have largely lacked adequate replication or experimental controls, and few have clearly defined milestones for "success". To address these concerns and facilitate informative evaluation, a road map is needed to guide experimental evaluation of these conservation interventions in logistically challenging systems. No conservation tool is suitable for all situations but most tools are useful when applied in appropriate situations, using best practices based on evidence. Asking whether headstarting "works" is simply the wrong question. Projects working to conserve threatened turtle populations should first define their goals (for example increased population size, increased juvenile survivorship or increased reproductive output). They can then assess whether headstarting can help achieve these targets, and if so, which specific husbandry, release, and post-release strategies are most appropriate. Most importantly, it should be paired with a robust monitoring program to evaluate effectiveness. Standardized techniques and experimental design would allow individual headstarting projects to contribute to the global effort to conserve turtle species.

Headstarting: Oral

Tracking Headstarted One Year Old Giant South American River Turtles (*Podocnemis expansa*) in the Rio Trombetas, Brazil with Sonic Transmitters.

Virginia Campos Diniz Bernardes[1], Richard Carl Vogt[1] and Camila Rudge Ferrara[2]
[1]Coordinação de Biodiversidad, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil CEP 69.067-375
[2]Wildlife Conservation International– WCSBrazil, Manaus, Amazonas, Brazil 69083
[dickturtlevogt@gmail.com]

We studied the migration of headstarted one year old *Podocnemis expansa* with sonic transmitters on the Rio Trombetas, Para, Brazil. We tracked turtles passively with an array of fixed receivers placed both upstream and downstream from the nesting beach and with a mobile receiver actively searching for tagged hatchlings in different habitats. 17 juveniles with transmitters were released on 13 December at the nesting beach along with 5000 recently emerged hatchlings amidst the group of adult females which had been aggregating in front of the nesting beach since the nesting season. On the following day 8 of these headstarted hatchlings were still in front of the beach along with two males with transmitters. On 25 December only 2 headstarted juveniles were in front of the beach, one entered the lake near the beach and remained there with two males for 11 days, 9-20 days after release. On 27 December one juvenile that had dispersed upstream on the 22 day returned migrating in the opposite direction, downstream, with a female with transmitter. On 6 January another juvenile which had migrated upstream returned to the area in front of the nesting beach with a group of adult turtles. One juvenile was found migrating with a group of at least 2 males with transmitters 4 km downstream from the release site 15-29 December. Afterwards it remained at this site until 4 January with this group of turtles. Two other juveniles migrated downstream from 19-24 December. One juvenile was found 4 km downstream from the release site for 10 days in January without any other adult turtles with transmitters. Two juveniles entered Jacare Lake, one with two males from 15-29 December. Two months after the release, at the end of February 30% of the one year old juveniles with transmitters could still be found. Most of their migration activity occurred nocturnally. These headstarted juveniles had nearly the same behavior as the recently hatched turtles released with sonic transmitters released in other years immediately after hatchling. However we did not find any of these headstarted hatchlings recorded in the fixed

stations 75 km farther downstream.
Headstarting: Oral

Riverine Turtle Distribution and Abundance within the Pascagoula River Drainage, Mississippi

Gabrielle Berry, Luke Pearson, and Carl Qualls
Department of Biology, University of Southern Mississippi, 118 College Drive #5018, Hattiesburg, Mississippi 39406
[Gabrielle.Berry@USM.edu]

With over 30 species, the state of Mississippi is a biodiversity hotspot when it comes to testudines. Turtles are one of the most at risk groups of animals in the world, with approximately 54% of species listed as threatened or endangered. Riverine turtles in particular, which make up the majority of the MS species, are a highly threatened group. A thorough understanding of habitat use, distribution, and abundance, on a large scale, is imperative for protecting and conserving these native river dwellers. Eight sites within the Pascagoula river drainage were surveyed, these included Oxbow lakes, and 2nd, 3rd, and 4th order streams. To obtain the turtles, baited hoop nets, with sizes of 4' seven ring, 4' five ring, 3' 3 ring, and 12" 5 ring, were used. Our preliminary results from three sites include 9 species and over 150 individuals from 4 families (Kinosternidae, Emydidae, Chelydridae, and Trionychidae). In the future, this study will also cover the Pearl River drainage, providing an extensive view of riverine turtle distribution and abundance across Southern Mississippi. Our survey results will hopefully guide the development of more informed management strategies for riverine turtle conservation.
Presentation type: Poster (Student)

Interspecific Variation and Ecological Correlations in Skull Characters of *Kinosternon* and *Sternotherus*

James F. Berry
Department of Biology, Elmhurst College, Elmhurst, IL 60126
[jimb@elmhurst.edu]

Thirty skull characters were measured in over 590 skulls of three species of *Sternotherus*, and 13 species of *Kinosternon*. Multiple regression analyses identified the characters that explained most skull variation among the species, and correlation analyses demonstrated their relationship to ecological conditions. Megacephaly is present in several species, and sexual dimorphism in skull characters is common, but not universal. Taxonomic implications are discussed.
Growth/Morphology: Oral

Is Coprophagy an Important Management Consideration for the Captive Breeding of Herbivorous Turtles? The Effects of Adult Fecal Matter Consumption in Hatchling *Dermatemys mawii* (Central American River Turtle)

Nichole D. Bishop[1], Thomas Pop[2,3], Thomas R. Rainwater[4], Jacob Marlin[2], Karen A. Bjorndal[5], and Raymond R. Carthy[6]
[1]School of Natural Resources & Environment, University of Florida, Gainesville, Florida USA;
[2]Belize Foundation for Research and Environmental Education, Toledo District, Belize;
[3]Hicatee Conservation Research Center, Toledo District, Belize;
[4]Tom Yawkey Wildlife Center & Belle W. Baruch Institute of Coastal Ecology and Forest Science, Clemson University, Georgetown, South Carolina USA;
[5]Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville, Florida USA:
[6]U.S. Geological Survey, Florida Coop Fish and Wildlife Unit, University of Florida, Gainesville, Florida USA
[*n00051891@ufl.edu*]

Many herbivores rely on gut microflora to digest plant material, and in vertebrates these microbes are often passed from mother to offspring. Herbivorous reptiles generally do not associate with their offspring so they must acquire their gut microflora through alternative methods. Previous studies have demonstrated that some non-chelonian herbivorous reptiles acquire their gut microflora shortly after hatching by consuming the feces of adults which serve as an inoculum. However, we know of no studies that examine the means by which herbivorous turtles and tortoises acquire important symbiotic bacteria. In this study, we tested the hypothesis that turtle hatchling consumption of adult fecal matter would influence the growth rate and

total mass gain of hatchlings due to the potential for acquiring gut microflora. To test this hypothesis, we used a captive population of *Dermatemys mawii*, a critically endangered, herbivorous, fresh-water turtle endemic to Central America. We used stratified random sampling to assign hatchlings from numerous clutches to a sampling group (control or inoculated). The control hatchlings were not exposed to adult fecal matter; the inoculated hatchlings were fed fresh adult feces *ad libitum* for 4 weeks in addition to their regular diet. Mass and straight-line carapace length measurements were taken weekly. This study is currently underway and we plan to present the preliminary results (1 month growth rates) in the 2017 TSA symposium. The results of our study may elucidate the role of coprophagy as a behavioral adaptation, and whether allowing hatchlings access to adult fecal matter could be an important management consideration in captive breeding populations.
Growth/Morphology: Oral (Student)

The Population Genetics of the Razorback Musk Turtle (*Sternotherus carinatus*) across its Range and the Implications for 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 a hotspot for turtle diversity, much of which stems from the particularly high levels of endemism across river systems in the Gulf Coastal Plains (e.g., the genus *Graptemys*). The razorback musk turtle (*Sternotherus carinatus*) is a highly aquatic, small to medium-sized turtle and an inconspicuous inhabitant of a number of Gulf Coast drainages that has received a lack of attention and research. For this study, we have collected tissue samples from across the species' range from Texas, Arkansas, Louisiana, Mississippi and Alabama, and developed a set of 10 polymorphic 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. Preliminary data indicate there are moderate amounts of population structure (F_{ST} = 0.121) across some populations. Though not currently listed as threatened or endangered by IUCN, there are disturbing levels of exploitation of this species for the Asian pet trade. Ultimately this study aims to use population structure in *S. carinatus* to fingerprint individuals from the trade and/or confiscations to help identify source populations and facilitate state agencies to make more informed conservation and management decisions.
Genetics: Oral (Student)

A Yankee Turtle Invading the Deep South: Discovery of the Northern Map Turtle (*Graptemys geographica*) in Mississippi

Grover Brown[1], Luke Pearson[1], Gabrielle Berry[1], McAuley Jaunsen[2], and Will Selman[2]
[1]Department of Biological Sciences, The University of Southern Mississippi, 118 College Drive #5018, Hattiesburg, MS 39401
[2]Department of Biology, Millsaps College, 1701 North State Street, Jackson, MS, USA, 39210
[*Grover.Brown@usm.edu*]

Aquatic habitats in Mississippi are biologically diverse, and the state is in the center of a global turtle priority area (aka, "hot spot"). To date, 29 turtle species have been documented in the state of Mississippi including terrestrial, freshwater and brackish aquatic, and sea turtles. The *Graptemys* genus (Map Turtles and Sawbacks) has 8 documented species within the state, the most of any state. However, based on existing distributional data, it seems very likely that a 9th *Graptemys* species may occur in the state: *Graptemys geographica* (Northern Map Turtle). *Graptemys geographica* is a wide-ranging species in the U.S. and Canada that occurs primarily in smaller streams and lakes from southern Ontario south to Alabama and Arkansas. Interestingly, a small portion of the Tennessee drainage, a drainage where the species has been documented previously, occurs in Tishomingo County in northeastern Mississippi. Even though multiple guides postulate that *G. geographica* occurs in Mississippi, no diagnosable photographs or specimens have been collected. In March 2017, three individuals were photographed from a Tennessee River tributary in Tishomingo County, Mississippi. Later in May 2017, 60 more individuals were spotted in canoe surveys and three individuals were collected from the same drainage; these are the first documented specimens of *G. geographica* from Mississippi. Additional surveys will be completed in 2017 and 2018 to better document the distribution of *G. geographica* in Mississippi.
Presentation type: Poster (Student)

The CRT l'Albera (the Albera Turtle and Tortoises Captive Breeding Center): Results of Twenty Five Years of Protecting the Local Species of Turtles

Joan Budó[1], Xavier Capalleras[1] , Jenar Fèlix[1] and Ramon Mascort* [1,2]
[1]CRT l'Albera (Centre de Reproducció de Tortugues de l'Albera); 17780 Garriguella; Spain
[2]C. La Jonquera, 17, 2; 17600 Figueres; Spain
[rmascortb@eremas.net]

There is only one single native population of Hermann's tortoise (*Testudo hermanni*) throughout the Iberian peninsula. It is isolated by almost 300 kilometres from the nearest dwellers, living in southeastern France. Twenty five years ago, the local population was seriously endangered by illegal collecting, wild fires and human development. This resulted in the creation of the ATA in November 1992, a non-profit association, in order to build a captive breeding and educational centre. In 1994 a fenced enclosure where tortoises could be observed and an adjacent teaching area were finally open to schools and private visitors. Rescued adult tortoises were then released into the fenced area. Since then, more than two thousand captive-bred juveniles have been released in several areas of the surrounding mountain range to reinforce the local population. In addition, more than four thousand juveniles have been released at two other sites in order to reinstate new populations. A few years later, the captive breeding program was extended to the locally critically endangered European pond turtle (*Emys orbicularis*), and nowadays almost five hundred juveniles have been released at twelve sites, mainly in compliance of different European Union (EU) projects. The CRT l'Albera is also involved in keeping pet animals that cannot be returned to their original countries and in removing red-eared sliders (*Trachemys scripta elegans*) and other non-native turtle species from the wild. Since the early years, about two hundred thousand visitors have visited the Captive Breeding Center where they have learned about turtle and tortoise biology and conservation.
Captive Husbandry: Oral

Explaining Unusual Distributions of Northern Map Turtles (*Graptemys geographica*)

Kurt A. Buhlmann[1] and James R. Angley[2]
[1]University of Georgia's Savannah River Ecology Lab, Drawer E, Aiken, South Carolina 29802 USA
[2]28 Southside Avenue, South River, New Jersey 08882 USA
[*kbuhlmann@earthlink.net*]

The Northern Map Turtle (*Graptemys geographica*) is a wide-ranging species in the central portion of North America. Northern map turtles are generalists among the map turtles and although riverine in their preferred habitats, they are also able to exist in lakes, reservoirs and other slow-moving water bodies. Distribution of Northern Map turtles show them to be primarily associated with major drainages and tributaries of the mighty Mississippi which enters the Gulf of Mexico. But there are some exceptions. Specifically, how did Northern Map turtles become associated with a subset of Atlantic drainages, notably the Susquehanna, Hudson, and Delaware Rivers? We researched the literature on geographic distributions and range extensions for Northern Map turtles over the last century, as well as documented a range extension of our own in the Raritan River of central New Jersey. We propose that these Atlantic drainage distributions of Northern Map Turtles are not the result of pet trade releases, Native American trading, or natural occurrences, but rather result from the extensive series of barge canals built in the United States starting in the 1820s.
Geographic Variables: Oral

Comparison of Head-start Methodology and Post-release Survivorship and Movements in Head-started Wood and Blanding's turtles, with Implications for other Turtle Species

Kurt Buhlmann[1], Colin Osborn[2], Jared Green [3], Brian Bastarache[4], Tracey Tuberville[1], Brian Butler[5], Amelia Russell[2], And Stephanie Koch[3]
[1]University of Georgia's Savannah River Ecology Lab, PO Drawer E, Aiken, South Carolina 29802 USA
[2]U.S. Fish and Wildlife Service, Basking Ridge, New Jersey, USA
[3] U.S. Fish and Wildlife Service, Sudbury, Massachusetts, USA
[4] Bristol County Agricultural High School, Dighton, Massachusetts, USA
[5] Oxbow Associates, Inc., Boxborough, Massachusetts, USA
[*kbuhlmann@earthlink.net*]

Headstarting programs for freshwater turtle species are showing success. Blanding's (*Emydoidea blandingii*) and Wood turtles (*Glyptemys insculpta*) are species of northeastern North America. Although they are often sympatric in geographic distribution, they occupy different local habitats. Therefore, challenges to hatchling survival may differ. Here, we compare survivorship and methodologies among head-start programs for Wood and Blanding's turtles with implications for other freshwater species. Blanding's turtles have been head-started and released on a wildlife refuge in Massachusetts 2007-present, and Wood turtles similarly on a wildlife refuge in New Jersey 2011-present. In the recovery projects for both species, concurrent releases of both direct-release (DR) hatchlings (after nest emergence) and treatments involving indoor/overwinter head-starting (HS) for 9 months has occurred. Our HS of both species are comparable in size (i.e., carapace length) when released at 9-mos age to 3-4 yr-old wild turtles. Overall recapture success for Blanding's turtle 3-yrs later indicated a cumulative survivorship of nearly 85% for HS vs. 12% for DR. For Wood turtles, cumulative survivorship of the 2011 cohort (N=22) is currently 36% at 6-yrs post release, while comparatively only three (1.3%) of 227 DR released 2007-2015 have been recaptured. Radio-tracked HS Wood Turtles occupy streams and adjacent riparian woodland and grass/shrublands and have greatest movements in the first weeks post-release, but surviving individuals establish home ranges which become focused and smaller in successive years; they use the same habitats as resident adults for foraging and winter hibernation. Blanding's turtles are released in fen and shrub-dominated boggy marshes; recapture data indicate overall fidelity, with some emigration overland to adjacent wetlands. Growth and development of secondary sex characteristics of HS Wood Turtles post-release suggest that age to maturity may be shortened, while we are less certain of that for Blanding's. Documented deaths of radio-tracked HS Blanding's turtles are most often attributed to winter kill (either freezing or anoxia), but the overall recapture data indicates this to be a minor concern. Wood turtle HS are still vulnerable during the activity season to predation by raccoons, as well as tractors and mowing activities on adjacent farmlands.
Headstarting: Oral

Aquatic Turtles – The Perfect Critters for Teaching Student Research Skills, Conducting Meaningful Long-Term Studies, and Promoting Community Conservation

John Byrd And Kathy Strunk
191 Nature Lane, Clinton, Tennessee 37716 USA
[creso@acs.ac]

In 1989 the Department of Energy partnered with Anderson County and Oak Ridge Schools, TN to develop an education/research program that promotes field research experiences for middle and high school students. All partners recognize the appeal of using field studies to teach basic science skills as well as the importance of conducting long-term population research on the local flora and fauna of the Valley and Ridge Ecotone. The program, known as the Clinch River Environmental Studies Organization (CRESO), places a high value on bringing together a diversity of students of variable ages and backgrounds to help build a stronger and broader sense of community. Aquatic turtle studies allow students to rapidly build a large data base while experiencing a broad scope of research related challenges, ranging from constructing data sheets, data processing and analyses, to developing techniques for avoiding systematic errors. Student conservation efforts through community outreach education are fruitful because of the charismatic nature and unique ecology of aquatic turtles. Our turtle research began in 1990 and continues today, and we never tire of trying to figure out what each individual turtle is "trying to tell us." This presentation will include student generated analytics on morphological and natural history information comparing turtles found in two separate pond habitats and a local fish hatchery. There is no finer group of critters for combining research, citizen science, and promoting positive conservation attitudes and behavior.
Community Outreach and Partnerships: Oral

Constraints and Solutions to Managing Chelonians in a Small Institution

Zachary Byrne
Cameron Park Zoo, Waco, Texas 76707 USA
[zbyrne440@gmail.com]

The Cameron Park Zoo herpetology staff currently manages a collection of 121 different species of herpetofauna. 25 of those species are chelonians for a total of 60 individual turtles and tortoises ranging in conservation status from least concern to critically endangered. With a relatively small budget and only 3 full-time herpetology staff, it can be challenging to devote the time, space, and resources required to provide these turtles with the care they deserve while still managing the rest of the

collection. By necessity, we have found multiple ways to overcome these husbandry challenges. Whether it is repurposing old salt mixing bins as an enclosure, or finding the perfect combination of animals for a mixed-species exhibit to save space, we are constantly thinking of new ideas allowing us to work smarter not harder.
Zoos and Chelonians: Oral

Revisiting Sex-biased Turtle Road Mortality with an Unusually Unbiased Dataset

Sue Carstairs[1], Marc-Dupuis-Desormeaux[2], and Christina Davy[3]
[1]Ontario Turtle Conservation Centre, 4-1434 Chemong Rd. Selwyn, ON
[2]York University,4700 Keele Street, Toronto, ON
[3]Trent University, 2140 East Bank Dr, Peterborough, ON
[suecarstairs@sympatico.ca]

Road mortality poses a major threat to the persistence of threatened turtle populations. A growing body of evidence based on site-specific road mortality surveys suggests that roads have a disproportionately high impact on female turtles, because of females' increased exposure to vehicles while they search for nesting sites. The Ontario Turtle Conservation Centre (OTCC) is home to the Kawartha Turtle Trauma centre, Ontario's only dedicated turtle hospital. This facility admits 400 – 500 native turtles yearly from across southern Ontario, and road injuries are the primary cause of admission. We revisited the hypothesis of female-biased turtle road mortality using admissions data from the OTCC. Our dataset included Painted Turtles (*Chrysemys picta)*, Snapping Turtles (*Chelydra serpentine)*, Northern Map Turtles (*Graptemys geographica)* and Blanding's Turtles (*Emydoidea blandingii)* admitted to OTCC's hospital from January 2013 to October 2016. The total number of male and female Painted and Blanding's turtles admitted during this time, were not significantly different. Although individual years showed no significant difference in male vs female Snapping Turtles admitted to OTCC, the combined years showed more females than males admitted for road injuries/mortalities. Our map turtle sample size was small, but showed a strong bias towards females. As expected, admission of female turtles peaked in June. Male admissions showed multiple smaller peaks throughout the season. Our admissions data provided a unique, temporally un-biased and geographically broad snapshot of turtle-vehicle interactions that can directly inform conservation and management policies. Specifically, our data strongly suggest that road mitigation or population augmentation actions that target only females are insufficient to offset the impacts of roads on threatened turtle populations.

Road Ecology: Oral

Sex and Clutch Effects on Growth Rates of Gopher Tortoises, *Gopherus polyphemus*

Julie cobb, Matthew Carey, and David Rostal
Georgia Southern University Statesboro, Georgia 30458 USA
[jc00760@georgiasouthern.edu]

Maternal and environment effects can influence the growth rate of an animal. This study was performed to analyze whether sex or maternal/clutch effects influenced growth rates of hatchling gopher tortoises. The sex of a tortoise can be determined by the temperature of incubation. A total of thirteen gopher tortoise nests were collected in the field at two sites, five from George L. Smith State Park and eight from Fort Stewart Army Reserve, in southeast Georgia. Nests were allowed incubate in the field until August 20th at which time the eggs were brought into the lab to finish incubating. Sex determination was complete at this point. The tortoises' growth rates were measured weekly with six measurements, straight carapace length, length, depth, mass, plastron minimum and maximum, from February 2016 to the end of October of the same year. The tortoises were kept isolated to minimize social interaction affects. Tortoises were fed Mazuri tortoise diet. The sex of each tortoise was determined using laparoscopy following the completion of the study (Jan.-Feb. 2017). Growth rates were similar between clutches. Sex did not affect growth rates significantly. Maternal/clutch was observed to affect size. Tortoises that were larger at the start of the study were larger at the end of the study. Maternal effects on hatchling size at the beginning of the growing season directly effected hatchling size.
Presentation type: Poster (Student)

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

Andrew T. Coleman
Birmingham Audubon Society, Birmingham, Alabama 35222 USA
[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, and this behavior is currently being quantified in Alabama. This 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, identified to species, and measured, if possible. These data indicated a potential size limit for predation. The most commonly identified species was the Common Musk Turtle (*Sternotherus odoratus*), but prey matter also included Stripe-necked Musk Turtle (*Sternotherus minor peltifer*), Common Snapping Turtle (*Chelydra serpentina*), Northern Map Turtle (*Graptemys geographica*), Ouachita Map Turtle (*Graptemys ouachitensis*), Eastern Painted Turtle (*Chrysemys picta picta*), and Yellow-bellied Slider (*Trachemys scripta scripta*). 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.
Presentation type: Poster

Actual genetics situation of the box turtle (*Terrapene coahuila*) in Cuatrociénegas México

Xochiquetzal Cortes-Rodríguez and Ella Vázquez-Domínguez
Instituto de Ecología, Universidad Nacional Autónoma de México, Cd. De México *[bios_quetzal@yahoo.com.mx]*

The box turtle (Terrapene coahuila) is a semiaquatic species, microendemic which distribution is limited to ponds and wetlands located at Cuatrociénegas valley in Coahuila Mexico. This valley is semi isolated in Chihuahua's desert. This species of turtles is classified as "endangered" according to IUCN. The habitat of box turtle has been reduced in 70% because of human activities, specially owing to extraction, deviation and construction of a complex water channel grid. The presence of isolated and different populations of Terrapene coahuila has been a result of the loss of habitat, such populations have a limited dispersion across the desert. The endemic and restricted species, which also have low dispersion capability, often have small population size and limited gene flow. Due to the aforementioned these kind of populations exhibit stochastic gene processes like genetic drift and inbreeding. The limited range of distribution, high specificity of the habitat and small populations of box turtle could cause the negative genetics effects that were described. In this work were analyzed the actual levels of diversity and genetics structure of the box turtle. 112 individuals were sampled from six different populations across the Cuatrociénegas valley. There were analyzed 12 nuclear microsatellite markers, one nuclear gen and 2 mitochondrial genes. The heterozygosity observed levels (Ho) were found in a 0.52 - 0.60 range, lower than the reported before. It was detected the presence of inbreeding in some populations and were identified two different genetic groups, however the levels of genetics differentiation between populations were low. This information in conjuction with preexistent works will allow the development of more suitable conservation programs.
Genetics: Oral (Student)

Challenges to Recovery and to Protect the Critically Endangered Hogei Sideneck Turtle, *Mesoclemmys hogei,* in Southeastern Brazil

Marcos Coutinho[1], Gláucia Drummond[2], and Richard Vogt[3]
[1]Instituto Chico Mendes de Conservação da Biodiversidade – Centro Nacional de Pesquisa e Conservação de Répteis e Anfíbios, Base de Pesquisa de Minas Gerais, Brasil
[2]Fundação Biodiversitas, Minas Gerais, Brasil
[3] Coordenação de Biodiversidade, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil CEP 69.067-375
[medcoutinho@gmail.com]

Long-term systematic studies conducted in the Carangola River basin in the last 25 years revealed a drastic decline in population size of one of the last remnants of *Mesoclemmys hogei* in its distribution area. Urgent action needed to be done in order to avoid species extinction in one of the most important sites of species' occurrence. On the ground conservation plans for

Hogei sideneck turtle comprises several challenges concerning habitat protection, public awareness and public policies to protect biodiversity at the local level. In order to achieve our conservation goals, Biodiversitas Foundation with the support of the Rainforest Trust, Turtle Survival Alliance, Wildlife Conservation Society and National Research Center for Reptiles and Amphibians acquired a key area which became the first private reserve to protect a freshwater turtle in Brazil. The associated next steps include firstly to implement the reserve, building infrastructure, equipment and a working team. Other challenges are establishing a free-fishing zone given that fishermen catch and kill turtles accidently; to promote the recovery and connection of gallery forest forming ecological corridors; to improve awareness of local communities and to implement environmental education programs; to influence local environment policies, all of these associated with the continuous Hogei population monitoring. Besides these, it is essential to develop financial mechanisms to ensure the reserve long term conservation goals.
Conservation & Management: Oral

Home Range of Texas Tortoises (*Gopherus berlandieri*) in Jim Hogg County, Texas

Ross O. Couvillon and Leonard A. Brennan
Caesar Kleberg Wildlife Research Institute, Texas A&M University–Kingsville, Kingsville, Texas, 78363 USA
[ross.couvillon@gmail.com]

Texas Tortoises (*Gopherus berlandieri*), the smallest North American tortoise species, are chiefly associated with the Tamaulipan Biotic Province of southern Texas and northern Mexico, and its distribution appears limited to thorn-scrub communities. Compared to other *Gopherus*, the biology of this species remains poorly understood. We studied tortoises via radio telemetry on a private property in southern Texas managed for recreational hunting. Tortoises were relocated 1–3 times a week during their primary active period (April–November). Home ranges were calculated with the 95% Minimum Convex Polygon method. In 2015, median home ranges were 82.9 ha and 1.3 ha for adult males (n=4) and adult females (n=6), respectively. In 2016, median home ranges were 12.4 ha, 0.9 ha, and 1.8 ha for adult males (n=9), adult females (n=9), and juveniles (n=9), respectively. Home ranges varied greatly within gender and age classes. This is only the second study from an inland Texas Tortoise population. Identifying home range size is a crucial first step in identifying how habitat components should be dispersed across the landscape to sustain Texas Tortoise populations in a region subjected to woody brush encroachment, invasive grasses, and management techniques aimed at benefiting game species.
Tortoises: Oral (Student)

Detection of Ranavirus (Frog Virus 3) in Translocated Gopher Tortoises (*Gopherus polyphemus*) in Florida, USA

Rebecca Cozad[1], Terry M. Norton[2,3], Matthew Aresco[4], Tracey Tuberville[5], Matthew Allender[6], and Sonia Hernandez[1,7]
[1]Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia USA
[2]Georgia Sea Turtle Center, Jekyll Island Authority, Jekyll Island, Georgia USA
[3]St. Catherines Island Foundation, Midway, Georgia USA
[4]Nokuse Plantation, Bruce, Florida USA
[5]University of Georgia's Savannah River Ecology Lab, Aiken, South Carolina USA
[6]University of Illinois College of Veterinary Medicine, Urbana, Illinois USA
[7]Southeastern Cooperative Wildlife Disease Study, UGA College of Veterinary Medicine, Athens, Georgia USA
[racozad@uga.edu]

Gopher tortoises (*Gopherus polyphemus*) are listed as threatened throughout most of their range and are still facing population declines as a result of direct habitat loss and habitat fragmentation. High-levels of human harvest throughout most of the 20th century have also caused significant population declines or extirpation of gopher tortoises, especially in southern Alabama, southwestern Georgia, and the Panhandle and northern peninsula of Florida. Translocation of tortoises from lands that will be destroyed by development has become an important tool for conserving the species and minimizing losses of individuals. Infection with *Mycoplasma* spp, has been widely studied in gopher tortoises, yet other emerging pathogens (e.g. ranavirus, herpesvirus) have not received as much attention in either wild or translocated populations, and have only rarely been documented. The Nokuse Plantation is a 54,000 acre protected conservation preserve located in the Florida Panhandle that has received almost 5,000 translocated tortoises since 2006. As part of a broader health assessment project, 56 previously translocated tortoises were captured and sampled in Jun-Aug 2016. Whole blood and oral/cloacal swabs were tested for nine pathogens, including ranavirus (FV3), *Mycoplasma*, and herpesvirus, using Fluidigm qPCR assays. Whole blood samples were negative for all pathogens. Fifteen out of 39 (38%) oral/cloacal swabs were positive for FV3 (38%), 16/39

(41%) were suspect for *Mycoplasma agassizii*, and 3/39 (8%) were co-detected for FV3 and *M. agassizii*. In other chelonian species, infections with ranavirus present as explosive outbreaks with mortality rates that approach 50-100%. Out of tortoises that tested positive, 33.3% (5/15) appeared healthy and the others had clinical signs such as eroded/asymmetrical nares, pale mucous membranes in the oral cavity, and/or were mildly thin. Evidence of ranavirus has not been implicated in any mortalities at Nokuse thus far. Detection of ranavirus in these tortoises may suggest that these are carrier animals that are persistently shedding at a low rate. Tortoises that were positive for ranavirus represent 11 different donor sites from around the state of Florida. These results indicate the need for further research into true prevalence of this pathogen in seemingly healthy animals, especially as it relates to translocation management.
Tortoises: Oral (Student)

Effects of Health Status and Enclosure Density on Home Ranges of Translocated Gopher Tortoises (*Gopherus polyphemus*) in Florida, USA

Rebecca Cozad[1], Terry M. Norton[2,3], Matthew Aresco[4], Derek Breakfield[4], Jeff Hepinstall-Cymerman[1], Tracey Tuberville[5], and Sonia Hernandez[1,6]
[1]Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA USA, [2]Georgia Sea Turtle Center, Jekyll Island Authority, Jekyll Island, GA USA, [3]St. Catherines Island Foundation, Midway, GA USA, [4]Nokuse Plantation, Bruce, FL USA, [5]University of Georgia's Savannah River Ecology Lab, Aiken, SC USA, [6]Southeastern Cooperative Wildlife Disease Study, UGA College of Veterinary Medicine, Athens, GA USA. [racozad@uga.edu]

Gopher tortoises (*Gopherus polyphemus*) are listed as threatened throughout most of their range and are facing population declines as a result of direct habitat loss and habitat fragmentation. Translocation of tortoises from lands that will be destroyed by development or committed to other activities has become an important tool for conserving the species and minimizing losses of individuals. Translocated tortoises have been shown to make longer movements and have larger home range (HR) areas post-relocation, but recent studies have shown that long-duration enclosures increase site fidelity and greatly improve the probability of establishing populations. Studies have also demonstrated that in free-ranging populations, tortoises with severe clinical signs of Upper Respiratory Tract Disease (URTD) made longer movements and had larger HRs than asymptomatic or ones with mild signs. Tortoises relocated to Nokuse Plantation, a private conservation preserve in the Florida Panhandle, are released with their cohort in protected enclosures (20-80 acres each) surrounded by silt fencing for containment and electric fences for predator exclusion. Initial tortoise density within enclosures ranged from 2.2 – 7.4 tortoises per acre. Twenty-eight selected tortoises from two Nokuse sites (DB1, high density, and SR1, medium density) were divided into two health status groups ("healthy" and "at risk") based on body condition and Packed Cell Volume (PCV). Tortoises were tracked for 9 months (or until removed from study based on deteriorating condition) and home ranges were estimated using Kernel Density estimations. Tortoises in the "healthy" group had similar home range sizes between sites, while tortoises in the "at risk" group had larger home ranges in the high density site. The introduction of translocated tortoises from different donor sites presents a higher risk of exposing naïve populations to novel pathogens, therefore increasing the risk of pathogen transmission. Increased movement and home range in tortoises with lower health status could lead to further declines in health for the individual, as well as a higher potential for disease transmission in areas with higher tortoise density.
Presentation type: Poster (Student)

How Long is Too Long? A Soft-release Repatriation Trial of Radiated Tortoises with a Village Community in Southern Madagascar

Andrea Currylow[1, 2], Soary Randrianjafizanaka[3], Rick Hudson[4]
[1]ACEcological Research & Consulting, Oceanside, CA, USA
[2]Intergative and Evolutionary Biology, University of Southern California, Los Angeles, CA, USA
[3] Tropical Biodiversity and Environmental Doctoral Department, University of Toliara, Toliara, Madagascar
[4]Turtle Survival Alliance
[a.currylow@gmail.com]

Perhaps one of the most well-documented species poached from the forests of Madagascar is the Critically Endangered Radiated Tortoise (*Astrochelys radiata*). These tortoises have been increasingly discovered in confiscations comprising hundreds of individuals at a time, overwhelming resources recently established to care for and re-release the animals in-country. But the specifics of successful repatriation have not been established for this species. To determine the best repatriation strategy

that ensures survival and site fidelity for Madagascar's Radiated Tortoise, we investigated three captivity and release strategies across animal demographics. We developed a repatriation study around trial releases that involved testing two soft releases (12-month and 6-month on-site enclosures) and a hard release. We then used radiotelemetry and iButton temperature loggers to monitor a large subset of the release animals (37♂, 32♀, 35 SA; approx. 12 of each per release strategy) for two years after the release. We employed local villagers to track the animals and to be community liaisons of the conservation message to ensure the new tortoise population would be protected from poachers. We transferred the animals to enclosures at different times of the year so that they could released together at the height of the active season for the species. Preliminary results indicate that adults require less time to acclimatize to new areas than do sub-adults, meaning that resources could be saved in monitoring and maintenance. Adult tortoises maintained larger home ranges than did sub-adults, and all animals decreased exploratory behavior after year 1. It appears as though Radiated Tortoises are able to adapt well to new areas and that a soft-release strategy benefits the animals as far as site fidelity, but with diminishing returns after about six months of penning. We suggest that timing of release be based on the ecology of the species and be the driving factor in soft-release penning timing.
Conservation & Management: Oral

Comparing Unmanned Aerial Vehicles (UAVs) to Traditional Field Methods in Surveying of Basking Riverine Turtles

Kelly Daniels[1], Thomas Wilson[2], and Andy Carroll[3]
[1]Department of Biology, Geology, and Environmental Science, The University of Tennessee at Chattanooga, Chattanooga, Tennessee 37403 USA
[2]112 Davenport Hall, Chattanooga, Tennessee USA
[3]SimCenter 203, Chattanooga, Tennessee USA
[vls161@mocs.utc.edu]

Unmanned aerial vehicles (UAVs) are an emerging technology that shows promise in ecological research. We are currently conducting a preliminary study testing their usefulness for sampling freshwater turtles in pond environments. In this comparative study, we are comparing UAVs to traditional sampling methods such as basking traps and spotting scopes. UAVs have yet to be used successfully for sampling freshwater turtles; however, they have been used with mixed success for monitoring mammals and birds. Herein, we propose that the conservation utility of UAVs be formally tested in the field prior to them being used to make adaptive conservation and management decisions. We are statistically evaluating the use of UAVs in contrast to proven field methods as a means to elucidate our basic understanding of occupancy, site fidelity and species richness. Being able to successfully use UAVs for ecological surveying would provide an easy, efficient, and less invasive way to study basking turtles.
Presentation type: Poster (Student)

In the Shadows of a Brownfield: Using Citizen Scientists to Better Elucidate the Spatial Ecology the Eastern Box Turtle (*Terrapene carolina carolina*, Linnaeus, 1758) in Southeastern Tennessee

Mark J. Dillard[1], Paul-Erik Bakland[1], Jeremy Hooper[1,2], Penni Jo Wilson[3], Team Salamander[1], and Thomas P. Wilson[1]
[1]Department of Biology, Geology and Environmental Science, 615 McCallie Ave., The University of Tennessee at Chattanooga, Chattanooga, Tennessee 37403 USA
[2]Tennessee Department of Environment and Conservation, 312 Rosa L Parks Ave., Nashville, Tennessee 37243 USA
[3] Division of Natural Sciences, *Cleveland State Community College, 3535 Adkisson Drive, Cleveland, Tennessee 37312 USA*
[Thomas-wilson@utc.edu]

The landscape throughout the range of the eastern box turtle (*Terrapene carolina carolina*) has changed drastically over the last few centuries. Habitats are altered by anthropogenic effects and this often impacts populations of turtles. In this study, the spatial ecology and seasonal movement patterns of the Eastern Box Turtle in contrasting habitat types was investigated by a team of students and resident citizen scientists. Eastern Box Turtles had home ranges that averaged (mean = 3.77 ± 2.82 ha, minimum convex polygon) in size among individuals. There was no significant difference between mean annual home range size of males and females but home range size for male turtles was numerically larger during the summer activity season when contrasted with the spring activity season (P = 0.02). At the landscape level, turtles used eastern deciduous forest and successional habitats and they selected sites with woody debris, groundcover, and successional vegetation with a significant amount of canopy cover. Our team has shared their findings with policy makers and associated stakeholders in an effort to

make adaptive conservation and management decisions while using education practices as a guide.
Freshwater Turtles of the SE: Oral (Student)

If You Build It They Will Come, the Success and Strategies of the Turtle Survival Center.

Clinton S. Doak
Turtle Survival Center, Turtle Survival Alliance 1989 Colonial Parkway, Fort Worth, TX 76110
[Cdoak@turtlesurvival.org]

The Turtle Survival Center is the largest and most enduring project ever taken on by the Turtle Survival Alliance. Designed to propagate some of the rarest Tortoises and Freshwater turtles in the world, the TSC has been functioning and growing ever since its inception in 2013. The TSC has quickly become the crown jewel in TSA's global network of linked assurance colonies, helping meet the TSA's commitment to zero turtle extinctions. By implementing strict breeding protocols that allow only for pair breeding, parentage and linages can be closely tracked, making sure that genetic diversity is ensured for all species at the TSC. But breeding some of the rarest chelonians in the world comes with its own set of challenges and techniques. Through hard work and determination the staff at the TSC has managed to successful breed and hatch 15 of the 27 species that are currently residing there. The majority of these breedings did not come easily and took years of combined experience and techniques from the entire staff at the TSC.
Captive Husbandry: Oral

A Tiny Turtle Tale: Genomic Assessment Reveals Increase in Genetic Diversity Following Bog Turtle (*Glyptemys muhlenbergii*) Translocation Program

Cassie M. Dresser[1], R. Michael Ogle[2], and Benjamin M. Fitzpatrick[1]
[1]Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, Tennessee 37996 USA
[2]Department of Herpetology, Zoo Knoxville, Knoxville, Tennessee 37914 USA
[*]Lyman Briggs College, Michigan State University, East Lansing, Michigan 48824 USA
[cassie.dresser@gmail.com]

Translocations following captive breeding and headstarting programs are one of the primary contributions made by zoos to achieve global conservation objectives. Since 1991, Zoo Knoxville has implemented a translocation program for the federally threatened Bog Turtle (*Glyptemys muhlenbergii*), yet no assessments have been done to investigate the genetic impacts of the Zoo's efforts. So, we used 7030 SNP markers derived from RADseq data to test whether the release population has enhanced genetic diversity relative to the source populations, as expected from a deliberate admixture. After confirming that the source populations used in the translocation program were genetically differentiated, we estimated the genetic diversity in each population and determined that diversity in the release population was substantially greater than any source population. However, this diversity level was lower than expected from modeling admixture with equal source contribution from each population. Failure to achieve the expected level of diversity could be a result of nonrandom success of founders from different sources or unrecorded bias in the implementation of the translocation program. Although we focus on a Bog Turtle translocation program here, this genomic assessment technique would benefit many existing and proposed translocation programs, particularly in regards to establishing clear and objective criteria of success.
Headstarting: Oral (Student)

Movement and Habitat Preference of Breeding Female of Hogei Sideneck Turtle ((M*esoclemmys hogei*) in the Mid Carangola River, Southeastern Brazil

Glaucia M. Drummond[1], Marcos Aurelio S. Lopes[1]*, Rogerio L. Silva[1], Alexandre Godinho[2], and Marcos E. Coutinho[3]
[1]Biodiversitas Foundation, Brazil
[2]Federal University of Minas Gerais, Brazil
[3]National Research Center for Reptiles and Amphibians/ICMBio, Brazil
[medcoutinho@gmail.com]

Hogei Sideneck Turtle (*Mesoclemmys hogei*) is a freshwater turtle with geographic distribution restricted to the Brazilian southeastern Atlantic Forest. The species population status is defined as critically endangered according to IUCN and the Brazilian official Red List. IUCN also recognizes *M. hogei* as one of the 25 species of freshwater turtle mostly endangered in the planet.

As a part of a recovery plan, we used radiotelemetry to identify movement pattern and use of habitat of three gravid females in the mid Carangola River, from February to October 2015. Females were captured using fyke-nets and submitted to X-Ray to identify the presence of eggs. Selected gravid females were measured, weighed, marked with radiotransmitters and released at the site of capture. Carapaces size and weight varied from 31.1 e 35.3 cm and 2.9 e 4.6 kg, respectively. Females presented similar movement pattern. The remained at the same site for a number of days, after which the move distances ranging from 2.5 to 4.5 km. After that, they remain at the new site for several days until another movement pick was observed. Regardless the movement direction (up or down river), females remained within 15 km of the Carangola River. The sites where the stay for longer periods (≈80% of the studied period) were characterized by slow flow and shaded calm waters, with the presence of figs, inga trees and aquatic macrophytes. Our results were considered when choosing sites to establish a hogei protected area in the mid Carangola River.
Ecology/Field Studies: Oral

Blood Along Heart Lake Road: Mortality Surveys and Mitigation
Marc Dupuis-Désormeaux[1], Vince D'Elia[2], Casey Cook[2], Mandy Karch[3] and Suzanne MacDonald[4]
[1]Department of Biology, York University, Toronto, Ontario, M3J 1P3 Canada
[2]Toronto and Region Conservation Authority, Toronto, Ontario, L4K 5R6 Canada
[3]Ontario Road Ecology Group, Royal Ontario Museum, Toronto, Ontario, M5S 2C6 Canada
[4]Department of Psychology, York University, Toronto, Ontario, M3J 1P3 Canada
[marcd2@me.com]

A group of citizen scientists, working together with a local Conservation Authority, performed mortality surveys along a 2 km road that bisects an important wetland near Brampton, Ontario, Canada. Over four years (2011, 2013, 2015 and 2016), we documented 4008 cases of road mortality. Out of that total, we identified 2943 frogs, 245 turtles, 146 snakes, 246 mammals and 210 birds. We discuss the consultation process with the municipality, the remediation measures considered and the mitigation implemented, including: signage, pavement markings, exclusion fencing, and an eco-passage. The result was a marked reduction in the road mortality at the sections that received mitigation. Future remediation plans are also discussed.
Road Ecology: Oral

Immigrants Welcomed: Colonization of an Artificial Urban Wetland Complex by Various Turtle Species
Marc Dupuis-Désormeaux[1], Emma Followes[2], Andrew RamesBottom[2], Suzanne MacDonald[3]
[1]Department of Biology, York University, Toronto, Ontario, M3J 1P3 Canada
[2]Toronto and Region Conservation Authority, Toronto, Ontario, L4K 5R6 Canada
[3]Department of Psychology, York University, Toronto, Ontario, M3J 1P3 Canada
[marcd2@me.com]

Many regional conservation bodies invest heavily in the restoration and/or creation of wetlands to counteract the destruction of habitat commensurate with past urbanization. We conducted a turtle mark-recapture survey in a 250 ha artificially created wetland complex in a large North American city (Toronto, Ontario). We found that two of Ontario's possible nine native turtle species were well represented and breeding: the Snapping (*Chelydra serpentina)* and Midland Painted (*Chrysemys picta marginata*) turtles, and one further native species was present but not well established: the Blanding's turtle (*Emydoidea blandingii*). We also visually detected a single Northern Map turtle (*Graptemys geographica*) and a Spiny Softshell (*Apalone spinifera sp*?) but could not positively identify the softshell to a subspecies. Further, we captured several exotic Red-Eared Sliders (*Trachemys scripta*). We found that species representation and density were not equally distributed throughout the wetland complex. Certain ponds had very high turtle densities (27 turtles in 0.05 ha equivalent to 540 turtles per hectare) while others were much lower (2.5 turtles per ha). We also noted that certain water bodies were almost exclusively populated by certain species, while others had a species representation more in line with natural reference ponds. We describe the key features of each pond and its unique turtle assemblage and discuss the importance of microhabitat features to pond colonization by various turtle species. We also tracked the movement of several turtles fitted with VHF transmitters, in order to better understand the usage of the artificial wetlands complex. We found that most turtles limited their movements to the ponds in which they were captured, although some males were found using multiple individual water bodies over the study period.
Geographic Variables: Oral

A Case study in Conservation and Private Industry: Tailoring Management Plans to fit Industry Objectives and Expectations
Brian Durkin, Kaite Anderson, Teal Richards-Dimitrie, and Richard Seigel
Department of Biological Sciences, Towson University, Towson, Maryland 21252 USA [bdurki1@students.towson.edu]

Conservation often requires researchers and managers to work directly with private industry to develop specific management plans. Working with the private sector comes with its own set of factors that dictate what practices can be utilized. Management requires the development of strategies that accomplish the desired results while meeting the expectations of private companies. Exelon Generation Corp., operators of the Conowingo Hydroelectric Dam on north eastern Maryland have funded research on the nesting ecology of the state endangered Northern Map Turtle (*Graptemys geographica*) since 2010. Research has focused partly on the development of management strategies to reduce the high rate of nest depredation. Nesting habitat has been found to be limited to a few suboptimal locations along the river below the dam. The intensity of nesting is highly variable by location and sites with high nest intensity have high rates of predation by Raccoons (*Procyon lotor*). Due to the combination of limited nesting habitat, high predation rates, and low recruitment, the regulation of nest depredation is necessary to ensure the viability of the population. Primary methods for management of the nest depredation fall into two categories, predator removal or predator exclusion. While strategies in both categories have been shown to be effective, some may not be appropriate when considering the needs of industry. Predator removal, a recommended strategy that is low cost, does not meet requirements because of perceived issues with public relations. Likewise, methods of exclusion utilizing electric fencing, also an effective low-cost strategy, is not feasible due to concerns of liability and the public. In this case a strategy that is effective and limits undesirable confrontations with the public outweighs the monetary costs for Exelon. Caging individual nests has been shown to prevent depredation by raccoons but requires observation of a nesting event, at least for this species, which is time-intensive and comes at a higher cost. A management plan involving the monitoring of nests for protection through researcher observation and time lapse video cameras has been employed with the goal of reducing the predation rate to 40% to increase recruitment and maintain a stable population.
Conservation & Management: Oral (Student)

Education and Outreach Tools for the Modern World
Steve Enders, Anthony Pierlioni, Chris Leone, Amanda Sargent, Kevin Minto, and Casey Leone
theTurtleRoom, P.O. Box 521, Lititz, Pennsylvania 17543 USA
[steve@theturtleroom.com]

Twenty-six years ago, the World Wide Web became publicly available. Since then, the pace of innovation has grown exponentially. The internet has now permeated our society, as has the phenomenon known as social media. As social media has grown, traditional, face-to-face methods of outreach and education have had their impact minimized, but new opportunities for reaching the general public, chelonian hobbyists, and "turtle lovers" have been borne from these web-based applications from which much of society receives information. More specifically, this information is consumed not from desktops or even laptop computers, but through mobile devices. Recent data from one analytics firm reports that the average U.S. consumer spends 5 hours per day on their phone. As a result, utilizing social media is not just recommended, but vital for any organization looking to both spread awareness about their cause and engage their current supporters. We will cover the advantages and disadvantages of several tools we use for outreach and education including theTurtleRoom.com, Facebook, Instagram, Twitter, YouTube, and MailChimp. In addition to the aforementioned tools, we will also discuss the overarching principals we use to guide our online presence, specific techniques used for each platform, mistakes we have made and the lessons learned from these mistakes, the dissonances that must be maintained for success, and the importance of collaboration between conservation organizations, specifically on social media.
Community Outreach and Partnerships: Oral

Overview of Turtle Research at the Tennessee Aquarium
Joshua R. Ennen
Tennessee Aquarium Conservation Institute, Tennessee Aquarium, Chattanooga, Tennessee, 37402 USA
[jre@tnaqua.org]

The Tennessee Aquarium has a diverse holding of freshwater turtles from around the world, and the Conservation Institute has been conducting turtle-related research since its inception in 1996. Turtle research is still a large part of the work being conducted at the Tennessee Aquarium Conservation Institute. There are several ongoing projects either focusing on species-specific or broad-scale questions related to turtles. One of the species-specific research projects includes Alligator Snapping Turtles (*Macrochelys temminckii*), a species listed as vulnerable by the IUCN since 1988 and a species of great conservation need in Tennessee. The objectives of the Alligator Snapping Turtle project are to determine the distribution and population status of the species in west Tennessee. In 2017, we began investigating the spatial ecology of juveniles (mean CL = 21.66 cm; SD = 1.82 cm) that were released over a decade ago as a part of reintroduction efforts by the Tennessee Wildlife Resources Agency in west Tennessee. Additionally, we are investigating the level of mercury contamination in blood and tissue of Alligator Snapping Turtles, Snapping Turtles, and Pond Sliders. Our more broad-scale research focuses on identifying biogeographical provinces and ecoregions to understand large-scale biogeographical patterns of turtles and prioritize conservation efforts.

Zoos and Chelonians: Oral

Habitat-associated Morphology Divergence Physically Constrains Reproductive Output in a Mud Turtle

Joshua R. Ennen[1], Mickey Agha[2], Jeffrey E. Lovich[3], Charles Drost[3], Michele Puffer[3], and Philip C. Rosen[4]
[1]Tennessee Aquarium Conservation Institute, Tennessee Aquarium, Chattanooga, Tennessee 37402 USA
[2]Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, Davis, California 95616 USA
[3]U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona 86001 USA
[4]School of Natural Resources and the Environment, University of Arizona, Tucson, Arizona 85721 USA
[jre@tnaqua.org]

Maternal body-volume is a well-documented physical constraint of reproductive output in reptiles. In turtles, this hypothesis is supported by a positive relationship between body size (i.e., carapace length and volume) and clutch size. However, due to habitat-associated morphological divergences reported in aquatic and semi-aquatic turtles, the maternal volume-reproductive output relationship might be more complex than previously known. For example, aquatic habitat characteristics, in particular water velocity, can influence shell morphology in turtles, where individuals are more hydrodynamic (e.g., flatter and smaller) in lotic than lentic systems. Here, we tested for habitat-associated divergence in shell morphology and reproductive variation between lentic and lotic populations of *Kinosternon sonoriense* in the U.S. and Mexico, including 24 geographically distinct populations and 1,236 individuals. We predicted that individuals inhabiting lotic systems would be more hydrodynamic and show a reduction in body volume, thus reducing clutch and egg size in females. Our results provided evidence for an environmental-based physical constraint on reproductive output by body volume in both lentic and lotic habitats. Specifically, our results suggest that flowing water (i.e., lotic) reduces not only body size but also body volume of individuals when compared to individuals inhabiting lentic habitats. We hypothesize that natural selection favors a hydrodynamic body form and reduced body volume in lotic habitats to increase locomotion efficiency, a finding reported in other aquatic vertebrates and turtles. In *K. sonoriense* and potentially in other semi-aquatic turtles, a relationship exists between body volume and habitat type that magnifies the physical constraint on reproductive output. This reduction in body volume associated with habitat results in smaller clutches of small eggs when compared to females in lentic habitats.

Reproductive Ecology: Oral

Thinking Outside the Shell for Conservation: Inspiring Zoo Guests by Training Behaviors in Radiated Tortoises for Public Encounters

Lauren Etzkorn
Animal Programs Specialist-Animal Programs Department, Columbus Zoo and Aquarium, Columbus, Ohio, USA
[lauren.etzkorn@columbuszoo.org]

Among those animals found in zoos, turtles and tortoises are less commonly appreciated by the public for being relatable than many of their mammalian counterparts. It can be difficult for zoo patrons to identify or empathize with species of the cold-blooded variety. At the Animal Encounters Village at the Columbus Zoo, animal care staff aim to provide opportunities for the public to relate to reptiles in a way that might change their perspective. Zoo-goers can visit with and learn about a number of tortoises of various species in the Village's Tortoise Yard. One of the most popular occupants

there is Grouchy the sulcata tortoise (*Centrochelys sulcata*), an individual who has been target trained to a red bucket in order to take a daily walk with zoo guests in tow. During Grouchy's trainer-accompanied treks, guests observe positive reinforcement training-in-action and sometimes have the opportunity to reinforce Grouchy with grapes. Radiated tortoise (*Astrochelys radiata*) Dia was trained to enter through a door onstage, walk to the edge of the stairs and slide down a ramp in order to get close enough for guests to touch his shell. Each of these experiences gives the zoo guests a chance to see these species making choices and demonstrating control over their environments. As a result of the incorporation of these trained behaviors into our program we have seen a significant increase in guest contributions to tortoise conservation efforts. This paper outlines the ways in which training behaviors in our tortoise residents, for the purpose of guest interaction, allows the public to relate to and ultimately become invested in their species' conservation.
Zoos and Chelonians: Oral

Refining the Techniques Used to Induce Egg Laying in Turtles

Mark Feldman and Elizabeth Feldman
PO Box 285, Kerikeri, New Zealand 0230
[nz.feldman@yahoo.com]

In previous years we have reported on our success using Lutalyse (prostaglandin F2 alpha) with, or without, Sedivet (romifidine) to induce egg laying in American turtles. Success rates (a turtle laying all its eggs after induction) have varied from 94% with a variety of sliders and map turtles to 80% with spiny softshells. It appears that Lutalyse initiates most of the cascade of natural events that leads to egg laying and the ovulation of the next clutch. However, Lutalyse must be used carefully because it migrates through mammalian skin and can cause diarrhea in everyone and abortion in pregnant women. In the past we have experimented with three alpha 2 agonists: xylazine, dexmedetomidine, and Sedivet (romifidine). All three have the potential to over-ride the inhibiting effects of capture stress on egg laying but Sedivet has the advantage of being the longest acting and proved to be the most effective. From November, 2016 to January 2017 we experimented with our colony of red eared sliders in New Zealand. We found that by giving both the Lutalyse and Sedivet simultaneously, doing our inductions at night, and doing repeat injections of Lutalyse within five hours, we could increase our success rate to 100%, even with turtles that had been poor responders in the past. However, our numbers were small, with only 40 inductions among the 12 females. We have now returned to the Concordia Turtle Farm in Louisiana to test these changes in technique with much larger numbers of turtles. In addition we will experiment with adding injectable calcium to our procedures. Since the success rate with Lutalyse alone is 94% with sliders and map turtles, we will use spiny softshells where our success rate has only been 80% when we used Lutalyse and Sedivet together. We will be able to report our results at the TSA conference in August, 2017. We have also set up a web-site (inducingturtles.com) which includes a series of four videos and the latest PDF outlining our recommendations. It's our hope this will make it easier for others to induce their turtles.
Physiology/Health: Oral

The Greenhouse for Culturing Juvenile Soft-Shelled Turtle, *Pelodiscus Sinensis*

Wang Fen[1,2], Jiang Yelin[1,2*], Cheng Yunsheng[1,2], Hou Guanjun[1,2], and Zhang Jing[1,2]
[1]Fishery Institute, AnHui Academy of Agricultural Science, HeFei, AnHui, China
[2]Anhui Engineering Research Center for turtle Farming Technology, HeFei, AnHui, China
[*jiangyelin@qq.com*]

Because of the high nutritional and medicinal values, soft-shelled turtle, *pelodiscus sinensis,* is also a highly appreciated part of many dishes of people in Asia. The juvenile will be incubated during Jun-Sep, and it's too weak to stand the cold temperature of winter, so it's necessary for juveniles to be cultured in greenhouse, which was heated by ground source heat pump system, and the water temperature was kept at about 30 °C. The top of the culture tank wall was built in the shape "T" to prevent escape. To gather and discharge suspended solids effectively, tank bottom was built into a wok shape sloping, and the suspended solids were discharged every day, and the level of the culture water almost weren't change, and the turtle wasn't disturbed. In addition, to adapt to the life habit of turtle, a special feature—the skirt-shaped 3-D shelter was equipped in the culture tank to decrease the disability rate, which was 1.2-m squared polyethylene knotless small mesh and hung 10 cm above water surface. After 10-month cultivation, the survival was about 86%.
Presentation type: Poster

The Growth and Movement of *Gopherus polyphemus*

John Floyd and David Rostal
Department of Biology, Georgia Southern University, Statesboro, Georgia, USA
[floydfjohn@gmail.com]

Gopherus polyphemus is a fossorial keystone species that inhabits sandy less dense areas of the southeastern United States. Its distinctive burrows are often home to more than 300 species, including several that are endangered. This makes their success curial to continued diversity of their habitat. In the summer of 2016 eleven female, fifteen male, and two juvenile gopher tortoises were captured in George L. Smith State park (GLS) in the continuation of a 23 year study. Tortoises were originally studied at GLS in 1994 to 1996. Over the years, studies followed up in 1998 to 1999, 2007 to 2008 and 2014 to 2016. Over the years a total of 158 tortoises have been captured, tagged and measured. Reproduction was measured using radiography. Tortoise straight carapace length (SCL), straight carapace width (SCW), depth, straight plastron minimum (SPLmin), and straight plastron maximum (SPLmax) was measured. Measurements from tortoises recaptured over the study period were compared with measurements taken in previous years. Females showed an average growth rate of 0.4526 cm/year in SCL with 45% showing more than negligible growth, 0.2040 cm/year in SCW with 43% showing more than negligible growth, 0.0455 cm/year in depth with 43% showing more that negligible growth, 0.2123 cm/year in SPL minimum with 43% showing more than negligible growth, and 0.1549 cm/year in SPL maximum with 43% showing more than negligible growth. Males showed an average growth rate of 0.1892 cm/year in SCL with 45% showing more than negligible growth, 0.0715 cm/year in SCW with 27% showing more than negligible growth, 0.05 cm/year in depth with 9% showing more than negligible growth, 0.1167 cm/year in SPL minimum with 18% showing more than negligible growth, and 0.1222 cm/year in SPL maximum with 29% showing more than negligible growth. The higher growth rate of females and higher percent of females that show more than negligible growth is most likely due females reaching larger sizes than males in this species. Female tortoises determined to be gravid by either ultrasound or palpation were then taken off site to be x-rayed for eggs. The average clutch size for 2016 was 6. The clutch size in the park has been increasing at a rate of 0.071 eggs per year presumably in response to improved habitat management at the park over the past 15 years. However, the number of gravid females this year was down to 36%. A similar decline in the number of reproducing in 2016 was observed on Fort Stewart in 2016. Environmental factors are being studied at this time. After the tortoise was released GPS coordinates were recorded and compared with data from previous years. The average movement per year was approximately 203.3 meters/year. Based on the movements of recaptured tortoises over the year, the tortoises are using the different regions in different years and are using all of the available habitat.

Presentation type: Poster (Student)

Glacial Growth Rates of a Long-lived Turtle, *Macrochelys temminckii*

Brian Folt[1], John Jensen[2], and Stanley Trauth[3]
[1]*Department of Biological Sciences and Auburn University Museum of Natural History, 331 Funchess Hall, Auburn, Alabama 36849 USA*
[2]*Georgia Department of Natural Resources, Nongame Conservation Section, 116 Rum Creek Drive, Forsyth, Georgia 31029 USA*
[3]*Department of Biological Sciences, Arkansas State University, Jonesboro, Arkansas 72467 USA*
[brian.folt@gmail.com]

Macrochelys temminckii (Alligator Snapping Turtle) is a large freshwater turtle occurring in North America, which has declined throughout the species' range. Despite much concern towards the conservation status of this species, conservation efforts toward this species and other large freshwater aquatic turtles are hindered by the paucity of knowledge relating to the natural history and population biology of this and other large freshwater aquatic turtles. In this study, we used data collected from long-term studies in Arkansas and Georgia to describe patterns of growth and longevity from two apparently viable populations. We developed models describing intersexual and age-class variation in growth rates and asymptotic maximum size, and test whether two populations at opposite ends of the species' range differ in patterns of growth. We compare our results to other growth studies of *M. temminckii* and *Chelydra serpentina*.

Growth/Morphology: Oral

Ecology and Trade of the Black-breasted Leaf Turtle (*Geoemyda spengleri*) on Hainan Island, China

Daniel Gaillard[1], Jeffrey E. Dawson[2], Lin Liu[3], Shao Fanrong[3], Luo Shujin[1], and Shi Haitao[3]
[1]*Department of Life Sciences, Peking University, Beijing, Peoples Republic of China*
[2]*Charles H. Hoessle Herpetarium, Saint Louis Zoo, St. Louis, Missouri, USA*
[3]*College of Life Science, Hainan Normal University, Haikou, Hainan, Peoples Republic of China*
[jdawson@stlzoo.org]

Primarily due to overcollection for trade, the Black-breasted Leaf Turtle (*Geoemyda spengleri*) is currently considered endangered by the IUCN. As with many Asian chelonians, conservation efforts are hindered by limited knowledge on this enigmatic species in the wild. From 2015 to present, we have investigated *G. spengleri* on Hainan Island, China, through field surveys, interview surveys of local people, and ecological studies. To date, surveys have been conducted in central and western Hainan, but all known populations of the species have been found within Qiongzhong County. We have confirmed its occurrence in the wild at two locations, while a third site has been reported by local people but remains unverified by us. On Hainan, *G. spengleri* is restricted to high elevation (above 600 m) montane forests with dense canopy cover ($\bar{x}$ = 96%) and frequent cloud immersion (RH > 80%). The annual range of air temperature in prime habitat is approximately 15-25°C. The species may be active throughout most of the year. Cloacal body temperatures of active turtles are slightly higher, but not greatly different, than ambient conditions. The species appears to rely on crypsis among leaf litter, logs, and rocks for defense. Wild pigs and civets are reported natural predators; we have observed turtles with shell and limb injuries consistent with predation attempts. Analyses of fecal samples have revealed the presence of invertebrates (including snails and insects) and plants in the diet. Local people state that females nest in open areas during the summer. A wild-caught female in our possession laid a single egg. At all sites identified on Hainan with *G. spengleri*, local people collect the species. Formerly, collection of this species was infrequent. However, recent increased interest from the pet trade has roughly tripled the price (to 300RMB ≈ 45USD) paid to locals, making collection more profitable. Targeted commercial hunting began on the island in 2015. An estimated 2,000+ individuals have since been removed, resulting in the dramatic reduction of one population. Local people report greater difficulty finding the species now. To further research and conservation, a captive assurance colony has been established at Hainan Normal University.

Ecology/Field Studies: Oral

Genetic Evidence of Fragmented Populations and Inbreeding in the Endemic Dahl's Toad-headed Turtle (*Mesoclemmys dahli*)

Natalia Gallego-García[1], Mario Vargas-Ramírez[2], Germán Forero-Medina[3], and Susana Caballero[1]
[1] *Laboratorio de Ecología Molecular de Vertebrados Acuáticos LEMVA, Departamento de Ciencias Biológicas, Universidad de los Andes, Carrera 1 No. 18A-10, Bogotá, Colombia*
[2] *Biodiversidad y Conservación Genética, Instituto de Genética, Universidad Nacional de Colombia, Ciudad Universitaria, Edificio 423, Bogotá, Colombia*
[3] *Wildlife Conservation Society, Turtle Survival Alliance. Avenida 5N # 22n -11, Cali, Colombia [natagalle@gmail.com]*

Population fragmentation is one of the most concerning consequences of habitat fragmentation, as small and isolated populations suffer of increased genetic drift and inbreeding. However, the extent to which habitat fragmentation leads to population fragmentation depends not only on the landscape structure, but also on the response of organisms to it. This behavioral component makes it difficult to detect population fragmentation even if the habitat is fragmented, unless appropriate tools are used. In this study, we used a molecular approach to evaluate if Dahl´s toad-headed turtle (*Mesoclemmys dahli)* population was fragmented, given that it occurs in a very restricted area within the most degraded biome of Colombia, the tropical dry forest. We developed a panel of 15 microsatellite loci in order to perform the first genetic assessment of *M. dahli* across its complete geographic range. We found that *M. dahli* has significant genetic structure with at least four subpopulations, with surprisingly moderate to high levels of genetic diversity. Despite its diversity, subpopulations are very small (Ne <50) and isolated, with little to no contemporary gene flow among them. As a consequence, mating among related individuals has been occurring, and all four populations are showing high degree of inbreeding. Given the conclusive evidence of severe population fragmentation and inbreeding, we recommend a new conservation status assessment, not based on geographic range, but on adult population size and level of fragmentation, and an urgent genetic rescue strategy accompanied by habitat restoration, to ensure that the combined effects of small, inbred, isolated populations and high habitat deterioration will not result in a rapid population decline.

Genetics: Oral (Student)

Coming Full Circle: How an Education Program has Translated into Conservation Action at the Ontario Turtle Conservation Centre in Peterborough, Ontario, Canada

Donnell Gasbarrini, Wendy Baggs, and Sue Carstairs
The Ontario Turtle Conservation Centre, Peterborough, Ontario, K9J 6X2 Canada
[d.gasbarrini@ontarioturtle.ca]

Public education and science communication is vital in creating awareness of conservation issues among the general public, and has the potential to initiate conservation action. Members of the general public hold great conservation power when armed with the knowledge, tools, and passion necessary to take action. Policy makers can be persuaded by public opinion, which is gained through a better understanding of the threats to local ecosystems and their inhabitants. The Ontario Turtle Conservation Centre (OTCC) is a multi-faceted conservation centre located in Peterborough, Ontario; a province where seven of the eight native turtle species are listed as " species at-risk". The OTCC is situated between the most densely populated area in the province, the Greater Toronto Area (GTA), and the Kawarthas, a major cottage destination, making its facilities and programs accessible to millions of people with various backgrounds and connections to the natural world. The OTCC's Education Program is one of the four main components through which the OTCC fulfills its mission: to protect and conserve Ontario's native turtle species and the habitats in which they live. The OTCC's Education Program began as an informal passing of information to individuals and families who were bringing injured turtles to the OTCC Turtle Trauma Centre for rehabilitative care. The Education Program has since grown to include a customizable presentation, to ensure all ages and knowledge levels can benefit from the Program. The Program provides an opportunity for participants to interact with live turtle ambassadors, and participate in interactive and educational activities. To determine the effectiveness of this program, surveys are completed by members of each group, to quantify the impact that the Education Program had on its audiences. In addition to increasing the general knowledge that participants have of chelonian anatomy, life history, and threats, the Education Program has initiated direct conservation action, resulting in more knowledgeable individuals aiding turtles across roads, the installation of mitigation structures (e.g. turtle crossing signs, wildlife culverts), and direct fundraising for the OTCC to aid in additional conservation efforts.

Community Outreach and Partnerships: Oral

The Shoulders of Giants: Learning from Success in Chelonian Conservation

Paul M. Gibbons[1], Peter Paul van Dijk[1], Craig Stanford[2], Anders G. J. Rhodin[3], and Eric V. Goode[1]
[1]*Turtle Conservancy, Ojai, California, USA*
[2]*Department of Biological Sciences, University of Southern California, California, USA*
[3]*Chelonian Research Foundation, Lunenburg, Massachusetts, USA*
[paul@turtleconservancy.org]

Over the years, few conservation initiatives have demonstrably rescued a turtle or tortoise species from the precipice of extinction, and few of these have created the conditions for long-term self-sustaining wild populations. Notable successes include the Galápagos tortoises from Española and Pinzón (*Chelonoidis hoodensis* and *C. duncanensis*) and the Western Swamp Turtle from Australia (*Pseudemydura umbrina*). A few programs are moving toward such success, including the Burmese Star Tortoise (*Geochelone platynota*), Burmese Roofed Turtle (*Batagur trivittata*), and Vietnamese Pond Turtle (*Mauremys annamensis*), with extinction having been averted through captive breeding while efforts to address the factors that drive the species toward extinction continue. Other programs, including the Ploughshare Tortoise (*Astrochelys yniphora*), enjoyed a period of success only to be overtaken by events far beyond the control of normal conservation actions. Declines of numerous species would have been much steeper, possibly into extinction already, if it had not been for species protective and trade management legislation and habitat protection actions. Even without implementing species-specific management measures, species such as *Stigmochelys pardalis*, *Lissemys punctata*, *Chrysemys picta*, and *Dogania subplana* are secure for the foreseeable future because they are fortunate enough to exist within a diversity of well-managed protected areas. For programs specifically addressing turtle species in decline, each program has experienced its own unique set of impacts, challenges, and opportunities. Conservation breeding has been an essential component for the recovery of species with only a few remaining individuals. Community education and ecotourism programs may have been helpful in many cases where potentially viable populations remained in the wild. Legislative action and participation of governmental organizations have been critically important factors, while habitat protection has been the unifying thread among all of the long-term successful programs. The Turtle Conservancy recently accepted the primary responsibility of protecting two threatened tortoise species by creating two new in-country protected areas with these tortoises as the flagship species. To be successful in the long term, these programs

need ongoing governmental participation and NGO partnerships to achieve effective security, habitat restoration, local community engagement, captive breeding where appropriate, and most importantly, long-term, sustainable funding.

Conservation & Management: Oral

One of the World's Worst Turtle Road Mortality Hotspots now has 89% Fewer Turtle Deaths, Though it Took a Small Community Over a Decade of Work and 2.7 Million Dollars to Make it Happen.

Scott Gillingwater
Upper Thames River Conservation Authority, London, Ontario, N5V 5B9 Canada
[gillingwaters@thamesriver.on.ca]

The Long Point Causeway, which fragments an important lake-marsh ecosystem in Ontario, Canada, had the unfortunate distinction of being one of the top 4 worst roads for turtle mortality in North America. Since road mortality data collection began in 1979, the 3.6 km causeway was found to be the cause of approximately 10,000 animal deaths per year, including over 100 species of reptiles, amphibians, birds and mammals. In 2005, two biologists assembled a small group of passionate community members and researchers to deal with this growing threat. From 2006 to 2016, at a cost of 2.7 million dollars, turtle road mortality was reduced by 89%. To achieve this, over 5km of exclusion fencing and 12 culverts (ecopassages) were installed and a large community education and participation program was initiated. Culverts included small, medium and large sizes, as well as both terrestrial and aquatic designs. The success of these mitigation strategies was assessed by comparing the results of road surveys conducted 5 years before and 5 years after fencing was installed, and by monitoring the use of newly installed culverts by turtles through motion-activated cameras, stationary antennas to detect PIT tagged turtles and by tracking turtles fitted with radio-transmitters. Culverts were successfully used by a number of species, including Blanding's turtle (*Emydoidea blandingii*), northern map turtle (*Graptemys geographica*), snapping turtle (*Chelydra serpentina*), and midland painted turtle (*Chrysemys picta*). At every turn difficulties arose during the implementation of this effort, resulting in new strategies, new partnerships, and developing a social as well as scientific approach to conservation. The local community's commitment, backed by emerging science, lead to local, national and international partnerships, funding opportunities and sharing of information. While successful, this effort would not have been possible without many individuals coming together and volunteering their time for over a decade. This project now serves as an example for future efforts in road mortality mitigation, and provides the proof that a small group of community members can create significant and lasting change.

Road Ecology: Oral

Preliminary Geometric Morphometric Analysis of the North American Genus *Pseudemys*

James C. Godwin[1], Chris Murray[2], and Joshua R. Ennen[3]
[1]*Alabama Natural Heritage Program, Museum of Natural History, Auburn University, Alabama 36849 USA*
[2]*Department of Biology, Tennessee Tech University, Cookeville, Tennessee 38505 USA*
[3]*Tennessee Aquarium Conservation Institute, Chattanooga, Tennessee 37405 USA*
[jcg0001@auburn.edu]

The phylogenetic relationships of the genus *Pseudemys* is unresolved resulting in dubious taxonomy. Based on largely morphological features, the number of currently recognized taxa of *Pseudemys* is nine that are loosely assigned into two "groups". The red-bellied group includes *Pseudemys alabamensis*, *Pseudemys nelsoni*, *Pseudemys rubriventris*. The remainder (i.e., *Pseudemys concinna*, *Pseudemys floridana*, *Pseudemys gorzugi*, *Pseudemys peninsularis*, *Pseudemys suwanniensis*, and *Pseudemys texana*) belong to a "concinna" group. Although nine species are recognized, many of the diagnostic morphological features (e.g., pre-frontal arrow, cusp, head stripe characters, and scute color patterns) display spatial variation and overlap among the species. Our goal in this study was to compare shell morphology among six species of *Pseudemys* and to investigate any ecological shape variation (i.e., drainage specific). We used 19 carapacial and 14 plastral scute landmarks in our preliminary analysis on 167 specimens of six taxa from the Auburn University Museum of Natural History collection. The preliminary results of our geometric morphometric analysis indicate no ecological shape variation; rather all shape variation appears to be taxonomically associated.

Presentation type: Poster

Molecular Analyzes Reveal Conservation Potential for the Critically Endangered *Mesoclemmys hogei*

Laís Gomes[1], Gláucia Drummond[2,] Rogério Silva[2], Daniel Teixeira[1], Marcos Coutinho[3], and Daniel Carvalho[1]
[1]Laboratório de Genética da Conservação, Programa de Pós-graduação em Biologia de Vertebrados da Pontifícia Universidade Católica de Minas Gerais, Brasil
[2]Fundação Biodiversitas, Minas Gerais, Brasil
[3]Instituto Chico Mendes de Conservação da Biodiversidade – Centro Nacional de Pesquisa e Conservação de Répteis e Anfíbios, Base de Pesquisa de Minas Gerais, Brasil
[laiscarvalhog@gmail.com]

The Hoge's Side-necked Turtle (*Mesoclemmys hogei*), a species endemic to the Paraíba do Sul River Basin, is among the 25 most endangered chelonians in the world. Molecular analyzes using mitochondrial (COI and 16S) and nuclear (five microsatellite loci) markers were carried out on 35 individuals from the mid Carangola River population. Aiming at the conservation of this species, a nature reserve was created in 2016 in this area, where the main *M. hogei* population remnants are found. This population has been continuously monitored over the last 25 years and intense demographic contraction has been observed. The neutrality tests based on mitochondrial DNA (mtDNA) corroborated the demographic decline, however, the nuclear DNA (nDNA) failed to detect genetic bottleneck or inbreeding. Although the nDNA revealed a low effective population size, ranging from 29,2 to 39,0 depending on the allele frequency considered, the genetic diversity estimated for both mtDNA (Hd=0,595) and nDNA (Ho=0,546; He=0,597; Ar=2,350) was moderate. The moderate genetic diversity and the lack of bottleneck and inbreeding evidence could be explained by the long generation time and lifespan described for the species, which prevented genetic signatures from being left by the population reduction. The mid Carangola population still presents enough evolutionary potential to be preserved. However, its genetic diversity cannot be overlooked, especially considering the low effective population size, much lower than the minimum size of 100 individuals estimated to keep a population genetically healthy even on the short term.

Genetics: Oral (Student)

Semicaptive Management Project for the Critically Endangered Central American River Turtle (*Dermatemys mawii*) as Part of a Comprehensive Reintroduction Program within Rio Tsendales, Montes Azules Biosphere Reserve, Chiapas, Mexico

Gracia Patricia Gonzalez-Porter[1] and Richard C. Vogt[2]
[1]National Museum of Natural History, Smithsonian Institution, 25 E. Wayne Ave. APT 802, Silver Spring, Maryland 20901 USA
[2]Coordenação de Biodiversidade, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil CEP 69.067-375
[graciapgp@gmail.mx]

This project is the first project of reintroduction and management of the species in semicaptive conditions in a protected area of Rio Tsendales, Chiapas within the species' natural distribution.

The objective of this project is to create a reintroduction program for the Central American River Turtle, being the first of its kind, the project will study different aspects of a reintroduction program. This plan will include four phases: a prospective phase, which include studies of remaining populations in the study area, pathogens, predators, occupied niches, food availability, and other threats that a reintroduced population could face, a pilot study, consisting of getting few turtles by capture or request from turtle farms; all animals will be marked, genotyped, and monitored to gather more information about these turtles and their relationship with the new environment; all animals will be health screened periodically, during this period as the semicaptive management will be refined and pitfalls overcome. After two years more individuals, aprox. 700 will be requested and captured in the wild, by trapping or using dogs to find nests, all new organisms will have comprehensive health screening, identified and integrated into the colony. Then monitory studies will take place to learn about their homing behavior, being a source of individuals for reintroduction projects and other studies about this species.

Conservation & Management: Oral

An Evaluation of Culturing Carolina Diamondback Terrapins in Charleston, South Carolina

Andrew M. Grosse[1] and Erin M. Levesque[2]
[1]South Carolina Department of Natural Resources, 220 Santee Gun Club Rd., McClellanville, South Carolina, USA
[2]South Carolina Department of Natural Resources, 211 Sawmill Creek Rd., Bluffton, South Carolina, USA
[grossea@dnr.sc.gov]

During the 2014-2016 mating/nesting season (May through July), viable clutches (1,089 eggs total) from 130 diamondback terrapin females captured in trammel nets and viable clutches from 24 land-captured terrapins were collected and incubated at either male-producing (27°C) or female producing (31°C) temperatures. There was no difference in hatching success between these groups ($p>0.05$). There was a positive correlation with larger females producing more eggs per clutch and a greater mean egg size. Growth of hatchlings in Year 1 fed one of three diets (fresh fish, ZooMed pellets, or Mazuri pellets) was assessed from October 2014 through April 2015 to evaluate feed type; both groups fed commercial pelleted diets grew significantly more than those fed fish only. A total of 411 "headstarted" (juveniles raised in a hatchery to accelerate growth) terrapins and 227 hatchlings have been released into the Charleston Harbor Estuarine system since 2014. Seventy-seven individuals have been retained to confirm sex, and twenty-three remain in a culture pond at the Waddell Mariculture Center for future investigations of accelerated time to maturity of head-started individuals. Results from this study provided information about how to efficiently capture females, harvest eggs and grow hatchlings/juveniles in order to supplement depleted wild populations. Access to the large number of hatchlings and juveniles that can be cultured in the laboratory also allows investigation of the biology of these naturally cryptic life stages that will allow us to better manage wild populations.

Ecology/Field Studies: Oral

Life in the Fast Lane: Differences among Three Southeastern US Semi-aquatic Turtle Species in Their Metabolic Responses to Increased Temperatures

David L. Haskins[1,2], Jarad P. Cochran[1,2], Kimberly M. Andrews[1], and Tracey D. Tuberville[1]
[1]Savannah River Ecology Lab, University of Georgia, Drawer E, Aiken, South Carolinia, USA
[2]Interdisciplinary Toxicology Program, University of Georgia, Athens, Georgia, USA
[davidhaskins44@att.net]

Physiological maintenance of ectotherms is largely dependent on temperature. In these species, abrupt changes in environmental conditions can cause shifts in energy budgets, with higher temperatures requiring more energy be devoted to maintenance functions and less to reproduction. Freshwater turtles as a whole are of conservation concern; thus, it is important for researchers to elucidate their physiological responses to temperature shifts, particularly given current climate change predictions. We quantified O_2 consumption (VO_2) and CO_2 production (VCO_2) at three different temperatures (25C°, 30C°, and 35C°) in three species of semiaquatic turtles that vary in their degree of terrestriality: Chicken Turtles (*Deirochelys reticularia*), Eastern Mud Turtles (*Kinosternon subrubrum*), and Common Musk Turtles (*Sternotherus odoratus*) using a flow-through respirometer. As expected, temperature significantly affected metabolic rate in all three turtle species. Turtle VO_2 and VCO_2 were both significantly higher (all $p < 0.001$) at 30C° (6.87 mL/hr – 15.52 mL/hr) and 35C° (9.23 mL/hr – 22.58 mL/hr) compared to 25C° (3.99 mL/hr – 10.59 mL/hr). Turtle mass also had a significant impact on VO_2 ($p = 0.009$) and VCO_2 ($p = 0.003$), however, this effect was not as significant as other variables within the models. Most interestingly, metabolic rates were significantly higher in *D. reticularia* than in *K. subrubrum* and *S. odoratus* (all $p < 0.005$), even after accounting for differences in body size. The combination of increased metabolic costs and shorter life span of chicken turtles relative to mud and musk turtles may place them at a particular disadvantage to future climate scenarios that predict increased temperatures, particularly when considered in combination with field studies demonstrating their vulnerability to prolonged drought. Our findings, when combined with knowledge of other ecological traits, may be a useful tool for predicting relative sensitivities of turtle species to predicted climate change.

Physiology/Health: Oral (Student)

Understanding the Geographic Distribution of Turtles is Fundamental to Conservation and Management: Determining the Southern Distribution of the Suwannee Cooter (*Pseudemys concinna suwanniensis*)

George L. Heinrich[1,2] and Timothy J. Walsh[2,3]
[1]*Heinrich Ecological Services, St. Petersburg, Florida, USA*
[2]*Florida Turtle Conservation Trust, St. Petersburg, Florida, USA*
[3]*Bruce Museum, Greenwich, Connecticut, USA*
[george@heinrichecologicalservices.com]

Understanding the geographic distribution of turtles is vital to assuring appropriate conservation and management efforts. Concerns exist regarding inaccurate and outdated range maps presented in field guides and other publications. We will review a survey of Florida rivers to determine the southern distribution of the Suwannee cooter (*Pseudemys concinna suwanniensis*), the largest member of the speciose turtle family Emydidae. Restricted to rivers that drain into the northeastern Gulf of Mexico along the northwest coast of Florida, the southern distribution and status of this subspecies is uncertain and hence of conservation concern. Recent fieldwork has documented five new river records, two county records, and a range extension.
Geographic Variables: Oral

The Effects of Climate on Annual Variation in Reproductive Output in Snapping Turtles (*Chelydra serpentina*)

Ashley R. Hedrick[1], Hanna M. Klondaris[1], Laura C. Corichi[1], Michael J. Dreslik[2], and John B. Iverson[1]
[1]*Department Biology, Earlham College, Richmond, Indiana 47374 USA*
[2]*Illinois Natural History Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois 61820 USA*
[johni@earlham.edu]

Reptiles are highly dependent on climatic patterns to regulate their behavior and physiology, and studies of the effects of climate on the biology of organisms are increasingly important given expected climate change. Our study examined the effects of climate variation over 15 of the 26 years between 1990 and 2015 on the reproductive output of the Common Snapping Turtle (*Chelydra serpentina*). Egg mass, clutch size and clutch mass (relative to body size) were significantly higher in years following warmer temperatures in September and October of the year before reproduction, but not related to temperatures in April and May just before reproduction. Of the above life history traits, egg mass varied the least across years, and after warm autumns small turtles (225-285 mm carapace length) increased clutch mass by increasing clutch size but not egg size. In contrast, under the same conditions, large turtles increased clutch mass by increasing egg mass but not clutch size. Our data suggest optimal egg size may vary with female size. Climate change may already have impacted reproductive output in snapping turtles at the site because temperatures during September and October have increased about 0.5 °C each decade for the last 45 years.
Reproductive Ecology: Oral

A Study of an Aquatic Turtle Assemblage in a Northwest Georgia Lake and Wetland Prior to Restoration

Tegan Hendricks, Jonathan Leberman, Carrie Swinney, Chris B. Manis, and G. John Lugthart
Department of Natural Sciences, Dalton State College, 650 College Drive, Dalton, Georgia 30720 USA
[teganmichelleh@gmail.com]

We conducted a five-year study to characterize the aquatic turtle community within an urban park in Dalton, Georgia prior to a pending habitat restoration project. We sampled with hoop traps to collect turtles from Threadmill Lake, a ~1.01 ha subdivided lake and an adjoining ~0.70 ha wetland. Sampling occurred during two-week periods in June 2012, July 2013, June 2014, June 2015, and July 2016. We recorded morphometric data and sex was determined for adults. Each turtle was uniquely marked and released immediately after processing. We captured a total of 892 turtles representing four families and six species. Catch per unit effort ranged from 0.86 turtles/trap/day (2015) to 2.39 turtles/trap/day (2016). Population estimates for the five most abundant species were as follows: *Sternotherus odoratus (*846 ± 95), *Trachemys scripta* (413 ± 51), *Chelydra serpentina* (395 ± 64), *Pseudemys concinna* (384 ± 65), *and Chrysemys picta* (140 ± 28). These "before" data will be useful in assessing effects of upcoming stabilization and revegetation of the shoreline on the turtle community.
Freshwater Turtles of the SE: Oral

Head-starting that Works: Growing a Colony of Bolson Tortoise (*Gopherus flavomarginatus*)

L. Scott Hillard and Christiane Wiese
Turner Endangered Species Fund (TESF), HC31, Box 95, Caballo, New Mexico 87931 USA
[hillard@earthlink.net]

The Bolson tortoise is the largest and rarest tortoise in the Americas. It is listed among the "Top 40 Tortoises and Freshwater Turtles at Very High Risk of Extinction." Prehistorically, Bolson tortoises ranged as far north as Oklahoma and as far west as Arizona (USA) in Chihuahuan Desert-like habitat. Exact wild population size is unknown, but we are operating under the model that as few as 2000 remain, confined to the Bolsón de Mapimí region of Mexico. From a private collection of 30 adult tortoises residing in the US, we have produced over 500 hatchlings since 2010. The goal of the Turner Endangered Species Fund's bolson tortoise restoration project is to establish two or more safety colonies in New Mexico. To get there, we take three important steps: we collect and artificially incubate eggs to minimize nest predation, we keep hatchling tortoises "up" during their first winter to expedite growth, and we continue to protect young juvenile tortoises in head-start pens until they reach a predator-resistant size (~100 mm MCL). To accomplish these goals, we monitor adult females for high reproductive effort and track and know the fate of every egg. We also monitor genetics to ensure that known adult diversity is represented in offspring, and we seek to incorporate offspring from new adults. To turn hatchlings into adults, we ensure good growth in head-start enclosures by providing ample forage. Once the tortoises have reached 100 mm MCL (in ~3-7 years), we move them to unprotected semi-wild enclosures where we continue to monitor growth rates and confirm high juvenile survivorship. Thus, our overarching goal is to produce brand new reproductive adults. This conservation project succeeds because the people involved are passionate about *long-term* Bolson tortoise survival, and because it has the benefit of a large enough founding group of breeding adults that produce at least 50 new tortoises per year. Perhaps most importantly, the project enjoys the support of a private land owner conservationist (Ted Turner) who likes to use his land for the protection and conservation of endangered species.
Headstarting: Oral

Evaluating Mojave Desert Tortoise Underpass Designs

Kerry L. Holcomb[1], Ashley R. Holcomb[2], Aaron Rutledge[3], Mark Slaughter[3], and Florence M. Gardipee[4]
[1]*U.S. Fish and Wildlife Service, Palm Springs, California 92262 USA*
[2]*The Great Basin Institute, Las Vegas, Nevada 89113 USA*
[3]*Bureau of Land Management, Las Vegas, Nevada 89130 USA*
[4]*U.S. Fish and Wildlife Service, Las Vegas, Nevada 89130 USA*
[kerry_holcomb@fws.gov]

Road mortality and habitat fragmentation must be addressed if we are to avoid the extinction of many chelonian species. The Mojave desert tortoise (*Gopherus agassizii*) is particularly at risk, as evidenced by roadside tortoise populations that have been depleted due to road mortality and lack of immigration. Fortunately, fencing roadways and installing desert tortoise friendly underpasses have the potential to mitigate threats posed by road mortality and habitat fragmentation. To ensure underpasses are providing optimal mitigation value we must determine whether the cross-sectional area of an underpass and the material(s) used to construct an underpass influence the probability that a tortoise will pass through as intended. The Bureau of Land Management and the U.S. Fish and Wildlife Service have been using passive infrared sensor camera traps to determine the probability that a tortoise will pass through desert tortoise specific underpasses along sections of U.S. Highways 93 (March 2015 to present) and 95 (March 2017 to present) in Nevada. Underpasses along U.S. 93 are constructed with corrugated metal culverts, have cross-sectional areas that range between ~0.29 and ~0.66 square meters, and span a distance of ~ 30 m. Culverts along U.S. 95 are constructed with concrete, have cross-sectional areas that range between ~1.39 and ~2.97 square meters, and span a distance of ~45 m. Cameras were ceiling mounted 80 cm into either side of the underpasses to capture top-down images of each tortoise's carapace as it enters/exits an underpass, enabling identification of individual tortoises and estimation of straight-line carapace length. As of November 2016 (presentation will include data through June 2017), underpasses along U.S. 93 had been entered by eight individual tortoises on twenty-one occasions, and two tortoises have passed through. One of those tortoises has been observed passing through a single underpass on nine occasions. Based on preliminary data the probability that a tortoise will pass through a corrugated metal underpass with a cross-sectional area equal to ~0.29 square meters is 0.40 (two of five tortoises) and the probability that a tortoise will pass through a corrugated metal underpass with a cross-sectional area greater than or equal to 0.45 square meters is 0.00 (zero of three tortoises). Pre-

liminarily, these data indicate that the desert tortoise may have an affinity for underpasses with smaller cross-sectional areas.
Road Ecology: Oral

Motor Boat Injury Rates and Patterns in Aquatic Turtle Communities

Ethan C. Hollender, Travis L. Anthony, and Day B. Ligon
Department of Biology, Missouri State University, Springfield, Missouri USA
[Hollender112358@live.missouristate.edu]

Boat traffic has long been known to impact aquatic wildlife. However, the effects are unlikely to be evenly distributed among all the species that compose a community, with differences in behavior and habitat use influencing which species are most susceptible to boat strikes. We quantified boat traffic and measured the frequency of scarring from traumatic injury in 9 species of freshwater turtle across 5 sites in northeastern Oklahoma. Overall, injury rates correlated strongly with increases in boat traffic ($R^2 = 0.99$, $P < 0.001$). In one species that was common at all 5 study sites (*Graptemys ouachitensis*), 13.4% of individuals exhibited scarring, 1.5 times the average rate across species. Injury rates of other species ranged 0–8.8%. Missing hind limbs occurred 2.4 times more frequently than missing forelimbs, and the same pattern was seen in carapace damage, with scarring to the posterior half of the carapace 1.4 times more prevalent than the anterior half. Our findings likely underestimate the negative impacts of boat traffic on freshwater turtles, as we were only able to detect those animals that survived boat encounters; boat strikes that resulted in death could not be quantified or included in our analyses.
Presentation type: Poster (Student)

The Effects of Road Mortality on a Small Freshwater Turtle

Hunter J. Howell and Richard A. Seigel
Department of Biological Sciences, Towson University, 8000 York Road, Towson, Maryland 21252 USA
[hhowel1@students.towson.edu]

Roads impact wildlife in a variety of direct and indirect ways. Roads may act as barriers to dispersal, lead to decreasing population size, decrease genetic diversity, change animal behavior, lead to direct mortality, and increase habitat disturbance and edge effects. Road mortality is especially detrimental in long-lived species, like freshwater turtles, that rely on high adult survivorship to counter high juvenile mortality. The spotted turtle (*Clemmys guttata*) is a small long-lived freshwater turtle that is endangered in Canada and proposed for listing in the USA. Between 2014-2017 we used a capture-mark-recapture protocol to record 376 captures of 104 individuals. We then used program MARK to estimate population size and program VORTEX to run a population viability analysis (PVA) and sensitivity analysis to attempt to quantify the impact that road mortality has on a population of *C. guttata*. The baseline model for the North Wetland Complex (NWC) population predicted an r value of -0.017 and a probability of quasi-extinction within 150 years as 61%. Including realistic estimates of road mortality (modeled as two individuals killed per year) into the NWC, the r value dropped to -0.044 and the probability of quasi-extinction within 150 years was 100%. Increasing adult survivorship by 2% from the projected value of 96.3% to 98.3% nearly stabilized the population. These results demonstrate the drastic impact that road mortality may have on small-bodied pond turtles and reinforces the importance of high adult survivorship in long-lived species.
Presentation type: Poster (Student)

Integration of Extrinsic Partners with AZA Species Survival Plans: There's More Than One Way to Breed a Turtle

Bill Hughes[1], Michael Ogle[2], Daniel W. Pearson[3], Lauren Augustine[4], and Sara Sullivan[5]
[1]*Tennessee Aquarium, One Broad Street, Chattanooga TN*
[2]*Zoo Knoxville, 3500 Zoo Drive, Knoxville TN*
[3]*Florida Department of Environmental Protection, 4801 Camp Ranch Road, Gainesville, FL*
[4]*Smithsonian National Zoological Park, 3001 Connecticut Ave. NW, Washington D.C. 20008 USA*
[5]*Brookfield Zoo, 8400 W 31st St, Brookfield, IL*
[bhh@tnaqua.org]

Because the threats facing chelonians are so severe, long term sustainability of assurance colonies is a critical goal. Population size and genetic diversity as well as consistent reproduction are vital components for achieving this goal. However, zoos and aquariums have limited holding space and in some cases limited expertise with certain species. To this end, involvement with private breeders and non-AZA institutions is warranted but the level of involvement with such extrinsic partners varies greatly between different institutions. There are currently 49 species of turtles managed as Species Survival Plans/Candidate programs under the Chelonian Taxon Advisory Group. All but seven of these programs include private individuals and non-AZA institutions as participants. This presentation will discuss the benefits of including extrinsic partners by providing examples of successful collaborations.
Zoos and Chelonians: Oral

Diversity of North American Map and Sawback Turtles (Testudines: Emydidae: *Graptemys*)

Flora Ihlow[1,2], Peter Praschag[3], Morris Flecks[1], Melita Vamberger[2], and Uwe Fritz[2]
[1]*Herpetology Section, Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany*
[2]*Museum of Zoology, Senckenberg Dresden, Dresden, Germany*
[3]*Turtle Island, Graz, Austria*
[F.Ihlow@ZFMK.de]

With 14 species and one additional subspecies, the genus *Graptemys* represents the most diverse genus in the family Emydidae. Although some species are characterized by pronounced morphological differences, previous phylogenetic analyses have failed to confirm significant levels of genetic divergence for many taxa. As a consequence, it has been debated whether *Graptemys* is taxonomically inflated or whether the low genetic divergence observed reflects recent radiations or ancient hybridization. In this study, we analyzed three mtDNA blocks as well as 12 nuclear loci of 89 specimens covering all species and subspecies. Our analyses of the concatenated mtDNA sequences reveal that the widespread *G. geographica* constitutes the sister taxon of all other *Graptemys* species. These correspond to two clades, one comprises all broad-headed species while the other contains the narrow-headed species. Most species of the broad-headed clade are reciprocally monophyletic, except for *G. gibbonsi* and *G. pearlensis*, which are not differentiated. By contrast, in the narrow-headed clade, many currently recognized species are not monophyletic and divergence is significantly less pronounced. Haplotype networks of phased nuclear loci show low genetic divergence among taxa and many shared haplotypes. Principal component analyses using coded phased nuclear DNA sequences revealed eight distinct clusters within *Graptemys* that partially conflict with the terminal mtDNA clades. This might be explained by male-mediated gene flow across and female philopatry within drainage basins. Our results support that *Graptemys* is indeed taxonomically oversplit and should be revised.
Genetics: Oral (Student)

State Wildlife Action Plan and State Wildlife Grants – Directing and Funding Conservation of Arizona's Turtles

Cristina A. Jones
Terrestrial Wildlife Branch, Arizona Game and Fish Department, Phoenix, Arizona 85086 USA
[cajones@azgfd.gov]

State Wildlife Action Plans (SWAP) are firmly grounded in science, and focus on practical, proactive measures to conserve wildlife and habitat before they become too rare or costly to restore. In 2005, all 50 States and five U.S. territories developed a SWAP reflecting each state's unique natural resources and conservation needs, and identifying Species of Greatest Conservation Need (SGCN) for each state. The State Wildlife Grants Program provides federal dollars to every State and territory

with a SWAP to support cost-effective conservation aimed at preventing wildlife from becoming endangered. The Arizona Game and Fish Department (Department) completed their SWAP in 2006, and a 10-year revision in 2015. The State of Arizona ranks among the highest for its biological diversity – third in the nation for the number of native bird species, second for reptiles, fifth for mammals, eighth for overall vertebrate diversity, and with more than 800 native wildlife species, the highest diversity of any inland state. Of these, 531 species are listed as SGCN – 63 are amphibians and reptiles, including six species and one subspecies of turtle. The Department developed priority conservation actions with the assumption that restoration of ecosystem structure, processes, and functions would have the most benefit for the most species. These conservation actions that are specifically aimed at removing or alleviating the effect of stressors on the landscape and benefitting all species that inhabit that landscape. This presentation will highlight the SWG funded conservation activities directed towards meeting conservation goals directed at turtles in Arizona.
Conservation and Policy in North America: Oral

Aggressive Management Strategies Essential for the Geometric Tortoise (*Psammobates geometricus*) and its Fynbos Habitat

James O. Juvik[1] and A. Ross Kiester[1]
[1]Turtle Conservancy, PO Box 1289, Ojai, California 93024 USA
[jim@turtleconservancy.org]

The South African Tortoise Conservation Trust manages an 812 acre Preserve for the Geometric Tortoise and its Fynbos habitat near Cape Town South Africa. The few remaining tortoise populations are trapped in such small habitat fragments and have suffered extirpation or dramatic declines in recent decades. Major anthropogenic threats compel us to manage aggressively to mitigate them: *Fire*: 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. In March 2017 a wildfire ignited by an adjacent highway accident and driven by very strong winds and extreme drought conditions burned more than 40 acres of our reserve killing several dozen adult tortoises. We already have well-established internal Preserve firebreaks and a rapid firefighting response but these are insufficient. We are considering installing a sprinkler system to protect the Preserve along its highway and rail boundaries. Further, we estimate it will take decades for this population loss to recover naturally and this leads us to consider a substantial head-starting program for future population supplementation. *Alien Species*: The Australian Port Jackson Acacia (*Acacia siligna*) is an aggressive, invasive tree capable of completely destroying Fynbos. We have committed to a massive and ongoing eradication and re-invasion suppression program that will have to be a permanent component of the Preserve habitat management. *Subsidized Predators*: Cape Fox, mongoose, Raven and Pied Crow are documented predators on juvenile Geometric Tortoises. Their populations are large due to human subsidies and present a threat to the tortoise population so we are employing tortoise decoys to better assess these threats. Our intention is to implement non-lethal predator avoidance training using these decoys equipped with bitter taste, mild electric shock, or other repellents. *Climate Change*: Climate warming is occurring more rapidly in South Africa than the global average with concurrent shifts in precipitation regimes. Our reserve has suffered unprecedented drought in recent years raising the wildfire risk and reducing Fynbos productivity. We are considering the possibility of supplemental irrigation on the Preserve to maintain historical average rainfall totals and seasonality.
Conservation & Management: Oral

Nesting in Close Quarters: Causes and Benefits of High Density Nesting in Painted Turtles

Steven Kell[1], Ronald Brooks[2], and Jacqueline Litzgus[1]
[1]Department of Biology, Laurentian University, Sudbury, Ontario, Canada
[2]Integrative Biology, Guelph University, Guelph, Ontario, Canada
[skell@laurentian.ca]

Nesting is a costly time for female turtles, both energetically and from threat of predation. Although predation rates of eggs and juveniles are often high, ensuring maximum survival of offspring is crucial for population stability and individual fitness. Therefore, females should try to maximize offspring fitness while also minimizing risk to themselves. Our past observations indicate that female painted turtles at our study site in Algonquin Park are nesting at higher densities than random, suggesting some benefit to themselves and/or their offspring. Our goals are to determine if females are choosing to nest at high densities,

what cues they use to locate nest sites, and what benefits the offspring might accrue from incubating at high nest densities. We will use ArcGIS to perform a spatial analysis on nest locations using data from 2015-2017 to determine if nest density is non-random or a product of abiotic nesting conditions. Why a female may choose a nesting location will be determined based on olfaction and visual cues provided by other females. Artificial nests scented with either turtle urine or water will be randomly distributed across the nesting site, allowing females to potentially choose to nest near or avoid other nests. Turtle models will be placed at the nest site in 3 densities, rotating locations each day to determine if nest site choice and nest density are driven by visual cues. Nests will be caged to prevent predation and spatial analyses conducted using ArcGIS to determine if incubation duration differs based on nearest neighbor distances. Our study will expand the knowledge of turtle reproductive biology and will also help in conservation as this information could be used to make artificial nesting mounds more attractive to female turtles.
Presentation type: Poster (Student)

Road Effects on Painted and Snapping Turtle Population Demographics in Algonquin Provincial Park, Canada

Steven Kell[1], Ron Brooks[2], and Jacqueline Litzgus[1]
[1]Department of Biology, Laurentian University, Sudbury, Ontario, Canada
[2] Integrative Biology, Guelph University, Guelph, Ontario, Canada
[skell@laurentian.ca]

Road mortality is a significant threat to turtle populations and has contributed to potentially deleterious changes in population demography. Road mortality can occur during annual nesting migrations of females, dispersal of juveniles, movements to escape unfavorable habitat conditions or find suitable habitat, or to find mates. We hypothesize that proximity to roads will decrease the health and fitness of turtle populations due to an increase in mortality from vehicle collisions, leading to changes in demography. To test this hypothesis, we are surveying turtle populations in 8 impact sites (wetlands along the major highway corridor) and 8 non-impact sites (wetlands >4 km from roads) in Algonquin Park. Snapping turtles and painted turtles from these wetlands will be captured in spring by canoe and dip net and in late summer by trapping; to compare body sizes and conditions, injury rates, chronic stress through cortisol levels in toe nail clippings, population age structure and sex ratio, and population density between impacted and non-impacted sites. We predict that non-impact sites will contain populations with larger body sizes, fewer injuries and lower stress, older aged individuals, and an equal sex ratio. Age of turtles will be estimated through a novel method using Pentosidine assays. We know that roads cause direct mortality of turtles; our study will quantitatively determine whether roads negatively influence turtle populations in more subtle indirect ways. Our findings can be used to inform future implementation of road mortality mitigation such as barrier fencing, ecopassages, and nest caging on roadways.
Road Ecology: Oral (Student)

Diversity, Distribution, Illegal Trading, and Threats to Freshwater Turtles in Pakistan

Zaheer Khan and Roohi Kanwal
Department of Zoology, University of Karachi, Karachi-75270, Pakistan
[zaheer@scspkarachi.org]

Pakistan has been gifted with a great variety of Biodiversity having eight species of Freshwater Turtles including Spotted Pond turtle (*Geoclemys hamiltonii*), Crowned river turtle (*Hardella thurjii*), Brown roofed turtle (*Pangshura smithii*), Indian roofed turtle (*Pangshura tectum*) , Indian narrow-headed soft-shell turtle (*Chitra indica*), Indian soft-shell turtle (*Nilssonia gangeticus*), Indian peacock soft shell turtle (*Nilssonia hurum*) and Indian flapshell turtle (*Lissemys punctata andersonii*). Population estimation of freshwater turtles was conducted in selected wetlands of Indus River system. Population of *Lissemys punctata* was found as abundant while *Pangshura tecta* and *Geoclemys hamiltonii* were recorded as common. Population of *Nilssonia hurum* was recorded as less common. *Chitra indica* was found as rare. Hunting and Illegal trading were recorded as major threats for their survival for utilization in pharmaceutical, food and pet industries outside Pakistan. Pakistan is a developing country so the threats due to habitat destruction, urbanization, developmental projects, construction of dams, barrages, roads are also effecting their populations. Natural disasters, diseases and Invasive species are also increasing the mortality ratio. About 68% of their illegal trade in Pakistan includes the trade of live specimen while remaining 32% includes the trade of meat, carapace, plastron, calipee, eggs and Hatchlings for different purposes. Over exploitation leads them towards extinction. The

reason behind this research was to summarize the current status of Freshwater Turtles, their trade consequences and to propose a conservation model for their protection.
Presentation type: Oral
Session: General field studies, surveys etc.

How IUCN Red-listing Works:
A New Red List Assessment for the Bolson Tortoise (*Gopherus flavomarginatus*)

A. Ross Kiester[1], Rosalinda Palomo-Ramos[2], Judith Ríos-Arana[2], Anders G. J. Rhodin[1,3], Peter Paul van Dijk[1], and Eric V. Goode[1]
[1]Turtle Conservancy, PO Box 1289, Ojai, California 93024 USA
[2] Department of Chemical and Biological Sciences, Universidad Autónoma de Ciudad Juárez, Avenida Plutarco Elias Calles 1210, Fovissste Chamizal, Ciudad Juarez, Chihuahua 32310 Mexico
[3]Chelonian Research Foundation, 168 Goodrich Street, Lunenburg, Massachusetts 01462 USA
[ross@turtleconservancy.org]

The IUCN Red List is the global standard for the conservation status of all species. The Tortoise and Freshwater Turtle Specialist Group is responsible for supporting the Red List process. Over the years this process has become quite complex as the IUCN has sought to develop criteria and metrics for the listing categories that are more consistent and objective. This process is a classic example of working at the science/policy interface. All available science is used, but frequently those data are not yet of the quality that would qualify for scientific publication. Nonetheless, a decision must be made with whatever information is available. We review the process of preparing an updated Red List assessment for the Bolson Tortoise. Its listing was last updated in 2007 when it was categorized as Vulnerable. We examined four types of data. 1). Revisits to sites censused for presence/absence by David Morafka and colleagues during the 1980s; 2.) Estimates of habitat loss to agriculture and cattle made by over-flights and examination of remote sensing images; 3.) Analysis of structured sample surveys of local people who interact with the tortoise and provide traditional ecological knowledge; and 4.) Calculation of Extent of Occurrence and Area of Occupancy. These data are then combined with our knowledge of the demography of this species with its long-delayed maturity, low reproductive rate and slow recruitment. Synthesizing all available information we conclude that this species qualifies for re-assessment as Critically Endangered. We discuss the IUCN process for additional data input, review and ultimate adoption of this new Red List document.
Plenary Session: Oral

Nest Survivorship and Demographic Trends of Declining North Carolina Bog Turtle Populations

Michael Knoerr[1], Kyle Barrett[1] and Gabrielle Graeter[2]
[1]School of Agriculture, Forest, and Environmental Sciences, Clemson University, Clemson, South Carolina 29634 USA
[2]North Carolina Wildlife Resources Commission 1751 Varsity Drive, Raleigh, North Carolina 27606 USA
[mike.knoerr@gmail.com]

Declines in bog turtle populations have prompted efforts by the North Carolina Wildlife Resources Commission and Project Bog Turtle to conduct annual surveys within North Carolina. These data suggest that many of the surviving populations are small in size, declining, and possibly at risk of extirpation. Previous analysis indicates that some sites have much higher annual survivorship and abundance than others. Several of the smaller populations appear to have little to no recruitment. Low reproductive rates, nest success, and/or juvenile survival may be limiting factors for these populations. Site and landscape-scale characteristics of each wetland may be driving this variability. To better understand drivers of recruitment failure, we chose to investigate the role of meso-carnivores on nest success across these sites. Thus far, we have documented and characterized several dozen bog turtle nests across the region, documented predation events that appear to coincide with demographic trends, and photographed the meso-carnivore responsible for near complete nest failure within one wetland. We are currently monitoring additional nests across several wetlands to see if these patterns continue in 2017. With this dataset, managers will likely have a better understanding of what is contributing to reduced recruitment in these bog turtle populations. This knowledge will play a key role in identifying and prioritizing management initiatives in the near future.
Reproductive Ecology: Oral (Student)

Captive Breeding and Headstarting Increase the Wild Population of the Critically Endangered Western Swamp Turtle *Pseudemydura umbrina* by an Order of Magnitude

Gerald Kuchling
Western Australian Department of Biodiversity Conservation and Attractions, 5 Dundebar Rd, Wanneroo, WA 6065 Australia
[Gerald.Kuchling@dpaw.wa.gov.au]

Three decades ago, in 1987, the wild population of *Pseudemydura umbrina* counted less than 30 individuals, down from over 200 in the mid-1960s despite the creation in 1962 of two nature reserves encompassing all known habitat. With 17 individuals in captivity, only three of which were adult females, the world population was below 50. Captive breeding was on a standstill. This downward trend not only meant that, in the late 1980s, *Pseudemydura umbrina* was the world's most critically endangered Chelonian, but combined with the low reproductive rate of the species (females produce 3-5 eggs per year, low hatchling survival, 8-15 years until maturity is reached) resulting in a slow intrinsic rate of natural population increase, it also meant that active intervention was clearly needed to avert extinction. Policies of the rescue operation which started in 1988 included: to make captive breeding successful; to temporarily take all wild females into captivity; and to headstart hatchlings produced in captivity for 2-4 years to a body mass >100g prior to release into the wild. Since 1994 annual releases into three nature reserves (one reintroduction and two introductions/assisted colonisations) added up to a total of about 600 headstarted juveniles >100g. In addition 86 hatchlings were only headstarted for a few weeks prior to release to a body mass of 10-15g to augment the last tiny self-sustaining population, to compensate for missing hatchlings due to the temporary removal of their mothers from this population. In all release populations survival rates are comparable to estimated natural age-class specific survival rates. In all release populations some turtles reached maturity and started to reproduce. However, the drying climate in south-western Australia meant recruitment in one release population could only be demonstrated once groundwater supplementation into two swamps was stepped up, and in another release population recruitment could only be demonstrated outside the actual nature reserve in a privately owned swamp with more reliable water levels. Headstarting combined with other recovery actions increased the wild population about 10-fold, but partly due to poaching of wild adults over the last decade the adult population still hovers only at about 50.
Headstarting: Oral

3rd Attempt to Artificially Inseminate the last female Yangtze Giant Softshell Turtle *Rafetus swinhoei*

Gerald Kuchling
Chelonia Enterprises, 28 Tokay Lane, The Vines WA 6069 Australia
[Gerald.Kuchling@uwa.edu.au]

Semen collection by electro-ejaculation and artificial insemination of the last pair of *Rafetus swinhoei* in China unfortunately did not produce any fertilized eggs in 2015 and 2016. In preparation for the new attempt on 14 April 2017, the male and the female were separated in mid-October 2016 so that the male would not loose sperm through (due to his damaged penis) unsuccessful mating attempts during winter and early spring. Several changes occurred regarding team members and procedures. Firstly, Thomas Hildebrandt and Susanne Holtze (Department of Reproduction Management of the Leibniz Institute for Zoo & Wildlife Research in Berlin) agreed to team up for the procedure with Paul Calle (WCS), Gerald Kuchling (TSA), veterinarians from the Suzhou Zoo and Changsha Zoo, as well as representatives of WCS-China and the China Zoo Society. State-of- the-art equipment not available during previous attempts included a flexible electro-ejaculation probe, a 3D-ultrasound system and a battery-driven flexible video-chip endoscope with an integrated LED-light source and a working channel – used to position through the cloaca – golden tipped guide wires into the openings of the oviducts. These wires are then used as guides to push insemination catheters into the oviducts. This less invasive and risky method is preferable to the insemination through coelioscopy, which was performed in 2016 primarily because trials with various softshell turtles at Omaha's Henry Doorly Zoo had demonstrated that, with the equipment then available, insemination directly into the oviducts through a cloacal approach was not possible. Due to his heavily damaged penis, semen collection on 14 April 2017 was again challenging and only a small amount of uncontaminated high quality semen could be secured. The female had to be kept anaesthetized for over three hours to insert a catheter into one of the oviducts – confirming the problems with insemination through the cloaca detected during the trials last year – and the female could not remain anesthetized any longer. At the time of abstract submission the female had not yet oviposited, thus the result is unknown. Unfortunately assisted reproductive technology remains our only hope to propagate a new generation of the Giant Yangtze Softshell turtle.
Presentation type: Poster

Small Steps Towards BIG Conservation

Keri Lammering
St. Louis Zoo, One Government Drive, St. Louis, Missouri 63110
[klammering@stlzoo.org]

The St. Louis Box Turtle Project takes a holistic approach to research and outreach for box turtle conservation in the Midwest. The project consists of three core components: 1) scientific research on the ecology and health of urban and rural box turtles, 2) education to connect people to nature, and 3) to create awareness of conservation challenges for box turtle populations. Our multidisciplinary team works to achieve the overarching goal of turtle conservation based on strong field ecological and health science studies and outreach opportunities. Our outreach efforts largely focus on connecting young people to nature. To this end, we work with schools within a five to ten mile radius of our two urban sites: Forest Park, a 1,293-acre city park in the heart of St. Louis and Little Creek Nature Area, a 98-acre natural area owned and operated by the Ferguson-Florissant School District. The proximity creates a strong local connection by highlighting nature within walking distance to students' schools and neighborhoods. We provide two classroom visits and two field visits for students between third and sixth grade. This project provides a strong STEM (multidisciplinary education initiative combining Science, Technology, Engineering, and Math) opportunity by immersing students in the scientific component of the project through radio telemetry of turtles and data collection alongside project researchers. Furthermore, the project involves a strong collaboration with our sister project in the Galápagos Islands, the Galápagos Tortoise Movement Ecology Programme, which uses giant tortoises to connect students in Galápagos to their natural surroundings. In this presentation I will discuss results from the project student/teacher evaluations and what these data reveal on common misconceptions about wildlife. Also, I will present how this information is helping us to strengthen our conservation messaging as we move forward with the project. We will also discuss how the partnership between the St. Louis Box Turtle Project and the Galápagos Tortoise Movement Ecology Programme creates an opportunity to connect students internationally using social media, video messaging, and shared curriculum.
Zoos and Chelonians: Oral

Naturalistic Keeping: Design and Construction of Captive Chelonian Habitat

Chris Leone
Garden State Tortoise, Galloway, New Jersey, USA
theTurtleRoom, P.O. Box 521, Lititz, Pennsylvania 17543 USA
[chrisleone@gardenstatetortoise.com]

Turtle and tortoise species have been maintained under captive conditions for what seems like an eternity to this point in time. Various methods have worked in keeping them healthy and reproducing. While this wide array of techniques has had fluctuating levels of success through the years, I have chosen to follow an approach that is as naturalistic possible. Chelonians have evolved to accept a diverse range of habitat specifications and even though we sometimes group many of them into categories such as "pond turtles", "grassland tortoises", or "tropical species" to name a few, we often forget that even within these groupings, the animals have preferences that set them apart.
The exploration of a species' natural habitat can go a long way in learning so much about what these creatures experience on a daily basis and the duration of their annual cycle. I have found it extremely beneficial to mimic wild spaces in every manner possible. Offering appropriate substrates, plant life, aquatic areas, and enclosure placement can all make a significant difference in keeping them comfortable. Stress is quite possibly the most common killer in chelonian keeping, so taking note of how and where they seek refuge in nature can save the lives of countless individuals. The construction of naturalistic, well-though-out environments can also be rewarding for the keeper and a beautiful expanse can be creating in any yard. In this film I discuss numerous particulars in fabricating a wonderfully designed naturalistic habitat for several species in captivity. It is my hope that what I have learned from providing my animals with these types of settings will aid others in having much success all while keeping their animals safe, content and productive. After all, if they must be in captivity, it is only right that we make them feel "at home".
Captive Husbandry: Oral

Phylogeny of the Enigmatic Eocene Testudinoid Turtle *Echmatemys* and the North American Origin of the Testudinidae

Asher J. Lichtig and Spencer G. Lucas
New Mexico Museum of Natural History, 1801 Mountain Rd. NW, Albuquerque, New Mexico 87124 USA
[ajlichtig@gmail.com]

Turtles of the genus *Echmatemys* have long been ignored in phylogenetic analysis, so we analyze the phylogenetic placement of seven species of these turtles. We find that the genus is diphyletic. The species from the lower Eocene San Jose Formation in the San Juan Basin, New Mexico, are stem Testudinidae rather than geoemydids, as previously hypothesized. Furthermore, *Hadrianus majusculus* is the most primitive tortoise known, lacking common, more derived tortoise traits such as costal wedging. Given this primitive state in North American tortoises, we suggest that Testudinidae (tortoises) originated in southern North America from one of the geoemydid-like forms lumped in the genus *Echmatemys*, which first appeared during the earliest Wasatchian. This is contrary to the conventional wisdom that tortoises originated in Asia, where their most basal genus *Manaouria* (based on genetic studies) lives today. We suggest an alternative interpretation, that tortoises arose in North America and subsequently emigrated to Asia and Europe during the second thermal maximum in the later part of the Wasatchian land-mammal "age." This warm period slightly preceded the deposition of the Bridgerian-equivalent units that yield the oldest tortoises in Europe and Asia. From Europe, immigration to Africa and from Africa to South America would follow in the Oligocene and later. Reports of unpublished Paleocene material in Asia may indicate that tortoises originated in Asia and then, together with some members of their stem lineage, immigrated to North America and then onward to Europe. This explains members of its stem-lineage co-occurring with tortoises in the San Jose Formation. In short, our understanding of tortoise origins is still limited but is improving as older material is being reanalyzed in the light of more recent discoveries.
Tortoises: Oral

Triassic Turtle Tracks Provide New Age Constraints on the Origin of Turtles

Asher J. Lichtig[1], Spencer G. Lucas[1], Hendrik Klein[2] and David Lovelace[3]
[1]New Mexico Museum of Natural History, 1801 Mountain Rd. NW, Albuquerque, New Mexico, 87124 USA
[2]Saurierwelt Paläontologisches Museum, Alte Richt 7, D-92318 Neumarkt, Germany
[3]University of Wisconsin-Madison, Department of Geoscience, Madison, Wisconsin 53706 USA
[ajlichtig@gmail.com]

Turtle tracks, ichnogenus *Chelonipus*, have been documented from the Early Triassic (Spathian) of Wyoming and Utah as well as the lower Middle Triassic (Anisian) of Germany, and are the oldest fossil evidence of turtles. The numerical age of the early Anisian type material of *Chelonipus* from Germany is about 245-247 Ma, and the Spathian *Chelonipus* tracks from Wyoming and Utah are between 247 and 249 Ma. In contrast, the oldest undisputed body fossils of turtles (*Odontochelys* from China) are of Late Triassic (early Carnian) age, and thus no older than 233-237 Ma. Thus, the oldest turtle tracks predate the oldest turtle body fossils by about 10 million years. Triassic turtle tracks assigned to *Chelonipus* have a pace angulation of 63°, which is similar to that of the extant turtle *Rhinoclemmys pulcherima.* In *Chelonipus*, the ratio of the stride to internal trackway width is approximately 1.25, which is between that of the terrestrial *Testudo marginata* (1.05) and semi-aquatic *Chrysemys picta* (1.39). We conclude that the trackmaker of *Chelonipus* was likely at least semi-terrestrial, spending a significant portion of its time moving on land, but entering water. This fits with a *Chelonipus* trackway from the Lower Triassic of Wyoming in which there is an apparent trend toward more buoyant locomotion as the trackway progresses. Triassic *Chelonipus* tracks do not fit what would be expected to be made by Triassic *Pappochelys* or *Odontochelys*, a supposed prototurtle and an early turtle, respectively. In contrast, these tracks are consistent with what would be expected from the Triassic turtles *Proganochelys* and *Proterochersis*. The features inferred to be present in these tracks support the notion that *Odontochelys* is a derived aquatic branch of the turtle stem lineage. *Pachypes* is an upper Permian footprint ichnogenus that has been inferred to represent a pareiasaurian trackmaker, and is similar to *Chelonipus* in several ways. *Chelonipus* occurs in a trackway pattern similar to the dual gait of pareiasaurs, with sprawling forelimbs with limited wrist motion. These revelations highlight the need to consider all available evidence regarding turtle origins.
Presentation type: Poster

Conservation of the Endemic Chelonians of Sulawesi: Forsten's Tortoise and Sulawesi Forest Turtle

Christine Light and Andrea Currylow
ACEcological Research & Consulting
[scubagirl2001@hotmail.com, a.currylow@gmail.com]

As part of the Wallacea Biodiversity Hotspot, Sulawesi, Indonesia, is home to many species found nowhere else in the world, like the babirusa, anoa, crested black macaque, and maleo. While there has been a significant push toward protecting some of these species over the last few years, there is no conservation efforts for Sulawesi's chelonians. For the two endemics in that region, the Forsten's Tortoise (*Indotestudo* forstenii) and the Sulawesi Forest Turtle (*Leucocephalon yuwonoi*), population status and distribution are unknown and estimates are based primarily on anecdotal information. Combined with severe deforestation, with over 80% of the island's forest degraded, and the pressure of unsustainable collection for the pet and bushmeat trades, time is running out, not only for these two species, but for this amazing island and all its inhabitants. We are beginning a long-term conservation collaboration starting with building working relationships with in-country partners and conducting turtle surveys to inform current status and distribution of these species. During the upcoming surveys, we plan to initiate long-term monitoring sites to be run jointly by project investigators, Indonesian university students, and local residents. Through citizen science and capacity building, we will train and empower these university students and local residents to spearhead the monitoring program. We hope that this program will produce invested "Species Stewards" comprising community members, as well as training the next generation of conservation scientists within Sulawesi. We also aim to widely publicize the collaboration and to publish results of associated studies. The associated conservation research initiatives will not only guide conservation efforts but also to promote community awareness and establish educational programs in these ecologically-important areas. Our findings will be used to guide effective *ex situ* and *in situ* conservation efforts through sound science. Through this work, we also hope to identify land areas for protection, preserving unique biodiversity of the region as well as the ecological requirements for these endangered chelonians.
Conservation & Management: Oral

Fifteen Years of Head-starting Alligator Snapping Turtles

Day B. Ligon[1], Denise M. Thompson[2], Kay Backues[3], Brian M. Fillmore[4], and Kerry Graves[4]
[1]*Department of Biology, Missouri State University, Springfield, Missouri 65897 USA*
[2]*Department of Integrative Biology, Oklahoma State University, Stillwater, Oklahoma 74078 USA*
[3]*Animal Health Department, The Tulsa Zoo, Tulsa, Oklahoma 74115 USA*
[4]*Tishomingo National Fish Hatchery, Tishomingo, Oklahoma 73460 USA*
[*DayLigon@missouristate.edu*]

In response to documented population declines of alligator snapping turtles (*Macrochelys temminckii*) in Oklahoma, the U.S. Fish and Wildlife Service established a head-start program for the species in 1999. It was—and continues to be—the only turtle propagation program in the federal hatchery system. The first brood stock was collected from the most robust population known to occur in the state, and consisted of 17 adults (5 males and 12 females). Subsequently, additional brood stock has been added to the program, both to increase production and genetic diversity. First reproduction occurred in 2002 when a single clutch was laid, but the rate at which nesting occurred increased in subsequent years. Today, most females nest annually. Reintroductions began in 2006, and to date 1,730 animals ranging 2–6 years old have been reintroduced at 6 sites in the Mississippi River drainage. Analyses of mitochondrial and nuclear genetic markers have been used to determine both the compatibility of brood stock and the geographic range over which reintroductions are appropriate. Critical to the head-start program has been the capacity for expansion of breeding and rearing facilities as production has increased, long-term institutional support for a non-traditional hatchery conservation effort, and close collaboration with wildlife veterinary professionals. Importantly, this head-start program has prioritized research, both to increase knowledge of the species' natural history and to provide data that improve the odds of success of the head-start and reintroduction efforts.
Headstarting: Oral

Research of Beal's Eyed Turtle (*Sacalia bealei)* in field and captivity, China

Liu Lin, Qingru Hu, Lijin Hu, Yingnan Lu, Han Yang, Fanrong Xiao, Haitao Shi
College of Life Sciences, Hainan Normal University, Haikou 571158, China
[haitao-shi@263.net]

The Beal's eyed turtle (*Sacalia bealei*) is a species endemic to China and has been listed as endangered by IUCN. In this paper, we studied the ecological characteristics of *S. bealei* both in field and captivity. Field research was conducted at Huboliao National Nature of Fujian, China. Methods such as radio-telemetry, plots survey, loop tracking and direct observation were applied to study the habitat selection, home range and reproduction behaviors of wild S.bealei. Habitat selection showed that S.bealei mostly inhabited primary tributaries of steams and had preference to sites with longer distance to human disturbance, medium elevation, mild slope, medium water depth, high canopy density, high percentage of exposed stones and so on. The linear home range of *S. bealei* was 184.89±25.98 m, the home range was 6256.91±1426.56 m^2 and the core home range was 892.01±205.86 m^2. Thirteen eggs were found in six nests, and the clutch size was 2.2 eggs. Eggs were about 45.5 mm long, 23.2 mm wide, and weighted 14.8 g. The incubation period was 85–108 d, with an average of 94.7 d; the incubation temperature was 17.51–29.64°C, with an average of 25.08 °C. In captivity, we studied the behaviors of *S.bealei* used digital surveillance system. Ethogram of *S.bealei* were set up with 9 major categories of 68 kinds of behavior. Activities of *S.bealei* in captivity showed diurnal-bimodal rhythm, with two peaks of 5: 00–9: 00 and 16: 00–19: 00. Seasonal difference showed that their maximum intensity of activity was in summer and winter, with 18.67±2.00 min/per hour in winter and 13.47±2.77 min/per hour in summer. The temperature and activity intensity showed a certain correlation (r = 0.501, P= 0.008). Egg laying in captivity of *S.bealei* were found in May and June, similar to that in field. We thank the support of National Natural Science Foundation of China (31372228), Hainan College Scientific Research Project (Hnky 2015-26) and Undergraduate Training Programs for Innovation and Entrepreneurship Project (ID 201611658037 and ID cxcyxj2015035).
Reproductive Ecology: Oral

Do *Graptemys pearlensis* and *Graptemys gibbonsi* Make the List? Status of the Western Megacephalic Map Turtles and Their Prospects for Federal Protection Under the U.S. Endangered Species Act

Peter V. Lindeman
Department of Biology and Health Services, Edinboro University of Pennsylvania, 230 Scotland Rd., Edinboro, Pennsylvania 16444 USA
[plindeman@edinboro.edu]

The Pascagoula map turtle (*Graptemys gibbonsi*) and Pearl map turtle (*Graptemys pearlensis*) were first separated from the Alabama map turtle (*Graptemys pulchra*) in 1992, under the former name, and subsequently recognized as two separate species in 2010. The possibility that they should be listed under the Endangered Species Act was recognized just a few years after their separation from *G. pulchra*, because basking surveys showed that at most sites on these river systems, they were considerably less abundant than two sympatric congeners listed as Threatened: the Pascagoula drainage's yellow-blotched sawback (*Graptemys flavimaculata*, listed since 1991) and the Pearl drainage's ringed sawback (*Graptemys oculifera*, listed since 1986). Scant historical data also indicated that the sympatric species pairs may once have been more similar in abundance. Now, more than two decades later, *G. gibbonsi* and *G. pearlensis* are being considered for listing by the U.S. Fish and Wildlife Service. From 2015–2017, I surveyed basking turtles at bridge crossings and in boat and canoe surveys and conducted trapping at several sites to ascertain the status of the two candidate species. Despite their similarity morphologically and in their basic ecology, there are two important differences that are pertinent to the question of whether or not they should be federally listed. First, their river systems are geomorphically very different. Medium to large tributary streams, which are inhabited by these species and may serve as buffers against some of the threats to them, are a considerably more prominent feature of the Pascagoula drainage than the Pearl drainage. Second, the reasons for the listing of each species' sympatric sawback congener are very different: the ringed sawback was listed primarily due to existing as well as imminent but as-yet unrealized threats involving habitat modification, while the yellow-blotched sawback was listed primarily due to perceived low populations, particularly in upper portions of the drainage, and concerns regarding water quality. The question of whether or not to list the two candidate species may therefore not have a single answer for both species.
Conservation & Management: Oral

Tiny Tortoises: Captive Care and Breeding of the Parrot-Beaked Tortoise (*Homopus areolatus*)

James Liu
Turtle Conservancy, 49 Bleecker St. Suite 601, New York City, New York 10012 USA
[james@turtleconservancy.org]

In 2006, the Turtle Conservancy began working with a pair of Parrot-Beaked Tortoises (*Homopus areolatus*) with the idea they would flourish in the Mediterranean climate of California, similar to their native range of South Africa. In order to accomplish this, staff created a small cold frame enclosure that successfully recreates their fynbos habitat, complete with misting system, artificial wind, and extensive digital monitoring equipment. In the past six years, the TC has had consecutive years of breeding and obtained eggs from this pair with successful hatchings. The female lays 1-2 eggs outdoors, which have been successfully incubated both in the ground and an artificial incubator, in various substrates. Hatchling are successfully reared in neighboring cold frame enclosures, in a similar fashion to our other South African species. Diet is composed of locally sourced produce for human consumption, as well as natural forage of sedums, flowers, and succulents. The goal of this project is to contribute to the growing body of literature on this seldom kept species and help develop a future viable, sustainable North American captive population for this species. We hope our understanding of the Parrot-beaked Tortoise and the Angulated Tortoise in captivity will help us better understand the land and animals on our preserve in South Africa, so that we can adapt our in situ conservation techniques for these species, as well as the Critically Endangered Geometric Tortoise.
Captive Husbandry: Oral

Turtle Marketing 101: Making Turtles the New Panda

James Liu
Turtle Conservancy, 49 Bleecker St. Suite 601, New York City, New York 10012 USA
[james@turtleconservancy.org]

Turtles have long had a marketing issue - While not as loathsome as snake or spiders, they have always failed to garnish the media attention that whales, elephants, great apes or pandas have. As a result, fundraising for freshwater and turtle conservation has proved difficult, despite the fact they are the most endangered vertebrate group on the planet. Rethinking the "brand" of freshwater turtles and tortoises is imperative to changing the status quo and making turtles a household name in conservation. The TC would like to showcase a marketing strategy to make turtles "the new panda." Strategies for social media, news, TV, publications and advertising are all important topics of discussion for everyone involved in chelonian conservation, not just communications team members. The TC uses social media, news outlets, billboards and notable personalities to help promote a greater appreciation for turtles and tortoises. These take from other modern conservation PR models, including pangolins, bats, and sharks, all of which have been unknown to the general public and fall into the category of less charismatic.
Community Outreach and Partnerships: Oral

The Southwestern Pond Turtle (*Actinemys pallida*) in the Mojave River of California: Past, Present and Future

Jeffrey E. Lovich[1], Robert Fisher[2], Shellie R. Puffer[1], Kristy Cummings[1], Sarah Greely[3] and Morgan Ford[1]
[1]U.S. Geological Survey, Southwest Biological Science Center, 2255 North Gemini Drive, MS-9394, Flagstaff, Arizona 86005, USA
[2]U.S. Geological Survey, Western Ecological Research Center, 4165 Spruance Road Suite 200, San Diego, California 92101, USA
[3]Living Desert Zoo and Gardens, 47900 Portola Ave, Palm Desert, California 92260, USA
[jeffrey_lovich@usgs.gov]

Two species of the turtle genus *Actinemys* currently range along the Pacific versant of the United States with relict populations in interior drainages of the Great Basin and Mojave deserts, as well as scattered oases in Baja California, Mexico. The genus was more widely distributed from the Miocene to the Pleistocene as shown by the fossil record. Fossil evidence from California suggests that the southwestern pond turtle (*Actinemys pallida*) made it as far into the Mojave Desert as the Salt Creek region near Death Valley during the pluvial period. As the interior of North America transitioned to a warmer, drier climate about 10,000 years ago, the turtle's range contracted toward the coast, isolating the Mojave River population. Uplift of the San Bernardino Mountains in southern California occurred within the last 2-3 million years further isolating Mojave

River turtles from coastal populations to the south. Genetic affinities of turtles in the lower reaches of the river at Afton Canyon are unknown, but evidence suggests that turtles at the Camp Cady Wildlife Area may have been augmented from coastal southern California populations. Published literature suggests that turtles were "not rare" in ponds along the intermittent, endorheic Mojave River in the early 1900s. Museum specimens (n=7) were collected from various localities along the river from 1937–1987. Ecological research on the lower Mojave River occurred in 1998 and 1999 documenting only 35 turtles with an estimated population size of less than 50 adults. Data on body size distribution, sex ratio, clutch size, egg size, nesting season, and nesting migrations differed little from data for populations elsewhere in the range of the species and the congener *A. marmorata*. Sporadic sightings of turtles document their continued presence along the lower Mojave River until 2014 at Camp Cady, after which they appear to have been extirpated for unknown reasons. Several photo-documented sightings occurred in Afton Canyon through 2017, but the population is much smaller than what was documented in the 1990s. Threats to the continued survival of the Afton Canyon population include floods, drought, and off-highway vehicle activity through the ponds and wetlands that support turtles.
Geographic Variables: Oral

Population Ecology and Movements of two *Kinosternon* Species from Mexico

RODRIGO MACIP-RIOS[1], IVETTE ENRÍQUEZ MERCADO[2], ÁNGELES APARICIO MARTÍNEZ[2], AND ALEJANDRO MONTIEL UGALDE[1]
[1]Escuela Nacional de Estudios Superiores, UNAM, Morelia, México
[2]Facultad de Ciencias Biológicas, Benemérita Universidad Autónoma de Puebla, Puebla, México
[rmacip@enesmorelia.unam.mx]

Mexico host the largest diversity of kinosternid turtles, however, the ecological and behavioral data available for these turtles are poor known. Very few studies have been made on the population ecology of Mexican turtles, an even fewer are the studies about measuring behavioral traits such moment patterns and home range. We compared basic population ecology and movement patterns in two species of *Kinosternon* (*K. hirtipes* and *K. integrum*) from two localities in Michoacán state. A capture-mark-recapture protocol was performed during an activity season to determine population parameters. Six *K. hirtipes* and six *K. integrum* females were equipped with radios and tracked every two weeks from June to December to determine their movements during activity season and during the aestivation period. Population size (171; C.I. = 117-282) of *K. hirtipes* was larger than *K. integrum* (16, C.I.=16-16). *K. hirtipes* population was mainly composed by adults between 80-130 mm in plastron length, but larger individuals and hatchlings was observed; sex ratio was significantly male biased (2:1; $X^2 = 5.22$, $p = 0.02$). The *K. integrum* population was structured mainly by adult females, but sex ration was not significant (1:1.8; $X^2 = 1.142$, $p = 0.2585$). The *K. integrum* population data represents the closest record of the species to the Patzcuaro Lake and seems to be colonizing the basin. The average home range of *K. hirtipes* was 4.4 hectares (± 7.04), and was directly associated to a permanent slow moving water system; turtles tend to move along the water and two individuals swap the body of water to another stream uphill, to return later in the season. On the other hand, the home range of the *K. integrum* was associated with a seasonal water tank for cattle and showed a smaller average homer range (0.60 ± 0.89 hectares). Turtles in this population move around water tanks and trough an ephemeral stream that flows downhill to the Patzcuaro Lake. *K. hirtipes* aestivates inside shallow water or in the muddy bank of their aquatic habitat, meanwhile K. integrum aestivates on diverse land microhabitats.
Ecology/Field Studies: Oral

Clean Water and River Health Education Using Freshwater Turtles: A Charismatic Approach

Simone Madsen[1], Robert Altonen[1], Thomas P. Wilson[2], Team Salamander[2]
[1] Southeast Tennessee RC&D, 450 Stuart Rd. NE Cleveland, Tennessee 37312 USA
[2] Department of Biology, Geology and Environmental Science, 615 McCallie Ave., The University of Tennessee at Chattanooga, Chattanooga, Tennessee 37403 USA
[smads.setnrcd@gmail.com]

Educating the public about clean water and conservation issues is vital to the health and safety of communities. However, outside of professional circles, the traditional means to illustrate the health of a river (or relative lack thereof) are not easily translated to the general public. Through analysis of existing literature and use of storytelling, this presentation considers the role that freshwater turtles can play in translating the water quality and stream health data of a river into a narrative based on

the turtle's life history. Because freshwater turtles have long life-spans, varied diet, and exhibit site fidelity, they can act as bioindicators for the general health of the streams in which they inhabit. Coupled with the historical and mythological significance of the turtle in human culture, freshwater turtles can become the charismatic symbol of clean water education and river conservation.
Freshwater Turtles of the SE: Oral

Investigations into the Captive Management and Reproductive Biology of the Central American River Turtle (*Dermatemys mawii)*, at the Hicatee Conservation and Research Center, Belize, C.A.

Jacob A. Marlin and Thomas Pop
Belize Foundation for Research and Environmental Education (BFREE), Mile 58, Southern Hwy, BFREE Reserve, Toledo District, Belize Central America
[jmarlin@bfreebz.org]

The Central American River Turtle, (Dermatemys mawii), known locally in Belize as the Hicatee has undergone massive declines throughout its limited range of southern Mexico, northern Guatemala, and Belize due to extensive harvesting for its meat. It is the only critically endangered vertebrate in Belize. As the lone surviving member of the family Dermatemydidae, it represents a unique evolutionary lineage and intensive conservation measures are needed to restore depleted wild populations and prevent the species from extinction. Captive management has been recommended but Hicatee have historically proven difficult to reliably reproduce in captivity due to their secretive and unusual aquatic nesting habits and the fact that eggs undergo embryonic diapause and delayed development. In order to address these challenges in a controlled setting, the Turtle Survival Alliance in partnership with the Belize Foundation for Research and Environmental Education (BFREE) completed construction on the the Hicatee Conservation and Research Center at BFREE in 2013. Breeding ponds were designed and constructed to permit the manipulation of numerous environmental variables that help determine cues for egg-laying, and ascertain some of the mysteries of Hicatee reproduction such as nest site selection, breaking egg diapause, and egg incubation. Since 2014, adult turtles (45) have been aquired from confiscations, rehabs, and wild stock. Succesful nesting has taken place each year, with a total of 127 eggs deposited to date, reflecting 12 nests, with high rates of hatching. Cative husbandry protocals have been put into place, including pond design, water management, nesting habitat, diet and feeding, and rearing of juveniles. Information gathered to date includes: nesting site preferences, clutch sizes, egg incubation, diet preferences, growth rates of juveniles including onset of sexual maturity, and best management practices for reliably breeding the species in a captive environment.
Captive Husbandry: Oral

Southern Accents: Status and Spatial Ecology of the Spotted Turtle (*Clemmys guttata*) in Florida

Jonathan Mays
Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Rd., Gainesville, Florida, 32601 USA
[jonathan.mays@myfwc.com]

The spotted turtle (*Clemmys guttata*) is a Species of Greatest Conservation Need in Florida, where it reaches the southern periphery of its range. A 2015 report by the Endangered Species Coalition listed the spotted turtle among 10 U.S. species most threatened by habitat fragmentation, and in 2013 this species was petitioned for federal listing under the U.S. Endangered Species Act. Spotted turtles have been documented from 15 counties in Florida, with most records limited to single specimens found on roads between March—May. Little information exists on the habitat, abundance, distribution, and ecology of spotted turtles in the Southeast, with no previous studies for the species in Florida. Since 2013, we've used radio telemetry and mark-recapture techniques to gather information on home range, movement, habitat, seasonal phenology, and population dynamics for spotted turtles in North Florida. Adult home ranges are small (mean = 1.4 ha), with turtles making small movements but staying active year round. Shallow water and abundance of downed woody debris within lentic wetlands are the most reliable habitat characteristics for predicting spotted turtle presence. Population size at occupied sites is small, with populations being both scattered and isolated across the landscape. Results from this study will provide biological information necessary for the long-term conservation and proper management of this rare and secretive species.
Conservation and Policy in North America: Oral

An Island of Misfit Tortoises: Using Waif Animals to Recover Populations on the Brink

Rebecca McKee[1,2], Kurt Buhlmann[1], Will Dillman[3], Barry Kesler[3] , Tracey Tuberville[1]
[1]University of Georgia's Savannah River Ecology Lab, PO Drawer E, Aiken, South Carolina 29802
[2]Daniel B. Warnell School of Forestry and Natural Resources, 180 E. Green Street, Athens, Georgia 30602
[3]South Carolina Department of Natural Resources, 1000 Assembly Street, Columbia, South Carolina 29201
[Rebecca.McKee25@uga.edu]

Due to many anthropogenic threats, the gopher tortoise (*Gopherus polyphemus*) is declining throughout its range. Although practices such as headstarting and habitat restoration play an important role in the species' conservation, these practices alone may not be sufficient to recover populations that have experienced a severe decline. As a result, translocation—the movement of animals from one location to another—has become a valuable conservation tool. While there are risks associated with any translocation, waif tortoises—animals that have been collected illegally, been injured, or have unknown origins—are generally excluded from translocations due to heightened concerns of introducing disease or altering the genetics of the recipient population. If these risks could be managed, waif tortoises could provide the needed numbers and genetic diversity to stabilize populations and prevent extirpations. In the early 1990s, a small population of gopher tortoises (n=<10) was discovered near Aiken, South Carolina. This discovery expanded the known range of gopher tortoises by 80 kilometers and resulted in the creation of the Aiken Gopher Tortoise Heritage Preserve (AGTHP). Due to the preserve's dire need for augmentation, the lack of suitable donor populations in South Carolina, and the site's isolation from other tortoise populations, the AGTHP provided the rare opportunity to study the effect of waif tortoise translocation without jeopardizing a viable population. Since 2006, over 280 waifs have been introduced to the preserve. Now that eleven years have passed since the original tortoises were released, our study will assess the post-release survivorship and site fidelity of the translocated waif tortoises, document evidence of reproductive success by surveying for nests and successfully recruited juvenile tortoises, genotype all tortoises to better understand reproductive and social integration of waif tortoise populations, and measure the overall health of the population by conducting health assessments and testing for common pathogens. Here we present a summary of the 2017 summer field season efforts and preliminary results.
Presentation type: Poster (Student)

Microbiomes of the Krefft's River Turtle (*Emydura macquarii krefftii*)

Donald T. McKnight, Deborah S. Bower, Ross A. Alford, Kyall Zenger, and Roger Huerlimann
College of Science and Engineering, James Cook University, Townsville, Australia
[donald.mcknight@my.jcu.edu.au]

Microbiomes have important ecological interactions with their host species, and it is increasingly becoming clear that they also have an important role in conservation and management efforts. Nevertheless, some taxa remain poorly studied, including turtles. Therefore, we conducted a pilot study to examine the microbiomes of Krefft's river turtles (*Emydura macquarii krefftii*). We compared microbiomes from their buccal cavities, the tops of their heads, portions of the shells with algae, and portions of the shells without algae. We identified a total of 771 operational taxonomic units (OTUs) representing 205 genera and 144 families. The OTUs present on each area of the turtles were generally similar, with 441 OTUs (151 genera; 115 families) found in all four areas. However, the buccal cavity had significantly lower taxonomic richness than the other areas, and 180 OTUs (22 genera; 13 families) were found everywhere except the buccal cavity. Similarly, taxonomic evenness was high and similar among the head (0.78), algae (0.78), and shell samples (0.75), but significantly lower for the buccal cavity (0.61). Finally, the most abundant families differed among the areas of the turtles. The three most common families for each area where as follows: buccal cavity = Flavobacteriaceae (30%), Comamonadaceae (15%), Neisseriaceae (9%); head = Comamonadaceae (10%), Deinococcaceae (7%), Kineosporiaceae (6%); algae = Methylococcaceae (10%), Saprospiraceae (9%), unidentified Cyanobacteria family (8%); shell = unidentified Cyanobacteria family (20%), Deinococcaceae (9%), Blastocatellaceae (7%). These results show that the turtles' exterior microbiomes are similar in composition, but the relative abundance of those taxa differ among the areas. Similarly, the buccal cavity microbiome consists of a subset of the taxa that are present externally, and those taxa are differentially abundant. This study is one of the first to examine the microbiomes of freshwater turtles, and we hope that it will guide future research on this topic.
Ecology/Field Studies: Oral (Student)

Estivation Site Selection of Western Chicken Turtles *(Deirochelys reticularia miaria)*

Donald T. McKnight[1] and Day B. Ligon[2]
[1]*College of Science and Engineering, James Cook University, Townsville, AU*
[2]*Department of Biology, Missouri State University, Springfield, Missouri, USA*
[donald.mcknight@my.jcu.edu.au]

Western chicken turtles (*Deirochelys reticularia miaria*) spend most of the year estivating on land, but little is known about their choice of estivation locations, and understanding their terrestrial requirements is important for conservation efforts. Therefore, we used radio telemetry to monitor nine males and four females and examine their estivation locations. Six of those males and two of those were followed for two years, and two of those males and one of those females were followed for three years. We examined site fidelity and compared the habitat features of their estivation locations to the habitat available in the area. We found that all males exhibited greater site fidelity than females. We also found that *D. r. miaria* selected sites that contained small mammal burrows, leaf litter, and less than 25% vegetative ground cover. Because this species relies on these estivation sites, protecting them is an important part of conservation efforts, and this study will help to guide those efforts.
Presentation type: Poster (Student)

Salinity Tolerance and Osmoregulation in Red-eared Slider (Trachemys scripta elegans)

Hong Meiling, Zhang Ke, Jiang Aiping, Li Jiangyue, Li Na, and Shi Haitao
College of life science, Hainan Normal University, Haikou, Hainan, R.P. China, 571158
[Meilinghong_ecnu@aliyun.com]

The red-eared slider (*Trachemys scripta elegans*), identified as one of the 100 most dangerous invasive species in the world, is a freshwater turtle originally from the eastern United States and northeastern Mexico. Our field investigation has shown that *T. s. elegans* can survive and breed successfully in saline habitats. In order to understand the salinity tolerance and osmoregulation of exotic *T. s. scripta* in different saline water, the chronic salinity stress of four groups (salinity 5, 15, 25‰ and control group) and acute salinity stress of four groups (salinity 5, 10, 15‰ and control group) were conducted respectively. The results showed that: (1) In chronic salinity stress, the blood osmotic pressure increased with ambient salinity increased, that in the group of salinity 25 would reach 400 mOsm/kg, was about 1.5-fold of that in the control group. When the ambient salinity was lower than 15‰, *T. s. elegans* could increase blood osmotic pressure by balancing the entry of NaCl with the secretion of aldosterone decreased, and by accumulating blood urea for osmoregulation effectors, and survive for at least three months. (2) In acute salinity stress, total free amino acid contents in the muscle in the salinity groups are significantly higher than the control group at 24 h- and 96 h- stress. Serine, alanine, arginine, proline, tyrosine, isoleucine, phenylalanine, lysine, aspartic acid and histidine response to salinity significantly through the analysis of the main effect. *T. s. elegans* can produce free amino acid into the blood in order to maintain osmotic balance through the metabolism of amino acids in the muscle and decomposition of soluble protein in the blood and liver. These results could provide theoretical basis for salinity tolerance of *T. s. scripta* and provides the basis of the invasion on physiology mechanism for T. s. scripta.
Presentation type: Poster

Sex Determining Morphometric Trait Analysis in Diamondback Terrapins

Chelsea Miles, Jay Y. S. Hodgson, and Kathryn S. Craven*
Armstrong State University, Savannah, Georgia 31419 USA
[Kathryn.craven@armstrong.edu]

Morphometric traits were studied in hatchling diamondback terrapins (*Malaclemys terrapin centrata)* to determine if they could be used as a tool to predict sex within the first year of growth. The Terrapin Educational Research Program of Savannah (TERPS) incubated rescued eggs in incubators set at male (25 C) and female (31 C) temperatures. Hatchlings were kept in 4 identical laboratory habitats at Armstrong State University and raised for 8 months. Measurements were taken weekly from all 19 individuals (10 females, 9 males). A total of twelve different measurements were taken, including those specific to the shell, head and tail. Principal component analysis (PCA) was used to evaluate divergence of male and female groups. Within the first year of growth, some individual traits, including cloacal distance and head width became predictive of male and female status. The PCA showed that by the end of the study, the traits as a group begin to predict sex.
Presentation type: Poster

A Cupulatta, France: a unique European Parc for Tortoises and Freshwater Turtles

Pierre Moisson
A Cupulatta, Vero, 20133 Ucciani France
[pierremoisson@orange.fr]

A Cupulatta (tortoise in Corsican language) is a private park opened to the public since 1998. It is home of 160 species of tortoises and freshwater turtles, with more than 3000 individuals. The geographical location of the Parc in the island of Corsica (France) is very favorable to all the world turtle exhibits. Since 2010, a new team with a veterinarian and a head keeper came to the Parc in order to maximize breeding and husbandry of different endangered species such as **Manouria impressa**, **Cuora trifasciata** and **Cuora mccordi**. Many data on breeding and husbandry are now regularly recorded (eggs measurements, fertility and fecundity of females, seasonality of breeding, clutches husbandry etc.). Corsica is also home of two wild turtle species: **Emys orbicularis** and **Testudo hermanni hermanni.** In collaboration with the Natural Spaces Conservatory (France), A Cupulatta is collaborating on the conservation of these endangered species. The center is also helping with the conservation and health assessment of wild **Caretta caretta** injured in the sea and brought to the Parc for a first diagnosis, treatments and release. Many students are also coming to the Parc for their undergraduate projects or their MSc thesis. The Parc is also collaborating with US researchers (University of South Alabama) who have been coming to the park to carry out sampling for genetics and thermal ecology projects. In addition to the exchanges with European structures, exchanges with US facilities would be an excellent opportunity for breeding and genetic management of captive species.

Zoos and Chelonians: Oral

Sex, Shells, and Weaponry: Alternative Reproductive Tactics in the Midland Painted Turtle, *Chrysemys picta marginata*

Patrick D. Moldowan[1,2], Ronald J. Brooks[3], and Jacqueline D. Litzgus[1]
[1]*Department of Biology, Laurentian University, 935 Ramsey Lake Road, Sudbury, Ontario, Canada, P3E 2C6*
[2]*Current Address: Department of Ecology and Evolutionary Biology, University of Toronto, 25 Willcocks Street, Toronto, Ontario, Canada M5S 3B2*
[3]*Department of Integrative Biology, University of Guelph, Guelph, Ontario, Canada, N1G 2W1*
[pmoldowan1@laurentian.ca]

The mating strategy of the Painted Turtle (*Chrysemys picta*) is recognized as involving an elaborate male foreclaw courtship display (titillation) coupled with female mate choice. Female *C. picta* purportedly choose mates on the basis of courtship display and/or traits that demonstrate male quality. However, long-term study of *C. p. marginata* in Algonquin Provincial Park (Ontario, Canada) demonstrates that males also exhibit an alternative, coercive mating strategy. Males are equipped with sexually size dimorphic tomiodonts, tooth-like cusps of the beak, which cause extensive wounding to the head and neck of females. Our data indicate that male tomiodonts function as sexual weapons to promote mate acquiescence. Using a 24-year dataset we investigated population-level trends in soft tissue wounds inflicted by conspecifics. Adult females experienced consistently more wounding than adult males or juveniles, and larger females had a greater probability of wounding compared to smaller females. Using over 100 hours of video recordings from experimental trials during the spring and late summer breeding periods, the courtship and pre-copulatory behaviors of males, including titillation, chasing, biting, forced submergence of females, and shell clattering, were quantified. Male reproductive tactics shift from courtship to coercion across ontogeny, and male size predicts the occurrence and frequency of coercive behavior. We also report a novel shell clattering behaviour. Our findings show that male *C. p. marginata* use their tomiodonts as sexual weapons for mate coercion, challenging the notion that sexual coercion is unlikely in open-water and free-swimming turtles. Our findings are contrary to the female choice mating system reported for *C. picta* and join a growing body of recent research demonstrating the importance of coercive tactics in the reproduction of male emydid turtles. Continued study of sexual dimorphism and variation in male phenotype is of interest to test sexual selection and mating strategy theories.
Plenary Session: Oral (Student)

Eastern Musk Turtle (*Sternotherus odoratus*) Predation on Invasive Snails, the Red-rimmed Melania *(Melanoides tuberculata)* and the Giant Ramshorn Snail *(Marisa cornuarietis),* in a Texas Spring

Madeleine Morrison[1], Eric C. Munscher[2, 3], Andrew D. Walde[3], Stephen Ross[4], and Brian P. Butterfield[5]
[1] *The University of New England, 11 Hills Beach Road, Biddeford, Maine 04005, USA*
[2] *SWCA Environmental Consultants, 10245 West Little York Road, Houston, Texas 77040, USA*

[3]*Turtle Survival Alliance, North American Freshwater Turtle Research Group, 1989 Colonial Parkway, Fort Worth, Texas 76110, USA*
[4] *Power Engineers, Inc., North Sam Houston Pkwy E #200. Houston, Texas 77060, USA*
[5] *Freed-Hardeman University, 158 East Main Street, Henderson, Tennessee 38340, USA*
[mbmorrison98@gmail.com]

There are many instances of invasive species becoming prevalent in their new ecosystems. Two species of snails, the Red-rimmed Melania (*Melanoides tuberculata*) and the Giant Ramshorn Snail (*Marisa cornuarietis*), have successfully invaded the Comal Springs ecosystem. Herein, we sought to determine the impact of these snails on a population of Eastern Musk Turtles (*Sternotherus odoratus*). Specifically, we wanted to discern what role these invasive snails played in the diet of Eastern Musk Turtles. We collected fecal samples from 50 *S. odoratus* individuals (23 females and 27 males) that were hand caught in Comal Springs. We cataloged all of the identifiable components in the fecal samples for each turtle and specifically searched for shell fragments of both species of invasive snail. Preliminary analysis indicates that *M. tuberculata* shells and shell fragments make up the majority of the fecal samples. Shell fragments from *M. cornuarietis* may also exist in several of the fecal samples. Future studies should explore the effects of these novel prey items on the population of musk turtles. Likewise, the effects of musk turtles on the population dynamics of these invasive snails should be investigated.
Ecology/Field Studies: Oral (Student)

Comparison of Behaviour, Body Condition, and Survivorship among Three Cohorts of Headstarted Wood Turtles (*Glyptemys insculpta*) Post-release

Damien Mullin[1], Rachel White[2], Jory Mullen[2], and Jacqueline Litzgus[1]
[1]*Department of Biology, Laurentian University, Sudbury, ON, P3E 2C6 Canada*
[2]*Huron Stewardship Council, Goderich, ON, N7A 1W2 Canada*
[dx_mullinsemeniuk@laurentian.ca]

Headstarting has been used for population augmentation of several turtle species across the globe, but there are still unanswered questions about the success of the practice. By definition, headstarted turtles have a larger body size compared to non-headstarted wild turtles, and larger body size should increase survivorship of headstarted turtles (i.e. "bigger is better" hypothesis). A population of endangered Wood Turtles (*Glyptemys insculpta*) was studied beginning in 1988, and by the late 1990s, a suspected poaching event resulted in the removal of approximately 70% of the population. A population viability analysis determined that extirpation was inevitable if no intervention was undertaken and so a headstarting project was initiated in 2003, with the first release of headstarted turtles in 2005. Our goal was to quantitatively test the assumption of "bigger is better" by comparing growth rates and survivorship of three groups of turtles: (1) 15 turtles headstarted for 2 years (C-2014), (2) 15 turtles headstarted for 1 year (C-2015), and (3) 15 turtles hatched in captivity then released (i.e. no headstarting; C-2016). We measured growth rates of headstarted turtles while in captivity, and then all three cohorts of turtles were radio-tracked weekly during the active season and monthly during the winter to monitor movements, growth, and survivorship in the wild post-release. C-2014s and C-2015s were tracked for one year, from June 2016 until June 2017. C-2016s hatched in late July 2016, were released on 2 August 2016, and tracked for one month. Home range sizes differed significantly among cohorts ($H=28.65$, $df=2$, $p<0.001$). The non-headstarted C-2016s had the smallest home ranges (0.006 ha); mean home range size for C-2015s was 1.28 ha; and for C-2014s was 4.45 ha. All cohorts exhibited positive growth post-release from captivity. C-2016s had a 73% confirmed survivorship during their month of tracking, and two turtles were confirmed to have survived the winter. To date (16 June 2017), C-2014s have a 73% confirmed survivorship and C-2015s have 53% confirmed survivorship. Preliminary data analysis will be presented. Given the growing number of headstarting projects globally, our study will provide data that can aid in improving the practice.
Headstarting: Oral (Student)

Evaluating the Effectiveness of Headstarting for Wood Turtle (*Glyptemys insculpta*) Recovery from a Suspected Poaching Event

Damien Mullin[1], Rachel White[2], Jory Mullen[2], and Jacqueline Litzgus[1]
[1]*Department of Biology, Laurentian University, Sudbury, ON, P3E 2C6 Canada*
[2]*Huron Stewardship Council, Goderich, ON, N7A 1W2 Canada*
[dx_mullinsemeniuk@laurentian.ca]

Headstarting is a conservation tool applied to turtles that includes collection of wild eggs, hatching and rearing the hatchlings in captivity for some period of time, and then releasing them back into the wild once they have reached a size that should increase survivorship. A population of endangered Wood Turtles (*Glyptemys insculpta*) was studied extensively beginning in 1988. By the mid 1990s, a suspected poaching event resulted in the removal of approximately 70% of the population. A population viability analysis determined that extirpation was inevitable if no intervention was undertaken and so a headstarting project was initiated in 2003 and the first cohort was released in 2005. Our goal is to quantitatively assess the effectiveness of the 14-year headstarting program using population modelling tools to compare demographic parameters (e.g. population size and sex ratios, adult survivorship, fecundity) before and after the poaching event. We will also model population growth rates and life stage sensitivities based on different headstarting scenarios to determine the next phase of recovery. To date, a total of 501 headstarted turtles have been released back into their maternal streams. At present, the population bears the hallmarks of a heavily managed system: headstarted turtles constitute a larger proportion of the population than non-headstarted wild turtles (110:20), and sexually immature juveniles outnumber sexually mature adults (106:24). The persistence of the population will likely require a demographic shift to a more natural situation in which the population is made up mostly of reproducing adults. Headstarted turtles from the first release groups are just now beginning to reproduce, indicating that the population may become self-sustaining. Headstarting efforts have been paired with habitat stewardship activities (e.g., nest site creation, predator exclusion) which have helped bolster recovery efforts in the local agriculturally-dominated landscape. Preliminary results from initial population modelling will be presented. Modelling population recovery scenarios with comprehensive long-term data is essential for evaluating the effectiveness of headstarting projects, while continuously improving recovery efforts.
Presentation type: Poster (Student)

An Iconic Freshwater Turtle Species, Hidden in Plain Site: Snappers within a Concrete Jungle.

Eric C. Munscher[1, 2], Jordan Gray[1], Arron Tuggle[3], and Carl Franklin[4]
[1]*Turtle Survival Alliance, 1989 Colonial Parkway, Fort Worth, Texas 76110, USA*
[2]*SWCA Environmental Consultants, 602 West Little York, Houston Texas, 77040, USA*
[3]*Ecosystem, Planning, and Restoration, 17575 North Eldridge Parkway, Building C, Tomball, Texas 77377, USA*
[4]*University of Texas-Arlington, 501 South Nedderman Drive, P O Box 19167, Arlington, Texas 76019, USA*

[emunscher@swca.com]

In October 2016 Turtle Survival Alliance – North American Freshwater Turtle Research Group (TSA-NAFTRG) Director Eric Munscher senior scientist Jordan Gray were conducting a herpetofauna assessment of Memorial Park in metropolitan Houston, Texas. During the survey, they trapped the Buffalo Bayou, the major waterbody that cuts through downtown Houston. They captured 6 Alligator Snapping Turtles (*Macrochelys temminckii*), representing both sexes, varying in size from 320 mm max carapace length (CL) to 602 mm max CL. The finding of this species in Harris County is significant due to the fact that it was thought to have been extirpated from the county for over 50 years. Subsequent trapping sessions have resulted in a total of 23 individuals trapped in two small segments within a 2-mile stretch of Buffalo Bayou. Over the course of the next two years TSA-NAFTRG plans on trapping monthly throughout the Buffalo Bayou drainage going east and west from our site zero, Memorial Park. Our long-term goals are to initially find the limitations of this hidden population and to eventually start long-term population monitoring, genetic analysis, home range, and nesting surveys all in an effort to promote conservation for the species in Houston, the 4th largest Metropolitan area in the country.
Freshwater Turtles of the SE: Oral

Use of Modified GPS Logger and Radio-Telemetry Methodologies for Studying Resident and Translocated Gopher tortoises (*Gopherus polyphemus*) in Southeastern Georgia

Lance Paden and Kimberly M. Andrews
Odum School of Ecology, University of Georgia, Athens, Georgia 30602 USA
[lpaden@uga.edu]

Gopher tortoises (*Gopherus polyphemus*) are frequently translocated to avoid direct mortality due to various land development practices. In many cases, there is minimal monitoring to confirm that translocated individuals are integrating success-

fully into an existing gopher tortoise population at recipient sites. The resident-translocated tortoise social structure dynamic at the Penholoway Swamp Wildlife Management Area in Wayne County Georgia is the result of two relocation cohorts totaling 138 tortoises which were relocated in March and September 2016 from Southern Ionics Minerals LLC. Mission Mine in Charlton County, Georgia., I implemented a multi-faceted approach to population monitoring at this site as part of my Master's thesis that included investigations into their spatial ecology, thermoregulatory, and physical health and disease occurrence. Modified recreational GPS logger units (i-gotU GT-120) and radio transmitters are currently deployed on 20 resident and 20 translocated adult tortoises (~9-15 months to date). Here, I present preliminary spatial results obtained from modified GPS logger units and weekly VHF radio-telemetry. The configuration of these GPS units has allowed an average battery life of 3 - 5.5months using an attempted logging interval of every 30 minutes from 0800-2100hrs. While the amount of spatial data obtained is overwhelming in comparison to traditional methods, a considerable amount of trapping time and maintenance is required on the part of the researcher for this species. Additionally, care must be taken to use an appropriate spatial data analysis method which overwhelms any error in logging accuracy by prioritizing areas of high use in a utilization distribution. High use burrows appear to be easily identifiable even within the raw data, regardless, despite any potential increased logging accuracy error due to being underground much of the day.
Tortoises: Oral (Student)

Use of Prescribed Fire to Increase Detectability of Gopher Tortoise Burrows Prior to Relocation

Lance Paden[1], Kimberly M. Andrews[1], *Carmen Candal[2], and James F. Renner[3]
[1]Odum School of Ecology, University of Georgia, Athens, GA 30602
[2]Jekyll Island State Park Authority Georgia Sea Turtle Center, AmeriCorps, Jekyll Island, GA 31527
[3]Southern Ionics Minerals LLC, 116 Hamilton St., Saint Simons Island, GA 31522
[lpaden@uga.edu]

The relocation of gopher tortoise (*Gopherus polyphemus*) populations has become a commonly used mitigation strategy where their presence conflicts with industrial, agricultural, commercial, or residential development needs. In order to strive for a "no tortoise left behind" policy, we seek survey approaches that increase our detectability of covert, hidden burrows, especially those of juveniles in dense vegetation. Additionally, moving a more fully intact community would presumably reduce the impacts to important tortoise social networks, and hopefully, increase the likelihood of re-establishment and reduce the overall stress of relocation on individuals. In 2016, we conducted a large translocation of over 100 tortoises from approximately 16 hectares of sandhill forest habitat. Initial surveys revealed a high density of hatchling and juvenile tortoises. We conducted a prescribed burn to clear out dense herbaceous groundcover that small tortoises use to help hide their burrows and therefore increase burrow detectability. Here, we present pre- and post-burn survey results of both tortoise and armadillo burrows. Fire proved to be an excellent tool to increase survey efficiency and accuracy, resulting in a more effective extraction and translocation of animals. Approximately 22% of all gopher tortoise and armadillo burrows in the impact area were detected post-burn, indicating that many burrows would not have been detected solely using pre-burn surveys. Proper detection of burrows is also crucial to detecting priority commensal species, such as eastern indigo snakes, Florida pine snakes, and gopher frogs, which may also rely on tortoise and armadillo burrows and are worthy of mitigation action.
Presentation type: Poster (Student)

Health Threats to Urban and Rural Box Turtles in Missouri

Jamie L. Palmer[1], Sharon L. Deem, DVM[1], and Stephen Blake, PhD[2],
[1]Saint Louis Zoo Institute for Conservation Medicine
[2]St. Louis University, University of Missouri in Saint Louis, SUNY-ESF, Washington University in Saint Louis, Saint Louis, Missouri USA
[jpalmer@stlzoo.org]

Turtles are in decline throughout the US due to over-harvesting, road kill and habitat loss caused by urban development, and disease. Although few studies have been conducted in Missouri, these same threats are believed to exist for box turtles in the state. To better understand conservation challenges for box turtles in Missouri, we started the St. Louis Box Turtle Project in 2012. In this project we study two populations of box turtles: one in a city park, Forest Park (FP) in St. Louis, and the other at a biological field station, Tyson Research Center (TRC). These two geographically separate populations have provided a means for us to compare turtles in an urban versus rural habitat. We sought to determine how movement ecology and the

health status of box turtles vary between and within sites and to apply these data towards conservation. A subset of turtles at both sites were fitted with radio-transmitters and tracked weekly (n=18). Additionally, health assessments were performed on all turtles encountered at designated periods during the year, which included measurements of hematology, chemistry profiles, corticosterone levels, and infectious disease status. We also marked all box turtles encountered, performed physical exams, and collected infectious agent data from April through October of each year since the start of the project in 2012. We have 2755 movement data points, which include 1769 points from 140 turtles in FP and 986 points from 154 turtles at TRC. From 2012 – 2015 we have 232 blood samples, 132 from FP and 100 from TRC, and 286 cloaca and 210 choanae swabs, which have been tested. Results support a number of differences between the two populations, including mortality rates, physical abnormalities and prevalence of infectious diseases. However, we also note many similarities in the turtles at the two sites, including body condition index, and hematologic and stress hormone values. These data, along with the movement ecology data, are valuable in guiding management strategies that may help ensure box turtle survival.
Physiology/Health: Oral

Distribution and Size Classes of Alligator Snapping Turtles (*Macrochelys temminckii*) in the Pascagoula River Drainage of Mississippi

Luke Pearson, Gabbie Berry, and Dr. Carl Qualls
Department of Biological Sciences, University of Southern Mississippi, 118 College Drive #5018, Hattiesburg, Mississippi 39406 USA
[luke.pearson@usm.edu]

The alligator snapping turtle (*Macrochelys temminckii*) is currently under review by the US Fish and Wildlife Service and other regulatory and management agencies to decide, by 2020, if populations have declined sufficiently to warrant listing as a threatened or endangered species. Within the last two decades, Kansas, Oklahoma, Missouri, Louisiana, Georgia, Alabama, Florida, and a few southeastern military installations have determined the status and/or distribution of *M. temminckii* within their respective regions. Surprisingly, data on geographical distribution and abundance of this species is lacking in Mississippi, creating a substantial void of information that is needed to accurately determine the status of *M. temminckii*. Our goal was to assess the status and distribution of *M. temminckii* throughout the Pascagoula River drainage in Mississippi by systematically trapping using a variety of baited hoop nets set near appropriate microhabitats (root masses, logjams, undercut banks, etc). All turtles were measured (carapace length, plastron length), weighed, uniquely notched, and blood was acquired from the dorsal caudal vein for future studies. Preliminary results show an increased trap capture rate between lentic (0.131 turtles per trap night) and lotic sites (0.067 TTN), and trapped *M. temminckii* from lentic systems are heavier (12.61 kg vs. 6.86 kg). Also, there is a proportionally higher capture rate of juveniles (n = 17; 50 g to 9.09 kg) compared to adults (n = 11; 9.41 kg to 27.82 kg). Larger numbers of juveniles suggest that populations are reproducing, which is vital for the persistence or recovery of *M. temminckii* in Mississippi.
Presentation type: Poster (Student)

A Preliminary Look at Declines in Capture Rates of *Sternotherus* Species at Wekiwa Springs State Park, Florida

Rylee Phillips[1,2], J. Brian Hauge[1,2], Eric C. Munscher[1,3], Andrew D. Walde[2], Brian P. Butterfield[1,4], and Ande Williams[1,5]
[1]Turtle Survival Alliance, North American Freshwater Turtle Research Group, P.O. Box 12074, Fort Worth, Texas 76109, USA
[2] Department of Biology, Peninsula College, Port Angeles, Washington 98362, USA
[3] SWCA Environmental Consultants, 10245 West Little York Road, Houston, Texas 77040, USA
[4] Freed-Hardeman University, 158 East Main Street, Henderson, Tennessee 38340, USA
[5] Florida Department of Environmental Protection, Apopka, Florida 32712, USA
[bhauge@pencol.edu]

Since 2000, Musk turtles (*Sternotherus minor minor* and *S. odoratus*) have been captured at Wekiwa Springs State Park, Florida, as part of a long-term population study. For the first several years, the focus of the study was on *Pseudemys* species and *Sternotherus* were captured incidentally. To date, more than 1,300 individuals of *S. minor minor* have been captured with over 700 recaptures. Beginning in 2010, a systematic approach which allowed collection of movement data was begun and this presentation focuses on data collected since then. While numbers of individuals captured in each sampling period shows considerable fluctuation, in March, 2016 we noticed a significant decline captures and this continued in July, 2016 and March 2017. While numbers captured are lower, a similar trend is seen for *S. odoratus.* This has prompted a search for possible rea-

sons for the decline. Qualitative changes in habitat due to selective use of herbicides to control hydrilla (*Hydrilla verticillata*) and flow and water quality data from the St. Johns Water Management District are addressed. Suggestions are sought from the turtle community for ideas and additional data to be collected.
Presentation type: Poster (Student)

An Overview of Captive-breeding and Reintroduction of Burmese Star Tortoises in Central Myanmar

Kalyar Platt[1], Steven G. Platt[2], Me Me Soe[1], and Khin Myo Myo[2]
[1]Turtle Survival Alliance, Aye Yeik Mon 1st Street, Hlaing Township, Yangon, Myanmar
[2]Wildlife Conservation Society Myanmar Program, Aye Yeik Mon 1st Street, Hlaing Township, Yangon, Myanmar.
[kalyarplatt@gmail.com]

The Burmese star tortoise (*Geochelone platynota*) is endemic to the dry zone of central Myanmar and classified as Critically Endangered by the IUCN. Populations were decimated during the early 2000s by illegal collecting to supply animals for the international pet trade and by 2010 *G. platynota* was ecologically extinct in the wild. Assurance colonies were established at three wildlife sanctuaries in Myanmar with the ultimate objective of returning tortoises to the wild. These efforts have been hugely successful and large numbers of offspring are now being produced each year (>3000 in 2016-17). Minzontaung Wildlife Sanctuary was selected as the first reintroduction site for captive-bred tortoises owing to local religious beliefs that protect tortoises. Reintroduction was preceded by a public education campaign in villages surrounding the sanctuary. Tortoises were penned for varying periods (6, 12, and 18 months) before being released. Released tortoises were monitored bimonthly with radio-telemetry. Based on this monitoring, a 12 month penning period appears optimum for reducing post-release wanderings. Public education appears successful as a number of tortoises that left the sanctuary have been voluntarily returned by villagers who forfeited considerable monetary gain from a black market sale. Security remains of paramount concern, especially in light of a large-scale theft engineered by a corrupt Forest Department employee. In 2016, our reintroduction program was expanded to include Shwe Settaw Wildlife Sanctuary (SSWS), a much larger protected area that could ultimately support a wild population of >50,000 tortoises. Efforts at SSWS are modelled on those at MWS, except that a much greater emphasis is placed on law enforcement patrolling. A National Star Tortoise Action Plan developed in 2012 recommended reestablishing wild populations of *G. platynota* in every protected area within the dry zone of Myanmar. To this end, Chattin Wildlife Sanctuary will be evaluated as a third potential release site for captive-bred *G. platynota* in the coming year.
Headstarting: Oral

Restoring *Batagur trivittata* to the Chindwin River of Myanmar: Lessons Learned in a Less-than-successful Reintroduction

Steven G. Platt, Kalyar Platt, and Myo Min Win
WCS/TSA Myanmar Program
[sgplatt@gmail.com]

The remaining wild population of Burmese Roofed Turtles (*Batagur trivittata*) consists of less than 10 adult females inhabiting the upper Chindwin River in Myanmar. *Batagur trivittata* has been the focus of an intense conservation program since the mid-2000s; nesting sites are monitored, eggs are collected and incubated under natural conditions, and hatchlings head-started for eventual release. A small assurance colony was also established at the Mandalay Zoo using turtles confiscated from fishermen and rescued from pagoda ponds. Our first reintroduction of head-started *B. trivittata* was undertaken during the dry season of 2015. Turtles were released at two sites: 1) a stretch of the Chindwin River near Limpha Village hosting the remaining wild population; 2) lower reaches of Nam Thalet Chaung, a tributary debouching into the Chindwin River at Htamanthi. One hundred head-started subadult turtles (equal sex ratio) were selected, screened for infectious diseases, and transported by road to our basecamp in Limpha Village. Temporary bamboo holding pens were constructed in shallow water at both release sites. All turtles were implanted with microchips for permanent identification and VHF transmitters were attached to a subset of 30 turtles (approximately equal sex ratio). Fifty turtles (15 telemetered and 35 without transmitters) were transferred to temporary holding pens at each release site in February-March. Turtles were maintained in the pens and then released one month later (late March-April). Most turtles remained near the release site through the remainder of the dry season. Preferred habitat appeared to be deep holes. Even during low water periods turtles proved difficult to relocate.

Contact with most turtles was lost when water levels rose dramatically at the onset of the wet season (July), and some turtles that could be relocated had moved great distances (>20km). The single greatest cause of mortality was entanglement in monofilament fishing nets. Although the fate of most turtles remains unknown, villagers occasionally report observations of basking turtles indicating some continue to survive. Released males may be responsible for fertile clutches produced by wild females in 2016 and 2017 (no viable eggs were produced in 2014 and 2015). Future reintroductions should focus solely on the Chindwin River near Limpha Village. VHF transmitters appear unsuitable for post-release monitoring of river turtles; the use of sonic or satellite transmitters should be considered. Community-based fisheries management might ameliorate incidental loss to fishing gear by creating fish conservation zones encompassing critical turtle habitat.
Headstarting: Oral

Reproductive Ecology of Desert Tortoises (*Gopherus agassizii*) in the Sonoran Desert Region of Joshua Tree National Park

Shellie R. Puffer[1], Jeffrey E. Lovich[1], Mickey Agha[2], Joshua R. Ennen[3], Kathie Meyer-Wilkins[4], Laura A. Tennant[1], Amanda L. Smith[5], and Michael S. Vamstad[6]
[1]U.S. Geological Survey, Southwest Biological Science Center, 2255 North Gemini Drive, Flagstaff, Arizona 86001, USA
[2]Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, One Shields Avenue, Davis, California 95616, USA
[3]Tennessee Aquarium Conservation Institute, Tennessee Aquarium, 175 Baylor School Rd, Chattanooga, Tennessee 37405, USA
[4]19233 Stratford Way, Apple Valley, California 92308, USA
[5]University of Arizona, College of Architecture, Planning and Landscape Architecture, 1040 Olive Road, Tucson, Arizona 85719, USA
[6]National Park Service, Joshua Tree National Park, 74485 National Park Drive, Twentynine Palms, California 92277, USA
[jeffrey_lovich@usgs.gov]

An important component of effective wildlife conservation is an understanding of life history traits and demographic structure of populations. Agassiz's desert tortoise (*Gopherus agassizii*) has been listed as a federally threatened species since 1990. Despite conservation efforts and its status as one of the most thoroughly studied turtle species, *G. agassizii* is still experiencing population declines across its range due to anthropogenic and natural pressures. *Gopherus agassizii* has a wide geographic range in California, inhabiting both the Mojave and Sonoran Deserts. The deserts differ in temperature, and timing and amounts of precipitation, all of which can influence the reproductive ecology (e.g. clutch size, clutch frequency, clutch phenology) of *G. agassizii*. In the Sonoran Desert, *G. agassizii* reaches the southern edge of its distribution where the ecology of the species is understudied in comparison to populations inhabiting the Mojave Desert. We studied fecundity and reproductive phenology of *G. agassizii* at two locations within the Sonoran Desert region of Joshua Tree National Park (JTNP), including the Pinto Basin (1997–1999) and Cottonwood Canyon area (2015–2016). In each year of the study, four to seven females were outfitted with radio transmitters and X-rayed once every 7–14 days from April to July to determine reproductive output. Overall means for annual clutch frequency (1.78 ± 0.10 clutches/female/year), clutch size (4.3 ± 0.27 eggs/clutch), and X-ray egg width (36.51 ± 0.13 mm) were all comparable to what has been published for populations in the Mojave Desert. Similar to other populations in both the Sonoran and Mojave deserts of California, *G. agassizii* in JTNP utilized a bet-hedging strategy, wherein tortoises produced multiple small clutches almost every year, including during some periods of drought. However, all females forwent reproduction in 1997 following one short drought period. Desert tortoises in JTNP produced shelled eggs approximately two weeks earlier (April 6) than the earliest dates reported for populations in the Mojave Desert which is likely an effect of a regionally warmer climate.
Reproductive Ecology: Oral

Estimates of Relative Preferred Temperatures in Turtles

Austin Ray[1], Scott Glaberman[1], Pierre Moisson[2], Miguel A. Carretero[3], and Ylenia Chiari[1]
[1]Department of Biology, University of South Alabama, Mobile, Alabama, USA
[2]A Cupulatta, Véro, 20133 Ucciani, Corsica, France
[3]CIBIO/Universidade do Porto Campus Agrário de Vairão 4485-661 Vairão, Portugal

Global climate change can negatively affect biological systems. These effects vary across ecosystems and species. Howev-

er, ectothermic organisms are thought to be more sensitive to climate change as their own homeostatic processes depend on environmental conditions. Ectotherms have various strategies to regulate body temperature such as moving between sunlight and shaded areas. Because of the importance that environmental temperature has on the biology of ectothermic organisms, uncovering the preferred temperature for ectothermic species and how they select these temperatures is of vital importance to understand how climate change may affect them. In this work, we examined the preferred temperature(s) and thermoregulatory behavior of nine different species of turtles (8 Testudinae and 1 Emydidae) in a semi-controlled environment. We examined whether individuals from each species sought higher or lower environmental temperatures in outdoor enclosures in which there were also indoor shelters available. Temperatures of each individual were continuously measured every twenty minutes for three months by attaching a data-logger on the carapace. Dataloggers were also placed in the enclosure of each species to obtain data on environmental temperatures available to the animals. Preferred temperature(s) and thermoregulatory behavior were analyzed across species and between sexes using the median of the data. Our results indicate that temperature selection generally varies between species, but not sexes, except for one species (*C. denticulata*). Among the studied species, *T. carolina* selects overall lower temperatures than the other species. In examining mass as a factor in temperature selection, temperature did not depend on mass across species and within each species. Temperature selection does not seem to be necessarily related to differences in temperatures in the natural habitat of each species.
Presentation type: Poster

Spatial Relationships and Anthropogenic Effects on River Turtle Assemblages in Kansas and Oklahoma

J. Daren Riedle[1], Travis Anthony[2], Day B. Ligon[3], and David R. Edds[4]
[1]Kansas Department of Wildlife, Parks, and Tourism, Pratt, KS 67124 USA
[2]J. Sargent Reynolds Community College, Richmond, VA 23219 USA
[3]Missouri State University, Department of Biology, Springfield, MO 65897 USA
[4]Emporia State University, Department of Biological Sciences, Emporia, KS 66801 USA
[daren.riedle@ks.gov]

A growing trend in turtle research focuses on how local and regional factors influence patterns of species richness and abundance of turtle assemblages. We sampled river turtles across seven drainages in eastern Kansas and Oklahoma. We used Redundancy Analysis, a linear ordination technique, to detect species correlations along gradients based on latitude and USGS Hydrologic Units (HUC: 4-, 6-, and 8-digit classifications). Latitude combined with 8-digit HUC classification explained the greatest amount of variability in species distributions, suggesting that regional species pools followed by local environmental conditions most influence assemblage patterns. To further examine these patterns, we sampled three rivers (Caney, Verdigris, and Spring) and measured a suite of environmental variables at each trap location. Results of our analysis suggest that both local environmental conditions and species interactions influence local assemblage structure. Turtle species were categorized by ecological guild, and, while species abundances varied between drainages, guild structure was similar in all but the most highly impacted drainages. Anthropogenic impacts, such as degradation of water quality, species removals, and repatriation efforts, influenced assemblage patterns and guild structure at all scales.
Ecology/Field Studies: Oral

Chelonian Conservation and the Kansas State Wildlife Action Plan

J. Daren Riedle
Kansas Department of Wildlife, Parks, and Tourism, Pratt, Kansas, 67124 USA
[daren.riedle@ks.gov]

Conservation activities and funding in Kansas are driven by our State Wildlife Action Plan (SWAP). State Wildlife Grants (SWG) are federal funds that can be used for all wildlife, and to be eligible for SWG funds each state was required to develop a SWAP. SWAPs are intended to be dynamic documents that guide agency and partner conservation planning. As part of the plan development, all fish and wildlife species in Kansas were evaluated resulting in the identification of 285 Species of Greatest Conservation Need (SGCN), including three species of chelonians. The Kansas SWAP also identifies habitats crucial to the survival and health of SGCN species. Habitat based projects can be focused towards non-SGCN species, as long as SGCN species may benefit from the project. All projects funded through SWG must be focused on SGCN and representative habitats as identified in the plan. Additional nongame funding in Kansas is available through our Chickadee Checkoff program, which are state income tax donations. The Chickadee Checkoff was established to fund small projects focused on

nongame wildlife and their associated habitats in Kansas. While the Chickadee Checkoff pre-dates federal SWG funding, the focus of the program has shifted to directly supporting the Kansas SWAP and SWG funded plans. Current chelonian focused projects in Kansas include status and reintroduction of Alligator Snapping Turtles, recovery plan development for the Northern Map Turtle, and sampling for relict populations of Yellow Mud Turtles in south-eastern Kansas.
Conservation and Policy in North America: Oral

Movements of Loggerhead Musk Turtles (*Sternotherus minor*) in a Central Florida Spring

Ayla Ross[1], Eric Munscher[2], Brian Hauge[3], Elizabeth M. Walton[4], and Brian. P. Butterfield[5]
[1]Department of Biology, Indiana University of Pennsylvania, Indiana, Pennsylvania 15705–1081, USA.
[2]Turtle Survival Alliance, North American Freshwater Turtle Research Group, P.O. Box 12074, Fort Worth, Texas 76109, USA
[3]Department of Biology, Peninsula College, Port Angeles, Washington 98362, USA
[4]School of Geosciences, University of South Florida, 4202 E. Fowler Ave., Tampa, Florida, 33620
[5]Freed-Hardeman University, 158 East Main Street, Henderson, Tennessee 38340, USA
[anross12345@gmail.com]

Health and population size of spring turtles are being monitored due to their role as bio-indicators to better understand the environmental factors affecting Florida. They are good indicators of spring quality due to their narrow home ranges and any changes in movement could be attributed to the changing environment. Movement patterns of turtles can vary depending on environmental pressures and correlate with sex, size, and location within the spring. We analyzed the movements of Loggerhead Musk Turtles (*Sternotherus minor*) in Wekiwa Spring State Park, Florida, over a period of 6 years using capture-recapture sampling. The spring was divided into ten 100 m sections. Individuals with 2+ data entries of run locations were used for a total of 108 individuals (42 males, 63 females). A majority of the turtles (52.8%) showed no movement and the remainder moved the distance of approximately one run section (47.2%) with an average movement of 0.81 runs (or ~80 m). No correlation was found between size and sex, size and movement, or sex and movement. The section of the run in which an individual was first captured showed a correlation with movement but the significance of these findings may be skewed by the research design. Individuals near the mouth of the spring showed more individuals moving downstream while individuals from the end of the spring were moving upstream. By continuously studying this population, researchers could evaluate changes in movement patterns which may indicate changes in spring habitat quality.
Presentation type: Poster (Student)

Evaluating Turtle Passage Gates using Remote Camera Traps and Visual Encounter Surveys

Jason P. Ross, Christina Y. Feng, and Michael J. Dreslik
Illinois Natural History Survey, Prairie Research Institute, Champaign, Illinios, USA
[rossjp15@illinois.edu]

The Asian Carp bypass barrier in northeastern Illinois was built to prevent invasive carp from entering the Great Lakes during high floods but has additionally fragmented wetland habitat. A year after the terrestrial barrier installation, wildlife passage gates were installed to facilitate movement of native organisms, including the state endangered Blanding's Turtle (*Emydoidea blandingii*). To determine the effectiveness of the gates, we conducted 45 visual encounter surveys along the barrier and placed wildlife cameras on 14 of 20 gates. We found five turtle species along the barrier and photographed three using the gates. Painted Turtles (*Chrysemys picta*) were commonly found along the barrier and were photographed using the gates frequently during daylight hours. Although Snapping Turtles (*Chelydra serpentina*) were less abundant, they were often photographed and at all hours. Female and juvenile Northern Map Turtles (*Graptemys geographica*) were occasionally found and photographed. We found three Blanding's Turtles along the barrier, but none were documented using the monitored gates. We also found one juvenile Red-eared Slider (*Trachemys scripta elegans*) along the barrier. Turtle species occurring in the area but not encountered or photographed were Spiny Softshell Turtles (*Apalone spinifera*) and Eastern Musk Turtles (*Sternotherus odoratus*). The cameras also documented abundant mammalian mesopredators. The barrier may act as a foraging corridor for mesopredators given we found 34 depredated turtle nests during visual surveys. Emydid turtles typically used gates during daylight hours whereas potential mammalian predators used gates at night. Overall, the gates were semi-effective at facilitating movement of turtle species present along the barrier other than Blanding's Turtles.
Presentation type: Poster

Population Dynamics in an Unusual Wood Turtle (*Glyptemys insculpta*) Population at the Southern End of the Range

Ellery Ruther[1,3] and Thomas Akre[2]
[1]*Smithsonian Conservation Biology Institute, Front Royal, Virginia, USA*
[2]*Smithsonian Conservation Biology Institute, Front Royal, Virginia, USA*
[3]*Present address: Department of Natural Resources and Environmental Science, University of Illinois, Urbana, Illinois, USA*
[eruther2@illinois.edu]

The wood turtle (*Glyptemys insculpta*) is a cryptic, semi-aquatic species that is declining across its range and, like so many chelonian species, is in need of effective monitoring and management. In Virginia, the southernmost extent of the species' distribution in North America, the wood turtle is considered threatened and is in threat of increasing range contraction. U.S. national forests afford the most immediate, and possibly the best, opportunity for conservation of wood turtle populations in Virginia because of its public ownership, overall size, contiguity, and relatively low degree of land conversion. Furthermore, because many of the wood turtle populations on national forests are found in the upper reaches of watersheds, additional research is needed in order to understand features of the unusual landscape (e.g. small streams and limited nesting sites). Beginning in 1994, a population of wood turtles on a national forest was monitored using capture-recapture methods. Prior to 2014, an informal sampling approach was taken, where aquatic visual encounter surveys (VES) were conducted intermittently during the years as resources were available. During a period of intense study of this population, from 2014 – 2016, VES were conducted in a robust sampling design in order to characterize population parameters. We captured 143 individuals from 2014 to 2016, most of which (87.4%) were originally captured prior to the intense sampling period. Estimates of turtle abundance varied seasonally from 91.1 to 129.7, and the overall estimate was 111.5 (± 8.0). Capture probability also varied seasonally, with an overall estimate of 0.64 ± 0.06. Although annual survival estimates varied somewhat, they were high overall (x= 0.9 ± 0.05). Interestingly, several turtles were documented in adjacent watersheds during the informal sampling period (i.e. mid-2000s) as well as during the intense sampling study period. We also sought to understand population parameters across the entire 25-year study period. In order to incorporate the evidence of population openness as well as varied sampling intensity, data was analyzed using hierarchical spatially explicit open capture-recapture models in WINBUGS and R. Results from the robust analysis and spatially explicit open population analysis will be presented and discussed.
Ecology/Field Studies: Oral (Student)

Hypomelanism Rates in a Captive Population of Alligator Snapping Turtles

Kristen E. Sardina[1], Denise M. Thompson[2], Rebecca Fillmore[3], Brian M. Fillmore[4], Kerry Graves[4], and Day B. Ligon[1]
[1]*Department of Biology, Missouri State University, Springfield, Missouri 65897 USA*
[2]*Department of Integrative Biology, Oklahoma State University, Stillwater, Oklahoma 74078 USA*
[3]*Durant State Fish Hatchery, Caddo, Oklahoma 74729 USA*
[4]*Tishomingo National Fish Hatchery, 5501 West Highway 7, Tishomingo, Oklahoma 73460 USA*
[*KristenSardina@missouristate.edu*]

Hypomelanism is occasionally observed in both wild and captive populations of reptiles, but due to its rarity it remains a poorly understood phenomenon, particularly in chelonians. This trait is generally presumed to arise from genetic mutations and be maladaptive in wild populations because of the potential for both increased depredation due to reduced camouflage and altered immunological or metabolic function. This anomaly may be markedly detrimental to hatchling turtles that experience high rates of mortality during early life stages. The presence of congenital hypomelanism in alligator snapping turtles (*Macrochelys temminckii*) is characterized by pink skin freckled with black, light-colored keratin on the beak, plastron, and carapace, and white irises. Despite the wide recognition of this condition in *M. temminckii*, the frequency at which it occurs and potential deleterious effects associated have not been reported. In this study, we calculated the frequency and distribution of pink hatchlings in a captive breeding population of alligator snapping turtles. We also compared phenotypic features, incubation duration, growth rates, and survival rates of hypomelanistic morphs to those of normally pigmented turtles in the population. Understanding the patterns of occurrence and consequences of hypomelanism to individuals has important implications for conservation management decisions with respect to brood stock selection and head-start/reintroduction programs currently being applied for the species.
Presentation type: Poster (Student)

***Siebenrockiella leytensis* (Taylor 1920) – lost, found, in peril!**

Sabine Schoppe and Diverlie Acosta
Katala Foundation Inc., 2nd Floor JMV Building, National Highway, Santa Monica,
Puerto Princesa City, Palawan, Philippines
[sabine_schoppe@web.de]

Described in 1920 from Leyte, Philippines, neither traced nor seen for almost 70 years, then re-discovered in 2004 in Palawan some 700km west from Leyte gave the former *Heosemys leytensis* a dubious fame that led to its current critically endangered status despite still being abundant in some few localities.
From being a protein source for some indigenous groups natives in Palawan the turtle first became one of the most desired species by collectors around the globe followed by an increasing demand from the East Asian food and traditional medicine markets. To address this challenge, Katala Foundation Inc. (KFI), a local NGO aimed at conserving highly threatened species in Palawan, adopted the turtle as its flagship species under the Philippine Freshwater Turtle Conservation Program (PFTCP) in 2006.
The presentation covers key research, challenges and conservation measures of PFTCP such as geographic distribution, home range, diet, habitat preferences and ecological role of the species, captive management at its only range assurance colony, the rescue of 3,831 individuals that got confiscated in 2015, KFI's information education campaign and the establishment of protected areas and reserves.
Presentation type: Oral
Session:

Growth and Survival of Head-started Alligator Snapping Turtles (*Macrochelys temminckii*) in Northeastern Louisiana

Nathan P. Schwartz And John L. Carr
Department of Biology, University of Louisiana at Monroe, 700 University Avenue, Monroe, Louisiana 71209 USA
[schwarnp@warhawks.ulm.edu]

Throughout the southern United States, large adult *M. temminckii* have historically been hunted at levels that have led populations to be considered threatened or endangered. Additionally, increased nest predation has lowered recruitment from recovering populations. One method to address population decline is a head-start program; however, some problems with head-started animals that may occur include disease, reduced growth, emigration, and death, so a crucial aspect is to examine how successful individuals are when compared to wild animals. To evaluate the *M. temminckii* head-start program, we examined growth measurements and survival. Turtles were raised at Tishomingo National Fish Hatchery until two-, three-, and four-years old. Then at two field sites, 10 two-, 5 three-, and 5 four-year olds were released for three consecutive summers, 2014-2016. Both field sites are oxbow lakes in different stages of succession located at Boeuf Wildlife Management Area in northeastern Louisiana. One site is a closed canopy swamp while the other is an open canopy lake with canopy cover on the bank. Measurements of plastron length, carapace length, weight, bridge length, and head width were collected on all 120 individuals before release and subsequently 81 individuals were remeasured in May 2015, October 2015, June 2016, October 2016, June 2017, or other times if deceased. Using ANOVA procedures in SAS, we found significant positive relationships between growth rate and year of release ($p = < 0.001$, $r^2 = 0.30$), as well as growth rate and hatch-year ($p = < 0.001$, $r^2 = 0.32$), but there was no relationship with age at release. Therefore, as the study progressed and as hatch-year progressed concomitantly, the growth rate increased. Survivorship was assessed by regularly locating all *M. temminckii*. Survivorship was 71% (four months), 52% (six months), 45% (eight months), 32% (ten months) and 24% (one year). As water levels decreased, there appeared to be an increase in mammalian predation on the *M. temminckii* near the bank of each field site.
Presentation type: Poster (Student)

Building A Better Crab Trap Bycatch Reduction Device: Superior Diamondback Terrapin (*Malaclemys terrapin*) Exclusion without Reducing Blue Crab Catch

Jeffrey Schwenter, Michael Arendt, and J. David Whitaker
Marine Resources Division, South Carolina Department of Natural Resources,
Charleston, South Carolina 29412 USA
[schwenterj@dnr.sc.gov]

Mortality in crab traps remains a principal diamondback terrapin (*Malaclemys terrapin*) conservation issue. Bycatch reduc-

tion devices (BRDs) limit terrapin entry through trap funnels; however, substantial modification of existing BRDs is required to maximize exclusion of diamondback terrapins and increase use compliance. The most widely marketed BRD dimension (2 x 6") provides only modest conservation impacts, as entry of smaller juveniles and adult males remains quite possible. A slightly smaller BRD design (1.75 x 4.75") that is now required for recreational crabbers in some Mid-Atlantic states reduces the size of terrapins that can enter traps, but also limits the overall size of blue crabs that can enter traps. During 2014, SCDNR biologists field-tested several BRD modifications that led to the creation of a novel 2 x 2⅞" BRD design in 2015 that greatly reduced terrapin entry but still fell short of optimizing large blue crab catch. In 2016, top and bottom edges were rounded to provide a greater vertical opening to accommodate large crabs, and installation of the BRD as far forward within the trap funnel as possible was also included to minimize crab escapement. During 214 trap sets (1129 hrs) from April through August 2016 and spring 2017, we captured 54 diamondback terrapins of which only 15% entered traps with BRDs. Catch of legal-sized crabs (n = 219, 38% of all captured crabs) per soak hour was not different between traps with (0.30, 95%CI: 0.18 - 0.42) or without (0.25, 95%CI: 0.16 - 0.34) BRDs, and size distributions for legal-size crabs (maximum capture size = 7" carapace width) were highly overlapping between trap types. Recreational and commercial crabbers continue to test this BRD design in South Carolina. Field reports are favorable and increased testing by crabbers in additional states is anticipated.
Ecology/Field Studies: Oral

A Major Field Experience: New Millsaps College Turtle Research Projects in Mississippi

Will Selman
Department of Biology, Millsaps College, 1701 North State Street, Jackson, MS, USA, 39210 [*will.selman@millsaps.edu*]

Millsaps College is a private, liberal arts college in Jackson, Mississippi. As part of the new Millsaps Compass Curriculum, students are required to complete a "Major Experience" as part of their coursework. Experiences that may fulfill this requirement include study abroad courses, service learning, or field research. Millsaps College is also located in central Mississippi, which is located in the Southeastern U.S. Turtle Priority Area (aka, "hot spot"). Within a ~1.5 hour drive of Millsaps, one could encounter 22 tortoise and freshwater turtle species, with the Pearl River and Lefleur's Bluff State Park (LBSP) only 2 km from the Millsaps campus. Therefore, Millsaps is uniquely situated to study many of the turtle species of the southeastern United States. In May and June 2017, three projects were started with Millsaps undergraduates to study turtles in the Jackson metropolitan region. Two projects were located in LBSP with the hope of beginning long-term studies. The first was to investigate aquatic turtle communities in cypress swamps of the Pearl River bottomlands, with a focus on understanding the ecology of the Southern Painted turtle (*Chrysemys dorsalis*). The second project was to investigate Box turtle (*Terrapene carolina*) ecology through a mark-recapture study. The third project was to conduct replicate river turtle surveys along 5 stretches of the Pearl River (total, ~26.5 rkm) with particular focus on documenting basking densities of Ringed Sawbacks (*Graptemys oculifera*) and Pearl Map turtles (*Graptemys pearlensis*). This stretch of the Pearl River is inclusive of a highly modified portion (i.e., channelized, desnagged, riparian trees removed) that is proposed for a lake development, the One Lake Project. All of these research projects will provide opportunities for students to fulfill their "Major Experience" requirement, learn research and data collection skills, gain valuable field experience, and contribute to the scientific understanding of turtle species in Mississippi.
Presentation type: Poster

Spatial, Seasonal, and Sexual Variation in the Diet of a Threatened Turtle Species (*Graptemys flavimaculata*) of the Pascagoula River System, Mississippi, USA

Will Selman[1] and Peter V. Lindeman[2]
[1]Department of Biology, Millsaps College, 1701 North State Street, Jackson, MS, USA, 39210 [2]Department of Biology and Health Services, 126 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, PA, USA, 16444
[*will.selman@millsaps.edu*]

The conservation of imperiled species often depends upon conserving their prey. *Graptemys flavimaculata* (yellow-blotched sawback) is an imperiled turtle endemic to the Pascagoula River system of Mississippi, USA. We investigated diet variability of *G. flavimaculata* relative to site geography, sex, seasons, and size. We captured individuals from May to October in 2007 and 2008 at two distant sites. One site is an inland freshwater tributary (Leaf River, LR) and the other site is coastal and tidally influenced (Pascagoula River, PR). Feces from males (n = 68) and females (n = 74) were collected and analyzed. Using the Index of Relative Importance (IRI; 0 - 100 scale, 100 = only item present in all samples), we found that *G. flavimaculata* are primarily sponge specialists for both males (IRILR = 84, IRIPR = 91) and females (IRILR = 84, IRIPR = 66). For both sexes, between-site differences were more varied than within-site differences; for the latter, prey items were typically similar for males and females at a single site, but importance varied. Seasonal comparisons suggest that both LR and PR females shifted diets towards mollusks during the spring and fall, possibly associated with increasing energy and calcium for reproduction. Based on the frequency of wood fragments in feces, submerged deadwood appears important for prey species. Managers should conserve deadwood along riverbanks (i.e., mature riparian corridors). If channel maintenance is needed, deadwood should be moved toward banks rather than removed to conserve structure for prey species colonization.
Presentation type: Poster

South Carolina's State Wildlife Action Plan and Associated State Wildlife Grants Program: Funding Herpetofauna Research for Responsible Management

Anna Huckabee Smith and Will Dillman
South Carolina Department of Natural Resources, Columbia and Charleston, South Carolina USA
[smithah@dnr.sc.us; dillmanj@dnr.sc.gov]

Securing funding for non-game and other traditionally under-represented taxa has been a challenge in the United States. Following previous failed attempts, in 2000 Congress successfully created the State and Tribal Wildlife Grants program. Every state and territory was required to complete a State Wildlife Action Plan (SWAP) with eight required elements in order to receive funding apportionments through the associated State Wildlife Grants (SWG) program. These plans outlined what species were most in need of management within the state, the threats they faced, and what management actions should be taken to conserve them. The South Carolina Department of Natural Resources (SCDNR) completed the State's plan in 2005 with a required 10-year revision following in 2015. South Carolina has 332 plants and 494 animals listed within its plan as "species of the greatest conservation need" (SGCN) with a grand total of 826 species represented. Although full funding for SWG was never realized, the program has nevertheless flourished and thus far has resulted in 79 grant projects and 6 additional Competitive SWG projects (multi-state). Of these projects, herpetofauna have been well-represented and much needed data on status and distribution of species has been gleaned from research and survey efforts. Examples of species studied include: pine barrens tree frog, gopher frog, wood frog, pickerel frog, milk snake, shovel-nose salamander, dwarf black-bellied salamander, dwarf siren, patchnose salamander, tiger salamander, flatwoods salamander, southern dusky salamander, Chamberlain's dwarf salamander, Eastern diamondback rattlesnake, timber rattlesnake, diamondback terrapin, loggerhead sea turtle, bog turtle, and gopher tortoise. This presentation traces the history of the quest for stable, adequate, non-game funding in the United States and further highlights research targeted on Testudines, in particular, that utilized SWG funding to achieve conservation goals.
Conservation and Policy in North America: Oral

Conservation of the Southern River Terrapin, *Batagur affinis*, in Cambodia

Sitha Som, Brian Horne, And Hul In
Wildlife Conservation Society- Cambodia Program
[ssom@wcs.org]

Once thought to be extinct in Cambodia, the critically endangered Southern River Terrapin also known in Cambodia as Royal Turtle (*Batagur affinis*) was rediscovered in the Sre Ambel river system in Southwest Cambodia in 2001. The Cambodian population is relatively small and declining due to illegal fishing, sand mining, and illegal logging of riparian habitat. To address these threats, Wildlife Conservation Society (WCS) in partnership with Cambodian Fisheries Administration (FiA) has been working to conserve this species since its re-discovery in 2001. Four main activities have been implemented: 1) nest protection and head-starting; 2) law enforcement; 3) education and outreach; and 4) research and monitoring. Since 2002, 41 nests have been protected resulting in 408 hatchlings with a 66% hatching success rate; when nests that were flooded are excluded from analysis the hatching success rate is >71%. An average of three nests is found and protected per year. In 2016, a new head-starting and breeding center was constructed to hold more than 200 hatchlings and sub-adult *B. affinis*. 27 *B. affinis* have been kept as an assurance colony at the Angkor Center for Conservation of Biodiversity (ACCB). The project released 21 sub-adults equipped with sonic transmitters in 2015. We have been monitoring the released turtles passively with automated receivers and actively monitoring with towable and directional hydrophones on a monthly basis to study their seasonal movement, habitat use, and survivorship. Survivorship has been high with only one confirmed mortality. Law enforcement and education programs have been a fruitful effort, for instance, more than five captured *B. affinis* have been returned to the project by local fisherman since 2015. We plan to release and monitor 25 more *B. affinis* in 2017 as part of our ongoing exper-

imental release program aimed at improving our head-starting protocols and boosting the wild population.
Conservation & Management: Oral

Growth Rates and Activity Patterns of Alligator Snapping Turtle Hatchlings

Sarah J. Spangler[1], Denise M. Thompson[2], Brian S. Edmond[1], Brian M. Fillmore[3], Kerry Graves[3], and Day B. Ligon[1]
[1]*Department of Biology, Missouri State University, Springfield, Missouri 65897 USA*
[2]*Department of Integrative Biology, Oklahoma State University, Stillwater, Oklahoma 74078 USA*
[3]*Tishomingo National Fish Hatchery, Tishomingo, Oklahoma 73460 USA*
[Spangler555@live.missouristate.edu]

Hatchling freshwater turtles are ubiquitously cryptic, secretive, and have low survival rates in the wild. These traits, along with their small size, make conducting field studies—and especially telemetry studies—of hatchling turtles challenging. Alligator snapping turtles (*Macrochelys temminckii*) are a good model organism for such research because of their relatively large size; whereas other North American freshwater turtles average 3.6–10.4 g at hatching, alligator snapping turtles average 18.0 g. We affixed radio transmitters with nominal battery lives of 90 d to hatchlings to study this important demographic group. Growth rates for wild alligator snapping turtle hatchlings are unknown, but we hypothesize that they correlate with foraging activity. It is generally accepted that adult alligator snapping turtles actively forage at night, yet employ a sit-and-wait foraging tactic during the daytime. In contrast, juveniles engage in more diurnal activity. The activity patterns of alligator snapping turtle hatchlings are unknown, as are changes in activity in response to fluctuations in water temperature. To investigate the growth rates and activity patterns of alligator snapping turtle hatchlings in southwestern Oklahoma, we released 15 transmittered alligator snapping turtle hatchlings into a fenced pond and monitored their activity using an automated receiver. We also recaptured the hatchlings periodically to obtain size data and to replace transmitters. Growth rates varied seasonally, and correlated positively with activity rates in late fall and early spring. No such correlation was evident during the coldest winter months. Although activity levels varied seasonally, the activity of hatchlings fit a unimodal diurnal pattern throughout the study.
Growth/Morphology: Oral (Student)

Headstarting: the Panacea for Freshwater Turtle Conservation?

Ricky-John Spencer
Hawkesbury Institute for the Environment and School of Science and Health, University of Western Sydney. Locked Bag 1797, Penrith, NSW, 2751
[r.spencer@westernsydney.edu.au]

Freshwater turtles are declining globally for a host of reasons. Poaching for food and the pet trade in Asia; wildlife diseases and invasive species in Australia; reduced habitat quality and increased urbanisation throughout the world are all contributing significantly to increased rates of decline and extinction. With multiple threats impacting multiple life history stages of freshwater turtles, the dilemma for conservation is the capacity to implement diverse, broad-scale management strategies to address each threat. Thus, it is time to evaluate whether headstarting may allow for simultaneously managing a range of threats affecting freshwater turtles. Headstarting, or captive rearing of eggs or hatchling turtles for release into the wild, is a conservation practice that has long been controversial. Cost-effectiveness, broad-scale applicability, population modelling and a lack of long-term monitoring have been cited as reasons against establishing headstarting programs, except for endangered species. Headstarting has far greater potential than a conservation tool of "last resort" and in this talk, I re-evaluate the role of headstarting for both re-establishing declining or locally extinct populations of endangered species or preventing the decline of common species. I use a theoretical approach to explore how both *ex-* and *in- situ* headstarting programs can be deployed to counter the impacts of poaching, invasive species and novel diseases and increased urbanisation. I explore novel ways of integrating headstarting into cultural practices, as well as, utilise landscape level resources to create broad-scale low-cost sustainable programs.
Headstarting: Oral

An Overview of the Intranuclear Coccidian Parasite of Testudines (TINC)

Natalie Stillwell
Department of Infectious Diseases and Pathology, College of Veterinary Medicine, University of Florida, Gainesville, Florida 32610 USA
[nksteckler@gmail.com]

The intranuclear coccidian parasite of testudines (TINC) was first identified in a radiated tortoise (*Astrochelys radiata*) in 1994 and has since been reported in several other captive turtle and tortoise species. Most reports have occurred in Testudine hosts in the suborder Cryptodira, superfamily Testudinoidea, with the majority of cases restricted to the family Testudinidae; however, cases have also been reported in the Emydidae and Geoemydidae families. Cases in Asian and African turtles and tortoises predominate, with the only reports in New World hosts being single cases until a recent detection in three red-footed tortoises (*Chelonoidis carbonaria*) within a private collection. TINC infection is associated with nonspecific, multisystemic clinical signs, which may include: anorexia, lethargy, emaciation, ocular and nasal discharge, and gastrointestinal signs. Severe multisystemic lesions may be present on postmortem examination. Several diagnostic options are available for TINC including identification of the parasite on nasal cytology or biopsy, as well as conventional and quantitative polymerase chain reaction (PCR and qPCR) assays to identify TINC DNA. Treatment for TINC includes providing supportive care, optimal husbandry and minimizing stress. Treatment with anti-coccidial drugs (e.g., ponazuril and toltrazuril) has been reported in TINC cases; however, the pharmacokinetics and optimal dosing regimens for their use in testudines have not yet been determined.
Physiology/Health: Oral

Exceptional Growth Rates in the Genus *Pseudemys*, a Look at Growth during the Maturation Phase Using New Data on *Pseudemys texana* and *P. c. suwanniensis*

Theresa Stratman[1], Eric C. Munscher[2,3], Andrew D. Walde[3], Nicole Salvatico[3,4], Stephen Ross[3,5], Brian P. Butterfield[6], Mike Farris[3,7], and J. Brian Hauge[3,8]
[1] *Senckenberg Biodiversity and Climate Research Centre (BiK-F) and Department of Biological Sciences at the Goethe University, Senckenberganlage 25, 60325 Frankfurt am Main, Germany*
[2] *SWCA Environmental Consultants, 10245 West Little York Road, Houston, Texas 77040, USA*
[3]*Turtle Survival Alliance, North American Freshwater Turtle Research Group, 1989 Colonial Parkway, Fort Worth, Texas 76110, USA*
[4] *Department of Biology, University of Central Florida, 4110 Libra Drive, Orlando, Florida 32816, USA*
[5] *Power Engineers, Inc., North Sam Houston Pkwy E #200. Houston, Texas 77060, USA*
[6] *Freed-Hardeman University, 158 East Main Street, Henderson, Tennessee 38340, USA*
[7] *SWCA Environmental Consultants, 10245 West Little York Road, Suite 600, Houston, Texas 77040, USA*
[8] *Department of Biology, Peninsula College, Port Angeles, Washington 98362, USA*
[theresastrat@gmail.com]

The genus *Pseudemys* represents some of the largest and most commonly viewed emydid turtles in North America, yet there is a paucity of data for many *Pseudemys* species. Here we present novel growth data and comparisons of spring-dwelling populations of four *Pseudemys* species (*P. texana*, *P. c. suwanniensis*, *P. peninsularis*, and *P. nelsoni*). Through long-term mark-recapture studies we were able to obtain growth rate data on individuals during their transition to maturity. At this life stage we found large variation in growth rates, even among individuals of similar initial sizes, with many individuals showing exceptional growth rates. Annual carapace growth rates (in cm/year) ranged from 0.50 - 5.86 in *P. nelsoni*, 1.04 - 8.9 in *P. peninsularis*, 0.44 -12.95 in *P.c. suwanniensis*, and 0.96 – 9.30 in *P. texana*. Despite being sexually dimorphic, for all species, annual carapace growth rates did not differ between the sexes. Comparison among species showed that carapace growth rates were significantly lower in *P. nelsoni* than in the other species, but the other species did not differ significantly from each other. The fast growth rates seen in these populations may be caused by various factors. Factors linked to habitat are of particular interest due to year-round favorable growth conditions created by the springs' constant temperatures, and the presence of energy rich, non-native food sources such as the aquatic plant Hydrilla (*Hydrilla verticillata*), and several species of invasive mollusks. Our surprising results and a lack of similar studies for comparison highlight the need for long-term studies that can link growth rates and habitat characteristics. Understanding such influences will be crucial to wildlife biologists and land / aquatic preserve managers charged with identifying population parameters critical for management.
Growth/Morphology: Oral (Student)

Body Condition and Body Composition of Captive and Reintroduced Alligator Snapping Turtles

Brandon S. Tappmeyer[1], Denise M. Thompson[2], Brian M. Fillmore[3], Kerry Graves[3], and Day B. Ligon[1]

[1]Department of Biology, Missouri State University, Springfield, Missouri 65897 USA

[2]Department of Integrative Biology, Oklahoma State University, Stillwater, Oklahoma 74078 USA

[3]Tishomingo National Fish Hatchery, 5501 West Highway 7, Tishomingo, Oklahoma 73460 USA

[*BSTappmeyer@missouristate.edu*]

Conservation biologists increasingly rely on captive breeding and reintroduction of threatened and endangered species to restore wild populations. Assimilation of captive animals released into natural environments can be negatively impacted by a variety of factors related to their captive rearing, including maladaptive social behavior, inability to identify appropriate food resources or potential predators, and poor physiological condition. Animals that exhibit such maladaptive traits when they are released may quickly adjust to their new environment and rapidly resemble wild conspecifics; alternatively, such negative traits may persist and significantly diminish survival and the overall success of the reintroduction effort. We began reintroducing alligator snapping turtles (*Macrochelys temminckii*) in northern Oklahoma in 2008, and mark-recapture efforts have revealed that individuals often grow well and exhibit habitat use patterns that are similar to those described for wild populations. In fact, in many instances growth rates have been observed that significantly exceed growth rates prior to release. This suggests not just that individuals are finding resources after release, but that their body composition may shift (improve) upon release. To explore this possibility, we used dual-energy x-ray absorptiometry (DXA) to compare the body composition of alligator snapping turtles that have spent at least three years in the wild to that of individuals housed both indoors and outdoors in captivity. The variables that we compared included total body fat, lean tissue mass, total bone mineral content, and bone density. Estimates of these variables measured using DXA were calibrated using traditional chemical analytical techniques. Finally, we compared variation in body composition to a traditional body condition index calculated from a mass-length regression.

Presentation type: Poster (Student)

Program Update: Conservation Efforts in Bangladesh

Scott Trageser

Creative Conservation Alliance, House #1/4, Block #C, Lalmatia, Dhaka-1207, Bangladesh

[trageser.scott@gmail.com]

Over the course of the last year, the Creative Conservation Alliance has made significant progress towards enhancing protection for the Sangu Matamuhuri Reserve Forest in the Chittagong Hill Tracts, Bangladesh. By establishing co-ops, posting signboards, launching a redesigned craft for conservation line, and establishing one additional school for conservation – the last old growth forests of Bangladesh are moving towards a sustainable future. Our organization has also recently finished constructing a new turtle conservation breeding center focusing on establishing the first successful captive breeding colony of *Manouria emys* in Bangladesh.

Conservation & Management: Oral

Developing Head-starting Strategies that work for Gopher Tortoises and Desert Tortoises: an Iterative Process

Tracey D. Tuberville[1*], Kurt A. Buhlmann[1], Dan P. Quinn[1,2], Jacob A. Daly[1,2], Brian D. Todd[3], J. Mark Peaden[3], and Melia G. Nafus[3,4]

[1]University of Georgia's Savannah River Ecology Lab, Aiken, South Carolina, USA

[2]Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia, USA

[3]Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, California, USA

[4]US Geological Survey, Fort Collins, Science Center, Fort Collins, Colorado, USA

[tubervil@uga.edu]

Perhaps due to failures of early high profile projects, head-starting has been long-deemed merely a "feel good" measure without serious merit as a conservation strategy. This perception has stymied research that could advance the development of rearing and release protocols most likely to lead to successful implementation. Recently, there has been a revival of interest in head-starting as a potential population recovery tool for turtles, with greater emphasis by researchers and conservation organizations on strong experimental design and effective post-release monitoring. We will summarize and compare two ongoing head-starting efforts – one for gopher tortoises (*Gopherus polyphemus*) at Yuchi Wildlife Management Area, Georgia, USA, and one for desert tortoises (*G. agassizii*) at Mojave National Preserve, California, USA. For each release experiment, we will

describe the experimental design, husbandry and release protocols, and the results to date, focusing on post-release site fidelity and survivorship. Emphasis will be placed on how our research objectives and implementation strategies have evolved as a result of lessons learned from earlier releases, and why we think head-starting should be considered an iterative process subject to constant evaluation and refinement rather than being judged "successful" or "unsuccessful" based on a single release. In addition, we will provide specific recommendations for husbandry and release protocols for these two imperiled species of tortoises, along with recommendations for future research directions.

Headstarting: Oral

The State of the Art of Captive Raising Turtles in China

Richard C. Vogt[1]

[1]Coordenação de Biodiversidade, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil CEP 69.067-375

[dickturtlevogt@gmail.com]

The Chinese are coming the Chinese are coming; I tripped over a chopstick the other day in the market! I was not excited about going to China, I could not speak or read Chinese, all the news stories on TV spread the word and visuals about overcrowding, smog, pollution, avian flu, economic affluence, government restrictions on birth, no restrictions on death, millions of live wild animals sold in the markets, and worse the turtle conservation mafia spreading the word that THE CHINESE are eating all of the turtles in the world, and THE CHINESE are devastating the populations of turtles in south east Asia and priming for attacking the rest of the world. I am from Wisconsin, so I know Joe McCarthy when I see him. As Senator Roselip used to say "Where are we going to get our cannon fodder if we allow the poor people to have birth control!" So I was pleasantly surprised with what I found. Some of the largest exporters of turtles in the world are from the southern USA, polluting the world with millions of Red-Eared Slider Turtles annually and infecting the whole world with noxious *Salmonella* bacteria, which are now found to be actively feeding on cancer cells in our bodies! So hatchling turtles should be returned to the dime stores of the USA! Some of the largest and most voracious importers of pet turtles in the world can be found in the USA they have their buyers search the turtle markets of the world over and pay $4000 a turtle for new hybrid species! I expected to find turtles in the menus of all restaurants like in Veracruz and Tabasco, Mexico in the 1960s-70s, not so. Or markets piled high with crates of live turtles, not so. The state of the art of raising turtles in captivity in China has a history of over 300 years, 60 years before the USA was called an independent country and over 3500 registered turtle farms. The state of the art of turtle growing in China is fantastic!

Captive Husbandry: Oral

Male Body Size Effects on Siring Success in the Gopher Tortoise (*Gopherus polyphemus*)

K. Nicole White[1, 2], Betsie Rothermel[3], Kelly Zamudio[4], and Tracey Tuberville[1]

[1] University of Georgia's Savannah River Ecology Laboratory, Aiken, South Carolina 29808 USA

[2] Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30602 USA

[3] Archbold Biological Station, Venus, Florida 33960 USA

[4] Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, New York 14853 USA

[knwhite21@gmail.com]

In many vertebrates, male body size likely influences individual fitness; hence, it may be important to siring success. FItter individuals may be more likely to dominate mating opportunities, skew siring success rates, and lower effective population sizes and genetic diversity. The mating system and reproduction of the gopher tortoise (*Gopherus polyphemus*) have been explored primarily through behavioral observations while just two studies have used molecular studies to investigate reproductive patterns. We evaluated the effects of male size on likelihood of siring offspring and how many offspring a sire in a high-density (~6/ha) population of gopher tortoises at Archbold Biological Station in Florida. We also report incidence and patterns of multiple paternity observed in the study. We collected 35 nests in 2015 and 2016 and incubated the eggs through hatching. Using 11 previously-developed polymorphic microsatellite markers, we genotyped all hatchlings (n = 220 from 31 successful clutches) and most potential dams and sires in the population (n = 101). Using programs CERVUS and COLONY, we assigned each hatchling to the most likely dam and sire. We evaluated the effects of male body size on probability of siring success (sire or non-sire) and reproductive success (number of offspring sired) using a zero-inflated Poisson mixture model. Larger males had significantly greater siring success than smaller males. Additionally, male body size was positively correlated with increased reproductive success though this result was not significant. Our results support previous findings

that larger males experience greater siring success than smaller males in this species. We observed multiple paternity in 24% of clutches, within range of previously reported rates. Understanding reproductive success and paternity distribution of this declining species may be important for developing effective management strategies.
Genetics: Oral (Student)

Restore to What? Reintroducing Bolson Tortoises (*Gopherus flavomarginatus*) into Prehistoric Habitat

Christiane Wiese and L. Scott Hillard
Turner Endangered Species Fund (TESF), HC31, Box 95, Caballo, New Mexico 87931 USA
[Chris.Wiese@retranches.com]

The fossil record indicates that large tortoises inhabited much of the North American Chihuahuan Desert until the first humans to arrive ~11,000 years ago began wiping them out by hunting them for food. The only tortoise species to still populate portions of the Chihuahuan Desert in north-central Mexico today is the bolson tortoise (*Gopherus flavomarginatus*). Its current range encompasses an area of around 6,000 km^2 in the south of the ~360,000 km^2 Chihuahuan Desert, about 300-700 km south of the US border. Fossil records place prehistoric bolson tortoises in Arizona, New Mexico, and Texas. The modern Chihuahuan Desert of New Mexico in the US closely resembles the bolson tortoises' current range in terms of vegetation, climate, soil composition, and geology. Media mogul, businessman, and conservationist Ted Turner owns two ranches in southern New Mexico within the Chihuahuan Desert eco-region. These ranches currently harbor a colony of 26 semi-captive bolson tortoise adults that are the foundation of the first and only bolson tortoise restoration project in the US. Beginning in 2006, the Turner Endangered Species Fund (TESF) established a robust breeding program designed to generate large numbers of new tortoises every year with the goal of establishing new wild populations of bolson tortoises in protected areas in the US. This endeavor not only provides a repository of bolson tortoises that might ultimately be essential for helping to stave off the extinction of the species in the wild, but also provides the opportunity to reintroduce the bolson tortoise to its prehistoric habitat in the northern portions of the Chihuahuan Desert. Unfortunately for the tortoise, today, the Chihuahuan Desert is bisected by the international border between the US and Mexico. For this reason, and because the bolson tortoise vanished from northern Chihuahuan Desert landscapes long before the "discovery" of the region by Europeans in the 16th century, the bolson tortoise is now considered non-native to the US. We will discuss the challenges we face in letting us bring back a species that many believe has been absent for long enough to now be considered an exotic species.
Tortoises: Oral

Application of Design Process Thinking and Structured Decision Making to the Conservation of Freshwater Turtles in the Thrive 2055 Region

Thomas P. Wilson[1], Mark J. Dillard[1], Chris Manis[2,3], Stefan Moss[4], Penni Jo Wilson[5], and Team Salamander[1]
[1]*Department of Biology, Geology and Environmental Science, 615 McCallie Ave., The University of Tennessee at Chattanooga, Chattanooga, Tennessee 37403 USA*
[2]*Dalton Middle School, 1250 Cross Plains Trail, Dalton, Georgia 30721 USA*
[3]*Dalton State College, 650 College Dr., Dalton, Georgia 30720 USA*
4 Department of Mathematics, Computer Science, Science, Business, and Physical Education, Georgia State University Perimeter College, Atlanta, Georgia 30302 USA
[4]*Division of Natural Sciences, Cleveland State Community College, 3535 Adkisson Drive, Cleveland, Tennessee 37312 USA*
[Thomas-wilson@utc.edu]

Good decision-making is essential to conserving wildlife populations. Whereas there may be multiple ways to address a problem using the scientific method, perfect solutions rarely exist. Conservation practitioners are therefore tasked with targeting optimal decisions that will best achieve desired conservation or education outcomes. Pedagogically speaking, the traditional approach of paring lectures and laboratories is not always effective when compared to research approaches utilizing problem-based learning with design process thinking. The latter has received some traction on our campuses and is a dynamic way to prepare students for productive careers in science. Conversely, structured decision making is a method of analysis used to identify the most effective, efficient and realistic optimal decisions that accounts for values and priorities of decision and policy makers as well as conservation stake-holders. In this talk, we illustrate the application of design process thinking and structured decision-making towards the conservation of freshwater turtles in the Thrive 2055 Region (15 counties that encompass the greater Chattanooga Metropolitan Region). Specifically, we make recommendations to faculty so that they can

better engage and equip students in education, research, outreach and conservation. We have used biological field stations and natural areas as a pivotal platform because they provide the frame work for students to better understand wildlife-habitat relationships in exurban systems. We have devise a plan to integrate the field work and problem solving into the curriculum so that students can gain hands-on experience in scientific research using turtles. Currently, our efforts are tied to the current research or instruction being performed at these field sites because they provide an excellent jump-off platform that dovetails flawless within a realistic problem based learning environment. In closing, our approach builds capacity for student lead research, facilitate partnerships among community stakeholders, and foster active yet collaborative learning by studying turtles in the Thrive 2055 Region.
Freshwater Turtles of the SE: Oral

Ecomorphological Correlates of Microhabitat Selection in Two Sympatric Asian Box Turtle Species (Geoemydidae: *Cuora*)

Fanrong Xiao, Jichao Wang, Haitao Shi, Zaizhong Long, Liu Lin, and Wei Wang
College of Life Sciences, Hainan Normal University, Haikou 571158, China
[xiao71815@163.com]

Closely related species that co-occur in homogeneous environments often possess differing morphologies, which can result in niche divergence that minimizes interspecific competition. In the present study, we examined the relationship between the ecomorphological characteristics and microhabitat selection of two Asian box turtle species, the keeled box turtle *Cuora mouhotii* and Indochinese box turtle *C. galbinifrons*, which have sympatric distributions in the rainforest of Hainan, China. We found that *C. mouhotii* had a relatively flat shell and preferred microhabitats with rock crevices and steep slopes in the field, whereas *C. galbinifrons* had a domed shell and was restricted to microhabitats of deciduous leaves under bamboo growing on gentle slopes. We conclude that morphological divergence allows the two *Cuora spp*. to use different microhabitats and, thereby, to successfully co-occur.
Presentation type: Poster

The Investigation on the Habitat and Resources Conservation of Golden-Headed Box Turtles, *Cuora aurocapitata*

Cheng Yunsheng[1,2], Jiang Yelin[1,2*], Wang Fen[1,2], Hou Guanjun[1,2], Zhang Jing[1,2], and Zhao Xiuxia[1]
[1]*Fishery Institute, AnHui Academy of Agricultural Science, HeFei, AnHui, China*
[2]*Anhui Engineering Research Center for turtle Farming Technology, HeFei, AnHui, China*
[*jiangyelin@qq.com*]

The golden-headed box turtle (*Cuora aurocapitata*) is a rare turtle and which has been listed as the first class protected animal in Anhui. To investigate the resource and habitat of wild Cuora aurocapitata, the field investigation was taken out at the main habitat during 2015-2016. The investigation results showed the turtle was hardly survived in some place, because the ecological environment had been greatly damaged in the Basin of Gufeng River, Caoci River and Tingxi River of Jing county. Mountain stream was relatively intact and the potential distribution area was about 15 km^2 for the turtle. Also the Yangshuwan reservoir and Jintian stream in Qingxi River Basin in an area of 30 km^2 in Yixian county. But it's hard to evaluate the number of wild individuals. The only undoubted thing was that the wild resources were declined due to the damaging habitat. It should establish natural reserve and develop artificial breeding to slow down the extinction of this endemic turtle.
Presentation type: Poster