TSA
turtle survival alliance

★ FORT WORTH, TEXAS 2018 ★

IUCN/SSC
Tortoise and Freshwater Turtle Specialist Group

16th 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 12 - 15, 2018
Fort Worth, TX

Additional Conference Support Provided by:
Kristin Berry, John Iverson, Matt and Leigh Ann Frankel, Anders Rhodin, David Shapiro, Brett and Nancy Stearns, Reid Taylor, and Tim Gregory

Support for the 2018 Behler Turtle Conservation Award Provided By:

With additional support from: Deb Behler, George Meyer and Maria Semple, and Brett and Nancy Stearns

2018 Conference Highlights

Keynote: George L. Heinrich

The Big Turtle Year: Celebrating Wild Turtles Across the United States

George L. Heinrich is a field biologist and environmental educator with a specialty in Florida reptiles. He is an invited member of the IUCN Tortoise and Freshwater Turtle Specialist Group, served twice as co-chair of the Gopher Tortoise Council, and is the executive director of the Florida Turtle Conservation Trust (FTCT). In 2017 the FCTC initiated The Big Turtle Year, highlighting the diversity of chelonians across the American landscape, while promoting their conservation.

Keynote: David Steen

Using the Internet to Communicate Science, Reach New Audiences, and Advance Reptile Conservation

David Steen is the Research Ecologist of the Georgia Sea Turtle Center on Jekyll Island, Georgia, the Executive Director of The Alongside Wildlife Foundation, and serves on the Board of Directors of the Wildlands Network. As a wildlife ecologist, conservation biologist, and public communicator, David studies how wildlife populations use landscapes and generates recommendations regarding how humans can develop, farm, restore, and live on these landscapes at the same time.

We hope everyone enjoys the festivities that this year's venue provides. Special thanks to the Hilton Fort Worth for helping us kick-off the festivites and to the Fort Worth Zoo for helping us wrap up the celebration!

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Featured Presentations

Dr. Jeffrey Lovich

Where Have All the Turtles Gone, and Why Does It Matter?

Camila Ferrara

Turtle Sound Communication: Investigating the Influence of Environment, Lineage, and Carapace Size on Sound Frequency

Carl J. Franklin

A State of Texas Turtles

From the Program Co-Chairs: WELCOME TO COWTOWN!

There is no better way to celebrate the month of August than attending the 16th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. After a very successful 2017 symposium in Charleston, South Carolina – to check out the Turtle Survival Alliance's new home – we are delighted to welcome you to city where the idea to create Turtle Survival Alliance was conceived: Fort Worth, Texas! This year's meeting, sponsored by Zoo Med Laboratories and the Fort Worth Zoo, is being co-hosted by the Turtle Survival Alliance and the IUCN Tortoise and Freshwater Turtle Specialist Group at the Hilton Fort Worth in downtown Fort Worth. Here, you can experience "a moment in time, a place in history," as this hotel was the scene of 35th President John F. Kennedy's final address on the morning of November 22, 1963. Come early to enjoy turtle trapping on the Trinity River – stay late to enjoy the Dallas World Aquarium and Dallas Zoo!

We have been assured by many locals that Fort Worth was born ready to host the largest gathering of turtle biologists, zookeepers, husbandrists, and enthusiasts, anywhere in the world! This year's symposium includes keynote presentations on *The Big Turtle Year* by George Heinrich and Timothy Walsh, and *Using the Internet to Communicate Science* by David Steen. We have special sessions on *Graptemys*, Texas Turtles, Headstarting, Zoos and Chelonians, Captive Husbandry, Field Studies and Techniques, and Conservation and Policy in the United States. The latter session will focus on management and mitigation plans, conservation strategies, and potential new funding initiatives that will have tremendous impacts on turtle conservation in the United States.

As this symposium enters its 16th year, its resounding impact on the conservation and biology of chelonians is quite evident. As always, we are looking forward to seeing many of our old friends, making new connections, and finding innovative ways to collaborate in the turtle conservation world. We hope to facilitate and encourage this level of continuity, which we do in part through Travel Grants and Student Presentation Awards. The Student Presentation Awards are made possible through generous donations from Anders Rhodin and the Chelonian Research Foundation. 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. This year we stepped in to help find the conference hotel, which was vetted by Rick Hudson, as our normal hotel hunter, Lonnie McCaskill, was traveling for work. We think everyone is going to enjoy this venue. Robert Villa and David Hedrick will be running the AV system and making sure your presentations run smoothly. Jordan Gray & David Hedrick will be pushing social media, and Zachary Walde will be taking your photos; smile! Nancy Reinert and Rose Tremblay will be here again to help run the hospitality suite, sell merchandise, run the auction, and do the 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. Jan Holloway, the TSA's new Administrative Coordinator will be getting you registered and helping organize another fabulous silent auction. As many of you have heard, Ilze Astad and Chris Clark, who have kept us all organized for the last few years, have moved on to other jobs. We can't thank them enough for everything they have done for the TSA in their short time with us. 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 Where the West Begins!

Andrew Walde and Cristina Jones, Program Co-Chairs

T-shirt Design Contest Winner!
Please join us in congratulating **Colin Gray**. Colin submitted the winning entry in the T-shirt design contest for the 16th 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 16th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles.

We are delighted to welcome you this year to Fort Worth, TX, or as it is affectionately referred to in these parts "where the west begins." The TSA is essentially returning to its roots, because Fort Worth was where the TSA was born back in January 2001. The Fort Worth Zoo hosted an international workshop that, over three difficult and trying days, finally resulted in an agreement and structure that became the TSA. It is altogether fitting and appropriate that 17 years later we should return to Fort Worth, and many in our ranks will remember that challenging but pivotal time in our collective history. On behalf of the staff of the Fort Worth Zoo, we take great pride in hosting you again and welcoming you to "Cowtown." Our downtown is very user-friendly and has a lot to offer in terms of dining and hospitality. Your conference venue is the beautiful Hilton Hotel, a historic landmark in Fort Worth because President John F. Kennedy spent his last night on earth in this hotel. In fact, our hospitality suite is the very same room where John and Jackie stayed the night before that fateful day.

Day 1, August 13th, kicks off with a bang and the plenary session has a packed agenda that is reflective of our very busy year. First, the TSA will introduce our new Executive Director, Rick Hills, who brings a wealth of enthusiasm and passion to this position. We will then have a summary session of the historic Radiated Tortoise confiscation in Madagascar that recently captured the attention of the global turtle conservation community. Joe Ventura will follow with a sobering reflection on the level of illegal trade in threatened North American turtles that is currently overwhelming USFWS resources. On a lighter side, George Heinrich (Florida Turtle Conservation Trust) and David Steen (Alongside Wildlife Foundation) will share some innovative ideas for popularizing and publicizing wildlife and reaching the masses with our stories. The afternoon of Day 1 is devoted to Texas turtles, hosted by the always entertaining Carl Franklin. Home to almost half of the turtle diversity in the U.S., this session will showcase some of that spectacular diversity with a great slate of speakers. Also, early in the evening of Day 1, IUCN-TFTSG Chair Craig Stanford will host a review of the chelonian species listed DD (data deficient) or NE (not evaluated) by the IUCN. Generally, these species are ranked as such because we lack data and this session will be an attempt to "shake loose some new information." On Wednesday night, August 15th, we wrap up with our Awards Banquet where the student awards and Behler Turtle Conservation Award winner will be announced. Hosted by the Fort Worth Zoo in the zoo's stunning new Savanna Events Pavilion (The Reserve), this will be an evening to remember. Yes, we will be outside in August in Texas, but the tent is cooled. Prior to arriving at The Reserve, you will enjoy a cocktail reception in the zoo's award-winning reptile and amphibian exhibit, the Museum of Living Art (MOLA). This promises to be a very special evening and is not to be missed.

We offer special thanks to the organizational skills of our conference team – Andrew Walde, Cristina Jones, Jordan Gray, Jan Holloway, and Janet Fincannon – who managed to balance a multitude of details in the months leading up to the conference. 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, is again the symposium's title sponsor. There are many other costs associated with this conference – travel grants, coffee breaks, catering, transportation, and the all-important hospitality suite. For helping to offset these costs, and for their generosity, we thank Advanced Telemetry Systems, Kristin Berry, Desert Tortoise Council, John Iverson, Fort Worth Zoo, Reid Taylor, George Meyer and Maria Stemple, David Shapiro, Brett and Nancy Stearns, The Surprise Spring Foundation, and Turtle Conservancy. Awards for the Best Student Presentations will again be presented and supported this year by Anders Rhodin and the Chelonian Research Foundation. And as a reminder please stop by and visit our vendors who have become such 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

Craig Stanford, Chair, TFTSG

John L Behler Turtle Conservation Award

This year the 13th annual Behler Turtle Conservation Award celebrates and honors Russell A. Mittermeier for his half-century of dedication to science and conservation of turtles and primates, as well as being a world-leading global conservationist of the highest caliber. Russ has been a hard-core herpetologist since childhood, with a particular interest in turtles, snakes, and crocodilians. As an undergraduate at Dartmouth (where he and Anders met and formed a life-long friendship) and at graduate school at Harvard, he pursued work on turtles and primates and carried out field work in Panama, Tanzania, Peru, Colombia, Brazil, and Suriname. The work in Brazil led to a number of publications on Amazonian turtles, the most notable of which was the redescription of the Red-headed Amazon Sideneck Turtle (*Podocnemis erythrocephala*).

In 1989, Russ became President of Conservation International, a position that he held for 25 years, switching to Executive Vice-Chair in 2014. At CI, he was the key figure in adapting Norman Myers' Biodiversity Hotspots concept as a core strategy for that organization for the next two decades, with hugely successful fundraising results. From Myers' original 10 hotspots, and then later 18, Russ and colleagues carried out research that eventually increased the number to 36. Russ also created the concepts of Megadiversity Countries and High Biodiversity Wilderness Areas as additional strategies for priority-setting, and also worked with several colleagues to adapt these and the Hotspots for turtle priority-setting as well. In addition, Russ has had a long history with IUCN. He has served as Chair of the IUCN Primate Specialist Group since 1977, and in 1979 began a process with Ed Moll and Peter Pritchard that resulted in the creation of the IUCN Freshwater Chelonian Specialist Group in 1981. He served as that new group's first Vice Chair under Ed Moll and has been on the Executive Committee of the combined IUCN Tortoise and Freshwater Turtle Specialist Group ever since, as well as a long-time and current Board member of Turtle Survival Alliance, Turtle Conservancy, Turtle Conservation Fund, and Chelonian Research Foundation. He was also present at the creation of the TSA in Fort Worth back in 2001. Other IUCN positions include the Steering Committee of the Species Survival Commission since 1982 and the IUCN Council from 2004 to 2012, and he was an IUCN Vice-President from 2008-2012. In December, 2017, Russ moved to Global Wildlife Conservation to work with Wes Sechrest and Don Church, and is currently that organization's Chief Conservation Officer. His work there, as it has for the past 50 years, focuses heavily on tropical forests and primates, with a strong side interest in turtles.

Although he has been involved in the creation of many different funding mechanisms for biodiversity conservation and is a regular participant in conferences on subjects as diverse as climate change, biodiversity, protected areas, and of course primates and turtles, he is happiest when out exploring yet another rain forest, or searching for a rare primate or turtle or some other flagship species on his bucket list, or adding yet another country to his Travelology List, currently at 169 countries. Indeed, based on a bird-watching model, he created the concept of Primate-Watching and Life-Listing to stimulate global interest in these animals, and is in the process of trying to do the same for Turtle-Watching. He has almost certainly been to more rain forests than anyone else and seen over 90 species of turtles in the wild.

Russ is especially proud of his work in discovering and describing species new to science. He has been involved in the description of 20 new species (3 turtles and 17 primates), has had 8 named after him (two lemurs, one saki monkey, three frogs, a lizard, and an ant – but no turtles yet), and has collected several named by other people. His work has been recognized by many different organizations, universities, and countries. He is a member of the American Academy of Arts and Sciences, has two honorary doctorates, one from Stony Brook and one from Eckerd College in Florida, was named a "Hero for the Planet" by Time magazine in 1998 (an honor shared by previous Behler Award winner Peter Pritchard), and has received nearly two dozen awards, including the Gold Medal of the San Diego Zoological Society (1987), the Order of the Golden Ark from Prince Bernhard of the Netherlands (1995), the National Order of the Southern Cross from the President of Brazil (1997), the Grand Sash and Order of the Yellow Star (1998) from the President of Suriname, the Sir Peter Scott Award for Conservation Merit from the SSC (2006), and the Harvard University Graduate School of Arts and Sciences Centennial Medal (2017). In September, he will also receive the prestigious Indianapolis Prize for his leadership in global conservation efforts. Last but not least, Russ has for a long time been a trusted friend, mentor, facilitator, and partnership builder for many in the turtle and global research and conservation communities.

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, Turtle Conservancy, IUCN Tortoise and Freshwater Turtle Specialist Group, Chelonian Research Foundation, Wildlife Conservation Society, Turtle Conservation Fund, Surprise Spring Foundation, Turtle Survival Alliance, Andrew Sabin Family Foundation, George Meyer and Maria Semple, Brett and Nancy Stearns, and Deb Behler.

Congratulations Russ, old friend—extremely well deserved!

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

Turtle Survival Alliance (TSA) and
IUCN Tortoise and Freshwater Turtle Specialist Group (TFTSG)
Policy on Annual Symposium Code of Conduct

The TSA / TFTSG Annual Symposium is a forum to present, consider, and debate scientifically relevant research and viewpoints professionally and respectfully. All participants will at all times be held to the highest standard of professional ethics and conduct. TSA and TFTSG are committed to providing a professional meeting environment that (1) fosters open dialogue and the exchange of scientific information and ideas, (2) promotes equal opportunities for and treatment of all participants, and (3) is free of discrimination or any forms of harassment or objectification based on gender, sexual orientation, age, disability, nationality, race, ethnicity, religion or religious belief, or military/veteran status. This policy applies to all attendees, including speakers, exhibitors, staff, contractors, volunteers and guests at the symposium itself and at associated activities in hospitality suites and venue facilities. **All presenters are requested to review and assess their own presentations for appropriateness of content so as not to transgress against this Code of Conduct.** If anyone has any concerns about perceived Code of Conduct-related issues at the Symposium, please direct them to either TFTSG Chair Craig Stanford or TSA Executive Director Rick Hills, who will discuss them with their teams.

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.do/2018Talks**. 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 12 – 3:00 PM – 5:00 PM
- August 13 – 8:00 AM – 4:00 PM
- August 14 – 8:00 AM – 4:30 PM

Contents of this Conference Program should be cited as:

Author. 2017. **Title**. In A.D. Walde and C.A. Jones (Eds.). Program and Abstracts of the Sixteenth Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. Turtle Survival Alliance, Fort Worth, Texas. pp. *xx–xx*.

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

- Advanced Telemetry Systems
- Desert Tortoise Council
- Holohil
- Mazuri
- Sonotronics
- Stoneridge Art Studios
- the Turtle Room
- Turtle Conservancy
- Turtle Survival Alliance
- Wildlife Materials, Inc.
- Zoo Med Laboratories

Conference Notes and Social Activities

Saturday, August 11

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

Sunday, August 12

- Registration — 2:00 PM – 5:30 PM (Registration Desk – West Promenade)
- Vendor Set up — 2:00 PM – 5:30 PM (Crystal A)
- Auction Item Drop Off — 3:00 PM – 5:30 PM (Crystal A)
- Poster Hanging — 3:30 PM – 5:30 PM (Crystal A)
- Icebreaker — 6:00 PM – 8:00 PM (Crystal D)

Monday, August 13

- Registration — 8:00 AM – 4:00 PM (Registration Desk – West Promenade)
- Auction Item Drop Off — 8:00 AM – 1:00 PM (Crystal A)
- Exhibit Hall Open — 7:30 AM – 6:00 PM (Crystal A)
- Poster Viewing — 7:30 AM – 6:00 PM (Crystal A)
- Silent Auction Opens — 4:00 PM (Crystal A)
- Silent Auction #1 Closes — 6:00 PM (Crystal A)

Tuesday, August 14

- Registration — 8:00 AM – 4:00 PM (Registration Desk – West Promenade)
- Exhibit Hall — 8:00 AM – 4:00 PM (Crystal A)
- Poster Viewing — 8:00 AM – 4:00 PM (Crystal A)
- Silent Auction #2 Closes — 1:00 PM (Crystal A)
- Poster Session — 3:30 PM – 5:30 PM (Crystal A)
- Silent Auction #3 Closes — 5:00 PM (Crystal A)

Wednesday, August 15

- Registration — 8:00 AM – 1:00 PM (Registration Desk – West Promenade)
- Auction Payment / Pick-up — 8:00 AM – 1:00 PM (Crystal A)
- Exhibit Hall Open — 8:00 AM – 1:00 PM (Crystal A) ***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 (Crystal A)
- 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 at the Fort Worth Zoo — Buses depart at 5:00 PM

Support the TSA!

Be sure to visit the TSA merchandise tables in the Exhibit Hall (Crytal A) 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 it generates funds to help support the TSA's conservation programs. The silent auction will take place on Monday and Tuesday in the Exhibit Hall (Crystal A), 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 (Crystal A). Please note: no auction items 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.

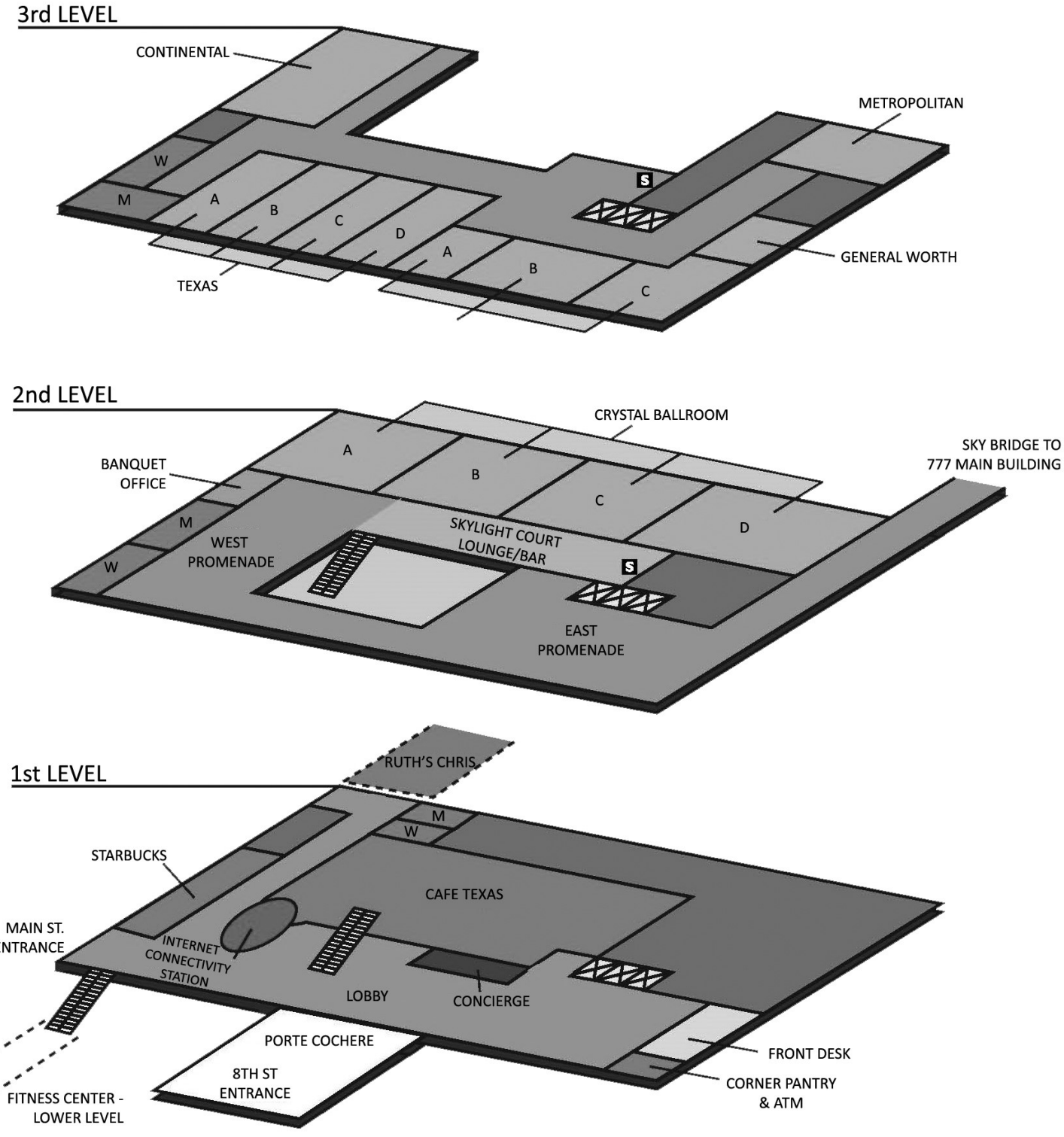
To our lucky winners: auction items may be paid for and picked up in the Exhibit Hall from 8:00 AM – 1:00 PM on Wednesday.

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: @turtlesurvival
Join the conversation! Use #TSA2018 when you post or tweet about the meeting or to follow along!

Hilton Fort Worth



Conference Schedule Overview

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<tr><td>9:00</td><td colspan="2" rowspan="12"></td><td colspan="2" rowspan="12"><u>TSA Board</u>
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(closed)</td><td>TFTSG</td></tr>
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George Heinrich</td></tr>
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<tr><td>11:15</td><td rowspan="3">Communicating Science
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<tr><td>12:00</td><td colspan="2" rowspan="2">Lunch</td><td colspan="2" rowspan="2">Lunch</td><td rowspan="2">Lunch</td></tr>
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(closed)</td><td rowspan="14"><u>Registration</u>
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Conference Schedule Overview

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<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="6">Conservation</td><td rowspan="6">Field Studies/
Techniques</td><td rowspan="6">Field Studies/
Techniques</td><td rowspan="6">Captive Husbandry
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<tr><td>10:45</td></tr>
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<tr><td>11:30</td></tr>
<tr><td>11:45</td></tr>
<tr><td>12:00</td><td>Lunch</td><td>Lunch</td><td>Lunch</td><td>Lunch</td></tr>
<tr><td>13:00</td><td rowspan="5">Conservation &
Policy in North
America</td><td rowspan="5">Graptemys</td><td rowspan="5">Field Studies/
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<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="3">Headstarting</td><td rowspan="3">Graptemys
(cont.)</td><td colspan="2" rowspan="4">Special Presentations</td></tr>
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<tr><td>15:00</td></tr>
<tr><td>15:15</td><td colspan="2" rowspan="4">Poster Session</td></tr>
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<tr><td>17:00</td><td colspan="2" rowspan="4">Banquet and Awards
At Fort Worth Zoo</td></tr>
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Daily Schedule					
	Saturday August 11		**Sunday August 12**		**Monday August 13**
	Texas D Room		**Texas D Room**		**Crystal B/C Rooms**
8:30					Turtle Survival Alliance - Opening Address
9:00			**TSA Board (9:00 - 17:00) (Closed)**		TFTSG - Update
9:15					Madagascar Updates R HUDSON, B RAPHAEL, N RAKOTOARISOA, AND S RANDRIANJAFIZANAKA
9:30					
9:45					
10:00					Smuggling of N.A. Turtles from U.S. to Asia J VENTURA
10:15					***Break & Posters***
10:30					The Big Turtle Year: Celebrating Wild Turtles Across the United States G HEINRICH
11:00					
11:15					Using the Internet to Communicate Science, Reach New Audiences, and Advance Reptile Conservation D STEEN
11:30					
12:00			***Lunch***		***Lunch***
					TSA Field Programs Chair: R. Hudson
13:00					India – S SINGH
13:15					Cambodia – S SOM
13:30					Sulawesi – C LIGHT
13:45					Bangladesh – S TRAGESER
14:00	**TCF Board (14:00 - 16:00) (Closed)**		**TSA Board (9:00 - 17:00) (Closed)**	**Registration In Lobby (14:00-17:30)**	Colombia – G FORERO-MEDINA
14:15					Myanmar – K PLATT/S PLATT
14:30					***Break***
					Texas Turtles Chair: E. Munscher
14:45					A State of Texas Turtles C FRANKLIN
15:00		**Registration In Lobby (15:00-18:00)**			
15:30					Fort Worth's Turtles - Trinity River Turtle Survey A BRINKER
15:45					Ecology of the Western Chicken Turtle in Texas B BOWERS
16:00					Home Range and Population Size of Rio Grande Cooters S SIRSI*
16:15					Impacts of Hurricane Harvey on Alligator Snapping Turtles E MUNSCHER
16:30					BBQ, Beer, and Turtles V RICARDEZ
17:00					
17:30					***Pizza and Beer***
18:00			**Icebreaker Social (Crystal D Room)**		Nomenclature and Taxonomy in Turtles; Just What is the Correct Name? S THOMSON
18:30					
19:00					IUCN – TFTSG Open Forum on Not Evaluated/Data Deficient Species C STANFORD

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

Daily Schedule		
	Tuesday August 14 – Crystal B	**Tuesday August 14- Crystal C**
8:30	**Morning Announcements**	**Morning Announcements**
	Populations/Status Chair: J. Gray	***Asian Chelonians*** Chair: D. Gaillard
8:45	Conservation Status of the Mexican Rough-Footed Mud Turtle R MACIP-RIOS	Black-breasted Leaf Turtle Research and Conservation J DAWSON
9:00	Abrupt Transition of Turtle Species Composition in Japan N KAMEZAKI	Nesting and Estimates of Snail Eating Turtles in Central Thailand Y VISOOT*
9:15	Assessing the Current Status and Distribution of Flattened Musk Turtles and Identifying Focus Areas for Conservation J JENKINS*	Population Demography of Southeast Asian Box Turtles (*Cuora amboinensis*) in Protected and Disturbed Habitats in Indonesia N KARRAKER
9:30	Population Dynamics of the Ornate Box Turtle at Two Sites in Illinois D EDMONDS*	Love Rollercoa$ter: Ups and Downs in Chinese Turtle Trade B ANDERS
9:45	*Testudo graeca nikolskii* Ecology at the Western Caucasus (Russia) O LEONTYEVA	Temperature Sex Determination of the Snail-Eating Turtle R PEWPHONG*
10:00		Status of the Asian Giant Softshell Turtle in the Philippines M ESCOBAR*
10:15	***Break & Posters***	***Break & Posters***
	Conservation Chair: B. Atkinson	***Field Studies/Techniques*** Chair: B. Anders
10:30	Recruiting Future Stewards Through Terrapin Research B ATKINSON	Preliminary Research on the Natural History of Chiapas Mud Turtle E REYES GRAJALES*
10:45	Conservation and Participatory Monitoring of Turtles in the Lower Rio Negro Mosaic of Protected Areas C FERRARA	Effects of Category 5 Hurricane Patricia on the Ecology of a Tropical Dry Forest Turtle (*Rhinoclemmys rubida perixantha*) in Mexico C CUPP*
11:00	Conservation Strategies for the Ephemeral Swamp Specialist *Pseudemydura umbrina* in South-Western Australia G KUCHLING	Conservation Detection Dogs' Role in Monitoring, Rescue, and Managment of Chelonians Globally P COPPOLILLO
11:15	Prioritising Hydrographic Regions for Brazilian Freshwater Turtle K STANNARD*	Antibacterial Activities of Plasma from the Common (*Chelydra serpentina*) and Alligator Snapping Turtle (*Macrochelys temminckii*) S BAKER
11:30	Vulnerability of Nesting Sites of *Podocnemis* Species and Effectiveness of Public Policies in the Brazilian Amazon C FAGUNDES	Differences in Innate Immune Mechanisms in Common and Alligator Snapping Turtles M MERCHANT
11:45	Reintroduction Program for Central American River Turtle in Mexico G GONZALEZ-PORTER	eDNA to Detect Alligator Snapping Turtles at the Edge of Range E KESSLER*
12:00	***Lunch***	***Lunch***
	Conservation & Policy in N.A. Chair: C.A. Jones	***Graptemys*** Chair: W. Selman
13:00	Strategic Road Effect Mitigation Planning K HOLCOMB	Growth/Body Condition of the Common Map Turtle: A 19-Year Study P LINDEMAN
13:15	The Mojave Desert Tortoise: A New Top 25+ Turtle in Trouble R AVERILL-MURRAY	Phylogeny of the Map Turtles (*Graptemys*) Reveals an Extraordinarily Recent Adaptive Radiation Across the Southeastern US B SHAFFER
13:30	Development of a Rangewide, Collaborative Conservation Strategy for the ESA-Petitioned Western Pond Turtle Complex J BUSHELL [P NANJAPPA]	The Pascagoula Map Turtle, Elevating a Candidate R DUMAS
13:45	The Recovering America's Wildlife Act: The Texas Model J DAVIS	Documenting Turtle Populations in the Urban Waterways of Alabama A COLEMAN
14:00	Desert Tortoise Council: 43y of Conserving N.A. Desert Tortoises M TUMA	Use of Habitat Features by Map Turtles in Louisiana J CARR
14:15	***Break & Posters***	***Break & Posters***
	Headstarting Chair: S. Carstairs	***Graptemys*** (cont.)
14:30	Analysis of 6 years of Post-Release Data of Headstarted Blanding's Turtles, Compared to a Control Group of Wild Blanding's S CARSTAIRS	Communal Hibernation in the Northern (Common) Map Turtle: Insights and Interrogations from 15 Years of Research in Ontario G BULTÉ
14:45	Mortality is too Damn High: Demographic Challenges of Alligator Snapping Turtle (*Macrochelys temminckii*) Translocations M DRESLIK	Notes on the Hatchling Emergence Ecology of Ouachita Map Turtles (*Graptemys ouachitensis*) on the Lower Wisconsin River, Wisconsin G GELLER
15:00	Population Growth Estimates and Potential Management Scenarios for Five Populations of the Endangered Bog Turtle in North Carolina M KNOERR*	A Pearl of Great Price: An Urban Stretch of River and its Importance for Two Endemic *Graptemys* Species of the Pearl River W SELMAN
15:15	Demographic Influence of Head-starting Blanding's Turtle in Illinois J ROSS	Map Turtle (*Graptemys*) Studies in Alabama J GODWIN
15:30-17:30	***POSTER SESSION***	

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

Daily Schedule		
	Wednesday August 15 – Crystal B	**Wednesday August 15 – Crystal C**
8:30	**Morning Announcements**	**Morning Announcements**
	Genetics Chair: F. Ihlow	***Captive Husbandry*** Chair: S. Enders
8:45	Gene Flow and Unexpected Ancient Divergences in Western Palearctic Pond Turtles (*Emys* spp.) M VAMBERGER	Getting in Front of the 8-ball: Establishing a Captive Breeding Protocol for *Pangshura smithii*, Before It Becomes Endangered P VANDER SCHOUW
9:00	Eggshells as Source of Maternal DNA in Six-Tubercled Amazon River Turtles (*Podocnemis sextuberculata*) C CAMILLO*	Successful Propagation of the Big-headed Turtle (*Platysternon megacephalum*) at the Turtle Survival Center C HAGEN
9:15	Double Vision: The Sympatric Interactions of Two Closely-Related Musk Turtles in the Pascagoula River System G BROWN*	The Shell-less Incubation Technique for Aquatic Turtle Eggs Q HU
9:30	Unexpected Lack of Genetic and Morphological Divergence in the Widespread Elongated Tortoise F IHLOW	Unlocking the Secret to Sulawesi's Endemic Turtles N HAISLIP
9:45	Forest Loss Drives Evolutionary Dynamics in the Endemic Dahl's Toad-headed Turtle N GALLEGO-GARCIA	Do Spiny Softshell Turtles Do "False Crawls" Before They Lay Their Eggs? M FELDMAN
10:00	Eight Foot and Flower Power Turtles: A Phylogenetic and Phylogeographic Approach to Conservation D GAILLARD	Probability of Nuchal Scute Presence in Captive Born Forsten's Tortoises (*Indotestudo forstenii*) B FORREST
10:15	***Break & Posters***	***Break & Posters***
	Field Studies/Techniques Chair: B. Atkinson	***Captive Husbandry (cont.)***
10:30	Alligator Snapping Turtles in Two River Drainages, Mississippi L PEARSON*	Husbandry and Reproduction of *Terrapene coahuila* C LEONE
10:45	Towards a Qualitative Understanding of Turtle Lifestyles: Morphology, Performance, and Ecology of Three Sympatric Turtles in a Tropical Dry Forest T BUTTERFIELD*	Amazon Forest Pond Turtles in the Terrarium of the Center for the Study of Amazon Turtles S MENEZES DE OLIVEIRA [R VOGT]
11:00	Health and Density Effects on Overwintering Behavior of Translocated Gopher Tortoises in Northwest Florida R COZAD*	Captive Management and Propagation of the Critically Endangered Southern Vietnam Box Turtle (*Cuora picturata*) at the Turtle Survival Center (TSC) C HAGEN
11:15	Insights into Freshwater Turtle Diversity and Perceived Threats Along the River Ganges, Northern India A MITAL*	Newly Discovered and Documented Ritualistic Behaviors and Communications Among a Rarely Observed Turtle, the Zulia Toad-head (*Mesoclemmys zuliae*) C FRANKLIN
11:30	The Use of Emerging Drone Technology for Conservation of Mojave Desert Tortoise and Bolson Tortoise T SHIELDS	Predator Exclusion Using Electric Fencing for Captive Turtles and Tortoises in Central Texas W MONTGOMERY
11:45	Tracking Turtles: Comparing Watershed to Waterfront Wetlands M DUPUIS-DÉSORMEAUX	Some Observations on Reproduction in Spiny Turtles (*Heosemys spinosa*) B HUGHES
12:00	***Lunch***	***Lunch***
	Field Studies/Techniques (cont.)	***Zoos & Chelonians*** Chairs: B. Hughes & A. Stern
13:00	Prey Diversity and Patterns of Dietary Overlap in an Insular Population of Ornate Diamondback Terrapins C FERRAN [B ATKINSON]	Road Mortality of Box Turtles in Oklahoma: Increasing Zoo Involvement A RICHTER*
13:15	Distribution and Habitat Associations of Western Chicken Turtles in Southeastern Oklahoma D LIGON	Overview of Turtle Research at Tennessee Aquarium Conservation Institute J ENNEN
13:30	Can Temporary Visits from a Common Snapping Turtle Cause Legacy Effects in Freshwater Food Webs? J ENNEN	Preliminary Data on Body Mass, Neonatal Color, and Morphological Changes in Captive Chinese Big-Headed Turtle with a Brief Mention on Incubation Temperatures and Sexing N SHELMIDINE
13:45	Variation in Clutch Phenology of Sonoran Desert Tortoises R AVERILL-MURRAY	A Comparative Diet Study for Hand Rearing Galapagos Tortoises A ORTEGA
14:00		Raisin' Alligator Snappers in a Double-Wide; Not Just a Country Music Song Title. Head-starting Alligator Snapping Turtles at the Nashville Zoo K GREGORY
14:15	***Break & Posters***	***Break & Posters***
	Special Presentations Chair: A. Walde	
14:30	Turtle Sound Communication C FERRARA	
15:00	Where Have All the Turtles Gone, and Why Does It Matter? J LOVICH	

*** Student Considered for Student Awards Competition**

Poster Presentations *(Crystal A)*	
Poster Session Tuesday, August 14th at 1530 h	
Turtle Community and Habitat Preference within Two Southern Mississippi Drainages G BERRY*	A Novel Method for Assessing Color Differences in Dichotomous Groupings: An Example with Sexual Dichromatism in the Central American River Turtle (*Dermatemys mawii*) N BISHOP*
Mercury Concentrations in Two Species of Freshwater Turtles from North Texas A BRINKER	Evidence of Male-Male Aggression in Loggerhead Musk Turtles (*Sternotherus minor minor*) in Florida Springs K CAMPBELL*
Post-release Growth Rates of Translocated Alligator Snapping Turtles (*Macrochelys temminckii*) M DRESLIK	Growth in a Central Illinois Eastern Box Turtle (*Terrapene carolina carolina*) Population D EDMONDS*
Don't Put All Your Eggs in One Basket: Lessons Learnt from the Largest Scale and Longest Term Wildlife Conservation Program in the Brazilian Amazon C EISEMBERG [K STANNARD]	Diatoms Associated with Turtles in Texas and Oklahoma K FAULKNER*
A Demographic Matrix-model Analysis of Spotted Turtles (*Clemmys guttata*) in Illinois C FENG	Habitats of Hatchlings in Three Turtle Species Living in the Fresh Waters of Japan N FUJIBAYASHI
Survey Effort and the Species Assemblage of Basking Turtles R GLASFORD*	Examining the Efficacy of Bait Types in Broad-Scale Turtle Surveys J GRIZZLE*
Next-generation Sequencing for Conservation of a Home's Hinge-back Tortoise (*Kinixys homeana*) Population in Central Ghana J KITTLE*	Moving Home twice: Impact of Suzhou Zoo's Move to a New Location on the Breeding Program of the World's Most Critically Endangered Turtle *Rafetus swinhoei* in China G KUCHLING
A Probable Testudinoid from the Upper Cretaceous of New Mexico A LICHTIG	Morphological Variation in Extant Testudinoids A LICHTIG
Hotspot of Red-eared Slider in Japan Y MAEKAWA*	Home Range and Spatial Ecology of the Eastern Box Turtle (*Terrapene Carolina*) in Southern Illinois E SHAMELY**
Tortoise Reintroduction as a Species Conservation and Rewilding Tool: The Atlantic Forest Case C STARLING-MANNE*	Current Status of Japanese Pond Turtle (*Mauremys japonica*) in Japan S SUNABA*
Chasing Chambal Chitra: Spatial Ecology and Seasonal Activities A TRIPATHI [J LANG]	Fungivorous Impressed Tortoise (*Manouria impressa*) Select Foods by Scent J WANG
Mixing Oil with Water: Investigations into the Effects of an Oil Spill on Reproductive Output in River Turtles M WELC	The Relative Influences of Turtle Ecology and Ambient Water Quality on Determining the Community Composition of Epizoic Diatoms N WILLIAMS*
***Student Considered for Student Awards Competition**	

Love Rollercoa$ter: Ups and Downs in Chinese Turtle Trade

BEN ANDERS
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The years 2015-2018 have been a pivotal time for the Chinese turtle industry. Trade value, demand, and unpermitted harvest and sale of various species have followed less than predictable patterns subject to rapid change, and haven't been heavily influenced by major international or physiographic boundaries. This talk will discuss the rise and fall of turtle trade through Hong Kong into mainland China for the aforementioned three-year period, and will explore some of the ways conservation dogma may adapt to better address an industry that is increasingly facilitated by digital technology's speed of communication and encryption.
Asian Chelonians: Oral

An Army of Turtle Nerds: Recruiting Future Stewards Through Terrapin Research

BENJAMIN K. ATKINSON[1] AND COLEMAN M. SHEEHY III[2]
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Ornate Diamondback Terrapins (*Malaclemys terrapin macrospilota*) are native to salt marsh and other estuarine habitats along Florida's Gulf Coast. However, little is known regarding their population demographics and habitat use throughout the range of the subspecies. In 2014, we identified a robust population of diamondback terrapins in the Cedar Keys National Wildlife Refuge and initiated long-term mark-recapture and ecological studies. We have subsequently collected data on population size, demographic structure, habitat use, and diet of the resident terrapins. Additionally, we have effectively leveraged this study site to train biology students in research and critical thinking skills, providing hands-on experience in coastal conservation and marine biology. Undergraduates involved in our terrapin research have attended Flagler College, Florida Gulf Coast University, Santa Fe College, and University of Florida. We also involved students from the Doris Duke Conservation Scholars program, and our efforts have spawned collaborative research projects for graduate students. Over 125 undergraduates have been involved to date from nine separate courses at four colleges and universities, and these numbers continue to grow. Flagler College's Coastal Environmental Science program has made this terrapin research and training of undergraduates a featured project; the Florida Fish and Wildlife Conservation Commission designated the population as a "sentinel population." We summarize results of our investigations with this terrapin population, implications for conservation, and discuss long-term goals to utilize this refuge for training and inspiring future stewards of Florida's Gulf coast ecosystems.
Conservation: Oral

Variation in Annual Clutch Phenology of Sonoran Desert Tortoises (*Gopherus morafkai*) in Central Arizona

ROY C. AVERILL-MURRAY[1], JEFFREY E. LOVICH[2], MICKEY AGHA[3], JOSHUA R. ENNEN[4], AND MEAGHAN AUSTIN[5]
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The phenology of egg production and oviposition affects survival and development of neonates – and in those with temperature-dependent sex determination, hatchling sex ratios – which combine to affect offspring and maternal fitness and population demography. The rapid rate of contemporary climate change may disrupt reproductive phenologies that evolved to match environmental conditions. To better understand the response of clutch phenology to annual and long-term changes in climate, we studied a Sonoran Desert Tortoise (*Gopherus morafkai*) population in Arizona in 1993 and 1997–2005, specifically quantifying three phenophases including: (1) the estimated timing of

appearance of shelled eggs in females, (2) the estimated timing that eggs were last visible in X-radiographs, and (3) the estimated duration between the first two events. The mean date for appearance of shelled eggs was 6 June, and the mean date they were last visible was 26 June; however, these dates differed significantly among years after controlling for individual female effects. The total number of days that eggs were visible across females within a year also differed significantly among years, but the mean duration that clutches were visible was not statistically different among years after controlling for individual female effects. Most females produced shelled eggs through heat-unit accumulation achieving 8.3 degree days within a 14-day moving average. The ability to vary the timing of egg formation and oviposition may buffer *G. morafkai* from some of the effects of predicted increases in temperatures, but species-specific information on developmental temperatures and nesting behavior is needed to determine whether or not the species will be able to produce viable clutches of mixed sex ratios in a warmer climate. Finally, three of 18 females exhibited inter-annual egg retention on 5 occasions from 52 clutches. Although *G. morafkai* ovulates only one clutch/yr, they may oviposit up to two due to inter-annual egg retention.
Field Studies/Techniques: Oral

The Mojave Desert Tortoise: A New Top 25+ Turtle in Trouble

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The Mojave Desert Tortoise (*Gopherus agassizii*) is listed as Threatened under the U.S. Endangered Species Act, and the Turtle Conservation Coalition recently added it to its list of "Top 25+ Turtles in Trouble." Declines up to 11% per year have occurred since 2004. Populations have increased in some conservation areas, but designated conservation areas lost over 120,000 adult tortoises (37%) between 2004 and 2014. Significant threats to the species include habitat degradation resulting from increasing invasive annual plants and associated impacts to individual nutritional status and health, as well as increasing wildfires that lead to landscape conversion. Human-subsidized predators substantially impact both juvenile and adult tortoises, and tortoises remain vulnerable to mortality along many highways. Habitat also continues to be lost to development and military training outside of conservation areas. In response to ongoing threats, land and wildlife managers recently reinvigorated recovery efforts. For example, habitat restoration in the northeastern Mojave Desert focuses on reducing invasive grasses with pre-emergent herbicides, restoring native species through seeding and outplanting, and conducting rigorous monitoring to evaluate the effectiveness of these techniques. A partnership between state, federal, and private managers in the western Mojave Desert works with local OHV groups to participate in route-restoration, accomplishing on-the-ground improvements while enhancing education and buy-in of an important desert user group. Mitigation fees in California support increasing management of ravens, including lethal removal of individuals documented to prey on tortoises, new efforts to reduce recruitment by oiling eggs, and research on deterrence methods to disrupt raven behavior and to condition ravens not to eat tortoises. While more work remains to be done, the question remains whether these efforts will be enough to recover the species. The looming specter of climate change may exacerbate population declines via increased and prolonged drought. Increasing temperatures during incubation also may affect population sex ratios or embryonic survival, depending on changes in reproductive phenology. Research on the effects of a changing climate on tortoise populations should guide future conservation efforts to maximize the prospects for recovery.
Conservation and Policy in North America: Oral

Antibacterial Activities of Plasma from the Common (*Chelydra serpentina*) and Alligator Snapping Turtle (*Macrochelys temminckii*)

SARAH J. BAKER[1], ETHAN J. KESSLER[1], AND MARK E. MERCHANT[2]
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Innate immunity provides a fast-acting, non-specific defense against microbial infection and appears to have particular importance in the immune response of ectothermic vertebrates. Chelonians are a globally distributed and diverse group, yet little is known about their basic immune function. The chelonian family Chelydridae is made up of two genera (*Chelydra* and *Macrochelys*), represented in our study by the widespread Common Snapping Turtle

(*C. serpentina*; CST) and the southeast USA endemic Alligator Snapping Turtle (*M. temminckii*; AST). Our goal was to quantify the innate immune response of the family Chelydridae, using antibacterial activity of plasma as a measure of immune function. Our results show that the plasma of both species has strong antibacterial properties, but CST plasma kills a higher percentage of bacteria than AST plasma. Additionally, while both species showed the highest antibacterial activity at 25-30°C, CST plasma retained its antibacterial properties at lower and higher temperatures than AST plasma. Our results indicate that, like many ectotherms, Chelydridae have a relatively strong innate immune response. The stronger, more robust immune response of CSTs compared to ASTs is likely correlated to the differences in geographic ranges but may also have implications for each species' tolerance to anthropogenic habitat degradation and global climate change.
Field Studies/Techniques: Oral

Turtle Community and Habitat Preference within Two Southern Mississippi Drainages

GABRIELLE BERRY, LUKE PEARSON, AND CARL QUALLS
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In the United States, and around the world, turtles are facing a multitude of threats that without intervention could lead to the loss of numerous species. The state of Mississippi in particular boasts the second highest turtle diversity within the United States, paling only slightly to neighboring Alabama. Riverine species make up the bulk of this diversity and are a particularly threatened group. However, little to no research has been done on a majority of MS species. A thorough understanding of habitat use, distribution, and abundance is imperative for protecting and conserving these native river dwellers. Sixteen sites within the Pascagoula River drainage, and 20 sites within the Pearl River drainage, including both rivers and oxbow lakes, were surveyed, totaling over 1,500 trap nights. Partially submerged baited hoop nets (3' and 4') were used to obtain the turtles. Individuals were also hand captured when the opportunity arose. Sight surveys were completed to get a more in-depth scope of overall diversity by adding (non-piscivorous) species our baited traps were deemed unlikely to attract. Canonical Correlation Analyses were used to elucidate microhabitat relationships preferences per species. Our preliminary results show the representation of 14 species, from 8 genera, with varying abundances based on location. There were distinct community differences associated with habitat, with river environments exhibiting much greater diversity than oxbow lakes. This study provides the comprehensive overview of riverine turtle distribution and abundance throughout Southern Mississippi necessary to make more informed management decisions which will aid in future riverine turtle conservation.
Presentation Type: Poster (Student)

A Novel Method for Assessing Color Differences in Dichotomous Groupings: An Example with Sexual Dichromatism in the Central American River Turtle (*Dermatemys mawii*)

NICHOLE D. BISHOP[1] AND RAYMOND R. CARTHY[2]
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Assessing the colors of stripes or skin patches on the head, neck, and legs of turtles has been used in a variety of studies. Researchers have used these variations in color to differentiate groups of turtles (e.g. sex), to assess states of health, and to measure the degree of phenotypic plasticity. Traditionally, visible colors have been quantified by measuring the wavelength of light reflected off a surface using a spectrophotometer, thereby allowing quantitative analyses. However, technology associated with this method is costly (often thousands of dollars) and may not be conducive to remote field studies. Here we present an alternative inexpensive way to accurately assess color differences using digital photographs of individual turtles. To demonstrate our technique, we assessed the differences in head coloration between male and female *Dermatemys mawii* in which sex was already known. *D. mawii* is an excellent subject for this study given the clinal variation in head coloration between sexes. Digital pictures of each individual were taken in the field with a plain color background. Color among the photographs was then standardized using the background color of each image. To quantify head color, the RGB (red green blue) color model was used. The RGB color model is a system in which color can be quantified using three-dimensions and Cartesian coordinates in a Euclidean space where red (x-axis), blue (y-axis), and green (z-axis) combine in varying intensities to produce all visible colors between black and white. In digital images, each pixel has three numbers that

correspond to Cartesian coordinates on the RGB model. Thus, we can determine if the differences between coordinates (i.e. different colors) are significant using binary logistic regression. We used mean and modal RGB head coloration and tested the fit of each model. Both models were significant (mean RGB $p<0.001$; modal RGB $p<0.001$), and the mean RGB head coloration had a predictive correctness 84.1% of the time compared to 83.7% for the modal RGB head coloration. Our results indicate that this method can be a reliable and inexpensive technique for quantifying and analyzing coloration between groups of individuals where a suspected dichotomy exists.
Presentation type: Poster (Student)

Movements, Home Range, Activity Patterns, and Habitat Selection of the Western Chicken Turtle (*Deirochelys reticularia miaria*) in Texas

BRANDON BOWERS[1], DANIELLE K. WALKUP[1], TOBY J. HIBBITTS[1, 2], PAUL CRUMP[3], AND WADE A. RYBERG[1]
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[2]Biodiversity Research and Teaching Collection, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843 USA;
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Little is known about the Western Chicken Turtle (WCT; *Deirochelys reticularia miaria*) in Texas. Past research suggests it is potentially rare in the state with a patchy distribution, and its habitat is under threat from increasing urbanization. For these reasons, and because there is a lack of formal protection for the subspecies and its habitat, the U.S. Fish and Wildlife Service (FWS) issued a 90-day finding that states listing the subspecies as threatened or endangered may be warranted. In this 90-day finding, FWS requested information on current and future threats to WCT populations and habitat throughout its range to help make a final ruling on listing. To address this request, we designed a GPS telemetry study to characterize the movements, home range, activity patterns and habitat selection of the WCT in a Texas population under threat from urbanization. Data from these four behavioral traits will be used to differentiate between aquatic movements among wetland habitats and terrestrial movements during nesting and estivation. Understanding the factors that influence movement patterns and habitat selection in both aquatic and terrestrial environments is central to managing or conserving this subspecies, especially given the identified potential threats posed by anthropogenic activities. For example, small home range movements among wetland patches during the activity season may be less likely to be influenced by anthropogenic landscape features causing direct mortality (e.g., roads) when compared with terrestrial movements for nesting or estivation. Here, we present preliminary results on these four behavioral traits from our first, on-going field season at Katy Prairie Conservancy. Collectively, these data will provide a greater understanding of broad and fine-scale habitat relationships for this subspecies that 1) inform the development of standardized survey protocols for the subspecies, 2) allow quantitative estimates of current habitat, and 3) identify conservation priorities and assist regional conservation planning for the subspecies.
Texas Turtles: Oral

Fort Worth's Turtles – Trinity River Turtle Survey

ANDREW M. BRINKER
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Urban rivers are convenient yet oft overlooked resources for chelonian biologists. For the opportunistic investigator they can provide a bountiful and economic research opportunity. The Trinity River in Fort Worth, Texas is one such body of water with six genera representing four families of turtles. The proximity of the survey site allows for a massive citizen science component. Students, teachers, and other community members can access the study sites using the Trinity Trails System. Turtles are collected using hoop traps, basking traps, seine nets and hand-captured. Morphometric data collected includes carapace length/width, plastron length, shell height. Turtles are marked using both shell notches and PIT tags. Species documented include *Apalone spinifera, Trachemys scripta, Graptemys kohnii, Sternotherus carinatus, Pseudemys concinna,* and *Chelydra serpentina*. Results presented will include sex ratios, estimated population sizes, movement in the river, resource partitioning, success of different baits, and general techniques that have improved our sampling efforts throughout the first year of the survey.
Texas Turtles: Oral

Mercury Concentrations in Two Species of Freshwater Turtles from North Texas

ANDREW M. BRINKER[1], MATTHEW M. CHUMCHAL[2], JAKE HARPER1, NICHOLAS ETHERIDGE[1], AND AIDEN ARAGON[1]

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Mercury is a neurotoxin that biomagnifies through aquatic food chains. Anthropogenic activities such as coal combustion and artisanal gold mining release mercury into the environment. Aquatic bacteria then convert inorganic forms of mercury into highly toxic methylmercury. Turtles acquire methylmercury through their diet. Methylmercury bioaccumulates in turtle tissues and can reach high concentrations. Native freshwater turtles are sometimes collected and shipped to Asia as a source of food and traditional medicine. This not only creates a conservation challenge, but also a potential health hazard for those that consume turtles. Herein, we use a non-invasive technique to determine mercury concentrations in living freshwater turtles. Toenail clippings were taken from adult *Chelydra serpentina* and *Trachemys scripta elegans*. Prior to Hg analysis, all tissues were dried in a 60ºC oven. We examined total Hg with a direct Hg analyzer that uses thermal decomposition, gold amalgamation, and atomic absorption spectrometry. The results include samples collected between March and July 2018.
Presentation type: Poster

Double Vision: The Sympatric Interactions of Two Closely-Related Musk Turtles (Genus: *Sternotherus*) in the Pascagoula River System

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The southeastern United States is a global turtle diversity hotspot, yet despite nearly a century of prolific publication, even some of the most common species remain understudied. A case in point are the humble musk turtles (Genus: *Sternotherus*). In South Mississippi, the Pascagoula River System marks an intriguing region for two of the genus' lotic species, as it near the westernmost extent of the Stripe-necked Musk Turtle's (*Sternotherus peltifer*) geographic distribution and is the easternmost extent of the Razorback Musk Turtle's (*S. carinatus*) geographic distribution. This narrow range of overlap between two ecologically similar turtle species provides interesting insight to the forces that create and maintain biodiversity in the region. Where the two musk turtle species are allopatric, they occupy nearly identical lotic habitats and fulfill a very similar ecological niche, such that in sympatry they seemingly violate the "Principle of Competitive Exclusion." To better understand how these species are able to co-occur within the Pascagoula River Drainage, we examined their interaction by 1) using nuclear and mitochondrial DNA to determine whether they are maintaining reproductive isolation or if the two species are hybridizing, and 2) comparing species' habitat preferences within the Pascagoula River System to evaluate levels of niche overlap. To date we have caught 98 *S. peltifer* and 80 *S. carinatus* from the Pascagoula River System. Approximately 7% of Stripe-necked Musk Turtles indicated some evidence of mixed ancestry, whereas we have yet to detect any signs of mixed ancestry in Razorback Musk Turtles suggesting gene flow may be unidirectional. Our data indicate that habitat preferences differ for each species with Razorback Musk Turtles being found primarily in large rivers, and Stripe-Necked Musk Turtles in smaller streams and tributaries. However, some large streams and small rivers facilitate syntopy.
Genetics: Oral (Student)

Communal Hibernation in the Northern (Common) Map Turtle: Insights and Interrogations from 15 Years of Research in Lake Opinicon, Ontario, Canada

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Northern Map Turtles are known to hibernate communally, but we know little about the ecological and social aspects of this behavior. We confirmed the location of communal hibernation sites using radio telemetry and direct

observations of turtles under the ice. Using radio telemetry, we documented the movements of turtles to and from hibernation sites. The timing of arrival and departure from the hibernation sites varied among individuals, but most individuals did not spend their active season near their hibernation sites. Mark recapture over a 15-year period indicated map turtles are faithful to their hibernation sites. Both males and females frequent the same general hibernation sites, and courtship and mating occur at the hibernation sites. Mate choice experiments performed at the communal hibernation sites indicated that males prefer larger females. We discuss the possible interactions between oxygen limitation during hibernation, sexual size dimorphism, mate choice, and communal hibernation.
***Graptemys*:** Oral

Development of a Rangewide, Collaborative Conservation Strategy for the ESA-Petitioned Western Pond Turtle Complex

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The Western Pond Turtle (WPT) complex (*Actinemys* spp.) represents a unique group of semi-aquatic native freshwater turtles found only in Western North America. Their historic distribution extended from northwestern Baja California, Mexico, north to Puget Sound, Washington and previously into southwestern British Columbia, though it is now considered extirpated in Canada. Formerly abundant, WPT are now declining throughout most of their extant range. In the United States, WPT were most recently petitioned for listing under the Endangered Species Act in 2012. Many conservation partners, including state and federal management agencies and zoos, and Canadian and Mexican partners, have been engaged in conservation efforts at small scales. The US Fish & Wildlife Service has set federal fiscal year 2021 for a decision on the listing of one or more portions of the species complex as either Not Warranted, Threatened or Endangered. This presented an opportunity to coalesce partners and scale up conservation efforts. Partners in Amphibian and Reptile Conservation (PARC) was engaged to assist in the effort to develop a rangewide conservation and management strategy. Major factors cited as limiting WPT populations include loss of aquatic habitats, reduced availability of nest habitat, elevated nest and hatchling predation, and road mortality. Many of these are tractable threats that can be addressed with habitat enhancement or restoration actions. Further, with both aquatic and upland habitats required by WPT, collaborative management approaches by multiple agencies and landowners will be imperative to benefit certain populations. The authors listed here present this talk on behalf of the current WPT Rangewide Conservation Coalition (RCC), currently composed of state fish and wildlife agencies, federal natural resource agencies, zoos, private consultants, and international partners. We will present the efforts of the RCC to develop a rangewide strategy that is already improving progress toward our goals of maintaining long-term viability and self-sustaining wild WPT populations throughout the species complex.
Conservation & Policy in North America: Oral

Towards a Qualitative Understanding of Turtle Lifestyles: Morphology, Performance, and Ecology of Three Sympatric Turtles in a Tropical Dry Forest

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Categorizing a turtle's ecology based on observations from the literature has been fundamental in learning general patterns of turtle form and function. Despite the continuing utility of these categorizations, it seems clear that there are situations when categorizations like "terrestrial" or "omnivorous" will fail to capture the continuity of turtle lifestyles. Therefore, it is important to develop a qualitative vocabulary that can accurately describe the diversity in turtle form and function that accounts for the differences between similar species. To do this, we examine the similarities and differences highlighted by categorical and continuous depictions of turtle functional traits across the three species (*Rhinoclemmys rubida*, *R. pulcherrima*, and *Kinosternon chimalhuaca*) that co-occur in the tropical dry forest of Jalisco, Mexico. Based on available literature, *R. rubida* is considered terrestrial and omnivorous and *R.*

pulcherrima and *K. chimalhuaca* semi-terrestrial and omnivorous. To determine if these categorization match what is observed in the field, we compare habitat using categories that represent the hydrological gradient in the tropical dry forest, and diet using stable isotopes. Then, we compare morphology and maximum swimming speed to see if differences in habitat and diet are related to qualitative differences in morphology and performance. Unlike information from the literature, which would suggest that these species substantially overlap in habitat and diet, we find very little overlap in both categories. The overlap that we do observe in habitat or diet is accompanied by separation of the other. These differences are correlated to qualitative differences in morphology and swimming speed. *K. chimalhuaca* occupies the wettest habitats, has longer hands, more webbing, smaller plastron, less-domed shell, and faster swimming speeds in proportion to its body size. Whereas, *R. rubida* occupies the driest habitats, has shorter hands, less webbing, longer plastron, more-domed shell, and slower swimming speeds. *R. pulcherrima* is intermediate to both species. Relationships between head morphology and diet are less clear which might be the result of changes in behavior rather than morphology. We conclude that a finer understanding of morphology and performance can be used to account for subtle differences observed in the habitat and diet of similar species.
Field Studies/Techniques: Oral (Student)

Eggshells as Source of Maternal DNA in Six-Tubercled Amazon River Turtles (*Podocnemis sextuberculata*)

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Recently, eggshell has been suggested as a reliable source of maternal DNA for loggerhead turtles. In this study we evaluate the efficacy of this method for Six-tubercled Amazon River turtles. Samples were collected in the Mamiraua Sustainable Development Reserve, Central Amazon, Brazil, in 2016. We captured 31 females and collected blood and one fresh egg of their nests (the morning after oviposition). DNA was extracted from eggshells using 5% Chelex and from blood using a modified CTAB protocol. We tested 25 microsatellite markers previously developed for Yellow-spotted and Giant South-American turtles to evaluate PCR amplification and levels of polymorphism. Allele frequency, observed and expected heterozygosity and non-exclusion probabilities were calculated using the Allele Frequency Analysis in CERVUS 3.7.0. Genotypes were compared using the Identity Analysis function in the same software, using fuzzy match criteria, and requiring perfect match for at least five loci and allowing mismatches at up to five loci. We genotyped 10 blood and 10 eggshell samples three times and estimated the genotyping error for each locus. Ten out of the 25 loci tested were polymorphic and scorable. Expected heterozygosity varied from 0.47 to 0.96 and the combined non-exclusion probability of full siblings sharing the same genotype was 9.3×10^{-6}. Total error rates varied from 0.06 to 0.19. Loci with highest heterozygosity and lowest full sibling non-exclusion probability were the ones with higher error rates. Only 13 of the 31 samples (42%) were correctly assigned and two (6.5%) were misassigned. Mismatches between blood and eggshell genotypes were mainly due to the presence of a non-maternal allele, presumably paternal alleles from the embryo. However, we also observed cases of mismatches for both alleles. In some eggshell samples we observed more than three alleles and although in many cases both maternal alleles were present, they were not the ones with highest intensity. This may be due to the low quality of eggshell DNA. Our results suggest that eggshells are not a reliable source of maternal DNA for Six-tubercled turtles, at least when using these loci. However, eggshells can still be considered as source of DNA for population genetics studies.
Genetics: Oral (Student)

Evidence of Male-Male Aggression in Loggerhead Musk Turtles (*Sternotherus minor minor*) in Florida Springs

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During the past nineteen years, the Turtle Survival Alliance-North American Freshwater Turtle Research Group (TSA-NAFTRG) has sampled turtles in Florida spring systems. Springs sampled for this study include Wekiwa Springs, Volusia Blue Spring, Manatee Springs, Fanning Springs, and Rock Springs. We have occasionally observed large Loggerhead Musk Turtles (*Sternotherus minor minor*) engaged in conspecific aggressive behavior. In all instances, a large (ca. 100 mm) male was observed chasing and biting the rear carapace of a similar sized or smaller male. Since 2001, we have documented damage to posterior marginal scutes and carapace and we hypothesize that much of this damage is due to the noted aggression. Data used in this analysis includes maximum carapace length, damage to the six posterior-most marginal scutes (L9, 10, 11, R9, 10 and 11), sex, and location captured within the spring if there is a boil/lagoon area and a run area. Results show that presence of damage to males was at least double that of females in each study site, the extent of damage (number of scutes damaged) to males was significantly higher, larger turtles generally had more damage, and turtles from spring runs had more damage than those from the more open boil/lagoon areas. Male-male aggression has been reported in other turtle species, but this is the first record to our knowledge in *S. m. minor*.
Presentation type: Poster (Student)

Use of Habitat Features by Map Turtles and Other Basking Turtles in Louisiana Streams and Lakes

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Freshwater turtles use a broad spectrum of habitat types at the landscape scale in terms of water-body type and many of these species regularly use emergent objects for aerial basking. Map turtles (*Graptemys)* are a highly-visible component of basking turtle assemblages, as are other deirochelyine emydids, in the south-central United States. The goals of this study were to compare the use of habitats and basking objects among basking turtle species. Using a combination of fixed and point count basking-turtle surveys between 1998 and 2018, the assemblage of basking turtles was surveyed at 185 stream and lake sites across five river drainages in Louisiana west of the Mississippi River, with most sites in the Red and Ouachita basins. Among the 6136 turtles observed, 11 species of three families were recorded, including three *Graptemys* species: *G. ouachitensis, G. pseudogeographica kohnii*, and *G. sabinensis*. As observed elsewhere, only two sympatric *Graptemys* species were found in each drainage. In general, at well-surveyed lentic sites, we commonly found the three species *G. p. kohnii, Pseudemys concinna*, and *Trachemys scripta elegans* in association and proportionally dominant in those samples. Depending on the specific nature of the sites, *G. p. kohnii* was sometimes the dominant species as opposed to *T. s. elegans*. Lotic sites were dominated by map turtles, but the dominant map turtle species varied by drainage basin and stream size. In general, *G. p. kohnii* predominates in the Ouachita River and *G. ouachitensis* in the Red River. With respect to basking objects, approximately 96% of objects consisted of dead tree material. For the species with the largest samples *(G. p. kohnii, G. ouachitensis, P. concinna,* and *T. s. elegans),* we compared estimated basking angles among species, and between males and females intraspecifically. The basking angle was not significantly different between the two species of *Graptemys*, but it was in comparisons of *Graptemys* to *Trachemys* or *Pseudemys* ($p < 0.001$). There were no significant differences between the sexes. A variety of deadwood objects is vital to serve for basking by the widest assortment of species in an assemblage of basking turtles.
Graptemys: Oral

Analysis of 6 Years of Post-Release Data of Headstarted Blanding's Turtles, Compared to a Control Group of Wild Blanding's, to Evaluate Headstarting as a Conservation Strategy for Freshwater Turtles

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Turtles are among the most endangered vertebrates on the planet and their long life history reduces the ability of populations to recover from declines. While mitigating threats is required to slow down population declines, supplementing populations with captive-reared juveniles (headstarting) may increase recruitment. This study

compiled six years of post-release radio telemetry data for headstarted Blanding's Turtles (n=36) and compared this to wild-hatched turtles at the same location (juvniles n = 5, adult n=13). We defined our long-term objective as obtaining recruitment of headstarts into the adult population in sufficient numbers to increase the population growth rate. Our short-term objective was to quantify the survival, behaviour, movement patterns, growth and habitat use of headstarts and compare these with wild-hatched juveniles at the same site. In addition, our objectives included utilizing knowledge gained during the initial years, to inform our methodology in future years. A 'hard' release of the headstarts was utilized, with no preconditioning. Both the headstarts and the wild turtles showed the same habitat use. While there was no difference in growth between the two groups when looking at mass, the headstarts grew slower when carapace length was assessed. There was no difference between groups in relation to home range area, and the distance per day travelled increased with size. Survival was lower in the headstarted group; no wild turtles died, but survival of headstarts showed marked annual variation, and on average was high. Mortality was highest the first year of study, and accounted for half of total losses. The release strategy was changed for subsequent years, which might have impacted future survival. Our ongoing study so far indicates favourable results in our short-term objectives in all areas, and suggests that headstarting is a viable conservation strategy for freshwater turtles.
Headstarting: Oral

Urban Turtle Project: Documenting Turtle Populations in the Urban Waterways of Birmingham, Alabama

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Alabama supports an impressive diversity in chelonian species, in part due to the extensive number of aquatic habitats within its borders. A portion of these aquatic habitats are located in urban settings, including the metropolitan area of Birmingham. The creeks and waterways in Birmingham proper are in two watersheds, the Black Warrior River and the Cahaba River, which have experienced significant degradation because of anthropogenic actions. Despite these negative impacts, large turtle populations exist in these waterways, but they have not been properly studied. The Urban Turtle Project, initiated in 2018, aims to document these populations using mark-recapture methods and community volunteers. One species of particular interest is the poorly studied Alabama Map Turtle (*Graptemys pulchra*), which inhabits the Cahaba River in Birmingham. In addition to demographic data, fecal samples and clutch size data are collected when available. To date, over 20 Alabama Map Turtles of all age classes have been collected, marked, and released. These data will provide insight to how this species as well as others persist in urban aquatic habitats.
Graptemys: Oral

Conservation Detection Dogs' Role in Monitoring, Rescue, and Management of Chelonians Globally

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Conservation detection dogs have been used around the world for the monitoring, management and rescue of chelonians. Here, we present an overview of the history and lessons from work on Desert Tortoises (*Gopherus agassizii* in Nevada and California, USA), Bog turtles (*Glyptemys muhlenbergii* in New Jersey, USA), Geometric (*Psammobates geometricus*), Padloper (*Homopus areolatus*), and Angulated (*Chersina angulata*) Tortoises (in Cape Province, South Africa), Blanding's Turtle eggs and nests (*Emydoidea blandingii*, Ontario, Canada), and the Ploughshare Tortoise (*Astrochelys yniphora*, Baly Bay, Madagascar), which highlight the diversity and challenges of using dogs to protect chelonians. In general, dogs are able to find tortoises more quickly and with higher probability than human searchers, particularly among smaller size classes and in more structurally complex habitats. The individual dogs chosen for this work must have manageable prey drive and be experienced in both detail work and area searches. Burrowing species present unique challenges, but these can be overcome. Advances in anti-trafficking methods, including container search techniques, will further expand the utility of dogs for turtle and tortoise conservation.
Field Studies/Techniques: Oral

Health and Density Effects on Overwintering Behavior of Translocated Gopher Tortoises in Northwest Florida

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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 fragmentation. Translocation of tortoises from lands that will be destroyed by development has become an important tool for conserving this species and minimizing losses of individuals. Temperature plays an important role in tortoise health, as tortoises can thermoregulate and induce a fever response to fight illness by altering their behavior, such as changing position within the burrow or emerging to bask. This change in behavior is most noticeable during the winter, when tortoises are thought to be relatively inactive. We investigated the overwintering behavior of healthy (H) translocated Gopher Tortoises and tortoises deemed "at risk" (AR) for developing disease, determined through health assessment, at two release sites during the 2016-17 inactive season using temperature loggers affixed to the carapace with epoxy. The two release sites were a high density site (DB1; 18 tortoise/ha) and a medium density site (SR1; 7.7 tortoises/ha). Overwintering onset, duration, and termination were determined for 23 tortoises representing 10 donor sites from seven Florida counties. Ten tortoises (three H, seven AR) did not overwinter. For overwintering tortoises, onset occurred between 12 November 2016 and 25 January 2017, and termination occurred between 18 February and 20 March 2017. AR tortoises had shorter overwintering periods (mean=83 days) than H tortoises (mean=101.7 days) when combined from both sites ($p=0.006$). DB1 tortoises had shorter overwintering periods (mean=83 days) than SR1 tortoises (mean=109.6 days) when combined from both health groups ($p=0.02$). Larger differences can be seen when tortoises are separated by both health group and site, with H tortoises in the medium density site demonstrating the longest overwintering durations ($p=0.007$). Though overwintering behavior is most affected by health status, with tortoises in poorer health exhibiting a complete lack of overwintering or a decreased overwintering duration, tortoise density has an additional effect on overwintering behavior. Lack of overwintering during the cooler months may result in further decreased health and body condition, potential cold stunning of tortoises, and an increased risk for predation.
Field Studies/Techniques: Oral (Student)

Effects of Category 5 Hurricane Patricia on the Ecology of a Tropical Dry Forest Turtle (*Rhinoclemmys rubida perixantha*) in Coastal Jalisco, Mexico

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The Mexican Spotted Wood Turtle (*Rhinoclemmys rubida perixantha*) is a small, terrestrial turtle endemic to the tropical dry forests of western Mexico. In October of 2015, Hurricane Patricia, a massive, category 5 storm struck the tropical dry forest of Chamela, Jalisco, a biosphere reserve in western Mexico where research on *Rhinoclemmys* was underway. The strong winds broke branches, toppled trees, and deposited considerable woody debris onto the forest floor. We investigated how Hurricane Patricia altered the structure of the forest, and how turtles responded to this disturbance. We measured the composition (leaf litter, vegetation, woody debris, bare soil) of microhabitats in the forest understory, and locations used by turtles, within 1x1 meter plots before the hurricane (2015) and recorded changes in the same plots after the hurricane (2017, 2018). We radiotracked movements of 6 turtles in 2017 to quantify potential changes in home range size, microhabitat use, and activity patterns after the hurricane. Woody debris increased significantly in the forest understory after Hurricane Patricia, whereas vegetation and canopy cover (both at 10cm and 150cm above the forest floor) decreased. Turtles responded to these changes with greater use of

woody debris and tree stumps as shelters, smaller home ranges (especially among males), and greater morning activity. The significant increase in woody debris after the hurricane may have reduced the home range size of turtles and increased their opportunistic use of fallen wood as refuge sites. Loss of canopy cover allowed more sunlight to penetrate the forest understory exposing the forest floor to more extreme midday temperatures, which may have driven turtles toward becoming active earlier in the day. Climate models predict tropical storms will grow stronger as global temperatures rise, yet our understanding of the impact of hurricanes on tropical dry forests is limited. Our data suggest that structural differences caused by the hurricane have led to qualitative differences in the home range sizes, microhabitat use, and activity patterns of *R. r. perixantha*. Additional research is underway to explore how changes brought about by Hurricane Patricia may affect other species that inhabit the tropical dry forest of Chamela.
Field Studies/Techniques: Oral (Student)

Preparing for the Recovering America's Wildlife Act (H.R. 4647): The Texas Model

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Most of the species in the U.S. are in dire need of sustainable conservation funding. In 2015, a panel of 24 visionary leaders from conservation groups and industry assembled to tackle this critical conservation need. In 2016, this panel released its final recommendations resulting in the Recovering America's Wildlife Act (H.R. 4647). H.R. 4647 has the potential to be the most impactful wildlife funding bill passed in over 80 years. It is a bipartisan bill introduced by U.S. Reps. Jeff Fortenberry, a Nebraska Republican, and Debbie Dingell, a Michigan Democrat. H.R. 4647 would redirect $1.3 billion per year in existing royalties from energy and mineral development of federal lands and waters and invest the money in fish and wildlife conservation. Based on the proposed allocation formula, Texas would receive approximately $64 million annually to implement the Texas Conservation Action Plan, the state plan detailing conservation actions for 1,310 Species of Greatest Conservation Need. Given the significant nature of this funding, Texas began preparing our state's conservation community when the panel first assembled. As a result, Texas has been a national leader, positioning itself to support such legislation. The Texas model of preparation has included regional summits, intense speaker campaigns, in-depth planning, and coalition building to allow the state to maximize its role to facilitate passage of this landmark bill. The processes Texas engaged in and products produced will be discussed. The benefits of the Texas model as well as the lessons learned will also be discussed.
Conservation & Policy in North America: Oral

Black-breasted Leaf Turtle (*Geoemyda spengleri*) Research and Conservation: Updates on Multiple Collaborations

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The Black-breasted Leaf Turtle (*Geoemyda spengleri*) is currently assessed as Endangered on the IUCN Red List. As with many Asian chelonians, *G. spengleri* is threatened by high levels of trade, but until recently, the natural biology of the species was little known. Over the past few years, research collaborations have formed, and the activities of these groups have started to increase knowledge about this species in the wild. Studies of populations on Hainan Island, China, began in 2015 and expanded to other sites within China during 2017 and 2018. Also in 2018, funding was received to begin field work in northern Vietnam. Additional range-wide projects are also ongoing or pending. Ultimately, the goal of these efforts is to benefit conservation and sustainability of the species. This presentation will provide recent updates on the work and future directions of these collaborations.
Asian Chelonians: Oral

Mortality is too Damn High: Demographic Challenges of Alligator Snapping Turtle (*Macrochelys temminckii*) Translocations

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The rapid loss of biodiversity and habitats has left many populations of susceptible organisms isolated in an inhospitable matrix. With emigration and immigration severed, such populations follow small population dynamics toward extinction. In cases where species have become extirpated from larger portions of their range, translocation efforts are the only tool to facilitate the rapid colonization of recovered habitats. We conducted a three-year study of translocation efforts on the Alligator Snapping Turtle (*Macrochelys temminckii*) in Illinois, Louisiana, and Oklahoma. We monitored the survival rates of released head-started and long-term captive turtles to determine if a translocation regimen was feasible for recovery. Higher than expected radio-failure rates and flooding precluded calculation of survival rates specific to each state. Therefore, we calculated all survival estimates across the entire study. Size at release, age, and time were the best predictors of survival where larger, older turtles had higher survival rates. The estimated population growth rate from our survival rates was under 1 ($\lambda = 0.8927$), suggesting a declining population. Stochastic sensitivity analysis found no stable demography. Only varying mortality rates +/- 50% revealed a stable demography using Leslie matrix projections. Population stability occurred when a 30% reduction occurred across all age-specific mortality rates. Thus, future releases must address survivorship for all age-classes.

Headstarting: Oral

Post-release Growth Rates of Translocated Alligator Snapping Turtles (*Macrochelys temminckii*)

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Assessing conservation strategies is an important factor in an adaptive management framework. There are numerous metrics which can be used to assess how a population responds to a strategy. The more metrics used and assessed, the better and more precise the strategic outcomes. One concern with translocations are the impacts to the organism's ecology, behavior, and life history. We conducted a three-year translocation project on the Alligator Snapping Turtle (*Macrochelys teminckii*) using head-started and long-term captive turtles released into sites in Illinois, Louisiana, and Oklahoma. Here, we report on post-release individual growth rates of turtles to provide inference into resource acquisition. We analyzed growth data first by examining the relative instantaneous growth rates (ΔGR) then by using a non-linear modeling approach. Growth rates were greater in turtles from the Louisiana and Oklahoma release sites than in turtles from the Illinois site. Turtles had the greatest growth rate in length in Louisiana and the greatest growth rate in mass in Oklahoma. Illinois growth rates were nearly half those found in Oklahoma and Louisiana. Low growth rates in Illinois may delay sexual maturity or reduce reproductive output for turtles in Illinois, thus compounding difficulties for recovery.

Presentation Type: *Poster*

The Pascagoula Map Turtle, Elevating a Candidate

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The Pascagoula Map Turtle (*Graptemys gibbonsi*) was long considered the same species as *Graptemys pulchra*. It wasn't until 1992 that it was described as a full species. Found only in the Pascagoula drainages, *G. gibbonsi*

populations have declined steadily within its historic ranges prompting the Chelonian Taxon Advisory Group to nominate the species as a Candidate Program. After becoming the Candidate Program Leader for this species in 2017, the author organized a collection trip to obtain an assurance colony. This presentation offers a short history of *G. gibbonsi*, a review of the collecting process and future plans for the species.
***Graptemys*:** Oral

Tracking Turtles in Toronto: Comparing Watershed to Waterfront Wetlands

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The Toronto and Region Conservation Authority (TRCA), with York University, are assessing the turtle population as well as the connectivity of the Lake Ontario wetlands and some of the main tributary watersheds in Toronto Canada. In addition to the turtle demographics, the research goals of the Waterfront Study are focused on better understanding lakefront wetland connectivity while the Watershed Study is concerned with usage of the connecting landmasses between the inland wetlands, the quality of the nesting sites and the dangers of road mortality. We use two different approaches to tracking turtles in these projects: for the Waterfront Study, we use acoustic telemetry to track the aquatic movement of turtles swimming in Lake Ontario between and within the various waterfront wetlands. We are the first turtle study to join the extensive GLATOS fisheries research network (a joint Canada/USA acoustic telemetry endeavor). For the Watershed Study, we are implanting Passive Integrated Transponders (PIT) tags and setting up antenna arrays to capture movement of PIT tagged turtles across culverts and near roads as well as tracking gravid female movement on land with GPS and VHF to nesting sites. We will be discussing preliminary results showing skewed sex-ratios in Midland Painted turtles (*Chrysemys picta marginata)* in the watershed wetlands but not in the lakeshore wetlands, as well as inter-wetland movement.
Field Studies/Techniques: Oral

Population Dynamics of the Ornate Box Turtle (*Terrapene ornata*) at Two Sites in Illinois

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Over the last two centuries, Illinois has lost more than 99% of its prairie and grassland habitats to agricultural conversion. Such a sudden and drastic loss of habitat has affected Ornate Box Turtle (*Terrapene ornata*) populations. Historically the species was known from 45 counties, but today it is confirmed in less than a dozen. As a result, in 2009 *T. ornata* was listed as a State threatened species. To better understand the demography of two remaining isolated populations, we carried out capture-mark-recapture surveys with a goal of determining whether they are stable, growing, or declining. We tested for equality in sex ratio, examined life stage structure, collected data on fecundity, and evaluated annual survival. Our results will help inform conservation decisions for the species and provide land managers with key information about what demographic parameters are most important to ensuring *T. ornata* continues to survive in Illinois.
Populations/Status: Oral (Student)

Growth in a Central Illinois Eastern Box Turtle (*Terrapene carolina carolina*) Population

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Changes in growth have conservation implications because body size and shape affect fecundity. With their long lifespan and delayed sexual maturity, turtle populations are especially sensitive to changes in fecundity and adult

survival. Examining growth can, therefore, lead to insights related to conservation, for instance if size or shape of turtles in a population change in years following implementation of new management practices. We conducted a growth analysis on a population of Eastern Box Turtles (*Terrapene carolina carolina*) at Lake Carlyle, Illinois using morphometric data collected over 16 years of capture-mark-recapture study. We used nonlinear growth curve models to examine carapace length and plastron length growth. We also explored relationships between growth and a management practice (woody vegetation removal), and we worked to identify differences in size and shape between sexes.
Presentation type: Poster (Student)

Don't Put All Your Eggs in One Basket: Lessons Learnt from the Largest Scale and Longest Term Wildlife Conservation Program in the Brazilian Amazon

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The Brazilian Government established the Amazon Turtle Project (Projeto Quelônios da Amazônia – PQA) in 1975 to monitor and protect the main nesting sites of Amazon River turtles. The PQA has become the largest scale and longest term wildlife conservation initiative in the Brazilian Amazon. We evaluated the outcomes of the PQA across 11 protected area localities over 30 years (1980-2008). Inside four PQA localities populations of *Podocnemis expansa* can be considered stable, one have declined and four have seen an increase in the numbers of nesting per site. The PQA conservation efforts for *Podocnemis unifilis* were not as successful as those of *P. expansa*, but were sufficient to stabilize or increase populations. These results might indicate that there is a minimum effort threshold for positive conservation outcomes, which was not achieved for *P. sextuberculata*. The current level of success in a given locality cannot be used as a tool to prioritize future protection efforts. We recommend that the PQA should maintain or increase its coverage due to the high levels of local unpredictability. If current harvest trends are maintained, it is likely the only surviving populations of *P. expansa* will be within protected areas. Considering the scope of the PQA and the period that it has been operational, it is surprising how little recognition it has received; the lack of national and international awareness of its achievements may be one of the main reasons behind the lack of support from the Brazilian Government. Wildlife conservation approaches have radically changed since the PQA was created in the mid-1970s and the PQA needs to adapt urgently to the new scenarios.
Presentation Type: Poster

Can Temporary Visits from a Common Snapping Turtle Cause Legacy Effects in Freshwater Food Webs?

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Some freshwater turtle species can make long-distance movements through terrestrial habitats. During these terrestrial movements, individuals can temporarily occupy other aquatic communities, such as wetlands. Although these individuals remain for short durations within these communities, these transient predators could potentially alter freshwater community composition and structure through strong top-down effects. If these short-term visits cause long-term alterations to composition and structure, these effects are called "legacy effects". To test if short-term visits from a transient freshwater turtle can have legacy effects on wetland communities, we constructed aquatic food webs in mesocosms using a combination of species: tadpoles from two frog species (*Hyla chrysoscelis* and *Rana sphenocephala*) as prey**,** *Lepomis macrochirus* and *Procambarus clarkii* as intermediate predators, and *Chelydra serpentina* as our transient predator. *Chelydra serpentina* visits were simulated for 4, 10, 20, and 30 days to understand community changes from short-term visits from a freshwater turtle predator. Our preliminary results suggest that turtles have strong top-down effects on aquatic communities and that even short-term visits from transient individuals will initiate legacy effects.
Field Studies/Techniques: Oral

Overview of Turtle Research at the Tennessee Aquarium Conservation Institute

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The Tennessee Aquarium and collaborators have several projects either focusing on species-specific conservation or broad-scale, biogeographical turtle questions. We have an ongoing project surveying for Alligator Snapping Turtles (*Macrochelys temminckii*) in West Tennessee. Additionally, we have several turtle projects including: the movement ecology of Alligator Snapping Turtles, detection and occupancy rates for *Chelydra serpentina* and *Trachemys scripta*, and mercury (Hg) concentrations in *C. serpentina* and *T. scripta*. Preliminary data suggests mean home range is 0.38 +/- 0.16 ha for juvenile Alligator Snapping Turtles, while the mean distance moved per day is 2.37 +/- 0.85 m. Regional occupancy and detection probabilities for *T. scripta* and *C. serpentina* are high but might be influenced by trap type. Finally, Hg muscle concentrations generally exceeded the EPA's suggested "avoid" category (> 0.46 ppm). Over the past year, our more broad-scale research focused on a review of salinity tolerance of freshwater turtles and a global analysis of sexual size dimorphism (SSD). Seventy freshwater turtle species from 10 families are reported to occasionally occupy brackish water. Based on sea level rise projections of 1 m (unmitigated) by 2100, 90% of coastal freshwater turtle species will be impacted. Similar to previous SSD work on turtles, we found the direction and magnitude of SSD was influenced by habitat. However, our results also provide evidence for climate and climate variability influencing SSD in turtles as well.
Zoos & Chelonians: Oral

Tracing A Giant: Updates on the Status of the Asian Giant Softshell Turtle (*Pelochelys cantorii* Gray 1964) in the Philippines

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The endangered Giant Softshell Turtles of the genus *Pelochelys* (Trionychidae) are some of the most striking aquatic turtles known from tropical South Asia, Indochina, Indonesia, Papua New Guinea, and the Philippines. The Asian Giant Softshell Turtle (*Pelochelys cantorii*) is one of the most taxonomically problematic species and its status and distribution in the Philippines has been shrouded in confusion for many decades. Through a combined synthesis of literature, field surveys and observations, we present preliminary findings on the taxonomic status of the Philippine population based on morphological examinations and molecular analysis using three gene markers (COI, ND3, and ND4) of recently collected voucher specimens from northern Philippines. We also provide updated information on the ecology and geographic distribution of *P. cantorii* in the Philippines. We further discuss threats to *P. cantorii* and its habitat, and present policy and management recommendations for its conservation.
Asian Chelonians: Oral (Student)

Vulnerability of Nesting Sites of *Podocnemis* Species and Effectiveness of Public Policies in the Brazilian Amazon

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Podocnemis species are illegally traded and consumed in the Brazilian Amazon. They are also impacted by extractive and agricultural activities and by infrastructure construction. The federal government initiated in 2015 the National Action Plan for the Conservation of Amazon Turtles (PAN) focusing on *Podocnemis expansa*, *P. unifilis* and *P. sextuberculata*. Amazonas state published a resolution in 2017 identifying 265 nesting sites for priority protection, which are Temporary Protection Zones for Turtles (ZPTQs). We evaluated the vulnerability of sandbanks to the human activities and we analyzed the coverage and the gaps of conservation actions (PAN and

ZPTQs). Species distribution models were used to identify potential nesting areas in the Brazilian Amazon. The sandbanks available in the main rivers of those areas were mapped using satellite imagery. The values of threats: deforestation, mining, dams and density of human communities were normalized from 0 to 1 and summed in each 10km^2 cell. We calculated the mean value of those threats and sandbanks area for each sub-basin. Sub-basins with the greatest values for those variables were considered as the most vulnerable. We calculated the coverage of PAN and ZPQTs in relation to the number of sub-basins and sandbanks area available in the study region. We evaluated if these public policies were located in the most vulnerable sub-basins. The areas of greatest gaps in conservation actions and vulnerability are located in the Tocantins-Araguaia basins and in rivers such as: Branco, Guaporé, Amazonas, Solimões, Madeira, Tapajós and Xingu. PAN and ZPTQs covered, respectively, 15.17% and 10.68% of the number of sub-basins mapped. About 21.05% of total area of sandbanks mapped are covered by PAN activities and 19% by ZPTQs actions. PAN contemplates 11% of the most vulnerable sub-basins and 43% of the total area of sandbanks. ZPTQs cover 9.4% of the most vulnerable sub-basins in the Amazonas state and 45% of the total area of sandbanks. We suggest the prioritization of conservation actions in areas of greatest gaps in conservation activities and vulnerability. In addition, we propose the articulation among institutions to increase the geographical coverage of the greatest impacted regions.
Conservation: Oral

Diatoms Associated with Turtles in Texas and Oklahoma

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The turtle carapace represents a suitable substrate for epibiotic organisms such as diatoms, a type of microscopic algae. Recent investigations have described two novel diatom species associated with the Red-headed Amazon River Turtle (*Podocnemis erythrocephala*) and one novel diatom species on the European Pond Turtle (*Emys orbicularis*). This warrants further investigation of diatoms on freshwater turtles in North America. The goal of this study was to document the diatoms associated with turtle species found in the Trinity River, Texas and Kiamichi River, Oklahoma. The Trinity River Turtle Survey team sampled diatoms from *Pseudemys concinna*, *Trachemys scripta*, and *Sternotherus carinatus* and the Oklahoma team sampled *Graptemys ouachitensis*. Diatoms were processed to remove the organic matter and identified to genus level. Two *Luticola* species were found from the Trinity River Turtles and three *Luticola* species (with one novel species) from the Kiamichi River turtles. *Luticola* is characteristic of aerophilic habitats and appears to be adapted to freshwater turtles. Future research remains to reveal diatom diversity on turtles in relation to turtle ecology.
Presentation type: Poster (Student)

Do Spiny Softshell Turtles Do "False Crawls" Before They Lay Their Eggs?

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In previous years we have reported on our success using Lutalyse (prostaglandin F2 alpha) with, or without, Sedivet (romifidine) to induce egg laying in a variety of American turtles. Success rates (a turtle laying all its eggs after induction) at the Concordia Turtle Farm have varied from 94% with a variety of sliders and map turtles to 80% with several species of American softshells. From November 2016 to January 2018 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 if needed, we could increase our success rate to 90% with turtles that had been poor responders in the past. However, our numbers were small, with only 77 inductions among the 12 females over two seasons. During the American summer of 2017 we tried some of the same methods with softshell turtles and could not achieve a success rate better than 80%. Our lack of success made us examine our past selection methods. Easily palpated species, like sliders and map turtles, were selected on the basis of having more than 2 palpable eggs in the lower pelvis of appropriate turgor. Accurate palpation was not

possible with softshell turtles so we just included any we found on the nesting area that were X-ray positive. This was probably a mistake because some of those animals may have been on a "false crawl". To see if this is true we will be taking a series of time lapse videos in July 2018 of the nesting area to determine if some softshell turtles do return to the water without attempting to lay. We'll show the videos at the conference so you can decide for yourself if they go on false crawls. In addition, we have set up a web-site (inducingturtles.com) which includes a series of six instructional videos in English or Chinese, and the latest PDF outlining our recommendations. It's our hope this will make it easier for others to induce their turtles.
Captive Husbandry: Oral

A Demographic Matrix-model Analysis of Spotted Turtles (*Clemmys guttata*) in Illinois

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Matrix models and perturbation analyses provide a useful framework for evaluating demographic vital rates crucial to maintaining population growth. Determining which vital rates most influence population growth is necessary for effective management of long-lived organisms facing population declines. In Illinois, the state-endangered Spotted Turtle (*Clemmys guttata*) occurs in two isolated populations, and management can benefit from an understanding of the species' local demographic behavior. We conducted a mark-recapture study on both populations in 2015 and 2016, used historical mark-recapture data from 1988 to 2010, and compiled reproductive data over the length of the study to derive a Leslie matrix for each population. We used the CJSRandom model in Program R, Package 'RMark' to determine female-only, age-specific survival rates ($n_{1\text{-}R}$ = 105, $n_{2\text{-}L}$ = 153) and calculated class-specific fecundity as the product of average clutch size, proportion of gravid females, hatchling sex ratio, and age-specific survival. We then combined the fecundity estimates with age-specific survival to create a Leslie matrix and used Package 'popbio' to conduct a perturbation analysis for each population. Data were sufficient to estimate meaningful rates for only one site, and this population exhibited a significant increase in survival with age and an asymptote near 99% adult survival. The maximum age of a female individual recorded from our population was 37 years, for which we estimated survival to be 98.8% with a 95% confidence interval of 95.7–99.7%. The proportion of gravid females was 0.69 and average clutch size was 3.4 eggs/female among mature adults (age 10+). Our perturbation analysis showed population growth was most sensitive to age (0, 1) survival and most elastic to pre-reproductive survival, which contradicts the life history pattern of many long-lived turtle species. We recommend two targeted conservation actions – habitat management and predator control – to maximize survival of younger turtles and increase the population growth rate.
Presentation type: Poster

Prey Diversity and Patterns of Dietary Overlap in an Insular Population of Ornate Diamondback Terrapin*s* *(Malaclemys terrapin macrospilota)*

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Diamondback Terrapins (*Malaclemys terrapin*) consume a wide variety of estuarine and marine gastropods, bivalves, and crustaceans throughout their range. However, relatively little is known about the diet of Ornate Diamondback Terrapins (*M. t. macrospilota*) in the Gulf of Mexico. The goals of this study were 1) to elucidate which taxa Ornate Diamondback Terrapins in this region exploit as prey, and 2) to test whether dietary overlap exists between individuals of different sizes (ages) and sexes. We studied an insular population inhabiting the Big Bend region of Florida's Gulf Coast within the Cedar Keys National Wildlife Refuge. Sixty-six fecal samples were passively obtained from different wild-caught individuals of both sexes that varied in size from juveniles to adults. Upon capture, terrapins were placed individually into bins of fresh water, which generally stimulated defecation. Fecal samples were strained, stored individually in 95% ethanol, and analyzed using a dissecting microscope. We also used a volumetric displacement method to characterize the relative abundance of various prey items per individual terrapin. The diets of the terrapins in our study consisted primarily of crustaceans (e.g. decapods and

barnacles) and gastropods. The largest prey items, such as mature Atlantic blue crabs (*Callinectes sapidus*) and juvenile horseshoe crabs (*Limulus polyphemus*), were consumed only by the largest terrapins, which were adult females. However, large females also consumed numerous smaller prey items such as fiddler crabs (*Uca* spp.) and periwinkle snails (*Littoraria* spp.) that overlapped in size with prey consumed by smaller terrapins (i.e., males and young females). We also observed evidence of incidental consumption of submerged aquatic vegetation, presumably linked to secondary consumption of prey attached to plant surfaces. The significant overlap in prey base we observed between terrapins of different sizes and sexes suggests that perhaps relatively small crustaceans and gastropods are not a limiting resource for this population. However, future studies could tease apart the relative importance of preference versus prey availability to understand dietary patterns observed.
Field Studies/Techniques: Oral

Turtle Sound Communication: Investigating the Influence of Environment, Lineage, and Carapace Size on Sound Frequency

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Recently we have advanced the understanding of turtle sound communication particularly in aquatic and semiaquatic species. Acoustic communication in aquatic environments is important because most of the species live in places with low visibility and the frequency propagation under the water is more efficient. To understand how turtles use sound to communicate we analyzed the influence of the environment, phylogenetic lineage, and carapace size on their sound frequencies. We have recorded thirteen turtle species from different habitats and the following lineages: Podocnemididae, Carottechelidae, Emydidae, Dermochelyidae, Cheloniidae, and Kinosternidae. Twelve species are aquatic (*Carettochelys insculpta*, *Chelonia mydas*, *Dermochelys coriacea*, *Lepdochelys olivacea*, *L. kempi*, *Natador depressus*, *Podocnemis expansa*, *P. sextuberculata*, *Emydoidea blandingii*, and *Trachemys scripta grayi*), and two semiaquatic (*Kinostern scorpioides* and *K. oaxacae*). We have defined four groups based on their environmental characteristics and natural history: 1) marine species, 2) aquatic species from big rivers, 2) aquatic species found in streams and/or lakes, and 4) semiaquatic species found in streams or small ponds within the forest. We used the maximum straight-line carapace length for each species from our database complemented with published data as an estimate of carapace size. The results of the analyses are interesting.
Special Presentation: Oral

Conservation and Participatory Monitoring of Turtles in the Lower Rio Negro Mosaic of Protected Areas

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For many decades, turtles have been an important source of food for local people in the Amazon. Currently, many turtle populations are declining because of overharvesting. The Rio Negro basin in the Brazilian Amazon supports a rich diversity of turtle species and is a hotspot for the Red-headed Amazon River (*P. erythrocephala*) and Big-headed Sideneck (*Peltocephalus dumerilianus*) turtles, where both are locally threatened especially by unsustainable consumption of individuals and eggs. For the purpose to conserve turtles and to ensure sustainable consumption for local people, since 2014, seven institutions (WCS Brazil, Pé-de-Pincha, IPÊ, FVA, ICMBio, SEMA, SEMMA) have created the Program: Turtle conservation of the lower Rio Negro Mosaic of Protected Areas. The program has four key strategies: 1) management and monitoring of nesting sites, 2) assessment of population structure, 3) consumption monitoring, and 4) environmental education. We have been working in three protect areas, with 13 riverine communities to protect 15 turtle nesting sites. To date, the program has protected 736 nests and released more than 5,820 hatchlings of Giant South American, Yellow-spotted Amazon, and the Red-headed Amazon River Turtles. Families participating in the program decreased consumption of turtle eggs, and the program has become a model for other similar projects in the region, with a growing number of communities becoming interested in managing turtles in their own protected areas.
Conservation: Oral

Probability of Nuchal Scute Presence in Captive Born Forsten's Tortoises (*Indotestudo forstenii*)

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There are several turtle and tortoise species that can be identified or differentiated from one another by determining whether or not a nuchal, or cervical, scute is present. In the case of the endangered Forsten's Tortoise (*Indotestudo forstenii*) the nuchal scute is not a reliable identifier, as there are two populations on the island of Sulawesi, one with this scute and one without. Captive husbandry has been an important part of the effort to preserve this species and ensure it will survive the steep decline that has been reported in recent decades. In a successful breeding program for this species, we have been able to collect and analyze data on the correlation between the presence or absence of a nuchal scute in hatchlings produced by founder pairs with and without nuchals, as well as those produced from mixed nuchal pairings. We have found a strong relationship between the present of a nuchal scute in the sire and dam and the resulting probability that offspring will or will not share the same trait as their parents.
Captive Husbandry: Oral

Newly Discovered and Documented Ritualistic Behaviors and Communications among a Rarely Observed Turtle, the Zulia Toad-head (*Mesoclemmys Zuliae*)

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The Zulia Toad-headed Turtle is endemic to the Maracaibo Basin of Venezuela and was first described to science by Peter Prichard in 1984. Since 2007 one adult pair has been maintained in captivity and successfully bred in the United States. This has allowed insights into ritualized mating behaviors and seemingly coordinated elaborate ritualistic greetings between siblings unlike those of any other turtle. Similar behaviors among other species of South American chelids may exist but have yet to be documented. These behaviors have been known by the author for some time but the information was intentionally suppressed out of political necessity. Unfortunately, one of the final edicts by former Venezuelan president Hugo Chavez was the threat to incarcerate Venezuelan scientists on charges of treason for collaborating with American scientists. Chavez is now dead and the small group of captive *M. zuliae* is stable. However, learning more about this enigmatic species in the wild is challenged as Venezuela is gripped in a downward spiral of an economy that would test the resolve and sensibility of even the most adventurous or fool hardy of herpetologist.
Captive Husbandry: Oral

A State of Texas Turtles

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Within the boundaries of Texas there are 268,581 square miles, 7 biotic provinces, 15 major river systems with a combined length of 80,000 miles, 25 native species of freshwater and terrestrial turtles (including 3 endemic species), 5 marine species, at least three major universities with strong academic herpetology programs, 16 zoos, and yet a Texas-sized hole in our knowledge pertaining to the ecology and natural history of our chelonians still persists! Fortunately, this is being remedied. Most species are abundant in the wild and relatively easy to study. In the past 10 years there has been a major increase in the amount of research focus applied towards Texas turtles. This also coincides with laws enacted to end almost all of their commercial trade. Social media, citizen science participation and academic endeavors are all being used to enhance our understanding and celebrate chelonio-philia while deliberately leaving an indelible impression among the youth in our state. This presentation will provide a visual celebration of Texas' turtle diversity and many of the people who are translating their experience and knowledge towards tangible conservation and understanding of a true Texas treasure.
Plenary session: Invited

Habitats of Hatchlings in Three Turtle Species Living in the Fresh Waters of Japan

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In Japan, there are three species of fresh water turtles living in the mainland, which Japanese Pond Turtle (*Mauremys japonica*), Reeve's Turtle (*Mauremys reevesii*), and Red-eared Slider (*Trachemys scripta elegans*). Native species is only *M. japonica*, *T. s. elegans* and *M. reevesii* are exotic species brought from North America and Mainland China respectively. *M. japonica* is decreasing and are designated as threatened species, but other two species, *M. reevesii* and *T. s. elegans* are expanding in western Japan. To understand the mechanism of declining turtle population and abnormal proliferation, it is important to know their life history. However, their hatchling or yearling are not much discovered and their habitats are not known. We reproduced various micro-environment habitats naturally present in aquarium (560×1660mm, water depth 150mm). We made acrylic lands and a stone piled island in the water. In addition, we set hideout places in the water with brown and green artificial leaves. Hatchlings were released into the aquarium, the position of the hatchlings took pictures every 30 minutes and was recorded. The hatchling used for the experiment is as follows: *M. japonica* (CL 66.9±11.9mm, N=4), *M. reevesii* (56.6±2.52mm, N=6), and *T. s. elegans* (31.3±1.26mm, N=7). It shows the ratio of land and water for each species by day and night. Hatchlings of *T. s. elegans* were spending almost the similar rate in the land and the water regardless of day and night. On the other hand, *M. japonica* often stayed in the water at night than day. Furthermore, *M. reevesii* spread both land and water at day, but almost water area at night. Whereabouts of water were different from by species. That is, *T. s. elegans* and *M. reevesii* were almost in the leaves and hardly around the stones. *M. japonica* were in the artificial leaves, and there were often in around the stones and in the gap between the walls. In this way, habitats of fresh water turtle hatchlings may be different from by species according to environment.
Presentation type: Poster (Student)

Eight Foot and Flower Power Turtles: A Phylogenetic and Phylogeographic Approach to Conservation

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Many species of Asian turtles are under severe threat of extinction due to over harvesting for the pet, medicine and food trades. While many of these species can be found in captivity, little is known about their natural history, ecology or genetic relationships. Two endangered south Asian species, *Cuora mouhotii* and *Cuora galbinifrons,* are no exceptions to these conditions. While some very beneficial research has shed light on basic ecology, movement and diet, we still do not have a solid grasp on the genetic structure and relationship within these two species. Understanding the phylogeographic structure within these species, can help preserve pure genetic lineages and maintain genetic diversity within captive assurance colonies. In addition, it can also be used as a tool to determine what geographic area confiscated animals originated from. In this study, we used both mtDNA and nuDNA markers to test if phylogeographic structure exists within each of these species. Samples were collected from animals originating in southern China and within Vietnam. Phylogeographic structure was found to be present within both species and follows a similar pattern. However, *C. mouhotii* shows greater geographic structure than *C. galbinifrons.* Our results show both species have been isolated in certain regions resulting in genetic divergence of different lineages. This information can be used to help preserve natural lineages of captive populations, and hopefully be used to release genetically "local" animals back to natural areas.
Genetics: Oral

Forest Loss Drives Evolutionary Dynamics in the Endemic Dahl's Toad-headed Turtle (*Mesoclemmys dahli*)

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Human-induced transformation of natural ecosystems has led to a simultaneous decrease in forest connectivity and patch size, and reduced dispersal among resource patches in many species. Small isolated populations usually suffer from inbreeding and loss of genetic diversity, which translates into a lower ability to adapt to the new transformed environment. However, forest fragmentation also increases environmental heterogeneity, which in conjunction with restricted gene flow can promote adaptation. We conducted a landscape genomics analysis using Restriction-site Associated DNA (RAD) sequencing to assess the effect of forest loss in shaping genetic diversity and structure in Dahl´s Toad-headed Turtle (*Mesoclemmys dahli*), a forest species that has lost almost all of its habitat. Based on 3225 neutral SNPs, we found that genetic differentiation was better explained by the cost of moving through the landscape matrix than by the species' dispersal capacity. This semi-aquatic turtle moves easier through forests (cost = 1) and cleared areas (cost = 12.6), than through rivers (cost = 62.71) and wetlands (cost= 197.71). The population is now fragmented into four independent genetic units, one located at the northeast of the species distribution where 30% of the original forest remains, and three at the southeast, where the forest cover has been removed almost completely. Outlier and genetic-environment association analyses indicate that the former is adaptively different from all the populations at the non-forested area. Populations in areas with no forest also showed lower levels of genetic diversity, especially diversity of adaptive importance. All populations where very small (Ne range 20 – 104) and extremely inbred (F range 0.2 – 0.3), but this was not related to forest quantity. Our results show that this forest species is adapting to open grasslands, which is encouraging given the low probability of restoring its habitat at a landscape scale. Nevertheless, adaptation is not helping to overcome other severe negative effects of habitat loss, such as genetic erosion, isolation, and consequently inbreeding. To alleviate this problem, we recommend gene flow augmentation, and based on our observed genetic patterns we provide guidance for the establishment of a genetic rescue program.
Genetics: Oral

Notes on the Hatchling Emergence Ecology of Ouachita Map Turtles (*Graptemys ouachitensis*) on the Lower Wisconsin River, Wisconsin, USA

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Despite its biological importance in shaping both individual fitness and population structure, much remains to be learned about the hatchling emergence ecology of most freshwater turtles. Here, we provide some of the first details on this early life stage for Ouachita Map Turtles (*Graptemys ouachitensis*), obtained during 2015–2017 along the Wisconsin River, Iowa County, Wisconsin, USA, using stand-alone trail cameras as a primary data-gathering tool. In contrast to some earlier reports for *Graptemys*, hatchling emergence was mostly diurnal and synchronous, primarily in the morning soon after soil temperatures began to rise from overnight low values. Data suggest a temperature change model of hatchling emergence cueing and may represent a local/regional adaptation to reduce nocturnal predation risks, principally from Raccoons (*Procyon lotor*). Initial dispersal bearings from nests were non-random and largely toward the nearest substantial vegetative cover, a woodland north of the nesting area, although there was variation in routes taken both between hatchlings and within that of given individuals. In addition to predation and flooding impacts, hatchlings on this small study site are affected by vegetative shading, leading to relatively long incubation periods (mean 83.2 d), low mean nest temperatures (25.9˚C), and a likely male-biased sex ratio.
***Graptemys*:** Oral

Survey Effort and the Species Assemblage of Basking Turtles

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In order to adequately manage turtle diversity, it may be important to confidently determine the assemblage composition for basking turtle species in an area. By analyzing data collected from fixed and point count basking turtle surveys across northern Louisiana, we evaluated basking turtle species richness via species accumulation curves. A point-count survey consisted of observations from a fixed point for a variable amount of time long enough to record the basking turtles visible within the field of view either with binoculars or a spotting scope, and our fixed-site surveys were both area and time constrained, usually limited to one hour. From July 1998 to May 2018, 353 such surveys were conducted at 185 sites where 6,136 individuals were spotted. Eleven different species were observed one or more times in 27 parishes west of the Mississippi River in five river basins: Mississippi, Red, Ouachita, Sabine, and Calcasieu. The species detected during the study include *Apalone mutica, A. spinifera, Kinosternon subrubrum, Sternotherus odoratus, S. carinatus, Graptemys sabinensis, G. pseudogeographica kohnii, G. ouachitensis, Pseudemys concinna, Trachemys scripta elegans,* and *Chrysemys dorsalis*. Most of the surveys occurred in the Ouachita River and Red River drainages, which share a common pool of potential basking turtle species. One to 27 surveys were conducted per site with a range of zero to 122 individuals observed, and an average of 17.4 individuals detected per survey. We examined hours surveyed, number of surveys, and total number of turtle specimens observed at each site to model the effort required to achieve a reasonably complete species richness value for a site. Preliminary results indicate that three or four visits to a site may be sufficient to approach the asymptotic number of basking turtle species, which typically coincides with 6–7 species for the richest sites.
Presentation type: Poster (Student)

Map Turtle (*Graptemys*) Studies in Alabama

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Alabama has six of the 14 currently recognized species of map turtles, *Graptemys barbouri, Graptemys ernsti, Graptemys geographica, Graptemys nigrinoda, Graptemys ouachitensis,* and *Graptemys pulchra*. All *Graptemys* species in Alabama are protected under the Alabama Department of Conservation and Natural Resources as nongame species. From 2000 to 2003 basking survey data was collected on several species (i.e., *G. barbouri, G. ernsti, G. nigrinoda* and *G. pulchra*) and additional data is currently being collected on *G. ernsti*. Basking surveys have not been conducted on *G. geographica* and *G. ouachitensis* because these species range widely outside Alabama. While Alabama is a center of *Graptemys* species richness few studies have been published. Shealy (1976) published on the natural history of *G. pulchra* (*G. ernsti*), Lahanas (1982) studied the natural history of *G. nigrnoda delticola*, and Lindeman (2016) the diets of *G. nigrinoda* and *G. pulchra*. In 1997 *G. barbouri* and *G. ernsti* were discovered in the Choctawhatchee-Pea rivers leading to a study of hybridization between these two mega-cephalic taxa (Godwin 2014 et al.). Ennen et al. (2016) followed with a study comparing populations of *G. ernsti* between the Conecuh and Yellow rivers. Ennen et al. (2014 and submitted) taxonomy and morphology of *G. nigrinoda* questioning the taxonomic status of the subspecies and a study on the plasticity of shell morphology as influenced by drainage area.
Graptemys: Oral

Reintroduction Program 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.

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The objective of this project is to create a reintroduction program for the Central American River Turtle, being the first of its kind in the area, 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 releasing 2000 hatchlings within a week of hatching from turtle farms. Hatchlings will be released in minimum groups of 50 and maximum of 200. All hatchlings will be marked, genotyped, individuals will be release in areas where we noted hatchlings were living in groups in the 1980s. The hatchlings will be monitored on a regular basis for at least 10 years, when they should be sexually mature.
Conservation: Oral

Raisin' Alligator Snappers in a Double-Wide; Not Just a Country Music Song Title; Head-starting Alligator Snapping Turtles at the Nashville Zoo

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Alligator Snapping Turtles (*Macrochelys temminckii*) are listed as state species in need of management, endangered under the Endangered Species act, and a species of greatest conservation need by the Tennessee Wildlife Action Plan. Nashville Zoo wanted to get involved with this species for two main reasons, to help TWRA (Tennessee Wildlife Resource Agency) in their effort to restore Alligator Snapping Turtles in Tennessee with head-started individuals as well as educating the public about the plight of Tennessee's rich aquatic biodiversity and the work that the zoo along with governmental entities are doing to preserve that diversity. Working with a species that is right here in our backyards was a great way to get Tennesseans excited about our conservation efforts. After getting support from U.S. Fish and Wildlife Service and TWRA, creating a plan of action, and setting up the details to go out in the field, Nashville Zoo staff were excited to get this head-start program started. For our first steps, we planned to collect, ultrasound and eventually hatch ASTs from animals found during a collection trip to a site in West Tennessee. Unfortunately, this trip did not yield the results we were hoping for, so we tried a new step. In collaboration with Tishomingo National Fish Hatchery in Oklahoma, TWRA was able to fly hatchling animals to Nashville for keepers there to raise them for their eventual release sometime in the future. In a controlled setting we were able to experiment with different environmental conditions such as temperature, lighting and diet to observe how they adapted or tolerated various situations. As there have only been three known sightings in Tennessee, conducting more site analysis and population surveys to determine appropriate sites for any release activities that might occur in the years to come and adequate populations for any further collection sites of possible gravid females or sites for nesting areas are our plans for the future, and our next steps.
Zoos & Chelonians: Oral

Examining the Efficacy of Bait Types in Broad-Scale Turtle Surveys

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While much has changed about the way we study freshwater turtles in recent decades, the basics remain the same. The use of traps is extensively relied upon, with various features such as trap dimensions, mesh size, and whether or not the traps are baited varying among studies and investigators. Most turtle biologists have their own personal preferences as to bait types when using baited traps. Using a large, historical data set on turtle surveys conducted from 1985-1987, we examined the relationship between the number of specimens captured per trap and the type of bait used. Traps were baited with fish, chicken, or a combination of the two. Fish was found to be significantly more effective in terms of total number of turtle captures per trap (ANOVA, $p = 0.017$). The mean number of turtle captures per trap for fish ($n = 6{,}193$) was 2.08, whereas with chicken ($n = 232$) the corresponding value was 29% less (1.48) and the fish-chicken combination was similarly low. Indications are that fish alone are more efficacious in trapping a variety of turtles in larger numbers than is chicken and a fish-chicken combination.
Presentation type: Poster (Student)

Captive Management and Propagation of the Critically Endangered Southern Vietnam Box Turtle (*Cuora picturata*) at the Turtle Survival Center

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The Southern Vietnam Box Turtle (*Cuora picturata*) was described in 1998 and for many years was known only from trade specimens until the first wild documentation in 2011. Originally recognized as a subspecies of *Cuora galbinfrons*, further molecular research elevated *C. picturata* to full species status in 2003. *C. picturata* has been commercially collected and observed in the international food and pet trades since at least the early 1990s. With a relatively small geographic distribution in Southern Vietnam, this species has never been traded in huge quantities like its closest relatives *C. bourreti* and *C. galbinifrons*. Still, over the past 30 years, small numbers of them have made their way into private and institutional collections in the United States, Europe, and Asia. Some of those original founders are now contributing to managed captive conservation breeding efforts. *C. picturata* has generally been considered difficult to breed in captivity with limited, yet steady success among a handful of keepers. 2018 has been a banner year for *C. picturata* propagation at the Turtle Survival Center (TSC). Presented here are captive management techniques implemented at the TSC that have resulted in the successful reproduction of this rare species.

Captive Husbandry: Oral

Successful Propagation of the Big-headed Turtle (*Platysternon megacephalum*) at the Turtle Survival Center

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With a heavily armored head that cannot be withdrawn into the shell, flattened body, and long strong tail that can be used as leverage when climbing, the Big-headed Turtle (*Platysternon megacephalum*) is a rather unique species belonging to the monotypic family Platysternidae. Their habitat is characterized by forested rocky clear-flowing hill streams where they occur in China, Vietnam, Laos, Cambodia, Thailand, and Myanmar. Populations across their range have rapidly declined due to the international food, pet, and traditional medicine trades. This decline prompted a proposal for the species to be upgraded from Endangered to Critically Endangered on the IUCN Red List of Threatened Species. With ongoing rampant illegal unsustainable harvesting a major concern, captive breeding may prove to be a valuable option for conservation efforts in the future. For multiple decades, wild caught Big-headed Turtles were commonly imported and available in the U.S. pet market until they were added to Appendix I of C.I.T.E.S. in 2011. Many zoological institutions and hobbyists have tried to breed *Platysternon* in captivity over the years but very few have been successful. Since 2015, *Platysternon* have been reproducing every year at the Turtle Survival Center (TSC). In all likelihood, the TSC will surpass its 30th hatchling in 2018. While historically difficult to propagate in captivity, our experience leads us to believe that by implementing some simple management techniques the Big-headed Turtle can be relatively prolific.

Captive Husbandry: Oral

Unlocking the Secret to Sulawesi's Endemic Turtles

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The Turtle Survival Center (TSC) has made Sulawesi's endemic turtles, *Leucocephalon yuwonoi* and *Indotestudo forstenii*, a major focus of our captive breeding and management. These species are notorious for their difficulty to maintain in a captive setting and generally low, to no, reproductive success rates. Since our husbandry efforts culminated in the repeated successful hatching of *I. forstenii*, we shifted our attention to *L. yuwonoi*. Initially, we investigated the diet to help determine whether the amount of protein was influencing reproductive output. However, after closely simulating the diet of other successful institutions, we concluded that this may not be playing a factor. We assessed several other variables such as enclosure arrangements, frequency of mating encounters, "priming" the

water before introductions, and others, all in attempts to determine what factors are the most important to the successful breeding of this species. This study is ongoing and preliminary results will be provided.
Captive Husbandry: Oral

The Big Turtle Year: Celebrating Wild Turtles Across the United States

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Turtles play significant ecological roles and are visible elements in many habitats. A long list of diverse threats to species globally has contributed to ~59% of all turtles being threatened with extinction. Working in negative synergy, these threats present broad and immediate conservation challenges for one of the most endangered wildlife taxa in the world. Despite the urgency of the situation, opportunities for conservation are abundant and the charismatic attraction of turtles makes them an excellent group for education and outreach efforts to enhance ecological, conservation, and environmental awareness. The United States is the most turtle-rich country (62 species and 89 terminal taxa), with many taxa of conservation concern. While species from areas such as Asia, South America, and Madagascar often receive the majority of conservation attention, the plight of species within the U.S. quietly goes unnoticed. The goal of The Big Turtle Year initiative is to increase awareness regarding the status of these often overlooked species and to emphasize their rich diversity, natural history, and conservation. Throughout 2017, Florida Turtle Conservation Trust researchers visited numerous sites accompanied by other biologists and conservationists in an effort to see as many species as possible during a single year, while examining threats and conservation actions needed. In addition, a national lecture series will disseminate the information gathered to a wide range of audiences, including stakeholders. For more information, please visit www.thebigturtleyear.org.
Plenary session: Invited

Strategic Road Effect Mitigation Planning

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Road mortality and other indirect road effects threaten the continued survival of the Mojave Desert Tortoise (*Gopherus agassizii*). Fortunately, exclusionary fencing paired with adequately spaced shade structures and tortoise underpasses has the potential to reduce habitat fragmentation and road mortality as well as enable the repopulation of at least 64,445 acres of depleted roadside critical habitat. Unfortunately, cost and logistics prohibit efforts to fence all or even most of the roadways that threaten the Mojave Desert Tortoise. To make this issue more manageable and to maximize returns on conservation efforts, the U.S. Fish and Wildlife Service (Service), in partnership with the Federal Highways Administration (FHWA), including FHWA designated state representatives, is developing a Recovery Importance Index (RII), a Feasibility Index (FI), and a composite Fencing Priority Index (FPI). The composite FPI (RII x FI = FPI) is intended to identify the 1-km segments of road that most severely need fencing from a biological need as well as feasibility perspective. In this approach, biological need (aka. RII) is evaluated in terms of road-effect zone area, average habitat potential value, and number of range-wide observations. Feasibility (aka. FI) is evaluated in terms of landownership, road design (at grade or not), and number of local roads or driveways that would perforate the fence. By using information on road-effect zone size, habitat quality, recent occupancy, and logistical feasibly, the Service hopes to optimize the efficiency of future efforts to mitigate the threat of roadways to the Mojave Desert Tortoise and broader desert ecosystems.
Conservation & Policy in North America: Oral

The Shell-less Incubation Technique for Aquatic Turtle Eggs

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In the captive turtle husbandry, acquiring undamaged and fertilized eggs is a crucial process that determines whether the breeding of the captive turtles is successful. However, eggs are fragile and sometimes break during mother turtles' nesting or manual digging processes. The shell-less incubation technique is developed for incubating of damaged turtle eggs without egg shells. This technique provides the ability to observe the entire turtle embryo development process visually and to increase the opportunity to save the accidentally broken eggs which may increase the overall hatching rate. This technique has been applied and successfully hatched out a hybrid of Japanese Pond Turtle *(Mauremys japonica)* and Chinese Pond Turtle *(Mauremys reevesii)*. The hybrid *(M. japonica x M. reevesii)* hatched on Day 45 after transferring the embryo to the artificial culture vessel. After hatching, the baby turtle survives and eats well. The artificial culture vessel is used to hold the embryo and is made of two major parts - a plastic cup and a piece of polyethylene (PE) film. Pure water was added to the bottom of the plastic cup. The incubation temperature was set at 86ºF (30ºC) and the relevant environment humidity was set at 90% for the entire incubation. Based on this successful case, more other aquatic turtle species may use this shell-less incubation technique to hatch out without egg shells if eggs were damaged.
Captive Husbandry: Oral

Some Observations on Reproduction in Spiny Turtles (*Heosemys Spinosa*)

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Heosemys spinosa has a reputation for being difficult to reproduce in captivity. During the past few years, however, there has been increased success by a number of facilities. Successful reproduction occurred at the Tennessee Aquarium for the first time in 2007 and at the author's private facility in 2009. Since then, there have been multiple hatchings which has increased insight into the factors potentially responsible. Some of these include low-protein diets, separation of males and females, reduced lighting, manual pipping of eggs, and a great deal of patience. Factors that do not seem as critical are incubation temperature and medium as well as seasonality. In addition, there are several things that need to be determined; these include temperature sex determination parameters and the ability of females to retain sperm. Insight has also been gained into longevity for this species.
Captive Husbandry: Oral

Unexpected Lack of Genetic and Morphological Divergence in the Widespread Elongated Tortoise (*Indotestudo elongata* BLYTH, 1854)

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The Elongated Tortoise (*Indotestudo elongata*) occupies a wide distributional range in Southeast Asia covering several well-known zoogeographic barriers. Across its range the species expresses high variability in size, shape, and coloration. To quantify morphological variation and to identify potential geographic patterns, we examined 166 adult tortoises (79 males and 87 females) from Vietnam, Cambodia, Myanmar, and Thailand and collected morphometric and coloration-related standard characters. To investigate for a potential genetic differentiation within *I. elongata* blood and tissue of 26 individuals including fresh samples as well as historic collection material were

obtained for genetic analyses. For all samples the ND4, Cyt b, and COI genes were sequenced. The dataset was supplemented with sequences obtained from GenBank. We found genetic and morphological variation to be only moderate in *I. elongata* and apparently not associated with zoogeographic features that have induced divergence in other lowland reptile taxa. This lack of divergence appears to be attributed to a long history of human mediated dispersal of a once small and localised ancestral population.
Genetics: Oral

Assessing the Current Status and Distribution, Locating Cryptic Populations, and Identifying Focus Areas for Conservation of Flattened Musk Turtles (*Sternotherus depressus*)

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The Flattened Musk Turtle (*Sternotherus depressus*) is a small kinosternid turtle endemic to the Upper Black Warrior River Basin (BWR) of Alabama. Severe range-wide declines attributed to sedimentation and chemical pollution from mining, agriculture, and development have been observed over the past few decades. In response to this decline, *S. depressus* was listed as threatened under the Endangered Species Act in 1987 and is considered to be critically endangered by the International Union for the Conservation of Nature. Despite listing, declines have continued, and trapping surveys indicate the species may now be at imminent risk of extirpation from over 90% of its historic range. In this study, we map stream substrate using side-scan sonar and conduct intensive wading surveys on the Locust Fork Watershed of the BWR to identify areas with suitable habitat structure and locate surviving populations where trapping surveys have failed. We present preliminary results from wading surveys and our plans to analyze sonar data to inform future recovery efforts.
Populations/Status: Oral (Student)

Abrupt Transition of Turtle Species Composition in Japan: A Case of Okayama Prefecture

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In the freshwaters of mainland Japan, the endemic Japanese Pond Turtle (*Mauremys japonica)*, Chinese Softshell Turtle (*Pelodiscus sinensis)*, as well as the introduced Yellow Pond Turtle (*Mauremys mutica)*, Reeves Turtle (*M. reevesii)*, and Red-eared Slider (*Trachemys scripta elegans)* can be found. It is thought that *M. mutica* was imported from China about 1,000 years ago, but since then it has not expanded its range and lives only in limited areas near Kyoto. *M. reevesii* were introduced from Korea 400 years ago, and *T. s. elegans* have been introduced from the USA within the last 60 years. In recent years, the number of *T. e. scripta* and *M. reevesii* are relatively large, and the two dominant species in Japan are considered to be rapidly transitioning from *M. japonica* to *M. reevesii*, and *M. reevesii* to *T. s. elegans*. We investigated the species composition of turtles in rivers and ponds of Okayama prefecture and predicted the transition process over 225 locations (149 ponds and 76 along rivers), from May 2014 to July 2017; turtles were captured using cage traps. We captured a total of 1,796 individuals, including 1,267 *M. reevesii* (70.5%), 484 *T. s. elegans* (26.9%), 35 *M. japonica* (1.9%), and 10 *P. sinensis* (0.6%), mainly in the southern part of the prefecture. *M. reevesii* has gradually increased in hundreds of years, and since 1990 it has spread explosively throughout Okayama and is now a dominant species. The density of *M. reevesii* was higher in ponds than the rivers, where no *M. japonica* were captured. We consider that *M. reevesii* has excluded *M. japonica* in the pond. *T. s. elegans* has a higher density in the river than in the pond, spreading its distribution from the river to the inland. It is considered that the density is higher in country rivers than downtown rivers where the human population concentrates, and from the position of the estuary, it has invaded through the sea instead of being expelled by people. Thus, in Okayama prefecture *M. japonica* that inhabited ancient times was driven away by *M. reevesii*. Moreover, *T. s. elegans* invaded there, and they are increasing at a violent momentum. Similar transitions are taking place in all parts of Japan, and worry about future biodiversity deterioration.
Populations/Status: Oral

Population Demography of Southeast Asian Box Turtles (*Cuora amboinensis*) in Protected and Disturbed Habitats in Indonesia

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The Southeast Asian Box Turtle (*Cuora amboinensis*) is one of the most heavily traded turtles in the world and is numerically the most important turtle exported from Indonesia. Targeted for food and traditional medicine trades largely in China and pet trade in the U.S., Europe, and Japan, as with many other turtles, delayed sexual maturity and small clutch sizes limit the capacity of populations to recover from impacts. Using mark-recapture methods, we compared abundance and demography of two protected populations (forested swamp and savanna ponds) inside a national park and two disturbed populations (fish aquaculture ponds and dam-created wetlands) outside the national park in Sulawesi, Indonesia. Turtle densities were >8x higher in forested swamp and >9x higher in savanna ponds in the national park than in the dam-influenced wetlands outside of the national park. No turtles were captured in the fish aquaculture ponds. Sex ratio (M:F) was about 1:1 in savanna ponds in the national park, and was nearly 2:1 in forested swamp in the national park and in dam-influenced wetlands outside of the park. Juveniles made up about 40% of each population in the national park, and about 70% of the population outside of the park. Mean carapace length of adults was about 10% smaller in turtles outside of the park. Informal discussions with local fishermen suggest there is currently little harvesting of *C. amboinensis*, but land use change from forested swamp and savanna to rice paddy and other agricultural/aquacultural production appears to be impacting turtle populations.

Asian Chelonians: Oral

Assessing the Efficacy of Environmental DNA to Detect Alligator Snapping Turtles (*Macrochelys temminckii*) at the Edge of Their Range

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Secretive aquatic animals are often particularly difficult to sample via traditional methodologies, especially when coupled with low population densities. Alligator Snapping Turtles (*Macrochelys temminckii*) are a fully aquatic chelonian endemic to the southeastern United States. At the northern extent of their range (*i.e.* Illinois and Indiana) this species is rarely encountered, and many records are chance encounters reported by citizen scientists. *M. temminckii* receive state-level protection throughout the bulk of their range and are currently under consideration for federal protection. As a consequence, documenting their occurrence across their range is a conservation imperative. Environmental DNA (eDNA) techniques detect DNA shed by animals into the environment to determine whether a species inhabits an area of interest. Due to their low detection probability at the edge of their range, eDNA may present a cost-effective method for *M. temminckii* surveys. We used an ongoing *M. temminckii* reintroduction in Illinois to test the efficacy of eDNA methods to determine detection limits using radio-telemetered individuals. Water samples were taken from known turtle locations, as well as random locations upstream and downstream from turtles. *M. temminckii* eDNA detections were positively correlated with turtle presence but showed limited downstream transport. Results from the Illinois methods-testing were applied to an eDNA survey of *M. temminckii* in two watersheds in Indiana, identifying locations with potential *M. temminckii* presence. Our results demonstrate that eDNA may be a viable means of detecting *M. temminckii* and could be utilized to better target areas to focus traditional sampling efforts.

Field Studies/Techniques: Oral (Student)

Next-generation Sequencing for Conservation of a Home's Hinge-back Tortoise (*Kinixys homeana*) Population in Central Ghana

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As sequencing methods improve, the ability to assess the genetic health of endangered populations becomes more feasible, even when there is little prior knowledge of the species' genome. The Home's Hinge-back Tortoise (*Kinixys homeana*), currently draft listed as Critically Endangered by a 2013 IUCN Red List workshop, serves as a good starting point for population genetics studies of species within the genus. For *Kinixys*, little to no genetic information has been published that would permit fine-scale population analyses. In this study, we aim to illuminate the genetic diversity of a population of *K. homeana* in Central Ghana. Shell samples from 93 tortoises were collected in 2014 and 2017 from Pra Suhein Forest Reserve (PSFR) and Kakum National Park (KNP) for DNA extraction. Double digest restriction-associated DNA sequencing provides genomic sequence for the identification of repeat regions suitable for microsatellite analysis of the population. We report allelic and nucleotide diversity, degree of inbreeding, and whether signs of a bottleneck are present. Additionally, population structuring between PSFR and KNP are tested for. Since the nearby communities have been harvesting tortoises from this site for a long but unknown period of time, we expect to detect low genetic diversity in this population coupled with signs of inbreeding. However, recently increasing human populations may result in stronger hunting pressures and a reduced population size within only a couple generations, potentially leaving remnants of a weak to moderate bottleneck. While structuring often tends to be weak among tortoise populations in the United States when barriers aren't present, roads and rivers occasionally reduce gene flow. Structuring is expected to be nonexistent to weak. The results from this analysis will be disseminated to the local communities and the Ghana Forestry Commission to better inform how humans are impacting tortoise populations. With some local support against harvesting tortoises, we hope to further encourage better management practices for this species.

Presentation type: Poster (Student)

Population Growth Estimates and Potential Management Scenarios for Five Populations of the Endangered Bog Turtle in North Carolina

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Recent literature suggests that several North Carolina Bog Turtle populations have low estimated adult survival estimates. Most of these populations appear dominated by old adults with few to no juveniles encountered in recent decades. Nest survival has been dramatically low at a subset of these sites over the last two field seasons, primarily due to predation. Two populations appear dramatically different, where capture data suggests a large proportion of young turtles, and where nest survival was substantially higher. We used stage-based population projection matrices to examine the effects of estimated survival rates on population growth (λ) for five North Carolina Bog Turtle populations. We also evaluated the efficacy of recruitment augmentation in the form of nest protection, lab-incubation of eggs, and a head-start scenario on improving λ. Only two of the five populations modeled appear to be stable or growing under current estimates. Unlike the stable populations, those in decline possess deflated survival estimates at multiple life-stages. These declining populations share many characteristics with, and may be representative of, many other populations in the state. High nest predation rates appear to reduce recruitment and may eventually affect the size and viability of these populations. These models suggest that management plans targeting increased recruitment (especially a head-start scenario) may substantially contribute to some populations reaching stability. Population growth will likely be dramatically higher when these efforts coincide with management to increase survival at other life stages. Our research highlights the need for managers to consider site-specific demography and vital rates in order to create effective management plans. These analyses also help managers make informed decisions as to where they might invest limited resources to maximize region-scale conservation outcomes.

Headstarting: Oral (Student)

Conservation Strategies for the Ephemeral Swamp Specialist *Pseudemydura umbrina* in the Drying Climate of South-Western Australia

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All five Mediterranean climate regions of the world are biodiversity hotspots, with ephemeral wetlands there representing disappearing ecosystems of major conservation concern because they harbor significant biodiversity. The Western Swamp Turtle (*Pseudemydura umbrina*) is the only turtle endemic to rain-filled ephemeral wetlands in a Mediterranean climate where low temperatures in cool wet winters restrict most energy acquisition to a short period in spring, and no food or water is available during long hot dry periods from late spring to autumn. Relying on abundant food within a short seasonal growth period (mainly macro-invertebrate blooms), *P. umbrina* shows an unusual dynamic energy budget for a turtle: it has the highest Arrhenius temperature for any reptile (almost 2.5-fold greater than that of 30 other Testudines, including five Chelidae) and the second highest somatic maintenance costs. Despite their longevity (life span similar to that of humans) these elements suggest a 'waste to hurry' strategy, interrupted by metabolic depression during estivation. This allows hatchlings to grow rapidly so they can survive their first summer. Massive habitat loss pushed *P. umbrina* to the rank of the world's most critically endangered turtle during the 1980s, but now it ranks 23rd due to successful recovery actions and the concomitant unfortunate decline of other turtles. However, the drying local climate, with rainfall decreasing under current climate change predictions, exacerbated by massive habitat loss and fragmentation, poses dramatic conservation challenges for this ephemeral swamp and clay pan specialist: the protected habitat areas are smaller than an individual's potential home range and the turtles are no longer able to move freely through the landscape among wetlands with different hydroperiods. To avoid emigration and loss of turtles from the four now existing populations during dry years, winter/spring drought refuges are created by: deepening parts of swamps; using bunds to channel surface flow; pumping ground water into some swamps; damming drainage lines to create ponds. In addition assisted colonisation is trialled to the wetter and cooler south coast. Although these sites are currently suboptimal for *P. umbrina*, progressing climate change may render them optimal during the potential lifetime of juveniles released now.
Presentation type: Oral

Moving Home twice: Impact of Suzhou Zoo's Move to a New Location on the Breeding Program of the World's Most Critically Endangered Turtle *Rafetus swinhoei* in China

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For a decade the last pair of the Yangtze Giant Softshell Turtle (*Rafetus swinhoei*) resided in old outdoor ponds specifically modified for their breeding in the old Suzhou Zoo in a world heritage listed garden. In late 2016 all Zoo animals moved into a modern purpose build new Zoo at the outskirts of Suzhou, with the exception of the *Rafetus* pair: since I considered their modern new pond and enclosure suboptimal they were allowed to remain in their old facility until April 2017. Surrounded by demolition crews and machinery, artificial insemination was again performed there on 14 April 2017 by a team which included Professor Thomas Hildebrandt, Dr. Susanne Holtze, Dr. Paul Calle, veterinarians from the Suzhou Zoo and Changsha Zoo, myself, as well as representatives of WCS-China and the China Zoo Society. Both *Rafetus* then moved into a temporary facility near Suzhou where they spent half a year waiting for a new facility in the new zoo. Eventually they moved into it on 06 November 2017. Despite the female carrying a full set of vitellogenic follicles in April 2017, she did not ovulate and lay eggs during 2017 and was eating only about half the amount of food she used to. An ultra-sound examination in early November 2017 showed massive follicular atresia with parallel proceeding vitellogenesis. Over the winter of 2017/18 the old male remained active and did not settle down by burrowing in the mud as usual and as the female did. An ultrasound examination of the female in mid-April 2018 revealed that atresia of last year's follicles was still not completed, but parallel she carried sets of new vitellogenic follicles. To let the male recover and settle in the new environment without disturbance no artificial insemination (AI) was attempted in the spring of 2018. Both male and female commenced feeding normally in early May, and in late May the female nested in her new enclosure and laid a clutch of 62 eggs. However, egg size was smaller than in previous years. Currently, it is still unknown if any eggs are developing based on last year's AI.
Presentation type: Poster

Husbandry and Reproduction of *Terrapene coahuila*

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The Coahuilan or Aquatic Box Turtle *(Terrapene coahuila)* currently sits as endangered on the IUCN red list and was included in the 2018 Turtles in Trouble update, named as one of the top 25+ most endangered chelonians on the planet. Its habitat preferences and highly restricted range to the wetlands of Cuatro Cienegas in northern Mexico along with habitat destruction have had devastating effects. They are now one of the rarest turtle species of North America and some sources report as few as 2,000 left in the wild. Despite this rather critical status in nature, *T. coahuila* has proven to be hardy and quite prolific under captive conditions. Few work with this species in America today with assurance colonies being uncommon. Interestingly, some who have been fortunate enough to maintain them have experienced a surprising amount of success. As members of the Association of Zoos and Aquariums *T. coahuila* Species Survival Plan, we have managed to actively propagate this species in southern New Jersey. Annual behavior patterns, oviposition frequency and clutch size along with diet statistics have all been recorded under our care. In addition, fertility rates, breeding data and hatchling growth have been observed for four years now. This talk will report our methods and ongoing success with this very endangered, yet reliably reproductive, box turtle species.
Captive Husbandry: Oral

***Testudo graeca nikolskii* Ecology at the Western Caucasus (Russia).**

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Testudo graeca nikolskii, which validity was confirmed at the genetic level, inhabits the Western Caucasus. Its area prolongs from Anapa city to Sukhumy city along the coastline of the Black Sea. One of the major key habitats of the subspecies, and one of the largest and most stable territorial groups of the Mediterranean tortoise *T. g. nikolskii* exists at the Abrau Peninsula. One of the purposes of Utrish reserve created in Russia in 2010 at the Abrau Peninsula is to protect this tortoise. Studies of *T. g. nikolskii* conducted since 1980 brought together an impressive material about its biology, ecology and biogeography. During field researches the tortoises were studied on the routes and permanent sites using tagging, radio telemetry tracking with subsequent measurements. Maximal *T. g. nikolskii* population density at the Abrau Peninsula reaches 10 ind./ha on the gentle slopes of the south-western and southern exposure within 100 m above sea level, covered with bushes, shiblyak, rock-oak forests and woodlands of juniper and pistachio. In other habitats average density is 1-5 ind./ha. Demographic structure is stable throughout many decades, adult males and females older than 20 years dominate (carapace length up to 249 mm) Younger generation are more variable in size, due to various (including anthropogenic) causes. *T. g. nikolskii* lives in nature approximately till 70 years and even more. Investigation of excrements and behavior showed that besides vegetation tortoises can consume carrion, eggs and nestlings. *Hyalomma aegyptium* is the ectoparasite of the tortoises. Some years, density of the ticks can reach 50-55 individuals per one tortoise. Radio tracking showed that the tortoises can stay at one place for a long time or move rapidly to a big distance. Hibernation of the tortoises takes place at the gentle slopes in the broadleaf forests with thick litter. Mediterranean tortoise ecologically is very plastic. It can survive even in extremely rarefied space between individuals and the barriers between populations. The main negative influence on the tortoise population: reducing and cutting of the area, hunting of the domestic animals on the tortoises, collecting as the pets.
Population/Status: Oral

A Probable Testudinoid from the Upper Cretaceous of New Mexico

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A new fossil turtle from the Upper Cretaceous (upper Campanian, ~ 75-76 Ma) Fruitland Formation of northwestern New Mexico is distinguished by the lack of a costiform process, significant overlap of the scutes on the visceral

side, lack of dorsal ridges, and smaller size (carapace length = 256 mm) than co-occurring baenids. These baenids form the distal portions of their costals late in ontogeny relative to extant turtles, and, at this small size, would still have large costal fontanelles. The overall shell of the new taxon has a low dome, with the posterior margin of the carapace slightly scalloped. The nuchal is significantly longer than wide, with no costiform process. There is no cervical scute in this individual. A small cephalic emargination of the carapace is present. This turtle has a neural formula of 4-6-6-6-6-6, with the more posterior neural sutures unclear. The costals vary in length near the midline in a similar manner to *Hadrianus* and *Anhuichelys*. The peripherals show a musk duct groove on peripheral 2 and possibly on peripheral 7. The plastron is only preserved on the left side, but the anterior and posterior lobes appear to be of similar width. The posterior lobe has an angular end, with a deep caudal emargination. The anal scutes are short, with a posteriorly concave curve near the lateral margin. The Late Cretaceous age of this specimen is further corroborated by the presence of a dromaeosaur claw in the adjacent matrix to the shell. This new turtle does not match any species previously known from the Cretaceous of New Mexico or, to our knowledge, from anywhere else. This is a significant discovery, as no testudinoids were previously known prior to the K-Pa boundary in North America. This suggests that, contrary to previous hypotheses, testudinoids entered North America before the K-Pa boundary.

Presentation type: Poster

Morphological Variation in Extant Testudinoids

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Many characters have been used to infer the relationships of turtles based on morphology, but few of these have been examined for variation. To try to understand how some of these characters vary we examined specimens from the collections of the Museum of Southwestern Biology. In *Gopherus agassizii,* we examined the shapes of the neurals, the general proportions of the neurals, the neural contacts with the costals, whether all costals reach the peripherals, whether the gulars overlap the plastron and the angle of the gular scute's posterior corner. The shape of the neurals varies greatly, with only neural 2 not exhibiting multiple morphologies. Neural 1 is rectangular, hexagonal with the short sides anterior or hexagonal, with the short sides facing posteriorly in multiple specimens. Neural 3 is either octagonal, hexagonal with the short sides anterior, or hexagonal, with the short sides facing posteriorly. A similar pattern persists posteriorly. The general proportions of the neurals are very consistent, always longer than wide. The contacts are fairly consistent but did vary, particularly in neurals 6-8. Costal 7 sometimes contacts costal 6, but about half do not. Neural 7 contacts either costals 6 and 7, 7 only or 7 and 8. In about 10% of our specimens, neural 8 is absent. In almost all specimens all of the costals reach the peripherals, but one has costal 4 expanded so that costals 3 and 5 do not reach the peripherals. The overlap of the gulars onto the entoplastron occurs in 40% of specimens, but does not reach the entoplastron in others. The gular angle varies from acute (75˚) to oblique (135˚), with a mean of 111˚. We also examined as many species as possible of juveniles with only partially formed costals to see if the pattern in which costals are widest at their proximal ends persists through ontogeny. We found that the widest costals in the adults are also the widest costals in the juveniles of all species we examined, including *Chelydra serpentina*, *Terrapene ornata*, *Pseudemys gorzugi*, *Chrysemys picta*, *Lepidochelys kempi* and *Gopherus agassizii*.

Presentation type: Poster

An Update on Conserving the Endemic Chelonians of Sulawesi: Forsten's Tortoise and Sulawesi Forest Turtle

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The endangered Forsten's Tortoise (*Indotestudo forstenii*) and the critically endangered Sulawesi Forest Turtle (*Leucocephalon yuwonoi*) are endemic to the Indonesian island of Sulawesi, and are among the least studied chelonians in the world. The Turtle Conservation Fund lists *L. yuwonoi* as a high priority species, in need of immediate and swift support. Based on data and information gathered from recent population surveys and resident questionnaires, it is apparent that *I. forstenii* is in at least as much peril, if not more. This project is a conservation

collaboration during which we are conducting population surveys to accurately determine distribution, with results also initiating a long-term species monitoring program to be run jointly by the Principal Investigators, students and faculty from local universities and residents from field sites. Through this program, we can track daily activity, foraging and reproductive behavior and determine the ecological requirements of the species. Concurrently, to work toward the goal of developing an *in situ* captive breeding program, we have partnered with a local university in Central Sulawesi, located in prime *I. forstenii* habitat, where they have implemented a rudimentary, student-run chelonian soft release program. This partnership provides a platform for education and outreach, allows for the opportunity to track and study a population of released turtles as an on-campus research and training project and will provide the opportunity to build assurance colonies for future reintroduction programs. Through citizen science and capacity building initiatives, we are training and empowering students and residents to participate in the field work and the future captive breeding program, and we will establish community awareness and educational programs at universities, schools and in communities to promote a positive perception toward the conservation of these species and their habitats. Combined, findings will contribute to the long-term goals of building much-needed assurance colonies for potential future reintroduction programs, protecting wild populations where possible and identifying parcels of land that could be purchased and protected to become sustainable preserves for these, and other, species.
TSA Field Programs: Oral

Distribution and Habitat Associations of Western Chicken Turtles in Southeastern Oklahoma

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We studied the distribution of Chicken Turtles (*Deirochelys reticularia*) in the Muddy Boggy and Clear Boggy river drainages in southeastern Oklahoma to determine conservation measures that could benefit the species. To this end, we conducted aquatic turtle surveys in 9 beaver ponds, 2 Wetland Reserve Program (WRP) sites, 5 cattle ponds, 6 ponds in woods, 4 oxbows, and 3 natural 'lakes' of varying geomorphology. Surveys were conducted using funnel traps of varying sizes, and the number of traps set varied with wetland size. We also radio-tracked a subset of animals to monitor movements among wetlands and terrestrial estivation. Chicken turtles were captured in 10 of 29 wetlands, but only beaver ponds appeared to support consistent populations. One WRP site yielded four specimens, and we hypothesize that these wetlands could be made more attractive to chicken turtles with adjustments to seasonal fluctuations in water levels. We also found that this species moves extensively among wetlands and spends most of the year in terrestrial dormancy. Therefore, we suggest that conservation of the species should focus on large-scale preservation of beaver ponds and surrounding woodlands, and on developing WRP management practices that benefit the species.
Field Studies/Techniques: Oral

Growth and Body Condition of the Common Map Turtle (*Graptemys geographica*): A 19-Year Study of Inter-Annual and Seasonal Variation

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I studied growth in Common Map Turtles (*Graptemys geographica*) from 1999–2017 at Presque Isle State Park, a sandspit peninsula on Lake Erie in Pennsylvania. I captured 1724 individual turtles and made between 1 and 9 recaptures (888 total) for 529 turtles. Plastral annuli were a reliable indicator of age for up to 10 years of age in females and up to 6 years of age in males in 236 of 248 recapture events (95%) that spanned an average of 2.2 years (range 1–6 years). Recaptured turtles of known age were up to 19 years old in both sexes and adults ≤19 years of age spanned the entire range of adult body sizes for each sex, although growth continued between recaptures for many adults of all sizes. To analyze interannual variation in growth, I began measuring medial widths of completed growth annuli in 2006 and amassed a data set of 1937 annulus widths from 381 females, dated as far back as 1998, and 910 annulus widths from 224 males, dated as far back as 2000. Within cohorts whose growth had occurred

under similar environmental conditions, annulus widths at particular ages did not vary by age at which the turtles were measured, thus they were considered to be unchanging records of past growth. Regression modelling related annulus width of each sex to age (declining width with age, consistent with the von Bertalanffy growth model) and to year. Years that had poorer or better growth were highly congruent between the sexes and the magnitude of growth was strongly positively correlated with the number of growing degree days (cumulative time above 10°C) during the time period when turtles exhibited new annulus formation, 11 June–19 August. Climatic data indicate warming of Presque Isle over recent decades and data from 18 *G. geographica* museum specimens collected at Presque Isle in 1900 suggest that contemporary growth is strongly enhanced by the warming environment. Variation in body condition was weak interannually, but body condition was highest in September, when turtles were not growing and were nearing the onset of the lengthy winter brumation in Erie.
Graptemys: Oral

Where Have All the Turtles Gone, and Why Does It Matter?

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Of 356 species of turtles worldwide, approximately 61% are threatened to some degree or already extinct. Turtles are now among the most threatened of the major groups of vertebrates, in general, more so than birds, mammals, fishes or even the much besieged amphibians. Reasons for the dire situation of turtles worldwide include the familiar list of impacts to other species including habitat destruction, unsustainable over-exploitation for pets and food, and climate change, the latter because many turtles have environmental sex determination. One way to increase recognition of the value of species is to look at the services they provide to an ecosystem, including those increasingly dominated by humans. Population declines can lead to function loss in ecosystems that may not be immediately apparent. Numerous publications have documented key ecological roles for a variety of species but few have examined the functional positions of turtles in their environments. Here we review the various services that large populations and diverse communities of turtles provide from an ecological perspective as significant bioturbators of soils, infaunal miners of sea floors, dispersers and germination enhancers of seeds, nutrient cyclers, and consumers. A major goal of our review is to place turtles within the overall context of ecosystem processes including energy flow, trophic status, mineral cycling, scavenging, and soil dynamics. Identifying these critical ecological roles is one step toward offering rationales for concerted efforts to conserve these emblematic creatures that have accompanied us into the Anthropocene, a time of extinction and decline for many terrestrial vertebrates. The collapse of turtle populations on a global scale has greatly diminished their ecological roles with, as yet, largely unknown consequences.
Special Presentation: Oral

Conservation Status of the Mexican Rough-Footed Mud Turtle (*Kinosternon hirtipes*)

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The Mexican Rough Footed Mud turtle (*Kinosternon hirtipes*) is distributed from western Texas to the Mexican Transvolcanic Belt. Six morphologic lineages have been described across its range. One lineage, *K. h. megacephalum* is considered extinct, the other four are restricted to one (*K. h. tarascense*) or two sites (*K. h. magdalense*, *K. h. chapalense*, and *K. h. hirtipes*), while *K. h. murrayi* is widespread. Based on available records, surveys were conducted in Jalisco and Michoacán where four of the six subspecies are suspected to occur. Populations of *K. h. murrayi* were located and characterized around Morelia, one of which was heavily male biased (3.1:1, $\chi^2 = 24$, $p < 0.001$), while the others showed low abundances. For the first time a population of *K. h.*

tarascense was located in Patzcuaro Lake, but abundance is very low and only nine individuals were captured. This taxon was originally described from town market specimens and nothing was known about its habitat. The nine individuals found here were in cattail swamps along lake shore. No *K. h. chapalense* were found in Chapala Lake, but three individuals were located and measured in Zapotlán Lake. Only five individual *K. h. magdalense* were located in the Magdalena basin and three were from a new locality for the taxon. No surveys were conducted in the Valley of Mexico for *K. h. hirtipes*. Interestingly, *K. integrum* was present in all the localities visited and in higher abundances than *K. hirtipes*. Forty-one *K. integrum* individuals were captured in the same habitat of *K. h. magdalense*, 103 individuals were captured in a single channel in Chapala Lake, and one individual was captured in Zapotlán Lake. In Michoacán, we found 43 *K. integrum* in sympatry with *K. h. murrayi* in one locality near Morelia, and 60 *K. integrum* were found 1 km away from the *K. h. tarascense* population in Patzcuaro Lake. In addition to the abundance of *K. integrum*, most of the aquatic habitats occupied by *K. hirtipes* are degraded or reduced. The abundance of *K. integrum* and habitat degradation impose immediate risks to these morphologically distinct, microendemic populations of *K. hirtipes*.
Populations/Status: Oral

Hotspot of Red-eared Slider in Japan

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The Red-eared Slider (*Trachemys scripta elegans*) has been imported into Japan as a pet from the United States since the 1960s. The hatchling of this species is popularly known as "Midori-game" in Japan. Midori-game is sold at a pet shop at $5 per animal, and there are games that scoop it at traditional festival stalls. Some of those turtles escaped from home, and some were released to rivers or ponds in the field by their keepers. There are few turtle ecologists in Japan and no one warned of the destruction of the ecosystem caused by the explosion of *T. s. elegans.* However, since around 2000, some naturalists have noticed that *T. s. elegans* is increasing in various places of Japan. Along with an increase in *T. s. elegans*, rare species of fish, aquatic plants and aquatic insects have disappeared. In Japan, in addition to *T. s. elegans*, alien species such as largemouth bass (*Micropterus salmoide*s), bluegill (*Lepomis macrochirus*), bullfrog (*Lithobates catesbeiana*) and red swamp crawfish (*Procambarus clarki*i) have increased, but the specific influence of *T. s. elegans* has never been studied. According to one theory, it is said that the disappearance of precious aquatic plant species is caused by the influence of *T. s. elegans.* In the freshwater of Japan, there are hotspots such as estuaries, moats of castles, canals and ponds, where *T. s. elegans* is breeding in high density. Since *T. s. elegans* is herbivorous, it is difficult to limit the population size of them and their density is higher than other turtle species in Japan. In 2010, Suma Aquarium Kobe began extermination and research of *T. s. elegans*. A pond to keep *T. s. elegans* was made in the aquarium, and accepted the turtle that the citizen exterminated. That was a trigger for the Ministry of the Environment and local city offices to begin to exterminate *T. s. elegans.* Although it is impossible to remove all *T. s. elegans* spread all over the western Japan, attempts to remove them from nature where rare species were maintained have started.
Presentation type: Poster (Student)

Amazon Forest Pond Turtles in the Terrarium of the Center for the Study of Amazon Turtles.

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The Center for the Study of Amazon Turtles has the mission of studying all aspects of the biology of the 18 Amazonian turtle species in nature and in captivity to promote conservation, management, and public education. We have small colonies of 15 species housed in 4 x 7 m aquaria, and a 10 x 10 m terrarium with six 1-m diameter ponds 30 cm deep. The well-ventilated two-story building maintains a natural light and temperature regime, with windows open during the day for natural sunlight. We have four forest pond species in the terrarium: *Mesoclemmys gibba*, *Platemys platycephala*, *Rhinoclemmys punctularia*, and *Kinosternon scorpioides*, and have been monitoring these species for three years 24 h a day with three surveillance cameras, recording their behavior. We prefer to study

turtles in nature, but there are many behavioral patterns which are not easily observed. We have noted that not all forest pool turtles are equal, two species adapted well to captivity, 14 *R. punctularia*, and 14 *K. scorpioides*, and maintain dynamic social interactions; we have recorded courtship, copulations, and nesting in both species. Both species feed well on kale, cord green beans, squash, and fresh fish, and appear to be resistant to pathogens in the soil and water of the terrarium. However the 18 *P. platycephala* and 8 *M. gibba* did not thrive in this environment; they lost body mass, did not attempt to copulate; one *P. platycephala* nested soon after she was captured in 2017. During three years (2015 to 2017) we lost 15 *P. platycephala* and five *M. gibba* to infections, suggesting that they are not as resistant to these captive conditions as *R. punctularia* and *K. scorpioides*. *Platemys* and *M. gibba* seem to have their activity patterns closely tuned to the raining season; and attempted to aestivate rather than remain in the pools. Future studies must include artificial or natural rainfall to regulate their annual cycles. Our studies in nature using VHF transmitters found *Platemys* to aestivate from the end of the rains in June until the beginning of the rains in December.

Captive Husbandry: Oral

Differences in Innate Immune Mechanisms in Common and Alligator Snapping Turtles

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The innate immune system is the primary mode of defense in ectothermic vertebrates, acting quickly to remove the threat of infection by potential pathogens. Results from previous studies in our laboratory indicated that the plasma of Common Snapping Turtles (CST, *Chelydra serpentina*) and Alligator Snapping Turtles (AST, *Macrochelys temminckii*) exhibited similar, broad-spectrum antibacterial activities. Typically, the direct killing of pathogens occurs via the serum complement system of proteins, which can be activated by one of three distinct mechanisms: classical, lectin, or alternative pathways. The alternative pathway is thought to be the most common, as it is continuously activated and functions by recognition of non-self tissues. To investigate the molecular mechanisms responsible for the observed antibacterial activities in AST and CST, the complement system was assessed using a sheep red blood cell (SRBC) hemolysis assay. Surprisingly, although the antibacterial activity had been shown to be similar, the intensity of the hemolytic activity against SRBC was much stronger in CST than AST. Treatment with classical inhibitors of the different complement cascades indicated distinct differences in the mechanisms of complement activation between the turtle species. We isolated two abundant mannose-binding lectin proteins from the plasma of ASTs that were present at extremely low amounts in CST plasma. Mechanistic studies revealed that the CSTs combat infection primarily using the alternative mechanism of complement activation, while ASTs rely heavily on the lectin-mediated pathway.

Field Studies/Techniques: Oral

Insights into Freshwater Turtle Diversity and Perceived Threats Along the River Ganges, Northern India

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The Gangetic basin supports 15 species of turtles including nine threatened species. Despite being a Global Turtle Hotspot, there is a lack of baseline information on the status, distribution and efficient survey techniques for turtles. This study aimed to document distribution, local diversity patterns of turtles along representative sites, and assess threats based on local people's perceptions. Along the entire 2525 km length of the river Ganges, Gill Nets (GN) of mesh sizes 3", 4", 8" were deployed at 32 intensive sampling sites of 5 km each from September-November 2017 and February-May 2018. Visual Encounter Surveys (VES) were conducted by boat for 2 km river stretches. Site-wise diversity indices were calculated for all sites. To assess perceived threats to turtles in the riverscape, semi-structured fishermen interviews (N=32) were conducted. A total of 11 species (N=161) were encountered during this study including the Endangered *Batagur dhongoka* (N=14) and *Chitra indica* (N=2) from three unprotected sites indicating these regions are important turtle conservation priority areas. The Shannon-Weiner H´ value ranged from 0 to 1.61 across the 32 sites. Species richness was found to be maximum in site Narora, Uttar Pradesh with Fisher's

alpha diversity (α) of 4.27. The Catch per unit effort (CPUE) across all sites from the study was 3.8 turtles/ trapping session. CPUE and detection rates varied among VES and the different GN, with the 4" mesh GN having higher detection probabilities for most species encountered. *Pangshura smithii* had the highest CPUE of 0.8 turtles/trapping session with the 4" mesh GN indicating it as an effective trapping method for detecting turtles in the Ganges- a wide, fast flowing, lotic river. Respondents were expert fishermen showing considerable ecological knowledge of turtles, their seasonal activity and nesting patterns. 80% respondents identified a minimum of five species from photographs. Accidental capture in nets was identified as the biggest threat, followed by intentional hook line captures for consumption, and then nest predation by animals, primarily feral dogs. There is still much to learn about turtle assemblage patterns at local scales, their habitat affinities and responses to anthropogenic activities in the Gangetic basin.

Field Studies/Techniques: Oral (Student)

Predator Exclusion using Electric Fencing for Captive Turtles and Tortoises in Central Texas

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It is an accepted fact among turtle and tortoise keepers that housing chelonians in outdoor pens or tanks, as the weather allows, greatly benefits the animals over full time indoor accommodations. Yet, outdoor pens can leave the reptiles susceptible to predation by any number of wild, feral, or domestic threats. In Central Texas, numerous predators of turtles and tortoises abound: skunks, opossums, raccoons, coyotes, domestic dogs, feral cats, and bobcats. In order to protect our collection of turtles and tortoises, we have developed a combination fence that utilizes standard wire fencing, a visual barrier, and an electric hotwire to exclude predators from large outdoor pens and water tanks.

Captive Husbandry: Oral

An Update: Impacts of Hurricane Harvey on an Iconic Freshwater Turtle Species, Hidden in Plain Sight: Snappers Within a Concrete Jungle

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Known as the "Bayou City," the City of Houston, Texas features numerous anthropogenically altered bayous that act as water carrying arteries through Harris County, Texas. In 2016 the Turtle Survival Alliance's North American Freshwater Turtle Research Group (TSA-NAFTRG) found a seemingly hidden— and reproductive—population of the Western Alligator Snapping Turtle (*Macrochelys temminckii*) within the vicinity of downtown Houston. The confirmation of this population in Harris County was significant. Despite anecdotal reports of individual turtles from the county, viable populations of this species were considered extirpated from the county for over 50 years. Subsequent trapping sessions during the 2017 study year (January—August) resulted in a total of 23 individuals recorded and PIT tagged within two small segments of a 6.4 km (4 mi) stretch of the Buffalo Bayou. In August 2017, Hurricane Harvey struck the Texas coast as a Category 4 storm, dropping record-breaking rainfall across southeast Texas and the Greater Houston metropolitan area. From August 27th to August 31st, 2017, Hurricane Harvey dropped 102 to 152 cm (40-60 in) of rain on the region. The storm flooded much of the region with historic water levels, eventually becoming the worst flooding event in the recorded history of the United States. Catastrophic flooding occurred for the Buffalo Bayou and all the other bayous bisecting Harris County. Once the floodwaters

receded, trapping for our long-term population monitoring effort of the Western Alligator Snapping Turtle in Harris County continued. From November 2017 through May 2018, an additional 19 Western Alligator Snapping Turtles were captured, ranging in size from 30.9 cm (12 in) max carapace length to 60.5 cm (24 in) max carapace length. The size range and sex ratios of specimens captured before and after the hurricane are approximately equal. Preliminary results, representing nearly one year of trapping efforts after Hurricane Harvey produced the worst flooding event in the United States' recorded history, seem to indicate that the *Macrochelys* population in the Buffalo Bayou was able to "weather the storm".
Texas Turtles: Oral

A Comparative Diet Study for Hand Rearing Galapagos Tortoises *(Chelonoidis microphyes)*

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Hundreds of Galapagos Tortoises have been produced in collections over the past several decades. Despite the species' documented lifespan of over one hundred years, many of the F1s have failed to survive past year thirty. Necropsies have revealed a high incidence of heart and liver disease. Survivors are commonly plagued with abnormal shell conformation, rapid weight gain and inability to adequately bear weight evenly on all four legs. Among all of the husbandry techniques implicated, dietary issues seem to be the most significant. The purpose of this study is to compare the results of hand-rearing Galapagos Tortoises utilizing our "tried and true" dietary regime, versus the use of a commercially-produced pelleted tortoise diet. Ten hatchlings (five different clutches from same sire x dam) were split into two separate groups as soon as they were started on food. One group was fed a variety of natural browse and the Gladys Porter Zoo (GPZ) house diet, while the other group was exclusively fed ZooMed (ZM) Grassland Tortoise Diet pellets. After three years, the tortoises on the pelleted diet showed excellent shell conformity, but grew at an unacceptably slow rate in comparison to the GPZ group. After re-evaluating nutrient levels in diets for both groups, the ZM tortoises were switched to ZooMed Forest Tortoise Diet pellets with the aim of achieving a more acceptable growth rate. A second test group of eight tortoises was added to the study to compare tortoises started on the Forest Tortoise formula. Currently in year four of this ongoing study, an exclusive diet of ZooMed Forest Tortoise has subjectively yielded positive results. In close comparison to the GPZ diet, the ZM group has grown at a steady rate with no appearance of shell abnormalities or ambulatory issues.
Zoos & Chelonians: Oral

Status of the Alligator Snapping Turtle (*Macrochelys temminckii*) in Two River Drainages of Central and South Mississippi

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There is a lack of historical and current information for the Alligator Snapping Turtle *Macrochelys temminckii*) in Mississippi, thus leaving a void of knowledge at the core of this species' geographic range. With the ongoing species status assessment of *M. temminckii* by the US Fish and Wildlife Service and other regulatory agencies, filling knowledge gaps in distribution and population abundance is crucial. Therefore, our goal was to fill Mississippi's knowledge void by assessing the status of *M. temminckii* in all major river drainages throughout the state. In 2017, we systematically trapped 17 locations within the Pascagoula River drainage using baited hoop nets set near appropriate microhabitats. From May to October 2017, we totaled 138 captures of 126 *M. temminckii* (17 males; 34 females; 75 juveniles) in 878 trap nights, averaging 0.16 turtles per trap night (0 – 0.33 TTN). *M. temminckii* captured in lakes were larger (mean: 33.6 cm SCL; 11.68 kg) than those in rivers (mean: 29.25 cm SCL; 7.47 kg), due to the higher catch rates of juveniles, and lack of large males ($\geq$ 50 cm SCL), at river sites. In May 2018, preliminary trapping at four locations within the Pearl River drainage yielded 19 *M. temminckii* (12 juveniles; 5 males, 2 females) in 246 trap nights, with sizes ranging from 17.9 – 61.8 cm SCL. Also, a yearling (4.1 cm SCL) and juvenile (17.8 cm SCL) were hand captured near traps. Preliminary catch rates in the Pearl River drainage varied from 0.03 TTN to 0.14 TTN (average = 0.08 TTN), which are substantially lower than catch rates within the Pascagoula River drainage. Throughout 2018, trapping will continue within the Pearl River drainage to further

assess distribution and population abundance of *M. temminckii* and compare these populations to those within the less altered Pascagoula River drainage.
Field Studies/Techniques: Oral (Student)

Tortoise Traffic is Accelerating the Extinction of the Radiated Tortoise in Southwestern Madagascar at Alarming Rate

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The Radiated Tortoise of Madagascar was elevated to Critically Endangered status by the IUCN in 2008. With ineffective enforcement capacity in the south-western region of Madagascar, 10 years after the species was elevated, traffic continues at an alarming rate and the extinction risk rises. At the level of the Regional Direction of Ecology and Forest Environment (DREEF) various studies have been carried out (biological, economic, etc.) to better understand the factors impacting commercial collection of Radiated Tortoises. (1) for consumption purposes in ten years, (2008-2018), on the collection areas (Efoetse, Itampolo, Androka), the range and distribution of the species decreased by 50%. Collectors are now working in the Lac Tsimananpesotse National Park. **At the national level**, in Toliara, the socio-economic studies have shown that in two fokontany (defined as community of communes/villages) of consumers, from 78 populations, 37% surveyed said they eat tortoise meat as a preference, and consider tortoise meat a traditional consumer dish since their ancestral time. The selling price is $7-9.00 US for a medium-sized tortoise and the monthly profit of dealers is $718 US for an average of 80 tortoises. For transporting tortoises, the monthly profit $480 for an average of 160 tortoises which brings him $3 each. In Fotadrevo (a remote village far to the north known for tortoise poaching), the collecting trip is 3-4 days on foot to reach an area dense in tortoises, and they return on foot at night with 2 bags of dry meat, each sold for .29 per piece, with a monthly profit of $479. At the **international level,** tortoise traffickers use fishing boats, like the last case on April 10, 2018 where more than 10,000 tortoises were confiscated in Tulear. Collectors use 2-3 trucks and go directly to collection areas and pay $9 per tortoise. Monthly collections are from 300-600 tortoises per truck. The situation is highly alarming, because with all these pressures on tortoise populations, and given the poverty of local communities and corruption, we are in a deadlocked situation. Strategies are being implemented to combat this scourge but we are far from reaching our goals. For dealing with the consumption side, we must prioritize poverty action plans, by identifying and financing communal development projects. For commercial poaching we recommend lobbying at the international level for assistance in being able to carry out effective interventions.
Madagascar Update: Oral

Temperature-Sensitive Period for Sex Determination of the Malayan Snail-Eating Turtle (*Malayemys macrocephala*)

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Many egg-laying reptiles possess temperature-dependent sex determination (TSD) in which gonadogenesis is determined by incubating temperature during a temperature-sensitive period (TSP) of development. Different temperature can induce change in sex determination cascade as well as sex ratio of the population in turtle with TSD. Prior studies on *Malayemys macrocephala*, a freshwater turtle found in Southeast Asia, showed that incubating temperatures could influence gonadal development, and suggested that *M. macrocephala* exhibits a TSD. However, information on period of temperature-sensitivity in this species is unknown. This study thus aimed to find a temperature sensitive period for sex determination of *M. macrocephala*. Turtle eggs were collected from rice fields in Phra Nakhon si Ayutthaya Province, central part of Thailand during December 2016 to February 2017. Based on 5 field surveys, a total of 570 eggs from 95 clutches were collected. In the laboratory, eggs were incubated at male-producing temperature (MPT, 26 °C) and shift to female-producing temperature (FPT, 32 C°), or vice versa. Shift

experiments were performed systematically in sequence of temperatures (26→32 °C or 32→26 °C) during developmental stages 13-21. After hatch, sex of individual turtle was determined by histological analysis. It was found that, in MPT to FPT experiment, sex of turtles shifted during stages 13 to 16 showed female-bias ratio while sex of control (no shift) and eggs shifted during stages 17-21 showed the original male-bias ratio. In FPT to MPT experiment, turtles shifted during stages 13 to 16 showed male-bias sex ratio while control and turtles shifted during stages 17-21 showed the female-bias sex ratio. This indicates that the TSP of *M. macrocephala* occurs during the middle third of development (stages 13-16) and encompasses the bipotential and sex determination phases of gonadal development. This information could be applied to validate the potential use of this species as an animal model for research in developmental biology as well as understanding potential impact of the current trend of thermal stress on freshwater turtle.
Asian Chelonians: Oral (Student)

The Turtle Survival Alliance (TSA) Response to The Confiscation of a Large Group of Radiated Tortoises (*Astrochelys radiata*) in Madagascar in 2018

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On April 10, 2018, the Madagascar Department of Ecology Environment and Forestry (DREEF) discovered and confiscated over 10,000 endangered Radiated Tortoises (*Astrochelys radiata*) in a home in Toliara, Madagascar. This was the largest confiscation of *A. radiata* ever made. DREEF immediately contacted TSA and Station d'Observation et de Protection des Tortues et de leurs Milieux (SOPTOM) for assistance in housing and caring for the animals. SOPTOM has a large tortoise rescue facility (Village des Tortues) near Ifaty which was opened to the tortoises. TSA immediately sent Malagasy veterinarians and husbandry personnel from its other centers in Madagascar to begin the arduous process of triage and treatment of the animals. The TSA issued a call for volunteers and supplies. On April 21, the first wave of responders, including 2 clinical veterinarians, a veterinary pathologist, 2 veterinary technicians, a veterinary logistics coordinator, and husbandry and construction specialists arrived in Antananarivo carrying 1,200 pounds of medical and husbandry supplies. Co-ordination of personnel, monetary resources, travel, and communications was initiated in California, Texas and New York.
Upon arrival in Ifaty, the team began to offer relief and aid to the dedicated personnel who had been providing care to the animals continuously since the confiscation. There was already a system in place for identifying sick animals, assessment and initial treatment, and provision of ongoing care. Modifying the system (such as combining fluids, antibiotics, and vitamins so that only one injection was necessary) improved efficiency. The clinic facility at Village des Tortues was used for hospitalizing cases requiring intensive care, and large outdoor enclosures were used for medical cases that were less critical. During the ensuing weeks, at both Ifaty and Itampolo, training of veterinarians, technicians, and husbandry personnel was provided as time allowed.

It is fortunate that radiated tortoises have evolved to survive adverse conditions. The animals had not been adequately fed or watered, nor had access to sunlight, for months. Post-mortem exams (performed on all tortoises

that died) were consistent with the clinical findings, primarily related to dehydration, emaciation, poor bone quality, and in a small percentage of the population, a syndrome of severe stomatitis and/or glossitis. Of the total number of oral exams done on ill animals, approximately 25% revealed some degree of stomatitis; representing 4 % of the total population. No other consistent clinical signs were seen. At necropsy, approximately 40% of the animals had oral lesions. Clinically ill animals ranged in weight from 33 – 1,166 gm. There were totals of approximately 4,000 clinical interventions, with 9,300 injections of antibiotics, fluids, analgesics, and vitamins administered over six weeks. The total number of tortoises that died was approximately 1,000 or 10% of the total confiscated. Seven hundred twenty-one of those deaths (7.2%) occurred within the first 10 days after confiscation. The mortality rate for the subsequent 55 days was 2.8%. At the time of abstract preparation, all of the tortoises had been moved to the TSA facility in Itampolo for long term care. Necropsy tissue samples, and samples for microscopy and PCR have been imported to the USA and are undergoing diagnostic testing.

Questions that remain to be discussed are: What is the short and long term future for these tortoises? How sustainable is the current model for response to confiscations? What are options for future confiscations? How do we tackle the tough discussions with governments where these confiscations are taking place? When will TSA experience donor and volunteer fatigue? Should we be providing more training of veterinarians, biology students, and husbandry personnel in range countries?
Madagascar Update: Oral

Preliminary Research on the Natural History of Chiapas Mud Turtle (*Kinosternon abaxillare*)

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Currently there is very little research directed towards the study of *Kinosternon abaxillare*. The works related to the understanding of their biology, ecology and the history of life are insufficient, not to mention, that they are non-existent. The Chiapas turtle is an endemic species that is only distributed in this State, to be specific, in the Central Depression. The objective of this study is to determine basic aspects of the ecology and history of the life of *K. abaxillare* in the town of Villahidalgo, Mpio. of Villaflores, Chiapas, Mexico, in order to initiate systematic studies around this species. The study was conducted from March of this year, with the end date of March 2019, sampling every month, with an effort of 3 days for each output in two different areas: Mangal and Tenazudo. So far there is a population of 16 individuals, in a proportion of 10 females and 6 males, with males of greater weight and size. Six elements of the study, population size, population structure, sex ratio, morphometric analysis and sexual dimorphism, some parasites found during the study, a brief description, the content and another description of this topic their reproductive habits observed so far. In addition to the above, it faces the social situation that confronts the natural spaces that occupy it, which is quite evident in this study, that the loss of the surface of green areas and bodies of water are subtracting areas potentially to be occupied in its life cycle, with possible collaborative proposals for its study and conservation.
Field Studies/Techniques: Oral (Student)

Barbecue, Beer, and Turtles: "A Long Term Population Monitoring Survey, Community Outreach, and Conservation Collaboration with a Local Austin Barbecue Establishment"

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Texas can rightfully make many a boasts, among them: a robust turtle diversity, a rich heritage of succulent BBQ, and beer. The popular County Line BBQ in Austin, Texas is situated alongside picturesque Bull Creek and home to hundreds of turtles. With the support of the restaurant owners, TSA-NAFTRG has successfully kicked off a

population study. County Line BBQ on the Lake is host to a fantastic amount of turtle diversity. Six native species of freshwater turtles have been found at the site over the past two years. Conditioned by the generous handouts from the restaurant's patrons. Easy to capture study specimens include the Texas Map Turtle (*Graptemys versa*), Red-eared Slider (*Trachemys scripta elegans)*, Texas River Cooter (*Pseudemys texana*), Eastern Musk Turtle (*Sternotherus odoratus*), Guadalupe Spiny Softshell (*Apalone spinifera guadalupensis*), and the Eastern Snapping Turtle (*Chelydra serpentina*). This setting allows researchers the unique opportunity to perform their study in comfort, interact with the public in grand style and influence while inspiring consideration for freshwater turtle species of the great state of Texas. We try to abide by a simple moto Drink beer save turtles and at this site we actually do.
Texas Turtles: Oral

Road Mortality of Box Turtles in Oklahoma: Increasing Zoo Involvement in Ecology and Research

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As habitat fragmentation due to human encroachment continues and accelerates, the monitoring of wildlife populations is critical to inform management decisions related to conservation biology, not only for researchers, but also for zoological institutions wishing to become more involved with local wildlife conservation projects. Low hatchling survival, slow recruitment into breeding populations, and delayed sexual maturity all contribute to turtles being highly susceptible to any increases in mortality which can lead to local and regional population declines and often extirpation. In Oklahoma, many areas that once supported robust turtle populations have recently experienced declines in turtle abundance due to increased urbanization and mortality associated with roads and traffic. During May-June of 2015 and 2016, four site categories were sampled (highway, undeveloped, suburban, and urban) that resulted in documenting 178 individuals (n=135 in 2015 and n=43 in 2016) of 8 species of turtles. Since 2010, other ongoing projects include phenotypic variation in Oklahoma turtle populations, the use of citizen scientists for data collection, and disease monitoring across the state. Ideas for future zoo involvement include the continuation of the projects referenced above, as well as a series of box turtle ecology seminars with the general public, designed to shine light on these important conservation issues, a citizen science training program, and an Ornate Box Turtle (*Terrapene ornata*) captive breeding, release, and tracking project. Working with the help of the Oklahoma City Zoo and increasing zoo involvement in these projects will allow greater public outreach and ultimately aid both parties involved.
Zoos & Chelonians: Oral (Student)

Demographic Influence of Head-starting on a Blanding's Turtle (*Emydoidea blandingii*) Population in DuPage County, Illinois

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The Blanding's Turtle (*Emydoidea blandingii*) is a long-lived species impacted by increased predation on young age classes. Blanding's Turtles were once common in the prairies and wetlands of northern Illinois, but now only occur in scattered populations. Given the conservation need to halt population declines, the Forest Preserve District of DuPage County (FPDDC) initiated and maintains a head-starting and release program to alleviate mortality in younger age-class turtles. To evaluate the effectiveness of the head-starting program, we conducted hoop trapping in 2017 and combined our data with 20 years of monitoring data from FPDDC to assess population demography. Our objectives were to determine sex and stage ratios, survival rates, population size, and population growth rate. The population has a high proportion of juveniles because of head-starting and is female biased because more eggs are incubated to be females. A Cormack-Jolly-Seber survival analysis for head-started turtles indicated an annual survival rate of 0.780 for all stage classes, so releasing turtles as 1-year-olds appears to be the most efficient strategy. A known fates estimate of adult female annual survival was high at 0.943, and a POPAN model indicates the population size has increased to 268. Our stage-based matrix model indicated population growth rate (head-

starting all hatchlings to one-year) is high at 1.07. Natural age 0-1 survival at a similar site suggests stopping head-starting altogether would result in a declining growth rate. However, determining nest and hatchling survival rates specific to DuPage County would be valuable to calculate how much head-starting is needed to sustain the population. For now, allowing 50% of females to nest each year naturally would allow estimation of nest predation rates and still maintain positive population growth. Overall, the head-starting program in DuPage County has been successful in growing the population to one of the largest in Illinois.
Headstarting: Oral

A Pearl of Great Price: An Urban Stretch of River and its Importance for Two Endemic *Graptemys* Species of the Pearl River

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Two *Graptemys* species (Map Turtles and Sawbacks) are endemic to the Pearl River system of Mississippi and Louisiana: *Graptemys oculifera* (Ringed Sawback) and *Graptemys pearlensis* (Pearl Map Turtle). *Graptemys oculifera* was designated as federally threatened in 1986, while *G. pearlensis* was recently petitioned in 2011 to be listed under the Endangered Species Act. Relatively little is known about either species in the Pearl River system in Jackson, Mississippi, even though Jackson is the most populated city along the river's entire length. We surveyed for both *Graptemys* species during June/July 2017 and 2018 using spotting scopes and binoculars. Surveys occurred along five equidistant stretches (5.3 rkm) from south of the Ross Barnett Reservoir to south of Interstate 20. We documented *G. oculifera* in all surveyed reaches of the Pearl, and all stretches had reproducing populations as evidenced by the presence of juveniles. Densities of *G. oculifera* were higher in upstream and downstream stretches compared to middle stretches. This is likely associated with human modifications to the middle stretches of river including altered riverine hydrology and a lack of riparian forest that borders the river. Even though densities of *G. oculifera* were lower in these stretches, we found reproducing populations in degraded habitat and sometimes moderate densities where pockets of suitable habitat occur. We found *Graptemys pearlensis* in all river stretches surveyed, but densities were much lower than *G. oculifera* in all surveys. Middle stretches are inclusive of a portion of the Pearl River that is proposed to be impounded for a flood control and economic development project. This project would certainly alter existing riverine hydrology to favor generalists that prefer non-flowing, lake settings (e.g., *Trachemys scripta*) at the expense of riverine specialists like *G. oculifera* and *G. pearlensis*.
Graptemys: Oral

The Phylogeny of the Map Turtles (*Graptemys*) Reveals an Extraordinarily Recent Adaptive Radiation Across the Southeastern US

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The map turtles (genus *Graptemys*) comprise a morphologically diverse clade that forms a major component of the southeastern US hotspot of chelonian diversity. Although well studied ecologically and often locally abundant, map turtles have long frustrated systematists both in terms of species boundaries and particularly the phylogeny of the group. The presumption, based on limited evidence, has been that map turtles are a relatively recent radiation and that recency has led to their phylogenetic uncertainty. We collected representative geographic samples for all described species and subspecies in the group, and present a molecular phylogeny based on 18 independent nuclear genes and a virtually complete data matrix for all taxa. We also make use of an empirical prior on rates of molecular evolution to estimate divergence times with a molecular clock under a coalescent framework. Together, the phylogeny and divergence time estimates suggest that, with the exception of the *G. pseudogeographica* group, all members of the group are monophyletic, including the recently described and somewhat contentious *G. pearlensis* and *G. g. sabinensis*. Perhaps most strikingly, we provide evidence suggesting that diversification within the group has been both more recent and more rapid than has so far been suspected. We provide a well-supported evolutionary framework for *Graptemys* that is necessary for understanding map turtle diversity, biogeography, and conservation of this often-threatened clade of turtles.

***Graptemys*:** Oral

Home Range and Spatial Ecology of the Eastern Box Turtle (*Terrapene carolina*) in Southern Illinois

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When human development degrades natural habitat and surrounding areas, abundant and otherwise healthy species can suffer. Eastern Box Turtles (*Terrapene carolina*) may seem common due to occasional sightings, but they are a local species in decline. Management plans to conserve this species including population monitoring and habitat assessment will be necessary to prevent further decline, especially in areas where human development is encroaching on suitable habitat. The objectives of this study are to determine average home range size, microhabitat preferences, and temporal activity patterns of Eastern box turtles on the SIUe campus. Based on similar studies, I expect to find home ranges of 2 - 7 hectares, and I hypothesize that the preferred habitat of the tracked turtles will be low riparian areas utilized in relation to temperature fluctuations. Home range and spatial ecology will be determined by use of radio telemetry: turtles across campus will be fitted with radio transmitters and located weekly with a radio receiver. When located, the turtles' GPS location, individual measurements, and habitat assessment will be recorded. Results of this study will provide useful information for current and future management plans of local Eastern Box Turtles by determining this species' microhabitat needs and the specific ways in which it utilizes its home range.

Presentation type: Poster (Student)

Contemporaneous Telemetry Methods Yield New Insights on Home Range and Population Size in Rio Grande Cooters (*Pseudemys gorzugi*) at the Devils River in Texas

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Rio Grande Cooters (*Pseudemys gorzugi*) are a narrowly distributed North American freshwater turtle species, restricted to the Rio Grande River /Rio Bravo and its tributaries. Modifications to in-stream flow rates of this river system are likely to have caused reductions in the extent of turtle occurrence and populations. In response to these putative declines, the species has been petitioned to be listed as federally endangered or threatened. However, this turtle is among the most data-depauperate species in North America. Determining population status and individual movements is critical to inform the listing process and future management. We generated high-resolution telemetry data by mounting GPS enabled Very High Frequency transmitters on 6 females and 4 males at the Devils River in Texas. We observed individual movements that far exceeded previously reported maximal movements for the species. Home ranges constructed using nonparametric kernel methods suggest the entire Devils River, at the least, be considered one example of a contiguous management unit for the species. Additionally, we analyzed Capture-Mark-Recapture (CMR) data from multiple years (2011 and 2014-2017) using Pollock's Closed Robust Design Model to arrive at a population estimate of 486 ± 114 turtles. Long-range individual movements detected from our telemetry study indicate that while the population estimate is derived from CMR at a single location it may arguably represent a useful exemplar for the population of the Devil's River. This study represents a successful example of technological improvements yielding pertinent insights on a poorly documented and threatened North American chelonian.

Texas Turtles: Oral (Student)

Preliminary Data on Body Mass, Neonatal Color and Morphological Changes in Captive Chinese Big-headed Turtle (*Platysternon megacephalum*) with a Brief Mention on Incubation Temperatures and Sexing

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This project looks to explore patterns of body mass growth along with neonatal color and morphological changes in this species and to investigate if there are early morphological indicators for sex determination and if this species has temperature dependent sex determination (TSD). Data were collected from 2013 to present on 20 captive hatched and reared Chinese Big-headed Turtles (*Platysternon megacephalum*) at the Wildlife Conservation Societies' Prospect Park Zoo. Hatchlings came from 5 different clutches from the same dam and sire with an average of 4 individuals in each clutch (range: 3-5 hatchlings). Hatchlings were weighed, measured with calipers, and photographed monthly for their first year of life and then every 6 months thereafter in June and December. Measurements were taken on the straight line carapace length and width, plastron length, head size, total tail length and post-cloacal tail length. Photographs were taken of the side of the head, the carapace, plastron and inside of the mouth. Incubation temperatures were adjusted with each clutch in order to begin exploring if TSD exists in this species. Attempts were made to sex hatchlings via laparoscopy at various carapace lengths in order to determine if there was an optimum size for when the procedure should be conducted.
Zoos & Chelonians: Oral

The Use of Emerging Drone Technology for Conservation of Two of the Top 25 Most Endangered Chelonians, Mojave Desert Tortoise (*Gopherus agassizii*) and Bolson Tortoise (*Gopherus flavomarginatus*)

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Unmanned aerial vehicles (UAS) have been around for nearly a century, however only in the past decade have they become readily available for commercial use. The use of the UAS in wildlife conservation has taken on many forms, from anti-poaching patrols to habitat mapping and evaluation. We have pioneered an innovative quad-copter drone for predator control to benefit the conservation of the Mojave Desert tortoise and implemented the use of a fix-winged drone with mapping GIS capabilities to assist in locating the last remaining wild populations of the Bolson tortoise in the Bolson de Mapimí within the Chihuahuan Desert. The common raven (*Corvus corax*) is a voracious, human-subsidized predator of juvenile desert tortoises. Raven numbers have increased in the Mojave Desert by over one thousand percent in the past three decades. We have engineered and tested a drone that can apply oil to induce egg-mortality in common raven nests. The implication of large scale implementation in areas of critical habitat of the desert tortoise has the potential to allow recovery and recruitment of the species to occur in areas where senescent tortoise populations are now being observed. The distinct, large burrow mound created by the Bolson tortoise allows for aerial recognition. Conducting more large-scale, comprehensive surveys than are otherwise feasible on foot allows for mapping the distribution and ultimately developing a management plan for conservation of the species.
Field Studies/Techniques: Oral

Restoring the Only Remaining Population of the Southern River Terrapin (*Batagur affinis*) in Cambodian Sre Ambel River System

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Sre Ambel River system is the only remaining habitat of Southern River Terrapin (*Batagur affinis*) also known as Royal Turtle in Cambodia. The species is the National Reptile of Cambodia signed by the Royal Decree in 2005. Since its rediscovery in 2001, the Cambodian population is relatively small and declining due to illegal fishing, sand mining, and illegal logging of riparian habitat. Sand mining has destroyed all nesting beaches in one of the two nesting rivers. To combat with the sand mining activities, WCS and Cambodian Fisheries Administration (FiA) used the results from our post-release monitoring where released 21 head-started sub-adults in 2015 to advocate the sand mining with Ministry of Mines and Energy (MME) to cancel all the mining licenses in the system- resulting a complete cancellation in July 2017. Workshop and site visit were also used to inform the issue. Monitoring method:

All 21 head-started turtles were attached with acoustic transmitters and microchips. The project uses active receiver and passive receiver to track their movements recording all bio-data such as habitat utilization, types of vegetation, water salinity, PH, conductivity and survivorship. The monitoring results really demonstrate that the species uses almost all parts of the rivers in the river system. Their movements are dependent on the season: they move downstream in rainy season to coastal area for foraging food such as prawns and mangrove seeds while in the dry season they move upstream for nesting and escaping from high level of water salinity. The project managed to release another group of 25 head-started turtles in July 2017 and they are ongoing monitored. Other activities include nest protection and head-starting program, law enforcement, education and awareness, and sandbar restoration. The complete cancellation of sand mining in the nesting area was the biggest successful result for the restoration of the species through the mentioned activities, especially sandbar restoration. Unfortunately, in 2018 sand mining has begun again, directly affecting the nesting beaches. We are working with the MME to get this activity stopped, but much damage has already been done and it is likely that extensive restoration of nesting areas will be necessary whenever the sand mining finishes.
TSA Field Programs: Oral

Prioritising Hydrographic Regions for Brazilian Freshwater Turtle Conservation to Improve Threat Mitigation

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Freshwater turtle species across the world are under increasing threat from human pressures including overexploitation and habitat modification. Brazil is no exception with seven of its 29 freshwater turtle species identified by the IUCN as being Vulnerable, Endangered or Critically Endangered. To prioritise where conservation actions needed to be focussed, the 12 Brazilian hydrographic regions were used as landscape scale units that were then ranked using updated information about species richness, endemism, data deficient species, and threat levels of their freshwater turtle fauna. Threats to freshwater turtle species identified by the Brazilian Red List were also analysed and ranked according to the most threatening processes overall and in each hydrographic region. The results of the hydrographic region prioritisation ranked Amazon, Southeast Atlantic, East Atlantic and Araguaia-Tocantins as the top four priority basins in Brazil for freshwater turtle conservation activities. The threat analysis highlighted “natural system modification”, “agriculture and aquaculture”, “biological resource use” and “energy production and mining” as the top four most threatening processes to freshwater turtles in Brazil. This study can be used to help conservation managers and policy makers to direct future conservation efforts to broader scale actions that encompass whole hydrographic regions. Freshwater turtles from a given basin share the same threats. Therefore, implementing policies and actions targeting the specific threatening process of each basin are needed to mitigate their overall impact on the population of Brazilian freshwater turtles.
Conservation: Oral (Student**)**

Tortoise Reintroduction as a Species Conservation and Rewilding Tool: The Atlantic Forest Case

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The loss of ecological functions due to defaunation is a pervasive phenomenon threatening ecosystems in the Anthropocene. Defaunated areas lack interactions that are important to the maintenance of plant communities, notably the dispersal of large seeded plants. The Atlantic Forest (AF) is a biodiversity hotspot of which only 12% remains, mostly as impoverished small fragments. The reintroduction of a forest tortoise (*Chelonoidis denticulatus*) presents itself as both a habitat restoration and species conservation tool, for this species is an important seed disperser of seeds up to 40mm in length, causing ingested seeds little damage. The tortoise’s ecological history in the biome is unclear and so far, but there are signs of its extirpation from most of the AF being due to hunting

pressure and habitat loss, which is supported by naturalists' reports and the species' life history. Envisioning its translocation to protected areas in the biome, we have calculated the credit of ecological interactions (CEI) to be cashed with the reintroduction of the species to the AF. The CEI was calculated based on the list of plant species observed or inferred to be eaten by the tortoise in the biome, which can be refined to contain only the plant species present in a region of interest. Plant species of special ecological and conservation concern were highlighted, and we hypothesized the potential effect of the tortoise-plant interaction on some of them. We recommend the reintroduction of this tortoise to restore dispersal of large seeded plants throughout their original range, since it is a far better candidate to perform this function in small fragments than its endothermic ecological equivalents. Efforts are now being directed at mapping its extirpation through time, if possible linking it to the chronology of human settlement. A tortoise reintroduction project is currently underway to test its effects and model the species seed dispersal, as part of REFAUNA, a refaunation initiative in the Tijuca National Park, an urban AF reserve in Rio de Janeiro, Brazil.
Presentation type: Poster (Student)

Using the Internet to Communicate Science, Reach New Audiences, and Advance Reptile Conservation

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We are experiencing a global biodiversity crisis and environmental regulations are under constant siege. Addressing these ongoing and widespread conservation issues requires innovative and novel strategies as well as an informed and motivated populace. It is widely suggested that science communication and outreach efforts offer one path for garnering the support of the public and this general idea has coincided with calls for scientists to engage in science communication efforts as a component of their position, if not as a moral imperative. Unfortunately, many scientists are unprepared for conducting effective outreach and risk professionally martyring themselves because institutional frameworks have not caught up to the idea that science communication is worthwhile. In this talk I will describe why I think many current science communication efforts are ineffective and use lessons learned over my last ten years of online outreach to offer some strategies for bursting out of the bubble, reaching new audiences, and even changing minds about snakes and turtles.
Plenary Session: Invited

Current Status of Japanese Pond Turtle (*Mauremys japonica*) in Japan

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The Japanese Pond Turtle (*Mauremys japonica*) is an endemic species in Japan. They are distributed in western Japan from Kanto to Kyushu. The Japanese people have loved turtles for a long time. The species of turtle drawn on Ukiyo-e in more than 200 years is a *M. japonica*. In the past, it seems that there were many *M. japonica* in freshwater of Japan. However, now its population size has decreased and the distribution area has been narrowed. It is believed that the cause is due to destruction of habitats such as renovation of rivers and invasion of alien species such as *M. reevesii* (introduced from Korea) or *Trachemys scripta elegans* (introduced from North America). In this paper, we report the current status of this species. In our survey throughout the western Japan, *T. s. elegans* and *M. reevesii* are the majority of them, and there are few *M. japonica*. In the Okayama Prefecture, *M. japonica* are only about 3% of all captured turtles. It is found more rivers than ponds. *M. japonica* were discovered in 12 of 145 ponds, whereas in the river it was found in 20 out of 129 research places. We represent the density of the turtle with CPT (Catch per Trap). The CPT of *M. japonica* in the pond was 0.3, but the CPT in the river was 0.6. It seems to be the reason why *M. japonica* remains in the river is that the river is more disturbed than the pond and the competition with other species is relaxed. Also, when examining species inhabiting each altitude, the habitat of *M. japonica* was biased towards those with relatively high altitudes. In the plain area, *M. reevesii* and *T. s. elegans* occupy fresh water habitat. In the present situation, *M. japonica* is being driven toward the mountain.

Presentation type: Poster (Student)

What is in a Name: Nomenclature and Taxonomy in Turtles; Just What is the Correct Name?

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In recent times taxonomy and nomenclature and their relationship to conservation has been challenged, by ornithologists and mammologists, but also by the ever-present issue of taxonomic vandalism. It has also become increasingly clear that the scientific discipline of taxonomy, and managerial field of nomenclature are not being taught well, if at all, as evidenced by the loss of knowledge on these fields. Increasingly dual nomenclatures are appearing. Poor decision making on the correct names for species are being published and unknowingly followed. Creating confusion. The Chelonian Research Institute and both of us individually have been at the forefront of turtle taxonomy and nomenclature for decades, both have published detailed nomenclatural assessments of species. The CRI continues to be a major host for scientists researching taxonomy and nomenclature. As such we are presenting an overview of how taxonomy and nomenclature relate to each other and how they are utilized by Conservation. Taxonomy is the science of delimiting species and establishing the relationships between them, also known as systematics and uses tools such as phylogenetics to do this. Taxonomy is a basal, hard science. Hence it must follow scientific principles. Nomenclature is a management tool, about what to call things. It is not a science and follows the rules of the ICZN. There is only ever one correct name for a taxon and the aim of nomenclature is for stability of the name. Not stability of the combination (genus + species). However, there is never a single, stable and correct combination of names, only the currently accepted hypothesis. Conservation is an end user of taxonomy and nomenclature. It needs to utilize taxonomy and nomenclature as it is given to them, else they can be accused of circularity. Through examples we are going to demonstrate the complex nature of taxonomy and nomenclature in turtles, for the benefit of Conservation. At the end it is our hope you will understand that your conservation policies need to be aimed at preserving the concept of the circumscription of the species, without being too hung on the names. The taxonomy, like all science, is dynamic and changes over time, but the populations you are trying to conserve remain the same population.
Special Presentation: Oral

Chelonian Conservation in Bangladesh – Program Updates

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Over the course of the last year, the Creative Conservation Alliance has made significant progress towards enhancing protection for seven threatened species of turtles and tortoises of the Chittagong Hill Tracts, Bangladesh. By establishing and supporting ten Indigenous Community Conservation Areas we have provided protection for 500 hectares of the last old growth tropical forests of Bangladesh. These protected areas are providing the only safe habitat for these species in the country which include: *Manouria emys*, *Heosemys depressa*, *Cuora mouhotii*, *Cuora amboinensis*, *Indotestudo elongata*, *Cyclemys gemelli*, and *Amyda ornata*. Our chelonian breeding center, established in 2017, is also well on its way to bolstering wild populations of *M. emys*, *C mouhotii*, and *H. depressa*. Together, these activities are creating a bright future for the threatened turtles and tortoises of Bangladesh.
TSA Field Program: Oral

Chasing Chambal *Chitra*: Spatial Ecology and Seasonal Activities

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The Indian Narrow-headed Softshell Turtle (*Chitra indica*) is a riverine species restricted to south Asia. We studied movements as well as seasonal activities of 11 adults and one subadult in the lower Chambal and Yamuna Rivers near their confluence in north India. Each turtle was radio-tagged with a VHF transmitter attached to the rear carapace, and tracked at 0.5-2 km range, multiple times per week. Behavioral observations were made visually and/or by monitoring radio signals for 1-4 hrs daily. In November 2017, 5 adults (1M:4F) and one subadult (F), ranging from 7-15 kg weight, and from 36-53 cm carapace length were tagged. In May 2018, 6 more turtles, all females, ranging from 11-50 kg weight, and size from 46-79 cm carapace length were tagged. Here, we present preliminary results from the initial tagged group. We logged 697 observations over 389 turtle-days on 4 resident turtles, released at their capture sites (=448 obs.), and on 2 transplanted turtles, shifted 62 river km to from their capture site to a release location within the protected National Chambal Sanctuary (=249 obs.). These observations were made on 165 days, from Dec 2017 thru May 2018; =180 days study period). Four resident females (3 adults; 1 subadult) occupied 2.6, 2.7, 7.3 and 11.7 river kms; two transplants occupied 13.1 and 14.3 river kms during the same period. Winter (Dec-mid Mar) behaviors consisted of daytime movements into shallow water (0.5-1m depth), and nighttime retreats to moderate depths (2-4m); tracking signals were strong and detectable day and night. In contrast, summer (mid Mar thru May) behaviors consisted of movements into shallow water only at night, and daytime retreats to deep pools (>5m depths) where tracking signals were undetectable. The single male turtle, a transplant, moved more frequently from pool to pool, over longer distances (>5 kms) than any of the tracked females. Transmitter ambient temperatures for two turtles ranged from 7-7.5 to 23.3-24.2 ºC in winter, and from 20.3-21.5 to 29.6-29.9 ºC in summer. When fishing occurred nearby, tagged turtles moved to adjacent undisturbed areas.

Presentation type: Poster

The Desert Tortoise Council: 43 Years of Conserving North American Desert Tortoise Species and Their Habitats

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The Desert Tortoise Council is a non-profit organization that was established in 1975 to advocate science-based approaches to conservation of the Mojave Desert Tortoise (*Gopherus agassizii*) in the southwestern United States and Mexico. Since the formation of the Desert Tortoise Council, our organization has expanded to include a variety of programs and actions that benefit desert tortoises, as well as additional species of desert tortoises that have been identified and named in subsequent years. Our goal is to promote, distribute, defend, and use science-based techniques to protect, conserve, manage, restore, and recover desert tortoise populations and their habitats. We hold an annual Symposium that brings together scientists, managers, and concerned people to share the latest scientific and conservation information about desert tortoises and management of their populations and habitats. We provide training courses in basic and advanced desert tortoise field techniques to biologists and managers. We support students by offering research awards, grants, and travel funding to attend symposia. We support additional desert tortoise research and conservation efforts through our grants program, and we have funded several recent projects, including population genetics research projects in Arizona and California, a land acquisition project in Mexico, and a conservation initiative in Las Vegas, Nevada. We also support projects involving other imperiled turtles and tortoises, including the recent recovery of confiscated radiated tortoises in Madagascar. Finally, we provide science-based information and recommendations to individuals, organizations, and regulatory agencies on matters pertaining to desert tortoise conservation and management of wild populations. The Desert Tortoise Council is open to membership by individuals or organizations, and we invite interested parties to join us.

Conservation & Policy in North America: Oral

Gene Flow and Unexpected Ancient Divergences in Western Palearctic Pond Turtles (*Emys* spp.)

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Using range-wide sampling, we analyse genetic differentiation and gene flow patterns in pond turtles (*Emys* spp.), with a special focus on secondary contact zones. Based on population genetic analyses of highly polymorphic microsatellite and mitochondrial markers, we show that genetic differentiation matches well with general Western Palearctic distribution patterns and current taxon delimitation. However, individual contact zones and introgression patterns differ across the distribution range, with limited gene flow between some taxa and broad-scale gene flow between others. Although the distribution pattern suggests that the individual mitochondrial lineages dispersed from former glacial refugia, or are still largely confined to their refuges, fossil-calibrated molecular clock calculations reveal Miocene and Pliocene divergence ages. Our long-term investigations in the genetic differentiation of European pond turtles result in an excellent understanding of the biogeography of a wide-ranging animal species distributed across a major part of the Western Palaearctic.
Genetics: Oral

Getting in Front of the 8-ball: Establishing a Captive Breeding Protocol for *Pangshura smithii*, Before It Becomes Endangered

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Pangshura smithii is a small to medium aquatic Geoemydid occurring in Pakistan, northern India, and Bangladesh. It is currently listed as Near Threatened under the IUCN. The species was legally imported from Pakistan into the US in the late 1990s, but has apparently not been imported since then. There are currently only 3 or 4 breeding groups in the US, all of which originate from this importation. This species has proven to be relatively prolific and easily bred in captivity. Lessons learned and knowledge gained from experiences breeding this species could help prevent it from declining to endangered status, as well as potentially being applied to congeners and similar species already listed as endangered.
Captive Husbandry: Oral

Investigations on Smuggling of North American Turtles from the U.S. to Asia

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In the past few years, a marked increase in smuggling of North American turtles has occurred. The turtles are being smuggled from major US cities to Hong Kong, Shanghai, and other Asian cities. The primary species are Box Turtles (*Terrapene species*) and Spotted Turtles (*Clemmys guttata*). Both species are protected on a state and federal level, leading to poaching large numbers from the wild. In addition, box turtles also have a zero quota making it extremely difficult to meet the requirement for legal export. Other species of protected US turtles have also been found to be smuggled in smaller amounts. US turtles are being smuggled primarily by mail, but other methods have been employed. The value of the turtles is fairly low in the US and often in the thousands of US dollars in Asia, making it very profitable for the smugglers.
Plenary Session: Invited

Nesting Biology and Estimated Number of Reproductive Female of the Freshwater Turtle *Malayemys macrocephala* in Central Plain of Thailand

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Malayemys macrocephala is a common freshwater turtle living in agricultural areas of Southeast Asia. In Thailand, *M. macrocephala* eggs have been intensively harvested and available commercially at the local market, making it vulnerable to population decline. This study aims to examine nesting biology and estimated number of reproductive females. Nesting of *M. macrocephala* were surveyed in a 15-hectare rice field at Phra Nakhon Si Ayutthaya Province, central part of Thailand. Turtle nest was monitored every other week during December 2013-May 2014. All turtle's eggs were collected for incubation at the laboratory until hatch. It was found that nesting season of turtle in this area were between late December to early April, with the peak of nesting activity during February-March. Total of 74 clutches with the size of 3-9 eggs (average of 6 eggs/clutch) was found in this area. Turtle nests were mainly found on the rice-field ridge. Seventy percent of the nests were laid within 5 meters from nearest water source, and more than 89% of the nests were covered by vegetation such as plant debris, grass and vine. In addition, mitochondrial DNA samples of hatchlings were analyzed for variation on *cytochrome b* gene for reproductive female estimation. Among 71 clutches of *M. macrocephala*, there are 7 different haplotypes nominally categorized as A, B, C, D, E, F and G. Number of nest in each haplotype is 24, 15, 5, 22, 3, 1 and 1 respectively. Since one haplotype may represent either one individual or group of maternally related individuals, the number of reproductive females in this area should be greater than the number of haplotype. Also, as there is no report of one female laying more than one clutch per night, therefore, 3 nests of haplotype D and 2 nests of haplotype B found in the same night should be laid by different females. As a result, mitochondrial DNA analysis revealed that there are at least 10 reproductive females living in this 15-hectare area. Combining field and molecular techniques of this kind could be helpful for determining reproductive population size of turtle for conservation planning in the future.
Asian Chelonians: Oral (Student)

Fungivorous Impressed Tortoise *(Manouria impressa*) Select Foods by Scent

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Impressed Tortoise *(Manouria impressa*) is a rare fungivore of vertebrates. Its current status is unclear in China and captive breeding is unsuccessful due to the lack of knowledge of its diet. This study confirmed the distribution of the tortoise's distribution in the southeastern Yunnan province of China and a sustaining population in Daweishan National Nature Reserve. Radio-tracked tortoises were observed to prey on mushrooms in the field and spent most (94.69%) of their time resting. The average home range of 5 tortoises in 2 months is 743.35m^2 (Minimum Convex Polygon) to 786.06 m^2 (95% Fixed Kernel Estimation). Tortoises prefer microhabitat with fallen leaves＞10cm and towards the bottom of hillslope. Captive cafeteria experiments showed *M. impressa* ate most species of fungi but rejected some fungi and all the plants. $\delta^{15}N$ values of the scutes of impressed tortoises were higher than other herbivorous tortoises. Other evidence of fungivorous diet includes the digestion of mushrooms and possible chitin-degradation microbes in the feces of *M. impressa*. Continuous monitoring using a low-light camera showed that the tortoises smelled the fungi before eating. Experiments that control the sense organ of tortoises and different characters (shape, size, color and odor) of food proved that olfaction is the major factor that tortoises select their food (fungi). Cluster and principal component analyses further showed that they seemed to prefer fungi that had similar volatile chemicals, such as 3-methyl-1-butanol and 3-methyl butyraldehyde, but avoid other irritant chemicals (ammonium carbamate, camphor, etc.)
Presentation type: Poster

Mixing Oil with Water: Investigations into the Effects of an Oil Spill on Reproductive Output in River Turtles

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On July 25, 2010, a 30-inch diameter pipeline ruptured near Marshall, Michigan, resulting in one of the largest inland oil spills in US history. Nearly 1 million gallons of oil flowed into the Kalamazoo River, a Lake Michigan tributary, resulting in approximately 38 miles of the river and associated floodplain being affected. Approximately 3,800 individual turtles suffered varying degrees of oiling, and were rehabilitated and released during the spill response of 2010-11. The primary species impacted were *Graptemys geographica* (77%), *Chelydra serpentina* (11%), *Chrysemys picta marginata* (6%), and *Apalone spinifera spinifera* (3%). All turtles that were rehabilitated and released as part of the initial spill response were marked with internal PIT tags or shell notched, enabling us to identify turtles that were rehabilitated in response to the spill and assess any impacts that exposure to oil may have had on the affected turtles or their progeny. Here we present preliminary results on nesting behavior and fecundity from the first year of post-clean up turtle monitoring. This study is part of a larger investigation into the long-term effects of a spill event on a freshwater turtle population, the first of its kind. Adult female *G. geographica* were captured at various locations within portions of the impacted river by hand and with hoop traps. Forty individuals were fitted with radio transmitters used to locate nesting locations. For each nest located, measurements were taken on egg mass, egg size, and clutch size. Nests were enclosed with wire caging to protect from predation. Fertility rates of each clutch were determined at the end of the season when hatchlings were released and eggs were dug up.
Presentation type: Poster

The Relative Influences of Turtle Ecology and Ambient Water Quality on Determining the Community Composition of Epizoic Diatoms

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Algae form the backbone of aquatic ecosystems as the base of the food web. Diatoms (Bacillariophyceae), a group of golden-brown algae, are abundant and important members of aquatic communities. These algae often attach themselves to the carapaces of aquatic turtles. Studies conducted in Oklahoma on turtle museum specimens suggest that some species of diatom specifically live on turtles; they do not live on other substrates within their environment (Wu and Bergey, 2017). However, no studies of this kind have been conducted in Texas. This study aims to sample at least 10 individuals each from live specimens of 5 different aquatic turtle species for the presence of epizoic diatoms. Turtles will be caught by live-trapping and by hand in central Texas rivers and ponds of varying water quality. Three scutes on the carapace will be gently scrubbed with a test tube brush to collect samples before releasing the turtle. Basic water quality metrics will be taken on site, and rocks will also be sampled for epilithic diatoms for comparison. Diatoms will be identified to species. Statistical analysis will consider the relative importance of water quality, substrate availability, and aspects of turtle ecology and behavior on the diatom community assemblage. Collections will be done both by our lab and in collaboration with turtle biologists as part of their own field collections. Outsourced data collection will be accomplished by sending collectors test tube brushes and water sampling equipment to use as they collect turtles as part of their own field work. This poster will present preliminary findings. This study is ongoing and is welcoming collaborators at this time.
Presentation type: Poster (Student)

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16TH ANNUAL SYMPOSIUM

ON THE
CONSERVATION AND BIOLOGY OF TORTOISES AND FRESHWATER TURTLES

AUGUST 12 - 15, 2018
FORT WORTH, TEXAS