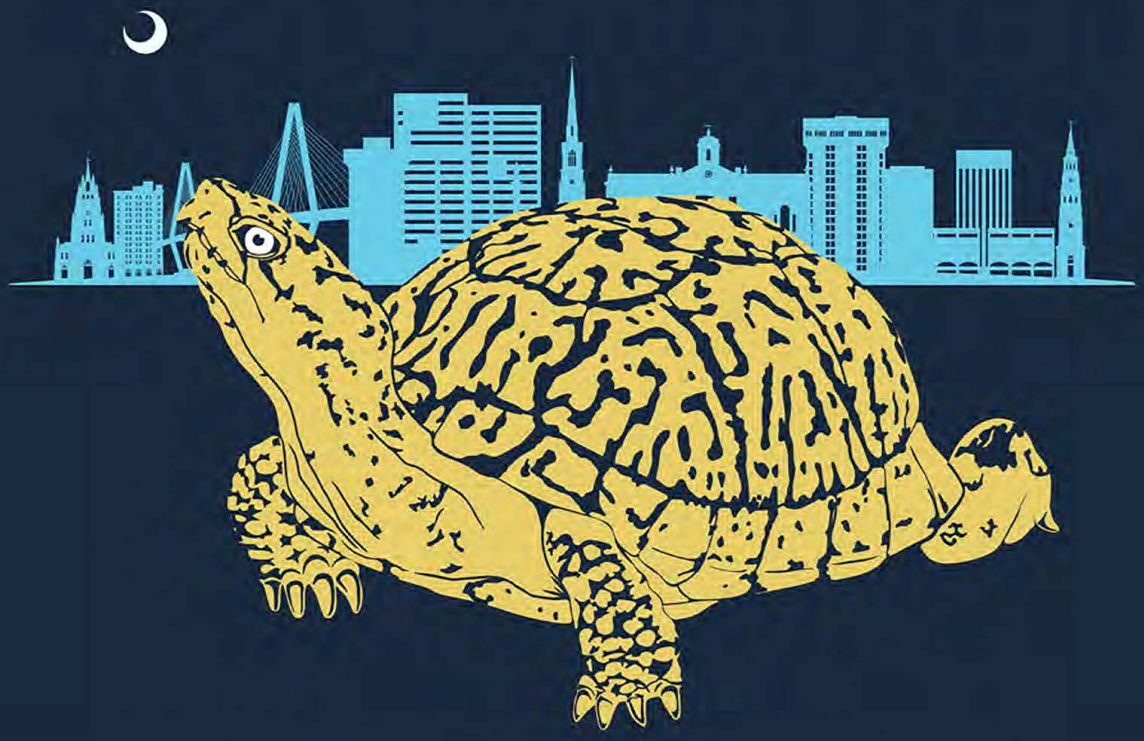
TURTLE SURVIVAL ALLIANCE

JULY 31 - AUGUST 3, 2023

IUCN/SSC Tortoise and Freshwater Turtle Specialist Group

21ST ANNUAL SYMPOSIUM ON THE CONSERVATION AND BIOLOGY OF TORTOISES AND FRESHWATER TURTLES



CHARLESTON, SOUTH CAROLINA, USA 2023

2023 ANNUAL SYMPOSIUM SPONSORS

Desert Tortoise Council — HATCHLING

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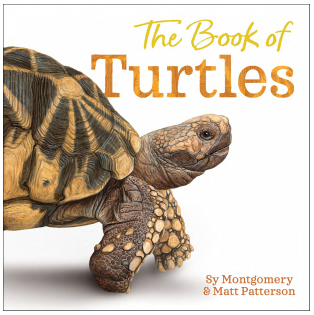
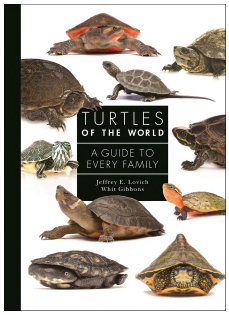
2023 Symposium Highlights

Book Signings—*The Book of Turtles* and *Turtles of the World: A Guide to Every Family*





This year we are thrilled to offer an exclusive book-signing event with conservation author Sy Montgomery and wildlife artist Matt Patterson signing copies of *The Book of Turtles* and Jeffrey Lovich and Whit Gibbons signing copies of *Turtles of the World: A Guide to Every Family*. Both of these exceptional books will be available for purchase on site through local vendor Itinerant Literate Books.

We hope everyone enjoys the festivities that this year's venue and special event locations have to offer. Special thanks to the Embassy Suites & Convention Center for helping us with the festivities and wrapping up the celebration!

Please join us in thanking *Guardian* sponsor Zoo Med Laboratories, *Protector* sponsors Dallas Zoo, South Carolina Aquarium, The Stuart Salenger Foundation, *Hatchling* sponsor Desert Tortoise Council, *Travel Grant* sponsors SWCA Environmental Consultants, John Iverson, Kristin Berry, and Deb Behler, and two anonymous *Guardian* donors for helping make this year's symposium possible.

South Carolina Aquarium

STUART SALENGER FOUNDATION, INC.

Listing as of July 10, 2023

TABLE OF CONTENTS

Keynote Address

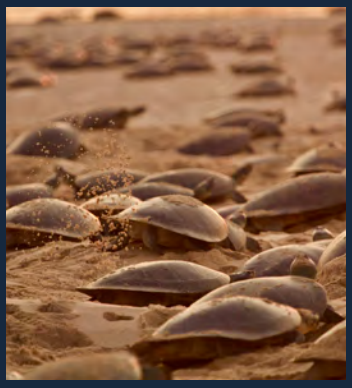
Sy Montgomery

Of Time and Turtles: Mending the World Shell by Shattered Shell

Behler Award Honoree

Kurt Buhlmann

Featured Session



South American Turtles

From the Program Co-Chairs: WELCOME TO CHARLESTON!

Dear Esteemed Guests and Colleagues,

It is with great pleasure and enthusiasm that we extend a warm welcome to each and every one of you.

The 21st Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles returns to Charleston, South Carolina—a region rich with chelonian diversity and home to the Turtle Survival Alliance headquarters and the Turtle Survival Center, our world-class conservation breeding facility, which symposium attendees have the exclusive opportunity to tour this year. Regarded as one of the most beautiful cities in the United States, Charleston has been nicknamed the "Holy City" due to its tolerance for religious freedom since the late 1600s, with church steeples representing a wide variety of denominations punctuating the skyline. We hope you enjoy this and all the impressive views Charleston has to offer during your stay here, including that of Charleston Harbor from the balcony of the South Carolina Aquarium during the icebreaker event.

For more than two decades, the symposium stands as a testament to the enduring commitment and collective efforts of individuals who recognize the significance of protecting all chelonian species and their native environments. This year, we're proud to bring you 132 unique presenters representing 30 countries from around the world. Along with featured plenary sessions, topics include Veterinary Medicine and Explorations, Genetic Investigations, Turtles of the Southeastern United States, South American Turtles, Field Studies, The More You Know, Headstarting and Translocation, Combating Wildlife Trafficking, Zoos & Captive Management, Kinosternids, Turtle Ecology, and Conservation Tools and Actions. Furthermore, the issue of road mortality is one that continues to lead to turtle declines around the world and one that countless grassroots groups, governmental and non-governmental agencies, and even single individuals try to reduce. We are excited to have Animex® International, experts at wildlife fencing solutions, lead a workshop on mitigating vehicular–chelonian interactions.

Amidst our shared passion for chelonian species, we would like to draw your attention to a unique opportunity for further support: leaving the Turtle Survival Alliance in your will and trust. This act of philanthropy ensures that your commitment to conservation endures beyond a lifetime, providing vital resources for the protection and preservation of endangered turtle and tortoise species for generations to come. Please visit us at the Turtle Survival Alliance table for more information.

Please join us in thanking our sponsors for their generous symposium support: Zoo Med Laboratories, The Stuart Salenger Foundation, Dallas Zoo, South Carolina Aquarium, Desert Tortoise Council, SWCA Environmental Consultants, John Iverson, Kristin Berry, Deb Behler, and two anonymous donors.

Together, let us embark on a transformative experience as we work towards a future of zero turtle extinctions.

Sincerely,

Andrew Walde
Co-Chair, 21st Annual Symposium
Director of Conservation and Science, Turtle Survival Alliance

Jordan Gray
Co-Chair, 21st Annual Symposium
Education Coordinator, Turtle Survival Alliance

From the Hosts: LIVE FROM CHARLESTON - WELCOME TO THE 21st ANNUAL SYMPOSIUM!

Dear Symposium Participants,

Welcome to the 21st Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles! We are thrilled to have you join us for this exciting gathering of like-minded individuals who are passionate about conservation.

This symposium is an opportunity for us to come together, share our research findings, exchange ideas, and forge meaningful connections with experts and newcomers from around the world. By bringing together diverse perspectives and expertise, we aim to inspire innovative approaches and collaborative efforts to tackle the pressing challenges faced by endangered species. Please plan to take advantage of the networking opportunities and engage in conversations with fellow participants during the icebreaker at the South Carolina Aquarium and during session breaks.

We have invited esteemed speakers who are leading authorities in their respective fields, ensuring that you will be exposed to cutting-edge research and conservation strategies. From "Beyond Captivity: The Benefits and Challenges of Rewilding with Captive-Bred Aldabra Tortoises" by Rich Baxter, to "The Turtle Trafficking Dedicated Data Centre" by Sarah Stoner, our program is carefully curated to cover a broad range of topics. Don't miss our featured presentation from renowned conservation author Sy Montgomery, who will be signing copies of *The Book of Turtles* with illustrator and wildlife artist, Matt Patterson. We are thrilled to offer this book-signing event as Jeffrey Lovich and Whit Gibbons will also be signing copies of their *Turtles of the World: A Guide to Every Family*.

The Turtle Survival Alliance and IUCN/SSC Tortoise and Freshwater Turtle Specialist Group are committed to making an inclusive environment for all, striving to create a welcoming and safe atmosphere where attendees can enthusiastically join in the sharing of turtle knowledge. This year, we've also included a special plenary presentation called "Moving Beyond Diversity: Building a Culture of Inclusion and Belonging" to be delivered by Rachel Branaman. Through our Travel Grants program and virtual involvement opportunities, we endeavor to foster inclusivity and enhance the diversity of perspectives at the symposium, all while expanding access to women, students, and those from developing countries and underserved communities.

As co-hosts, we are here to facilitate a conducive environment for learning, sharing, and networking. Should you have any questions or require assistance, please do not hesitate to reach out to our dedicated team members who will be readily available throughout the symposium. We want to ensure that your experience is both enriching and enjoyable. All of this would not be possible without the hard work and dedication of the Turtle Survival Alliance contributors. Thank you to symposium Co-Chairs Jordan Gray and Andrew Walde who programed the event; the administrative staff Amanda Beth, Dave Collins, David Hedrick, Ratri Lertluksamipun, and Chelsea Rinn, and contractors Rachel Branaman and Ashley Whittemore for supporting logistics; the incredible Turtle Survival Center staff Carol Alvarez, Clint Doak, AJ Fetterman, Cris Hagen, Amanda Romines, and Nita Yawn for hosting the tour; and Becca Cozad for assisting with the program of presentations. And, to our dedicated volunteers, thank you.

Welcome once again to the 21st Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles.

Sincerely,

Patricia Koval, Chair of the Board, Turtle Survival Alliance
Craig Stanford, Chair, IUCN/SSC Tortoise and Freshwater Turtle Specialist Group

Behler and Pritchard Turtle Conservation Awards 2023

This year the 18th annual Behler Award celebrates and honors **Kurt Buhlmann**, a founding Turtle Survival Alliance member. Kurt worked with Conservation International and was the original Turtle Survival Alliance Co-Chair with Rick Hudson when the Turtle Survival Alliance was an official Task Force of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group (TFTSG) before becoming its own stand-alone nonprofit. Kurt has a Ph.D. in Ecology from the University of Georgia, M.S. in Wildlife Sciences from Virginia Tech, and B.S. in Environmental Studies from Stockton State College. He is currently a conservation ecologist and Senior Research Associate at the University of Georgia's Savannah River Ecology Laboratory.

Kurt's research interests include life history and evolutionary ecology, with applications for the conservation and management of amphibians and reptiles. He serves on the Executive Board of the Turtle Conservation Fund and has worked with Partners in Amphibian and Reptile Conservation (PARC), state natural heritage programs, the Longleaf Alliance, and other nonprofit, state, and federal agencies on habitat management projects for amphibians and reptiles, including the use of prescribed fire and wetlands restoration. Kurt has collaborated on international and national turtle conservation efforts, and along with his partner and colleague, Tracey Tuberville, is actively focused on recovery, reintroduction, and headstarting projects for tortoises and freshwater turtles in North America. Kurt's personal mission has been to conduct relevant conservation science, but more importantly, to apply it on the ground to benefit and improve conditions for specific, defined populations of rare and threatened species. Kurt is a well-respected leader in our global chelonian conservation community and highly deserving of the Behler Turtle Conservation Award, and we are pleased to finally honor him at this time.

We also honor four Pritchard Lifetime Achievement Awardees this year, all for their outstanding long-term contributions to turtle conservation and biology: **Ken Dodd** for his ecology studies and conservation efforts for mud turtles and box turtles and his seminal work in the U.S. Office of Endangered Species; **Bruce Bury** for his ecology studies on Western Pond Turtles and conservation efforts for Desert Tortoises and his role in founding the journal Herpetological Conservation and Biology; **Earl Possard**t for his turtle conservation efforts through transformative funding programs by the U.S. Fish and Wildlife Service; and **Elmar Meier** of Münster, Germany, for his captive breeding and conservation of rare and endangered Asian turtles, especially Asian box turtles on the brink of extinction. Thank you to all for your dedication and perseverance in making a major difference for turtles.

The IUCN/SSC TFTSG and Turtle Survival Alliance are joined by the Turtle Conservancy and the Turtle Conservation Fund as co-presenters of the Behler and Pritchard awards, bringing together four turtle conservation organizations closely tied to both John Behler's and Peter Pritchard's legacies. Additional support for the Behler Award and its honorarium is also gratefully received from the following dedicated and generous co-sponsors: Re:wild, Andrew Sabin Family Foundation, Chelonian Research Foundation, Surprise Spring Foundation, George Meyer and Maria Semple, Brett Stearns, and Deb Behler.

Congratulations, Kurt, Ken, Bruce, Earl, and Elmar, and thank you all for your major efforts on behalf of turtles and their conservation—your recognition as Behler and Pritchard Awardees is most highly deserved!

Anders G.J. Rhodin, Rick Hudson, Vivian Páez, Peter Paul van Dijk, and Andrew Walde
Co-Chairs and Vice-Chairs, Behler Turtle Conservation Award Committee

T-shirt Design!
Please join us in thanking **Jordan Gray** for designing our T-shirt for the 21st Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. This year's design features arguably one of the most well-known, beautiful, and beloved turtles of South Carolina, the Eastern Box Turtle (*Terrapene carolina carolina*), set against the Charleston skyline.

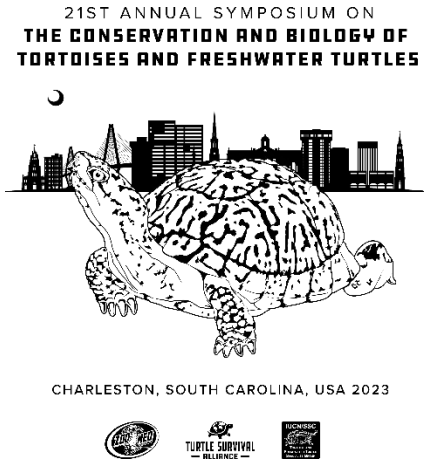


Photo Policy
Photographers will be taking pictures at the conference, which may be used for promotional and educational purposes. Registration or participation in the meeting and other activities constitutes an agreement to allow Turtle Survival Alliance to use and distribute attendees' image or voice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

TURTLE SURVIVAL ALLIANCE SYMPOSIUM
CODE OF CONDUCT
07/05/2023

BACKGROUND

Established in 2002, the Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles (the Symposium) is an international forum co-hosted by the Turtle Survival Alliance Foundation and the IUCN Tortoise and Freshwater Turtle Specialist Group (TFTSG) to present, consider, and debate scientific research and viewpoints that are relevant to the field of turtle and tortoise conservation.

Participation is open to anyone interested in the topics at hand and who pays the fee charged for attendance when the Symposium occurs in person, or who can access the YouTube Live link when the Symposium is presented online. Members of Turtle Survival Alliance may receive a discount on the fee charged to attend an in-person Symposium.

Anyone interested in submitting an abstract to present at the Symposium must do so pursuant to the guidelines, including deadlines that are prescribed and published each year. Speaker and poster presentation selection is solely at the discretion of the Symposium organizing group established annually by Turtle Survival Alliance and the TFTSG. Membership in Turtle Survival Alliance or the TFTSG is not necessary in order to present at the Symposium.

Participants may register for field trips organized by Turtle Survival Alliance in connection with the Symposium. Turtle Survival Alliance may also hold dinners and hospitality, social, or other events in conjunction with the Symposium. Participants may be required to pay additional fees to attend these field trips or events. Any such field trip or event will be considered to be part of the Symposium, regardless of whether it occurs before, during or after the Symposium, and whether or not it occurs at the venue of the Symposium.

INTRODUCTION

The Turtle Survival Alliance and the Tortoise and Freshwater Turtle Specialist Group (TFTSG) are committed to providing a safe, productive, and welcoming environment for all volunteers and Symposium participants at both in-person meetings and on virtual platforms. Individuals attending the Symposium and associated events have a right to an environment free from discrimination, bullying, inappropriate behavior, and harassment. These behaviors will not be tolerated at Symposium activities including field trips associated with the Symposium (whether onsite or at a different venue), social events sponsored by other organizations, and those held at public or private facilities (including banquets). Each participant, including any speaker, poster presenter, exhibitor, or volunteer, each guest of a participant, each service provider and any Turtle Survival Alliance employee, officer, Board member, or intern, will receive and must agree to abide by the terms of this Symposium Code of Conduct (Code) when registering for the Symposium. Participants may also be required to abide by any other policies or rules in furtherance of the Code announced at the Symposium.

Turtle Survival Alliance, the TFTSG, and the hosting entity reserve the right to change or alter the Symposium program or to remove a speaker, poster presenter, vendor and/or sponsor at any time. Anyone who has violated this Code in the past or who is violating this Code may be denied, or removed immediately from, a speaking or presentation opportunity and may be subject to other sanctions set out in this Code.

This Code defines expected and unacceptable behavior at the Symposium and Symposium associated events, both in-person and virtual, and the procedures for reporting and addressing unacceptable behavior (i.e., violations of the Code), including potential outcomes and consequences of unacceptable conduct. A violation of this Code may also constitute a violation of Turtle Survival Alliance's Code of Ethics for Turtle Survival Alliance's employees, officers, Board members, and others working directly with or for Turtle Survival Alliance.

EXPECTED CONDUCT:

Examples of expected and acceptable behaviors include, but are not limited to:

- Conduct yourself at the Symposium as you would at your place of work including, but not limited to, all Symposium-sponsored or affiliated presentations, workshops, socials, banquets, fundraising activities, and field trips.
- Treat everyone with respect and consideration, and value a diversity of views and opinions.
- Communicate thoughtfully with others and be considerate of the multitude of views and opinions that are different than your own, in all situations including but not limited to: while presenting, in one-on-one conversations, at exhibitor tables, and within group discussion.
- Assume good intentions of all participants.
- Critique ideas rather than individuals and avoid personal attacks directed towards others.
- Be mindful of your surroundings and sensitive to the experience of fellow participants.
- Welcome new participants and value the diversity they bring to the Symposium.
- Ask before initiating physical contact.
- Engage in friendly, consensual interactions among individuals and avoid potentially non-consensual physical contact with others.
- At Symposium events where alcoholic beverages are served, participants are expected to drink responsibly while also upholding the standards described in this Code.
- Alert Turtle Survival Alliance representatives (see contact list below) if you notice a situation that violates this Code or someone in distress.
- Comply with all applicable laws, including wildlife protection laws.
- Respect the rules, policies, and property of the Symposium venue, hotels, or contracted facility.
- Look out for the safety and comfort of your friends and colleagues.
- Be proactive in addressing potential conflicts by addressing them in a timely and respectful manner.

UNACCEPTABLE CONDUCT

The Turtle Survival Alliance has zero tolerance for any form of discrimination, harassment, or objectification, including sexual harassment, or any form of bullying. Behavior that is acceptable to one person may not be acceptable to another, so participants in the Symposium and events must use discretion to ensure that their words and actions communicate respect for others. This is especially important for those in positions of seniority, as those in more junior or subordinate positions may be reluctant to express their objections or discomfort regarding unwelcome behavior because of a real or perceived imbalance of power.

Participation in, facilitation of, or promotion of harassment, intimidation, or discriminatory behaviors at the Symposium in person, on virtual platforms or social media associated with the Symposium, or during other associated activities organized by Turtle Survival Alliance will not be tolerated. The Turtle Survival Alliance reserves the right to take any action deemed necessary and appropriate, including the immediate removal or blocking of individuals from virtual or social media platforms and the deletion of comments from the same, if comments or behavior are deemed to be unacceptable.

Unacceptable behavior includes, but is not limited to:

- Physical, emotional, verbal abuse or threats against any attendee, speaker, volunteer, exhibitor, Turtle Survival Alliance employee, officer or Board member, service provider or other Symposium or event guest.
- Disruption of talks at the Symposium or other associated events/activities organized by Turtle Survival Alliance.
- For exhibitors and individuals: placement or removal of materials on exhibitors' tables other than your own without permission.
- Photographing/copying/sharing of presentation slides if the presenter includes a statement or image indicating confidentiality or copyright protection.
- Publicly sharing the location or contact information of any other participant beyond information shared in the Symposium materials.

- Public sharing of sensitive locality data that might create risk to those sites from illegal harvesting.
- Making discriminatory comments.
- Reporting an incident in bad faith.

HARASSMENT

Sexual harassment is unacceptable conduct of a sexual nature that makes a person feel uncomfortable. Harassment and sexual harassment may also violate applicable US laws. Examples of behavior constituting sexual harassment include, but are not limited to:

Non-verbal Conduct

- Unwelcome physical contact or inappropriate touching.
- Physical violence, including sexual assault.
- The use of threats or rewards to solicit sexual favors.
- Display of sexually explicit or suggestive material or images.
- Sending sexually explicit messages or images electronically or by phone.
- Sexually suggestive gestures.
- Whistling or “cat calling”.

Verbal Conduct

- Comments, jokes or insults based on appearance, age, private life, etc.
- Sexual comments, stories, or jokes.
- Unwelcome sexual advances.
- Repeated and unwanted invitations for dates or physical intimacy.
- Condescending or sexist remarks.

REPORTING UNACCEPTABLE CONDUCT

The Symposium co-hosts have zero tolerance for any form of discrimination or harassment, including sexual harassment. Anyone reporting a violation or suspected violation of the Symposium Code of Conduct must be acting in good faith and have reasonable grounds for believing the information disclosed indicates a violation of the Code.

If you believe that you or anyone else is, or is about to be, a victim of conduct which is criminal in nature, please contact local law enforcement by calling 911 (in the US) and immediately notify facility security. When time permits, please share your experience with the Turtle Survival Alliance, per our reporting procedure, set forth below.

If you believe that you or anyone else is the subject of conduct of any sort that may violate this Code, whether or not it is conduct that may result, or did result, in notification of law enforcement or facility security, please report via the reporting procedures, as follows:

Contact the chair of the Turtle Survival Alliance Equity, Diversity, and Inclusion Committee, at: EDIChair@turtlesurvival.org or the Chair of the Board’s Governance Committee, at: GovChair@turtlesurvival.org. The Turtle Survival Alliance representative who receives the report of the complaint or concern has the responsibility to investigate it. The reporter may choose to remain anonymous.

Violations of this Symposium Code of Conduct should be reported verbally by a complainant to one of the above-named representatives of the Turtle Survival Alliance, preferably immediately after the violation has occurred. The representative may later request a written report. The report should include all the pertinent documentation needed for Turtle Survival Alliance to investigate the violation (including but not limited to date, time, misconduct observed, name of the person accused, and names of others who may have witnessed the misconduct, and any visual or audio evidence of the violation. Reports of violations or suspected violations will be kept confidential to the extent possible, consistent with the need to conduct an adequate investigation or to the extent allowed by law. All complaints will be treated seriously and responded to promptly by at least two board members. Actions to be taken will be discussed beforehand with the victim of the violation, wherever possible.

Upon receipt of a complaint, the Turtle Survival Alliance representative who received the complaint will communicate the allegation and provide all supporting materials to the full Board of Directors. Complaints will be handled with respect for the privacy of the victim and the alleged violator and will be confidential to the extent practical, given the circumstances.

If a complainant believes that the violation is of a criminal nature, Turtle Survival Alliance will assist the victim, if requested, in notifying legal authorities. If the victim does not believe that the complaint is of a criminal nature, the Turtle Survival Alliance representative receiving the complaint will listen to the victim and discuss next steps.

Turtle Survival Alliance will employ a "Two Strikes" policy for most Code violations depending on the severity of the offense. Individuals will receive a warning as described below for a first violation. Following the second violation, more severe consequences may be levied. **An exception to this Two Strikes policy will be made when an egregious violation occurs (including, but not limited to, one that requires intervention by venue security or law enforcement).** In such instances Turtle Survival Alliance may proceed directly to Removal, Rescission, or Barring Participation.

Two Strike Policy:

Strike 1: Warning

- Anyone requested to stop unacceptable behavior is expected to comply immediately; this strike will be considered a first "strike" warning.
- A person who has engaged in unacceptable behavior may be warned of an alleged or actual Code violation at any time during the Symposium, or afterwards based on the timing of reporting and opportunity for an appropriate investigation.

Strike 2: Removal, Rescission, or Barring Participation

Upon egregious violation, or following a second incident of unacceptable behavior which constitutes a violation (i.e., the second "strike"), authorized officers or employees of Turtle Survival Alliance or venue security may take any action which is, in their discretion, deemed necessary and appropriate, including immediate removal of the violator from the Symposium without warning or refund of any amounts paid to attend the Symposium or associated field trips or events. Turtle Survival Alliance reserves the right to:

- Prohibit attendance by the violator at any future Symposium or any other Turtle Survival Alliance-organized or hosted event, as well as at, or in, any Turtle Survival Alliance working group or other Turtle Survival Alliance -related activity.
- Deny consideration of the violator for any award, endorsement, leadership role, or project assignment associated with Turtle Survival Alliance.

PERSONAL SAFETY

Turtle Survival Alliance works with venue staff to make sure that meeting participants are safe. **If you believe that you or anyone else is in immediate danger at any time, please contact local law enforcement by calling 911 (in the US) and immediately notify facility security**.

All participants should report any questionable activity to a member of the EDI Committee, Turtle Survival Alliance employee, or Board member or to venue security for immediate action. **If you see something, say something. As a participant:**

- Be aware of your surroundings at all times.
- Regardless of where you are, use the buddy system when walking to and from the Symposium venue and networking events, especially during early or late hours.
- Do not wear your Symposium badge on the street. Take it off as soon as you leave the venue.
- Do not carry a lot of cash.
- Do not leave personal property unattended anywhere, any time.

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 https://bit.ly/TSA2023_Presentations. 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:

- July 30 – 4:00 PM – 7:00 PM
- July 31 – 2:00 PM – 5:30 PM
- August 1 – 7:00 AM – 4:00 PM
- August 2 – 8:00 AM – 4:00 PM

Contents of this Conference Program should be cited as:

Author. 2023. **Title**. In A.D. Walde and J. Gray (Eds.). Program and Abstracts of the Twenty-first Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. Turtle Survival Alliance, Charleston, South Carolina, USA. pp. *xx–xx*.

Please visit the vendors, sponsors, and non-profits in the Ballroom Foyer:

- Animex International
- Desert Tortoise Council
- Gregory George Designs
- Holohil Systems
- Itinerant Literate Books
- Mazuri Exotic Animal Nutrition
- Sonotronics
- Turtle Conservancy
- Turtle Survival Alliance
- Zoo Med Laboratories

Conference Notes and Social Activities

Sunday, July 30

- Registration — 4:00 PM – 7:00 PM (Registration Desk – Ballroom Foyer)
- Auction Item Drop Off — 4:00 PM – 7:00 PM (Beside Registration)

Monday, July 31

- Turtle Survival Center Tour — 9:30 AM – 1:00 PM (First bus departs at 08:15 AM)
- Registration — 2:00 PM – 5:30 PM (Registration Desk – Ballroom Foyer)
- Auction Item Drop Off — 2:00 PM – 5:30 PM (Beside Registration)
- Vendor Set up — 2:00 PM – 5:30 PM (Ballroom Foyer)
- Poster Hanging — 3:30 PM – 5:30 PM (Ballroom Foyer)
- Icebreaker — 6:30 PM – 8:30 PM (South Carolina Aquarium)

Tuesday, August 1

- Registration — 7:00 AM – 4:00 PM (Registration Desk – Ballroom Foyer)
- Auction Item Drop Off — 7:00 AM – 1:00 PM (Ballroom Foyer)
- Exhibit Hall Open — 7:00 AM – 4:00 PM (Ballroom Foyer)
- Poster Viewing — 8:30 AM – 6:00 PM (Ballroom Foyer)
- Silent Auction Opens — 4:00 PM (Ballroom Foyer)
- Drink Beer. Save Turtles.® — 6:00 PM – 9:00 PM (Rusty Bull Brewing Co.)

Wednesday, August 2

- Registration — 8:00 AM – 4:00 PM (Registration Desk – Ballroom Foyer)

- Exhibit Hall 8:00 AM – 5:45 PM (Ballroom Foyer)
- Poster Viewing 8:00 AM – 4:00 PM (Ballroom Foyer)
- Silent Auction #1 Closes 1:00 PM (Ballroom Foyer)
- Silent Auction #2 Closes 4:30 PM (Ballroom Foyer)
- Poster Session & Book Signings 3:45 PM – 5:45 PM (Ballroom Foyer)

Thursday, August 3

- Registration 8:00 AM – 1:00 PM (Registration Desk – Ballroom Foyer)
- Exhibit Hall Open 8:00 AM – 4:00 PM (Ballroom Foyer) ***Please note*** *– This is your last chance to purchase a commemorative T-shirt or other conference souvenir!*
- Poster Viewing 8:00 AM – 12:00 PM (Ballroom Foyer)
- Silent Auction #3 Closes 1:00 PM (Ballroom Foyer)
- Poster/Vendors Breakdown 12:00-1:00 PM (Authors, please take down your posters at this time. Any posters left behind will be discarded.)
- Auction Payment / Pick-up 4:00 PM – 6:00 PM (Ballroom Foyer)
- Cocktail Reception 6:00 PM – 7:00 PM (Ballroom Foyer)
- Awards Banquet 7:00 PM – 9:30 PM (Ballrooms A/B)

Auction Notes

The silent auction is always a fun part of the Annual Symposium, plus it generates funds to help support the Turtle Survival Alliance's conservation programs and projects. The silent auction will take place Tuesday - Thursday in the Exhibit Hall (Ballroom Foyer), 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 beside registration. Please note: no auction items can be accepted without completing this process! Auction items will be accepted from 4:00-7:00 PM on Sunday, 2:00 PM-5:30 PM on Monday, and 7:00 AM-1:00 PM on Tuesday. **It is very important that you get your items turned in during this time!** This will allow our volunteers enough time to catalog each donation and make sure that everything runs smoothly.

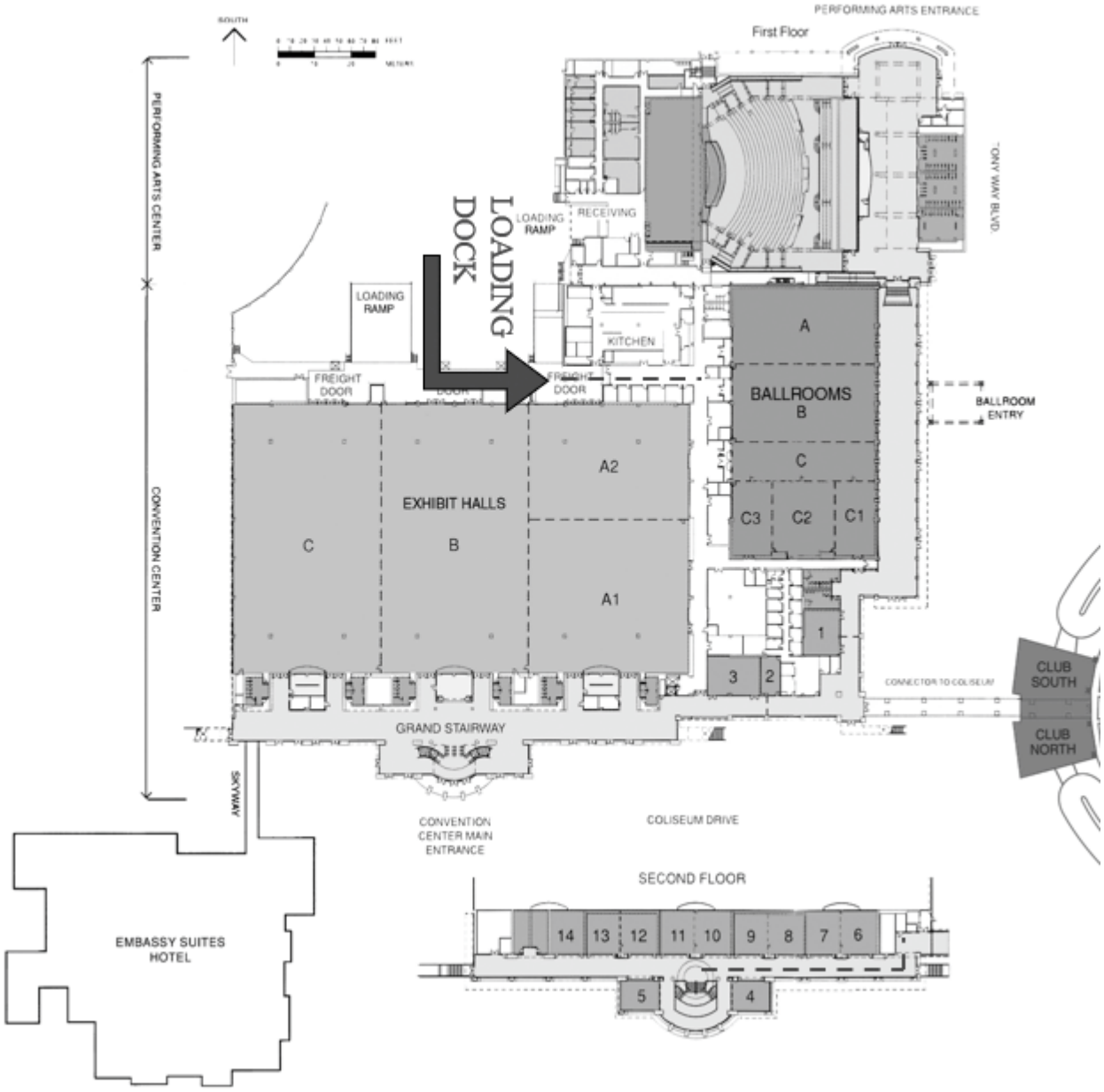
Social Media

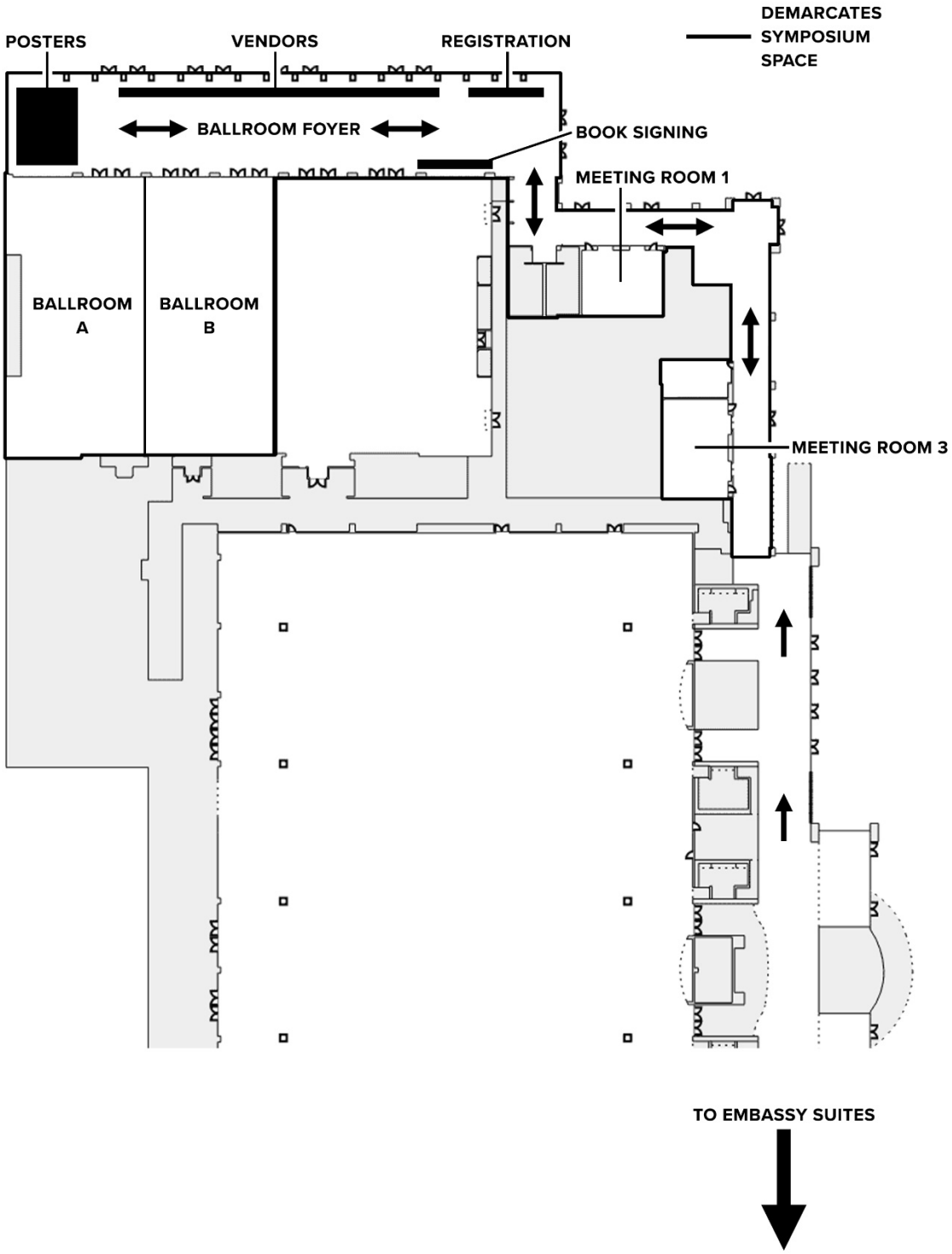
Stay up to date on the latest in turtle conservation news by following us on social media.

Facebook / Twitter / Instagram / LinkedIn @TurtleSurvival

Join the conversation! Use #TSA2023 when you post or tweet about the meeting or to follow along!

Embassy Suites & Convention Center




DEMARCATES SYMPOSIUM SPACE
POSTERS
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REGISTRATION
BALLROOM FOYER
BOOK SIGNING
MEETING ROOM 1
BALLROOM A
BALLROOM B
MEETING ROOM 3
TO EMBASSY SUITES

Conference Schedule Overview

<table>
<tr><th></th><th>Saturday
July 29</th><th>Sunday July 30</th><th colspan="2">Monday July 31</th><th>Tuesday August 1</th></tr>
<tr><td>8:00</td><td rowspan="12"></td><td rowspan="3"></td><td colspan="2" rowspan="4"><u>Turtle Survival Center Field Trip</u>

<u>Departs at 8:15 am</u>
<u>Be in the lobby ready to load at 8:00</u></td><td>Opening Address and Welcome</td></tr>
<tr><td>8:15</td><td>TFTSG</td></tr>
<tr><td>8:30</td><td>Moving Beyond Diversity: Building a Culture of Inclusion and Belonging</td></tr>
<tr><td>9:15</td><td rowspan="9"><u>TSA Board</u>
<u>(Closed)</u></td><td>Of Time and Turtles: Mending the World Shell by Shattered Shell</td></tr>
<tr><td>10:00</td><td>Break/Posters</td></tr>
<tr><td>10:15</td><td rowspan="8">Plenary Talks</td></tr>
<tr><td>10:30</td></tr>
<tr><td>10:45</td></tr>
<tr><td>11:00</td></tr>
<tr><td>11:15</td></tr>
<tr><td>11:30</td></tr>
<tr><td>11:45</td></tr>
<tr><td>12:00</td><td></td><td>Lunch</td><td colspan="2"></td><td>Lunch</td></tr>
<tr><td>13:30</td><td rowspan="6"></td><td rowspan="6"><u>TSA Board</u>
<u>(Closed)</u></td><td colspan="2"><u>Field Trip Returns to Hotel</u></td><td rowspan="6">Plenary Talks</td></tr>
<tr><td>13:45</td><td colspan="2" rowspan="5"></td></tr>
<tr><td>14:00</td></tr>
<tr><td>14:15</td></tr>
<tr><td>14:30</td></tr>
<tr><td>14:45</td></tr>
<tr><td>15:00</td><td rowspan="8"></td><td rowspan="8"><u>Registration In Lobby (15:00-19:00)</u></td><td><u>Turtle Conservation Fund Board Meeting</u>

(15:00-16:45)</td><td><u>Workshop</u>
Wildlife Fencing Solutions
Animex International

(15:00-16:45)</td><td>Break/Posters</td></tr>
<tr><td>15:15</td><td rowspan="7">Plenary Talks</td></tr>
<tr><td>15:30</td></tr>
<tr><td>15:45</td></tr>
<tr><td>16:00</td></tr>
<tr><td>16:45</td></tr>
<tr><td>17:45</td><td colspan="2" rowspan="3"><u>Icebreaker Social</u>
Buses depart hotel at 17:45
South Carolina Aquarium
(18:30-20:30)</td><td></td></tr>
<tr><td>18:00</td><td rowspan="3">Drink Beer. Save Turtles.®
Rusty Bull Brewing Co.
(18:00-21:00)</td></tr>
<tr><td>18:30</td><td rowspan="2"></td><td rowspan="2"></td></tr>
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Conference Schedule Overview

<table>
<tr><th></th><th colspan="2">Wednesday
August 2</th><th colspan="2">Thursday
August 3</th></tr>
<tr><td>8:30</td><td colspan="2">Morning Announcements</td><td colspan="2">Morning Announcements</td></tr>
<tr><td>8:45</td><td rowspan="6">Veterinary Medicine and Explorations</td><td rowspan="6">Genetic Investigations</td><td rowspan="6">Headstarting and Translocation</td><td rowspan="6">Combating Wildlife Trafficking</td></tr>
<tr><td>9:00</td></tr>
<tr><td>9:15</td></tr>
<tr><td>9:30</td></tr>
<tr><td>9:45</td></tr>
<tr><td>10:00</td></tr>
<tr><td>10:15</td><td colspan="2">Break/Posters</td><td colspan="2">Break/Posters</td></tr>
<tr><td>10:30</td><td rowspan="6">Turtles of the Southeastern United States</td><td rowspan="6">South American Turtles</td><td rowspan="6">Zoos & Captive Management</td><td rowspan="6">Kinosternids</td></tr>
<tr><td>10:45</td></tr>
<tr><td>11:00</td></tr>
<tr><td>11:15</td></tr>
<tr><td>11:30</td></tr>
<tr><td>11:45</td></tr>
<tr><td>12:00</td><td colspan="2">Lunch</td><td colspan="2">Lunch</td></tr>
<tr><td>13:00</td><td rowspan="5">Field Studies</td><td rowspan="5">South American Turtles</td><td rowspan="5">Turtle Ecology</td><td rowspan="5">Conservation Tools and Actions</td></tr>
<tr><td>13:15</td></tr>
<tr><td>13:30</td></tr>
<tr><td>13:45</td></tr>
<tr><td>14:00</td></tr>
<tr><td>14:15</td><td colspan="2">Break/Posters</td><td colspan="2">Break/Posters</td></tr>
<tr><td>14:30</td><td rowspan="5">Field Studies</td><td rowspan="5">The More You Know</td><td rowspan="5">Turtle Ecology</td><td rowspan="5">Conservation Tools and Actions</td></tr>
<tr><td>14:45</td></tr>
<tr><td>15:00</td></tr>
<tr><td>15:15</td></tr>
<tr><td>15:30</td></tr>
<tr><td>15:45</td><td colspan="2" rowspan="3">Poster Session & Book Signings</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>17:00</td></tr>
<tr><td>17:45</td></tr>
<tr><td>18:00</td><td colspan="2"></td><td colspan="2">Reception and Awards Banquet</td></tr>
</table>

Daily Schedule				
	Sunday July 30	**Monday July 31**		**Tuesday August 1**
	Meeting Room 1			**Ballroom A/B** Chair: J Gray
8:00		**Turtle Survival Center Field Trip** **Departs at 8:15 a.m.** **Be in the lobby ready to load at 8:00 a.m.**		Turtle Survival Alliance - Opening Address and Global Update
8:15				TFTSG - Update
8:30				Moving Beyond Diversity: Building a Culture of Inclusion and Belonging R BRANAMAN
9:15	**TSA Board** **(9:00 - 17:00)** **(Closed)**			*Keynote Address:* Of Time and Turtles: Mending the World Shell by Shattered Shell S MONTGOMERY
10:00				***Break & Posters***
10:15				Conservation of the Critically Endangered Burmese Roofed Turtle S PLATT
10:30				Long-Term Demographic Trends in a Wood Turtle Population Inhabiting an Unusual Landscape T AKRE
10:45				The Long Road to Home: Ontario Turtle Conservation Centre Builds a New Facility S CARSTAIRS
11:00				The Generality of Turtles Using Nest Site Choice to Counter Climate Change Effects on Embryos JS DOODY
11:15				Turtle Survival Center: Ten Years of Challenges and Successes C HAGEN
11:30				Reproductive Integration of Gopher Tortoises Following Multiple Population Augmentations T TUBERVILLE
11:45				Phyloregionalization of the World's Turtles Reveals Centers of Endemism and EDGE Species D JONES
12:00	**Lunch**			***Lunch 12:00 - 13:30***
13:30	**TSA Board** **(9:00 - 17:00)** **(Closed)**			Population Estimate of the Southern River Terrapin in Kemaman, Malaysia P NYOK CHEN
13:45				Beyond Captivity: The Benefits and Challenges of Rewilding with Captive-Bred Aldabra Giant Tortoises R BAXTER
14:00				Mapping Turtle Ranges: The Importance of Known Localities R KIESTER
14:15				New Genomic Insights Offer Some Hope for the Recovery of the Critically Endangered Magdalena River Turtle N GALLEGO-GARCÍA
14:30				***Break & Posters***
14:45				Tracking Turtles: An Overview of SnapperGPS and Potential Applications for Turtle Research and Conservation T THOMAS
15:00		**Turtle Conservation Fund Board Meeting** **(15:00-16:45)**	**Workshop** **Wildlife Fencing Solutions** **Animex International** **(15:00-16:45)**	A Yellow-Faced *Emydura* (Chelidae) in the Kimberley of Northern Western Australia—How Many *Emydura* Taxa Are Occurring There? G KUCHLING
15:15				Turtle Conservation in Myanmar: Turtle Survival Alliance/Myanmar Biodiversity Fund Program Update (2020-23) S PLATT
15:30				Use of Point of Care and Local Laboratories to Facilitate and Expedite Decision Making for Rewilding Chelonians B RAPHAEL
15:45				Endangered Southern Africa Dwarf Tortoises (*Chersobius* spp.): An Integrated Strategy for Threat Mitigation and Conservation J JUVIK
16:00				On Turtles and War: Nubian Flapshells in Northern Uganda L LUISELLI
18:00		**Icebreaker Social** **(South Carolina Aquarium)** **(18:30-20:30)**		**Drink Beer. Save Turtles.®** **Rusty Bull Brewing Co.** **(18:00-21:00)**

Daily Schedule		
	Wednesday August 2 – Ballroom A	**Wednesday August 2 – Ballroom B**
8:30	**Morning Announcements**	**Morning Announcements**
	Veterinary Medicine and Explorations Chair: S Divers	***Genetic Investigations*** Chair: N Gallego-García
8:45	Characterization of Innate Immunity of the Diamondback Terrapin M Merchant	Genomic Assessment to Evaluate the Impacts of Habitat Loss and Biological Invasion on the Puerto Rican Slider K Avilés-Rodriguez
9:00	Cases of Austwickiosis and Testudine Intranuclear Coccidiosis (TINC) in Captive Tortoises from the Private Sector S Poterala	Low Coverage Sequencing Provides Insights Into the Features of the Nuclear and Mitochondrial Genomes of the Alligator Snapping Turtle J Antonio Baeza
9:15	Identification of *Fusarium* Species From Captive-Raised Southern River Terrapins in Malaysia S Nordahliawate	*De Novo* Chromosome-Level Genome Assembly Offers Insights Into the Genetic Health of Aldabra Giant Tortoises F Gözde Çilingir
9:30	Rewilding Radiated Tortoises in Madagascar: Epidemiology and Management of an Old Pathogen in a Novel Environment B Raphael	A Genomic Assessment of the Utility of Using Subspecies for Diamondback Terrapin Conservation Management P Scott
10:45	Evaluation of the Feasibility and Safety of Endoscopic Sex Identification in 467 Turtles and Tortoises of Ten Species S Divers	Mud and Musk Turtles: Evidence for Codon Bias? D Starkey
10:00	Veterinary Medicine in Galapagos Tortoise Conservation and Welfare S Divers	Transcriptome Analysis of Muscle Tissues of the Chinese Softshell Turtle J Yelin
10:15	***Break & Posters***	***Break & Posters***
	Turtles of the Southeastern United States Chair: W Selman	***South American Turtles*** Chair: G Forero-Medina
10:30	Ecology of Eastern Chicken Turtles in Conecuh National Forest, Alabama A Coleman	How Many Times Do Giant South American River Turtles Climb on the Beach Before Choosing a Nest Site? C Ferrara
10:45	Population Estimates of the Pearl River Map Turtle in Mississippi Noah Devros*	NGO Karumbé Activities for Turtles Conservation in Uruguay A Estrades
11:00	Range, Movement, and Habitat Use of the Alligator Snapping Turtle P Delisle*	How Dams Have Affected Chelonians in the Amazon Region L Maia*
11:15	Monitoring of Ringed Sawback in the Pearl River of Mississippi M Jaunsen*	Water Canal: A Deadly Trap for Patagonian Tortoises E Kubisch*
11:30	Distribution and Abundance of Ringed Sawback and Pearl Map Turtle W Selman	Creating a River Turtle Management Plan for the Rupununi, Guyana N Millar
11:45	***Lunch 11:45-13:00***	***Lunch 11:45-13:00***
	Field Studies Chair: B Atkinson	***South American Turtles cont.*** Chair: G Forero-Medina
13:00	Cameras Capture Coastal Gopher Tortoise Activities and Commensals A Belchior	Key Biodiversity Areas for Turtle and Tortoise Conservation in Bolivia E Domic-Rivaeneira
13:15	Population Status and Conservation of Two Critically Endangered Large Softshell Turtles in Kaveri River, Tamil Nadu, India P Christopher	Contribution of Citizen Science to Bolivian Turtles in iNaturalist S Acebey
13:30	Stormwater Management Ponds Provide Habitat for Turtles B Crawford*	Access to and Use of Turtles in the Brazilian Amazon W Chaves
13:45	Allometry and sexual dimorphism in the Central American River Turtle (*Dermatemys mawii*) P Evans	Forensic Isotopic Approach to Trace Tortoise Trafficking in Brazil R Mayrink
14:00	Six Years of Monitoring: Investigating The Impacts of Wastewater Treatment Plant Effluents on Mediterranean Pond Turtle AS Le Gal*	Escaping the Habsburg Curse: Rescuing the Endangered Dahl´s Toad-Headed Turtle from the Dangers of Inbreeding G Forero-Medina
	Break & Posters	***Break & Posters***
	Field Studies Cont. Chair: B Atkinson	***The More You Know*** Chair: J Gray
14:30	Pollution and Risk Assessment of Heavy Metal Contamination in Aquatic Environments and Turtle Species in Nigeria A Oyegbami	*Chinlechelys tenertesta*: Understanding of Turtle Origins A Lichtig
14:45	The Importance of Riparian and Aquatic Vegetation for Central American River Turtle in a Lentic System in Southern Mexico E Reyes-Grajales*	Evaluating Bycatch Reduction Devices for Diamondback Terrapin Exclusion and Blue Crab Capture S Husband*
15:00	Effects of Habitat Alteration and Co-Occurrence With Introduced Red-Eared Sliders on Southwestern Pond Turtle Abundance M Skibsted*	Reproductive Behavior, Food, and Microhabitat Characteristics of Forsten's Tortoise Nests in Sulawesi, Indonesia Fauzia Noorchaliza*
15:15	Southern Pacific Pond Turtles (*Actinemys pallida*) in Different Habitats of the Same River Drainage N Stanek	Transfer of Potential Pathogens In a Captive Habitat F Tantu
15:30	Mortality Among Wood Turtle Populations Increases During Drought J Welch	
15:45-17:45	***POSTER SESSION & BOOK SIGNINGS***	

*** Student Considered for Student Awards Competition**

Daily Schedule		
	Thursday August 3 – Ballroom A	**Thursday August 3 – Ballroom B**
8:30	**Morning Announcements**	**Morning Announcements**
	Headstarting and Translocation Chair: F Kuzma	***Combating Wildlife Trafficking*** Chair: D Collins
8:45	Assisted Colonisation of the Critically Endangered Western Swamp Turtle: Insights from Two Years of Post-Release Monitoring B Nordstrom*	"Hello Hong Kong," Hello Turtles: Will Future Demand for Turtles Scale with Present Availability? B Anders
9:00	Pilot Augmentation of Elongated Tortoise in Cambodia C Griffioen	The Fight Against Radiated Tortoise Trafficking Continues and Intensifies S Randrianjafizanaka
9:15	Estimation of Habitat Suitability and Comparison of Home Range Sizes of Translocated Burmese Star Tortoises N Win Kyaw*	Urbanization and Connection to Nature: Implications for Demand for Tortoises and Freshwater Turtles in the United States W Chaves
9:30	Post-release Movements and Survival of Soft- and Hard-released Long-term Captive Eastern Box Turtles Relative to Sympatric Resident Turtles RJ Rimple*	The Turtle Trafficking Dedicated Data Centre S Stoner
9:45	Assessing the Efficacy of Headstarting for Eastern Box Turtles F Kuzma*	Identifying Drivers of Demand for Wild Turtles in the United States Z McMillian*
10:00		Key Partnerships to Confront the Illegal Trade in North American Turtles D Collins
10:15	***Break & Posters***	***Break & Posters***
	Zoos & Captive Management Chair: B Hughes & J Dawson	***Kinosternids*** Chair: C McAvinchey
10:30	Investigating Behavior and Physiological Metrics for the Management of Asian Box Turtles L Augustine	Population Ecology of the Alamos Mud Turtle and the Effects of a Prolonged Drought Between 2019-2021 in the Southern Sonora F Barbosa
10:45	The Asian Turtle Conservation Program: An Expanding Initiative of the Saint Louis Zoo WildCare Institute J Dawson	The Plight of the Vallarta Mud Turtle (*Kinosternon vogti*) T Blanck
11:00	Increasing Institutional Chelonian Species Diversity by Utilizing Polycarbonate Food Containers: Tennessee Aquarium Turtle Nursery B Hughes	Movement Patterns and Home Range of Sonora Mud Turtles C Drost
11:15	Captive Breeding and Headstarting of Bog Turtles at Zoo Knoxville S Nelson	Descriptive Morphology of the Striped Mud Turtle in Delaware J Thompson*
11:30	A Retrospective Assessment of Captive Breeding Efforts With the Madagascar Flat-Tailed Tortoise M Ogle	Turtle Tracking: Behavioral Ecology of the Tabasco Mud Turtle C McAvinchey*
11:45	Dallas Zoo: Chelonians Past, Present, and Future T Owens	
12:00	***Lunch 12:00 - 13:00***	***Lunch 12:00 - 13:00***
	Turtle Ecology Chair: P Lindeman	***Conservation Tools and Actions*** Chair: K Holcomb
13:00	Population Ecology of Diamondback Terrapins in Southeast Texas S Baker	Collaborative Conservation Efforts for the Malaysian Giant Turtle–Indonesia I Rahmawati
13:15	Disentangling the Role of Morphology and Behavior on Reproductive Success in a Population of Sierra Box Turtles in Sonora, Mexico T Butterfield	Effectiveness of Animex® Exclusion Fencing at Intercepting Nesting Freshwater Turtles Along Lake Ontario and Lake Erie K Gunson
13:30	Somatic Growth and Maturity for Four Species of River Cooter Z Siders	Turtley Wild: Study Abroad as a Tool for Conservation and Education D Gailliard
13:45	Long-term Capture-Mark-Recapture in a Small Urban Pond Complex B Glorioso	Conservation Action for the Spotted Turtle and River Cooter in Illinois M Dreslik
14:00	Evaluation of Boat Strike Injuries on Riverine Turtles with Emphasis on Demographic Variation C Godwin	Headstarting as a Component of Long-Term Recovery in Turtle Populations K Buhlmann
14:15	***Break & Posters***	***Break & Posters***
	Turtle Ecology Cont. Chair: P Lindeman	***Conservation Tools and Actions Cont.*** Chair: K Holcomb
14:30	Hurricane Ian Effects on Populations of Turtles in Southwest Florida C Lechowicz	Achieving Proper Shell Growth in Captive Raised Box Turtles C Hagen
14:45	Nest Site Fidelity in a Population of Diamondback Terrapins C Leone	Diamondback Terrapin Conservation Needs and Protective Actions, Florida G Heinrich
15:00	Changes in Composition and Structure of a Florida Freshwater Turtle Assemblage Associated with Degradation of a Spring Ecosystem G Johnston	Molecular phylogeny of the Indochinese box turtles: Indochinese Box Turtle, Bourret's Box Turtle, and Southern Vietnam Box Turtle F Ihlow
15:15	Tortoises as Prey: Patterns of Chimpanzee Predation on Hinge-back Tortoises in African Forests C Stanford	Known and Potential Impacts of Utility-Scale Renewable Energy Development on Agassiz's Desert Tortoises and Their Habitat J Lovich
15:30	Surveys of Basking Turtles in the Corn Wilderness of Southeastern and East Central Illinois, With Emphasis on Three Map Turtle Species P Lindeman	Fishing Gear and the Southern River Terrapin: Effective Conservation Approaches for Reducing Mortality—A Case Study in Cambodia S Som
15:45	Is There Habitat-Related Variation in the Body Sizes of Texas Map Turtles and Cagle's Map Turtles? P Lindeman	2020-2022 Common Raven Density Trends: Signs of Initial Success in Five of Six Intensively Treated Areas K Holcomb

*** Student Considered for Student Awards Competition**

Poster Presentations *(Main Hallway)*	
Poster Session—Wednesday, August 2nd at 15:45	
Population Structure of the Western Pond Turtle Across Twelve Military Installations in California E ASCHE	Diversity, Status, and Perception of People Towards Turtle Conservation in the Betana Wetland of Eastern Nepal With a Special Focus on Elongated Tortoise C BASYAL
Understanding Gopher Tortoise Ticks and Gopher Tortoises: A Review of the Literature and Our Preliminary Data I CAPES*	Assessing Epizoic Diatom Communities Inhabiting the Surfaces of Turtle Carapaces A COLEMAN
Baseline Energetic Requirements of Ornate Box Turtles A COLTON*	Great Lakes Rare Turtle Conservation Efforts Through John Ball Zoo M COURY
Habitat Description and Distribution Expansion of Guyanan Toad-headed Turtle to the Extreme North Region of Brazil F CUNHA*	Reproductive Aspects of One of the Southernmost Tortoise Population in the World M ECHAVE*
Survival Matters: Comparing the Demographic Traits of *Clemmys* and *Glyptemys* with Long-term Capture-recapture Data D EDMONDS	From Cages to Nature Reserves: Karumbé's Educational Program to Free Turtle Pets in Uruguay A ESTRADES
Welcome to the Neighborhood: Habitat Selection of the Nonnative Red-eared Slider P EVANS	Home Range Sizes and Habitat Selection of Spotted Turtles in Northern Michigan C JOHNSON*
Effect of Seasonal Nesting and Emergence Patterns on Oblong Turtle Hatchling Performance in South-Western Australia A KHATUN*	How Habitat Degradation Affects the Population Structure and Phenotype of the Mediterranean Pond Turtle AS LE GAL*
The Unusual Ontogeny of Baenid Turtles A LICHTIG	Seventy *Platysternon*-years: An Account of Two Long-term Captive Big-headed Turtles T LUNDY
Recording the Vocalizations and Associated Behavior of Burmese Black Mountain Tortoises in a Captive Setting J NEULIGHT*	Detection and Occupancy of the Western Pond Turtle (*Actinemys spp.)* M PARRY
Turtles and Tofu: Comparing Populations of Native Versus Introduced Turtles in Northern Taiwan L PAVLIK*	The Impact of Low Head Dams on Freshwater Turtle Species Assemblages S SIMMONS*
Sherlock Bones: Utilization of Wildlife Detection Dogs to Locate Eastern Box Turtles in Upstate South Carolina M STEPHENS*	Juvenile Survival and Growth Probability in the Suwannee Alligator Snapping Turtle T THOMAS
Using Automated Radio Telemetry to Track the Movement and Habitat Use of Diamondback Terrapins on a Barrier Island in Southeast Louisiana S TRUCKENBROD*	

***Student Considered for Student Awards Competition**

Contribution of Citizen Science to the Project Bolivian Turtles in iNaturalist

SANDRA ACEYBEY[2], ENRIQUE DOMIC-RIVADENEIRA[1] & GUIDO MIRANDA-CHUMACERO[1]
[1]*Wildlife Conservation Society, Programa Bolivia, Calle Gabino Villanueva 340, La Paz, Bolivia*
[2]*Ecología y Empresa S.R.L., Claudio aliaga 1223, La paz, Bolivia*
[sacebey@outlook.es]

In 2020 the project "Tortugas de Bolivia" was created in iNaturalist with the objective of knowing the diversity of turtles and their distribution in Bolivia. These contributions of citizen science constitute an important tool for participation, cost effectiveness in data collection and monitoring, and contributions to knowledge of natural history (Tsehelthrim et al. 2020), confirmation of threats and inputs for conservation actions. The objective was to analyze and review what kind of contributions of citizen science can be obtained from the analysis of records in iNaturalist, with emphasis on the Turtles Project of Bolivia. Aspects such as: year of observation, degree of identification/classification achieved and the number of agreements on identifications, areas of observation (department) were analyzed. Considering the differences in the degree of classification achieved, the quality of the records (incidental, degree of research and with the need for identification), wild and captive status, among others, were counted and compared at the different taxonomic levels. A percentage estimate of the data contribution from iNaturalist to Quelonio-BOL and other pages on the taxonomic group in the same application was also made. We reviewed 213 observation records between 2000 and 2021, of which 194 correspond to 12 native species, and 19 records are of introduced species. Of the total 69% corresponds to the wild state and 170 were identified at the species level, only 118 meet quality criteria established by iNaturalist. The species with the best quality of information were: Yellow-spotted River Turtle (*Podocnemis unifilis*), Yellow-footed Tortoise (*Chelonoidis denticulatus*) and Red-footed Tortoise (*Chelonoidis carbonarius*). These three species together with Geoffroy's Side-necked Turtle (*Phrynops geoffroanus*) are the most observed. At least 169 of the records of the Bolivian Turtles Project in iNaturalist are part of Quelonio-BOL (Domic-Rivadeneira et al. 2021). This work showed that the Bolivian Turtles Project is the most important at the national level for this taxonomic group, but that there is also a need to improve observations and participation through the citizen science for conservation.

South American Turtles: Oral

Long-Term Demographic Trends in a Wood Turtle (*Glyptemys insculpta*) Population Inhabiting an Unusual Landscape

THOMAS S. AKRE[1], ELLERY LASSITER[1,2], GRANT CONNETTE[1], ELLIOT LASSITER[1,3], JEFFREY DRAGON[1,4] AND J.D. KLEOPFER[5]
[1]*Conservation Ecology Center, Smithsonian's National Zoo and Conservation Biology Institute, USA*
[2] *Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK 74078, USA*
[3] *Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701, USA*
[4] *Pinelands Commission, New Lisbon, NJ 08064, USA*
[5] *Virginia Department of Wildlife Resources, Charles City, VA 23030, USA*
[akret@si.edu]

The Wood Turtle (*Glyptemys insculpta*) is considered endangered by the IUCN and is currently being evaluated for listing under the U.S. Endangered Species Act. Populations have been severely impacted by human encroachment across the range, and at the southern margin in Virginia, the species is considered a priority for conservation action due to apparent range contraction. Many of the remaining populations in northern Virginia occur at relatively high elevation sites on National Forest land. Although populations on these sites may benefit from landscape protection, whether these sites promote recruitment and adult survival is unknown. In order to determine the role the Forest plays in landscape and population conservation for the wood turtle in Virginia and West Virginia, we sought to determine variation in survival, recruitment and population size, from multiple data sets collected over nearly 30 years. At our location, monitoring through aquatic visual encounter surveys has been conducted by several different groups since 1994. To account for variable effort from surveys with varying objectives across years, we integrated recent and historical survey effort and capture data in a spatially-explicit capture-recapture framework, thus enabling estimation of survival, recruitment, and population size over a substantial portion of the species' lifespan (~30 yr). Not surprisingly, initial results revealed a strong effect of survey effort and season. And, unfortunately, despite our efforts to account for varying spatio-temporal effort across the sampling period, survival and population size estimates appear low and recruitment estimates appear high in early years, possibly from overestimation of survey uniformity in those years. Furthermore, despite an intense survey effort over the sampling period, apparent annual survival estimates had low precision and were not readily differentiated among years. Nevertheless, as survey effort became more uniform and complete over the sampling period, precision of demographic parameter estimates improved, leading to more reliable information for the last 20 years. The benefits of this approach will be presented in relation to our continued efforts to address the limitations of this data set, along with the implications for monitoring and modeling the population ecology and conservation of this species in the region.

Plenary: Oral

Effect of Seasonal Nesting and Emergence Patterns on Oblong Turtle (*Chelodina oblonga*) Hatchling Performance in South-Western Australia

MOST ALIZA KHATUN[1], ROBERTA BENCINI[1] AND GERALD KUCHLING[2]
[1]*UWA School of Agriculture and Environment, The University of Western Australia, Crawley, WA 6009, Australia*
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The nesting season of Oblong Turtles (*Chelodina oblonga*) in south-western Australia extends from spring (late September/October) to summer (January/early February), with hatchlings emerging from nests after variable incubation times (4-11 months) from mid-autumn (May) to late winter (August/early September). Embryos develop without interruption through diapause, but once embryos are fully developed embryonic aestivation/ hibernation extends the incubation period. At hatchling emergence from nests, I tested in the field through a righting and a two-meter walking test the following variables for possible effects on hatchling fitness: hatchling body mass and carapace length, month of nest construction, incubation temperature throughout the incubation period, length of incubation, month of emergence, and air temperature at emergence. The same hatchlings were used for the righting test and two-meter walking test by recording the time for hatchlings to right themselves after being flipped on their back and the time for hatchlings to walk a 2m distance. Emergence month, incubation temperature, body mass and size of hatchlings had no significant effect on the righting time and walking speed. Hatchlings that emerged in autumn, winter and spring showed no difference in performance. Righting time was 9 seconds faster for a 1°C increase in air temperature ($p=0.001$). The walking time was 15 seconds faster for a 1°C increase in air temperature ($p=0.0008$). When the incubation period increased 1-day, the righting response was 0.4 seconds faster for each extra day of incubation ($p=0.02$). Similarly, the walking time was 0.5 seconds quicker for each extra day of incubation ($p=0.04$). Hatchlings' righting response was similar between early spring and summer nests, but hatchlings emerging from the spring nests, walked 9-36 seconds faster over 2m than those hatched from the summer nests ($p=0.03$). The better righting and/or walking performance of hatchlings from spring nests and of those emerging after longer incubation periods and under warmer temperatures indicates that extended embryonic aestivation/hibernation is adaptive for this species in which predation of freshly emerged hatchlings is a significant factor for their recruitment into the population.

Poster Session

"Hello Hong Kong," Hello Turtles: Will Future Demand for Turtles Scale with Present Availability?

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Hong Kong S.A.R., China has been recognized as an important global turtle trade hub for at least three decades. The city's role in turtle trade has centered on importation for food markets and, more recently, burgeoning farming and pet trades primarily in mainland China. Given a wide scope of commerce in turtles and very large direct and indirect human populations the trade serves, it should be unsurprising that diversity in available species is generally high, especially if compared to typical western retail models. Demand for exotic turtle species continues to escalate in Hong Kong and mainland China alike, seemingly with increasing awareness of diversity as modern resources make such information more readily available. Surveys of storefront offerings in turtle diversity (i.e. what the general public can see and purchase) were made in Hong Kong over the course of eight years. The most apparent take-home message was that offerings during this time were considerably more diverse than those reported in decades prior to the city's role in global turtle trade. Despite a proportional increase in the percentage of captive-bred stock, number of species offered remained high. This beckons the question of whether the ever-expanding interest in turtle diversity among trade stakeholders in China will scale with what is presently available for purchase. In other words, will growing up with ready access to dozens of exotic turtle species generate an as-yet unknown caliber of turtle traders in the future? Additional considerations will be discussed.

Combating Wildlife Trafficking: Oral

Population Ecology of the Alamos Mud Turtle *(Kinosternon alamosae)* and the Effects of a Prolonged Drought Between 2019-2021 in the Southern Sonora

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In this work, ecological aspects of the Alamos Mud Turtle (*Kinosternon alamosae*) were evaluated in several intermittent ponds near the municipality of Alamos, Sonora. Hoop nets and radio telemetry were used to measure demographic and ecological aspects from 2019-2021. However, from November 2019 to June 2021 there was a prolonged drought and ponds that turtles inhabit did no fill with water and no turtles were collected in 2020. In total, 76 *K. alamosae* (33 males, 38 females and 5 juveniles) were collected from 2019 to 2021. Females have a taller carapace than males ($Z=2.72$, $p=0.006$). Sex ratio was slightly skewed to females 1:1.5 (M:F), but not significantly ($\chi^2=0.35$, $p=0.55$). Population structure was mainly composed of adults (28 males and 32 females, 78.94% of the total population). Five turtles were equipped with radio transmitters in 2019 at one of our study sites called "Palomar" and 69 relocations were accumulated from 2019-2021, with an average of 17.8 relocations per turtle. The most used terrestrial microhabitat by *K. alamosae* was woody debris (n=29, 40.02% of the total) and less frequent was soil shelter (n=6, 8.65%). The prolonged 2019-2021 drought resulted in a period of extensive aestivation where turtles spent an average of 591 days out of the water. Indeed, drought appears to have caused several deaths in the population since of the five turtles with radio transmitters two died before the rain arrived in 2021 without evidence of predation, also three additional turtles were found dead in the site. The furthest distance traveled to an aestivation site did not exceed 1000 m, which shows high fidelity to the pond. Despite the drought occurred in the study site, this research reveals that there is a healthy population of *K. alamosae* in Alamos, but increase in frequency and duration of droughts could be one of the main threats to this species in the future.

Kinosternids: Oral

Population Structure of the Western Pond Turtle (*Actinemys spp*.) Across Twelve Military Installations in California

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Western Pond Turtle (*Actinemys spp*.) populations are currently threatened with habitat loss, predation, and shell disease. The synergies among threats have caused severe population declines whereby they are an endangered species in Washington, a sensitive species in Oregon, and a species of special concern in California. It is imperative to investigate their status in California to determine how prevalent threats are and what level of conservation action needs to be taken to avoid declines. We examined the population structure of the Western Pond Turtle populations at twelve military installations across California through sampling in one-week bouts using 50 aquatic traps at one visit per base. We recorded the body size, life stage, and sex of all individuals. Our study is intended to represent a first pass at determining if there are any immediate conservation concerns, such as biases in stage or sex ratios and population size structure.

Poster Session

Investigating Behavior and Physiological Metrics for the Management of Asian Box Turtles

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Living collections provide the unique opportunity to study a species' behavior and physiology. This is particularly important for species with dwindling wild populations that are prioritized for conservation breeding and the development of assurance colonies.

The species within the genus *Cuora* are a high priority for conservation action, with most species listed as Critically Endangered on the IUCN Red List. In the United States, the Indochinese Box Turtle (*Cuora galbinifrons),* Bourret's Box Turtle *(Cuora bourreti*) and the Southern Vietnam Box Turtle (*Cuora picturata)* were historically managed under the Association of Zoos and Aquariums (AZA) Species Survival Plan (SSP), developing a network of institutions invested in the management of this species. Over the last decade, few institutions have successfully reproduced these species consistently, though there are some examples of success. In order to improve upon keeping methodologies, surveys and research projects have been initiated to collect valuable data from which to improve management. This study was conducted on the reproductive biology of these three species utilizing behavior and fecal hormone analysis. While the sample size was low (1.1 *C. picturata*, 2.1.1 *C. bourreti* and 1.2 *C. galbinifrons*), the results provide some insight into the breeding biology of this species. Briefly, fecal progestogen, estrogen, testosterone, and corticosterone metabolites were measured for the duration of a breeding season in order to determine the feasibility of non-invasive hormone monitoring. In addition, all reproductive introductions were recorded and analyzed for rates of reproductive and aggressive behaviors based on ethograms of tortoise and turtle behaviors. Despite four breeding pairs, only one pair produced viable eggs. The results of this study, in conjunction with other information gleaned from SSP participants and field biologists, can aid in the improved management of the species, a critical component of their conservation.
Zoos & Captive Management: Oral

Genomic Assessment to Evaluate the Impacts of Habitat Loss and Biological Invasion on the Puerto Rican Slider (*Trachemys stejnegeri stejnegeri*)

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The Puerto Rican Slider (*Trachemys stejnegeri stejnegeri*) is a medium-bodied freshwater turtle observed in natural and highly disturbed water bodies. Despite widespread records within its native range, relatively little information about the species' current impacts and ecological interactions is available. In the early 2000s, the International Union for the Conservation of Nature (IUCN) listed the species as Near Threatened. The species has not been evaluated since then. Local conservation agencies in Puerto Rico identify habitat loss, competition, and hybridization with invasive Red-eared Sliders (*Trachemys scripta elegans*) as the major drivers of population loss. However, the species is listed as data deficient due to insufficient studies. We used ecological and genomic approaches to assess the impacts of habitat loss, competition, and hybridization across Puerto Rico. We surveyed 32 wetlands and collected morphological data (N=351) and genetic data (N=144). Our surveyed yield 159 Puerto Rican Sliders, 46 Red-eared Sliders, and 10 Yellow-bellied Sliders (*Trachemys scripta scripta*). We also collected 136 Puerto Rican Sliders, which appeared to differ in coloration and morphology, which we classified as putative hybrids. Morphological assessment placed putative hybrids at intermediate shell symmetry, a taxonomic differentiation between Red-eared and Puerto Rican sliders. However, genetic assessment suggested approximately 10 of these putative hybrids as true hybrids. Our results also suggest a greater abundance of Red-eared Sliders in highly urbanized wetlands within Puerto Rico. Thus, using ecological and genomic assessment, our study identified a small number of hybrids between the native and invasive turtles. Moreover, we confirm that invasive Red-eared and Yellow-bellied sliders occur at several wetlands throughout mainland Puerto Rico, albeit at low abundances. We also document wild Red-eared Slider hatchlings suggesting breeding occurs at these wetlands. Given the locations where Red-eared Sliders were abundant, it appears that humans release the main source of propagules into specific wetlands within parks.
Genetic Investigations: Oral

Low Coverage Sequencing Provides Insights Into the Key Features of the Nuclear and Mitochondrial Genomes of the Alligator Snapping Turtle (*Macrochelys temminckii*)

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The Alligator Snapping Turtle (*Macrochelys temminckii*) is a culturally, ecologically, and evolutionary relevant species of conservation concern. In this study, we conducted a genome survey of *M. temminckii*. Using a low-coverage short read sequencing strategy, this study estimated the genome size, repetitive genome content, annotated and quantified repetitive elements, assembled the 45S rRNA DNA operon, and characterized in detail the mitochondrial genome of *M. temminckii*. Using a k-mer strategy, the estimated haploid genome size varied between 3.77 and 3.19 Gbp, which is within the range previously

reported for other representatives of the family *Chelydridae*. Repetitive genome content estimates using different k-mers (21 to 51) indicated that more than 75% of the genome of *M. temminckii* comprised repetitive elements. Considering only annotated repetitive elements, the most common repetitive elements were classified as Class I - Long Interspersed Nuclear Element (LINE) which were more abundant than Class I – Penelope and Class I - Long Terminal Repeat (LTR) Ty3/Gypsy mobile elements. Less abundant repeat element families in the nuclear genome of *M. temminckii* included Class I - DIRS mobile elements and Satellite DNA. The nuclear ribosomal operon was partially assembled into two contigs, one encoding the complete ssrDNA and a second comprising the full lsrDNA. The AT-rich complete mitochondrial genome was 16,570 bp long. These new genomic resources are of utmost importance to aid in the development of conservation plans for this freshwater turtle.
Genetic Investigations: Oral

Population Ecology of Diamondback Terrapins in Southeast Texas

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The Diamondback Terrapin (*Malaclemys terrapin*) is the only species of turtle found in the coastal marshes of North America. Limited data exists regarding their population ecology in the upper Texas coastal marshes. We have been conducting mark/recapture of a population in Jefferson County, TX, for two years in order to determine population size and spatial use prior to expansion of the Sabine Pass Ship Channel that will potentially alter mash hydrology and habitat. Diamondback Terrapins were captured using non-baited double throated hoop traps set in tidal channels throughout the marsh. Captured turtles were sexed and the following morphometric information was collected: mass, carapace length, carapace width, carapace height, plastron length, head width, and mass. All captured individuals were marked by injecting a passive integrated transponder (PIT) tag subcutaneously in the hind leg. Turtles were held overnight to collect fecal samples for diet analysis and then released at their original capture location. Prior to release, a blood sample was collected, along with a bite force measurement. Our initial analysis indicated a stable population that showed significant sexual size dimorphism, especially in head width, with females having significantly wider heads. We hypothesize this difference in head width confers a stronger bite force, enabling female Diamondback Terrapins to consume more mollusk and crustacean prey items. Consumption of hard-shelled prey is thought to provide a source of calcium to incorporate into egg shells prior to nesting. If this is true, we may also expect to find a seasonal shift in diet with mollusks and crustaceans accounting for a higher proportion of ingested food items prior to the onset of nesting. The results of this study will increase our knowledge of Diamondback Terrapins on the northern Gulf Coast, as well as provide important information for land managers concerned with population persistence.
Turtle Ecology: Oral

Diversity, Status, and Perception of People Towards Turtle Conservation in the Betana Wetland of Eastern Nepal With a Special Focus on Elongated Tortoise (*Indotestudo elongata*)

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Freshwater turtles are vital indicators of wetland habitat health. A loss of any species would result in significant losses in biodiversity and economic potential. Though Nepal has 18 turtle species, most are globally threatened. Betana Wetland, a biodiversity hotspot of Nepal, has a good stock of turtles, but its status is still unknown. So, this study attempted to collect information on the diversity, status, ethnozoology, and conservation issues of turtles in the area. The study was carried out in May 2022 including the wetland, forest, and household survey. For the wetland survey, a Visual Encounter Survey with the point count method on seven identified representative spots was carried out with 49 hours of survey effort. The survey was also carried out on a floating boat to explore the turtles at inaccessible sites to be reached on foot. The forest survey was carried out using an opportunistic survey method by 2 dedicated teams. Furthermore, a semi-structured interview was conducted in 100 households using systematic random sampling. For data analysis MS Excel 2010 and SPSS version 23 were used, applying Freidman and Chi-square tests. A total of 136 individuals of four species of turtles were recorded, with the majority of Indian Peacock Softshell Turtle (*Nilssonia hurum*) species followed by Black Softshell Turtle (*Nilssonia nigricans*), Indian Flapshell Turtle (*Lissemys punctata*), and Elongated Tortoise (*Indotestudo elongata*), incorporating both young and adults. 8% of respondents responded there is no decline in turtles in the wetland while 17 % of them have killed turtles at least once. A significant association was found between the sex category with the knowledge of the population trend of turtles and the practice of killing turtles in the

wetland. The majority identified the greatest threat to the turtles as illegal poaching while recreational activities as the least. The turtles were observed being familiar with the human presence nearby and feeding the food given by the visitors. Moreover, local people have been using turtles for various ethnozoological uses like food, religious importance, medicinal value, and decoration. The study recommends future studies relating radio telemetry monitoring and behavioral study to assess the actual status of turtles and understand their changing behavioral adaptation.
Poster Session

Beyond Captivity: The Benefits and Challenges of Rewilding with Captive-Bred Aldabra Giant Tortoises

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The Aldabra Giant Tortoise (*Aldabrachelys gigantea*), endemic to the Aldabra Atoll, Seychelles, is a vulnerable species with a population of around 100,000 individuals in the wild. Historically, these tortoises were found on many Seychelles islands, but harvesting by humans and habitat change caused the extirpation of tortoise populations on all islands except Aldabra. From this source population, a few viable tortoise populations have been established, but most efforts to repopulate these 'tortoise-less' islands have been relatively unsuccessful due to continuing human interference, habitat degradation, and predation by alien mammals. Many of these early translocated tortoises ended up in captivity as people revered them and for their use in cultural traditions. This desirability also led to tortoises being bred in captivity for the local and international pet trade. The international demand for *A.gigantea* is high, yet local breeders in Seychelles are seeing reduced demand due to competition from breeders in other countries. These tortoises require large enclosures with natural vegetation and large amounts of natural plant food to remain in good health, and local breeders have too limited space and resources to properly care for large giant tortoise herds.

Captive rearing (headstarting) programmes have played and continue to play an important role in tortoise conservation. We explore the feasibility of reintroducing Aldabra Giant Tortoises from captive herds to islands in their core historical range. Suitable translocation sites must fulfil several criteria for the translocation to proceed, such as habitat quality and availability of food sources, ample refuge, water, and low predation risk. Also, ascertaining the optimal size and density of tortoises will determine the impact the tortoises have in rewilded island habitats. There is a growing interest in and opportunity to use captive-bred tortoises in large numbers for rewilding projects, and such actions will also help managing captive herd densities and improving their welfare.
Plenary: Oral

What Makes a Good Wildlife Fence? An Exploration Into Identifying, Implementing, and Maintaining Effective Wildlife Exclusion Fencing

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We will explore key aspects that contribute towards the successful implementation of wildlife fencing for a wide range species and situations. In this workshop you will learn how to identify, design, install and maintain appropriate and effective mitigation solutions. The outcomes will provide you with a toolkit you can apply on your own projects and share with colleagues and partners.
Workshop

Wildlife Trail Cameras Capture Coastal Gopher Tortoise Activity Patterns and Reveal Commensals

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Gopher Tortoises (*Gopherus polyphemus*) are a keystone species native to upland habitats of the southeastern United States. Listed as Threatened in Florida and considered vulnerable throughout their range, Gopher Tortoises are of great conservation concern. The overwhelming majority of gopher tortoise publications focus on populations residing in longleaf pine ecosystems. As a result, their ecology in coastal habitats is dramatically underrepresented in scientific literature. We've undertaken a mark-

recapture demographic study and are gathering basic data on gopher tortoise natural history in these understudied coastal areas. Our two sites at the Guana Tolomato Matanzas National Estuarine Research Reserve in northeast Florida are increasingly rare examples of intact coastal dune and maritime hammock habitats that support healthy Gopher Tortoise populations. Beginning in 2021, we deployed RECONX Hyperfire 2 and JOH mini trail cameras to document tortoise activity and community ecology at these protected coastal sites. To date, we have analyzed >300,000 trail camera images focused on tortoise burrows. Our data indicate that tortoise activity is primarily driven by circadian rhythms and thermal patterns, with activity peaking at ambient temperatures between 22.2°C and 28.9°C. There are no significant differences in activity patterns between the populations in our two sites or to those in upland habitats. In longleaf pine studies, reptiles and amphibians are the most commonly observed commensal taxa. In our coastal sites, mammalian commensals were most abundant, accounting for over 83% of our observations. We also documented significant correlations between commensal taxa and ambient temperature, specifically between mammals and birds. Commensal activity across all observed taxa was most frequent when temperatures were between 13.9°C and 25°C. This data diverges from published literature on inland (longleaf pine) habitats, where commensalism occurs most often when ambient temperatures are markedly low or high. Commensal activity in longleaf pine is dominated by ectotherms and is primarily driven by thermoregulatory needs. Our data provide a year-round picture of how coastal gopher tortoise ecology shifts seasonally and is differentiated from inland populations. Trail cameras allow continuous, noninvasive monitoring, and our work adds to a growing knowledge base about gopher tortoise ecology.

Field Studies: Oral

The Plight of the Vallarta Mud Turtle (*Kinosternon vogti*)

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The Vallarta Mud Turtle (*Kinosternon vogti)* represents the smallest existing freshwater turtle species known to science and was only recently described. The species only occurs in the Bahia de Banderas valley along the pacific coast of Mexico, right within the vicinity of famous Puerto Vallarta and its local surroundings. Until its rapid development into a recreational valley within the last three decades, most of the Bahia Banderas consisted of swamps and marshland, most of which have been converted into fancy all-inclusive resorts. This left very few, highly fragmented remnant habitats suitable for *K. vogti*, covering less than 80 ha. As such, the species is ranked Critically Endangered by the IUCN since 2022 and included into CITES Appendix I to hinder its commercial trade. Yet, the main cause of the species' disappearance is not overexploitation but habitat degradation and destruction. We are currently aware of only four highly fragmented subpopulations, most of which are situated in the middle of urbanized areas or areas that are in high demand for future construction projects. We estimate that < 1,000 specimens remain in these subpopulations. With the beginning of the dry season the species leaves its wetlands and migrates to suitable remaining waterbodies or aestivates in the soil until the first rainfalls. Unfortunately, these once interconnected habitats are now cut by roads, representing a major cause of mortality. To prevent this, we constructed a reptile-fence in early February 2023; we will present on its results. In 2022 we were lucky enough to observe the egg deposition of a female in the wild, providing critical data for its natural behavior. Turtle Island maintains two legal breeding groups of *K. vogti*, from which the first successful hatching occurred in March 2023. Here we provide incubation and husbandry data, leading to this first captive breeding success of the species. In cooperation with the Turtle Survival Alliance, a conservation breeding facility for the species is under development in Puerto Vallarta, which we will also present. We additionally provide an insight into the trade of the species, comparing it with its sister species, the Cora Mud Turtle (*Kinosternon cora*).

Kinosternids: Oral

Headstarting as a Component of Long-Term Recovery in Turtle Populations

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A small relict population of Wood Turtles (*Glyptemys insculpta*) was discovered on a protected area in 2006. Marking of the old founder individuals and radio-tracking helped determine habitat use. Nesting females informed that nesting habitat and nest success was limited due to invasive plants, human landscape alteration, and raccoon depredation. We initiated habitat restoration: mowing in winter, invasive plant removal, and adjacent landowner education. We built a nesting "mound" with loamy soils, which Wood Turtles readily used, once shown. Hatchlings from protected nests were directly-released 2006-2015, yet only a handful have been discovered in later years. Each year, 2011-2022, some or all of each hatchling cohort were headstarted indoors overwinter for 9 months with a high school. All headstarts from the 2011 cohort, and portions of the 2012-2014 cohorts have been continuously radio-tracked after release. Headstarted turtles find their own food, establish home ranges, and hibernate communally with founder adults. Subsidized raccoons, lawnmowers, automobiles, flooding events—all human-instigated—are the causes of mortality. In 2017 the first males, and in 2019 the first females from the 2011 headstart cohort reached maturity at age 8-9, younger than expected by 4-5 years. Viable hatchlings (headstarts of headstarts) were produced in 2019 and 2020. Headstarting can pull a relict population out of the nose-dive to extirpation when used in conjunction with habitat restoration practices. It must be conducted with persistence and continuity over at least the number of years it takes for earliest cohorts to reach maturity and begin producing offspring of their own.
Conservation Tools and Actions: Oral

Disentangling the Role of Morphology and Behavior on Reproductive Success in a Population of Sierra Box Turtles (*Terrapene nelsoni klauberi*) at an 80-hectare field site in Sonora, Mexico: A First Report of Findings

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Since 2018 we have been studying the Sierra Box Turtle (*Terrapene nelsoni*) in an 80-hectare field site to understand how variation in behavior and morphology could lead to differences in reproductive success, and in-turn, influence how the population is maintained overtime. Here we report the first results of this study on sampling effort, population size/density, number of resident versus non-resident turtles, and personality of turtles. In addition, given that there is significantly more variation in head size in males compared to females, and males tend to fight, we equipped radios on 11 males and tracked their movements for two years. From 2018-2022 we conducted the total of 69-foot surveys, resulting in 471 total person hours, 63 new turtles, and 62 recapture events. Estimated population size is 65.6 ± 2.1 turtles and density is 2.2 turtles/hectare. Thirty-two of the turtles are residents meaning they have been detected in the study site for more than two years, 18 are non-residents or only observed once, and 13 turtles were first captured in 2022 and residency could not be determined. Personality was assessed on how turtles responded when being processed, "not shy" individuals were restless during handling with legs and head fully extended, "shy" individuals do not fully extend legs or head during handling but keep their shell open, and "very shy" individuals remained inside their closed shell. Personality was assessed in 49 individuals, 35 were not shy (71.4%), 5 were a little shy (10.2%), and 9 were very shy (18.4%), suggesting that most of the population is comprised of not shy, or "bold" individuals. Radio telemetry data from the 11 males provide anecdotal information that head size and personality may play an important role in maintaining a territory and access to females. Males with bigger heads tend to have less males and more females that have been observed within their home range area. The next step in this study is to use genetic data to build a pedigree of the population and determine if behavior and morphology lead to increased reproductive success.
Turtle Ecology: Oral

Understanding Gopher Tortoise Ticks and Gopher Tortoises: A Review of the Literature and Our Preliminary Data

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Gopher Tortoise Ticks (*Amblyomma tuberculatum)* are the largest ticks native to North America. They are obligate parasites whose distribution largely coincides with their primary vertebrate host, the Gopher Tortoise (*Gopherus polyphemus)*. Gopher Tortoises are a celebrated, imperiled keystone species endemic to the southeastern United States. They play crucial roles in maintaining biodiversity and ecosystem function. Gopher Tortoise Ticks are found sporadically throughout the southeastern United States – but do not parasitize tortoises exclusively. Larvae, nymphs, or adults can also parasitize other reptiles, birds, and mammals. Gopher Tortoises face declining habitat due to development of uplands. This threat, coupled with parasitism, may

exacerbate their decline. Gopher Tortoise Ticks can cause their host anemia, immunosuppression, and increased susceptibility to predation. Additionally, ticks serve as vectors for a variety of zoonotic pathogens, which may include viruses or bacteria, such as those that cause rickettsial diseases. However, physiological and environmental limits for *A. tuberculatum* distribution are poorly understood. Knowing the ecology and behavior of the gopher tortoise tick is important for effective management of the Gopher Tortoise. Here we synthesize the current knowledge of interactions between *G. polyphemus* and *A. tuberculatum*, describe results from a survey of coastal Gopher Tortoise populations – and outline needs for future research to understand the potential health burdens of ticks on Gopher Tortoises. We conducted a comparative study between two sites within the Guana Tolomato Matanzas National Estuarine Research Reserve in northeast Florida, investigating ectoparasitic loads of tortoises in coastal dunes and maritime hammock. Nearly all captured Gopher Tortoises in our dune site were parasitized by ticks, whereas none were present on tortoises at our maritime hammock site. Our results to date reflect the known natural history of female ticks, who excavate small depressions in well-drained sandy soils to oviposit. Novel management strategies may be essential to protect the health and conservation of gopher tortoises in their ecosystems.

Poster Session

The Long Road to Home: Ontario Turtle Conservation Centre Builds a New Facility

SUE CARSTAIRS

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The Ontario Turtle Conservation Centre (OTCC, operating name of the Kawartha Turtle Trauma Centre) is a registered charity that was founded in 2002 as a small grass-roots, volunteer-run organization. Since that time, it has blossomed into a fully fledged conservation centre with a muti-faceted approach to turtle conservation. It is the only CVO (College of Veterinarians of Ontario) accredited veterinary hospital dedicated to native turtles, in Canada. The programs carried out include a hospital for treatment, rehabilitation, and release of injured or ill turtles from across Ontario and beyond (approximately 2,000 admissions per year), an extensive education program, a headstarting program (approximately 8,000 eggs incubated per year), and field research. The data collected in the various programs is utilized in all areas of turtle conservation, and is available to help other projects such as road mortality mitigation work. The hospital also acts as a bio monitor for turtle populations and allows an annual survey for emerging infectious diseases. OTCC facilitates collaboration and discussion between all groups conducting turtle conservation work in Ontario, through the Ontario Turtle Conservation Network, which it hosts. The latest growth phase of the OTCC will see a purpose-built 10,000 sq ft facility constructed, on 100 acres of land that has been gifted to OTCC along with existing buildings. Plans for the construction of OTCC's new home started in 2017. With a few plot twists along the way, the construction is almost completed. The facility will house the expanded hospital and headstarting area, as well as large public education facilities both inside and outside.

Plenary: Oral

Urbanization and Connection to Nature: Implications for Demand for Tortoises and Freshwater Turtles in the United States

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In the United States, approximately 84% of people live in urban areas. Urbanization has profound implications for how people interact with and connect to nature and wildlife. Although there is a decline in people's direct interactions with nature and connection to nature as urbanization increases, overall urban demand for wildlife, including tortoises and freshwater turtles, is predicted to increase over the next decades because of the increasing human population. At the same time, we do not currently understand the consumers of tortoises and freshwater turtles in the United States (U.S.). Given the unprecedented rate of urbanization and concerns about the increasing demand for tortoises and freshwater turtles in the US, this study aimed to understand how the degree of urbanization in the U.S. affects people's interactions with and use of tortoises and freshwater turtles. We conducted a national panel survey of 1500 people using QuestionPro. To ensure our sample reflected the population of the United States, we included sampling quotas for age, race/ethnicity, gender, income, education, and degree of urbanization. We aimed to understand how the degree of urbanization influences (1) the type of turtle use (i.e., pets, food, medicine, ornaments), (2) how turtles are acquired (e.g., purchased at a pet store, directly harvested from the wild), and (3) species acquired (e.g., native

versus exotics). We also aimed to understand how the degree of urbanization is associated with people's connection to nature and, in turn, how connection to nature influences people's use of turtles. We will present the results with recommendations for interventions related to the demand side of the turtle trade in the U.S. Our work brings novel insights on where and how better communicate with turtle consumers to reduce the demand for turtles of concern in the U.S.
Combating Wildlife Trafficking: Oral

Access to and Use of Tortoises and Freshwater Turtles in the Brazilian Amazon

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The world is urbanizing at an unprecedented rate, bringing new challenges to people and biodiversity. Currently, over 55% of the world's population lives in urban areas compared to approximately 33% in 1960. This demographic shift has resulted in increased urban demand for natural resources, including wildlife, and such demand is predicted to continue increasing in the next decades. Thus, understanding demand for wildlife in urban areas is important to address these challenges. We used the Theory of Access, in which access is defined as the ability to benefit from "things", to understand how access mechanisms – e.g., mobility, access to labor, household composition (e.g., single versus dual-adult households) – in a rural-urban gradient influence households' use of wildlife, with a focus on tortoises and freshwater turtles (hereafter "turtles"). We also assessed whether being multi-sited (i.e., having residence in both rural and urban areas) or single-sited affected turtle use (i.e., harvesting, non-monetary trade, monetary trade, and consumption of turtles as food). From May to July of 2022, we conducted 783 surveys of randomly selected households in urban, peri-urban (the region surrounding urban areas), and rural areas of Manaus and Carauari municipalities (Amazonas state, Brazil). Since most wildlife use is illegal in Brazil, we conducted these surveys using an indirect questioning technique that reduces bias in reported sensitive behaviors. We predict that households with higher mobility, occupations in the primary sector (e.g., fishing, agriculture), and dual-adult household status will have higher turtle use than other households, but the relative effect on each type of use (trade, consumption) will vary across the rural-urban gradient. We also predict that multi-sited households will increase urban access to turtles. By understanding the mechanisms of turtle use, this study will support the design of adaptive and participatory approaches needed for effective turtle management and conservation in the Amazon.
South American Turtles: Oral

Population Estimate of the Southern River Terrapin *(Batagur affinis)* in Kemaman, Terengganu, Malaysia

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Population studies are important to establish and appraise management practices, and have been carried out on various species of turtles. Numerous approaches have been used to estimate population sizes including mark-recapture methods. Attempts had been made to determine the population size of the critically endangered Southern River Terrapin *(Batagur affinis)* in Malaysia through mark-recapture surveys. However, historical surveys either showed no consistent estimates or too few collections were made to provide any estimates. Further, the Department of Wildlife and National Parks estimated population sizes from the incomplete count of wild nests collected, considering some *B. affinis* deposit multiple clutches in a nesting. This was the first study that attempted to systematically quantify the wild population of *B. affinis* through a mark-recapture study in the Kemaman River, Terengganu. This study was conducted during the nesting season, from February to March 2012 to 2023. An anti-poaching team of local villagers patrolled the nesting bank for female *B. affinis*. Once a nesting female was detected, they were allowed to nest undisturbed. After the nesting process was completed, the female was hand-captured and brought to the camp site to be measured and weighed. Then, they were scanned for the presence of a microchip. In the absence of a microchip, a new passive integrated transponder (AVID ProID, Avid Identification Systems, Inc., Norco, CA, USA) was implanted subcutaneously with a disposable syringe into the left inguinal region of the female. A total of 130 individual *B. affinis* were microchipped from 2012 to 2023. Of these, 56 individuals were recaptured when they had returned subsequently to nest. By utilizing mark-and-recapture data of the nesting females over 11 years, the Schnabel mark-recapture method estimated a total of 235 wild *B. affinis* in the Kemaman River. A comparison between this and other populations in the remaining wild population in Malaysia is provided.

This population study confirms that Terengganu, Malaysia is truly the last stronghold for this species. Conservation efforts should be intensified to protect the species from further decline.
Plenary: Oral

Population Status and Conservation of Two Critically Endangered Large Softshell Turtles (*Nilssonia leithii* and *Pelochelys cantorii*) in Kaveri River, Tamil Nadu, India

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Leith's Softshell Turtle (*Nilssonia leithii*) and Cantor's Giant Softshell Turtle (*Pelochelys cantorii*) are two large softshell turtle species found in India. Leith's Softshell Turtle is endemic to peninsular India and Cantor's Giant Softshell Turtle has a wide distribution across South and Southeast Asia. Both species are recorded from the Kaveri River, Tamil Nadu, India. They are listed as Critically Endangered by the International Union for Conservation of Nature (IUCN) Red List; there have been very few records of these turtles from the Kaveri River. Both species face severe threats due to anthropogenic pressures such as habitat loss and overexploitation as a food source. Only limited data is available on these species' exact distribution, population status & ecology. In the present study supported by the Turtle Conservation Fund (TCF) and the Chelonian Research Foundation (CRF), we carry out field surveys to understand these turtles' current distribution, population status, behavior, and ecology in the Kaveri River. In this poster, we discuss the current population status and threats faced by Leith's Softshell Turtle and Cantor's Giant Softshell Turtle in the protected and unprotected areas of Kaveri River, Tamil Nadu. A large extent of the river flows outside protected areas in the state of Tamil Nadu. The field surveys were carried out along the river both inside and outside protected areas. All the sightings were made when the turtles surfaced for breathing, or while basking on the boulders in the river/sandbanks. The presence of the turtles was indirectly confirmed by their tracks left on the riverbanks while basking. Turtles were sighted both inside and outside of protected areas of the river. Despite facing continuous threats, the two species still exist outside protected areas. Awareness to local communities and forest department and focused conservation measures can help the long-term survival of these charismatic species in the Kaveri River.
Field Studies: Oral

***De Novo* Chromosome-Level Genome Assembly Offers Insights Into the Genetic Health of Aldabra Giant Tortoises (*Aldabrachelys gigantea*)**

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The Aldabra Giant Tortoise (*Aldabrachelys gigantea*) is a Vulnerable species listed on the IUCN Red List (v2.3) due to its limited distribution and the threats posed by climate change. However, conservation efforts have been hampered by the lack of genomic resources for *A. gigantea*, one of only two species of giant tortoises remaining in the world. To address this knowledge gap, we produced the first chromosome-level *de novo* genome assembly of *A. gigantea* using PacBio High-Fidelity sequencing and high-throughput chromosome conformation capture. Our high-quality genome assembly of 2.37 Gbp, with a scaffold N50 of 148.6 Mbp, and a resolution of 26 chromosomes, provides crucial insights into the genetic health of the Aldabra giant tortoise populations. Our RNA sequencing-assisted gene model prediction identified 23,953 protein-coding genes and 1.1 Gbp of repetitive sequences. Synteny analyses among turtle genomes revealed high levels of chromosomal collinearity, even among distantly related taxa. To assess the utility of our genome assembly for species conservation, we performed a low-coverage resequencing of 30 individuals from wild populations and two zoo individuals, detecting genetic population structure in the wild

and identifying the most likely origin of the zoo-housed individuals. We further identified putatively deleterious mutations to be monitored, which can aid in genetic diversity management and rewilding efforts. Our study establishes a high-quality chromosome-level reference genome for *A. gigantea* and one of the most complete chelonian genomes available, shedding light on the genetic health of the *A. gigantea* populations and providing important genomic resources for their conservation.
Genetic Investigations: Oral

Ecology of Eastern Chicken Turtles (*Deirochelys reticularia reticularia*) in Conecuh National Forest, Alabama

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Eastern Chicken Turtles (*Deirochelys reticularia reticularia*) have not received the attention in Alabama as have populations in other areas and other chicken turtle subspecies. The present study examined the demography of Eastern Chicken Turtles in Conecuh National Forest, which most likely supports the largest population in the state. Trapping efforts were initiated in February 2021, and visual surveys and hoop nets were utilized to capture individuals. To-date, of the trap captures, 24 capture events have been recorded over 22 trap nights for a catch per unit effort of 1.09 turtle/trap night. Most captures have occurred in spring or late summer. A male-biased capture ratio was observed, and 7 individuals were recaptured. Gravid females were documented in February and October. An acoustic telemetry study will begin in summer 2023 to track habitat use.
Turtles of the Southeastern United States: Oral

Assessing Epizoic Diatom Communities Inhabiting the Surfaces of Turtle Carapaces

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Diatoms are microscopic, photosynthetic algae that can occur in both marine and aquatic habitats and produce a significant portion of global oxygen. They can be free-living or on various surfaces, including turtle shells. A number of studies have examined this ecological relationship between diatoms and marine turtles, but fewer studies have documented diatom communities on aquatic turtles. The present study aimed to close this knowledge gap by comparing diatom communities of various aquatic turtle species captured during the Urban Turtle Project. The carapaces of sampled turtles were brushed, and samples were stored in ethanol until processing. Processed samples were examined using both light microscopy and scanning electron microscopy. Diatoms were identified to genus (if possible) based on morphological features of their shells. Diatom communities were composed mostly of pennate diatoms, and of those, biraphid diatoms of the Naviculoid group appeared to be the most numerous. Influence of turtle habitat was examined by comparing community structure.
Poster Session

Key Partnerships to Confront the Illegal Trade in North American Turtles

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The illegal trade in North American turtles is a complex, multi-faceted problem significantly impacting wild turtle populations and demanding a broad range of expertise and resources to solve. An Association of Zoos and Aquariums (AZA), Saving Animals from Extinction (SAFE) program plan, the AZA SAFE American Turtle Program, was developed as a comprehensive program to coalesce partners from AZA, other NGOs and academic institutions with state and federal biologists and law enforcement officers. The Program is hosted by and furthers the mission of the Turtle Survival Alliance: To protect and restore wild populations of tortoises and freshwater turtles. During this same period a similar initiative, the Collaborative to Combat the Illegal Trade in Turtles (CCITT) was begun by state and federal biologists through the Northeast Partners in Amphibian and Reptile Conservation (NEPARC) and was growing rapidly. These efforts merged in 2019 with leaders from the American Turtle SAFE Program and the CCITT joining to co-chair the CCITT Confiscation and Repatriation working group. In 2020, the CCITT officially joined the Partners in Amphibian and Reptile Conservation (PARC) organization as a PARC National Task Team further expanding the scope of this effort. An additional key partnership is with the Association of Fish and Wildlife Agencies

(AFWA), a non-government organization that works with state, provincial, and territorial wildlife agencies, and partners across North America. AFWA has worked to increase awareness among state wildlife agency leadership about the illegal trade in turtles and the roles that states play. Each of these partners bring unique skills, expertise, and resources to confront the complex challenges of illegal trade in North American turtles.
Combating Wildlife Trafficking: Oral

Baseline Energetic Requirements of Ornate Box Turtles (*Terrapene ornata*)
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Increasing ambient temperatures due to climate change may lead to altered behaviors as turtles attempt to regulate internal body temperatures. Increased efforts to maintain temperatures may result in energetic tradeoffs, leading to reduced individual fitness and, thus, population abundance. Estimation of resting metabolic rates for turtles affords calculation of baseline energetic requirements and the potential to predict costs associated with warming landscapes. Using flow-through respirometry, we will determine the resting metabolic rates (RMRs) of adult Ornate Box Turtles (*Terrapene ornata*) across a temperature gradient to provide information on energetic costs. The baseline estimates will then be used to determine the annual RMR costs on the landscape.
Poster Session

Great Lakes Rare Turtle Conservation Efforts Through John Ball Zoo
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The John Ball Zoo's (JBZ) conservation strategic plan mandates that 3% of the AZA due revenue be dedicated to in situ conservation and that more than half of that effort is focused on Great Lakes projects. The Great Lakes are known to harbor a diverse amount of turtle species, in particular rare and endangered turtles within the Emydidae family. There are myriad drivers of rapid decline for these rare turtles: habitat fragmentation, mesopredation, road mortality, and illicit collection and trade. In order to curb the loss of these species, the JBZ initiated its Great Lakes Rare Turtle program. The program is building towards projects that address key threats to rare turtle species. In collaboration with Michigan Natural Features Inventory, JBZ is conducting research on the distribution and demography of Spotted Turtles (*Clemmys guttata*) throughout Southwest Michigan and Wood Turtle (*Glyptemys insculpta*) nesting ecology and protection in Muskegon County, MI. Competitive State Wildlife Grants support both projects. In addition, John Ball Zoo has established an Eastern Box Turtle (*Terrapene carolina carolina*) head start program in collaboration with Pierce Cedar Creek Institute and Grand Valley State University. The program aims to increase the survival rate of box turtles and test the efficacy of headstarting as a turtle conservation tool. Recently the JBZ and GVSU started a community science effort to identify locations that pose a road mortality threat to Blanding's (*Emydoidea blandingii*) and other turtles. Data will help to guide mitigation efforts. The research and conservation efforts of John Ball Zoo and its partners are crucial in protecting the rare turtle species in the Great Lakes region. The data collected from these projects will help develop effective conservation strategies to protect these species and their habitats. The collaboration between John Ball Zoo, Michigan Natural Features Inventory, Pierce Cedar Creek, and Grand Valley State University is a testament to the importance of partnerships in conservation efforts.
Poster Session

Stormwater Management Ponds Provide Habitat for Some Native and Non-native Turtles in Virginia
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As a result of stormwater management regulations, stormwater management ponds have become common features of modern urban landscapes. Stormwater ponds are designed to intercept and retain stormwater runoff from impervious surfaces such as

roads and roofs. Their ultimate goal is the protection of ecosystem integrity of natural receiving waters, such as streams and wetlands, by promoting groundwater recharge and sequestering pollutants. It has been suggested that stormwater ponds may provide ecosystem functions similar to natural wetlands, including supporting biological diversity associated with wetlands. While stormwater ponds have been shown to be important for some endangered fishes, aquatic invertebrates, and amphibians in urban environments, no studies have investigated the habitat value of these ponds for turtles. Using visual encounter surveys, we sampled 62 ponds for turtles in the towns of Blacksburg and Christiansburg, Virginia, during the summer of 2022. We selected ponds for surveying that included the range of hydroperiods represented by the ponds in the two towns. We documented eight taxa of turtles with juveniles and adult Common Snapping Turtles (*Chelydra serpentina*) and Eastern Painted Turtles (*Chrysemys picta picta*) being most common. Hierarchical N-mixture models, and model comparisons using Akaike Information Criteria, suggested that detection probabilities were highest in early summer and when temperatures were moderate (i.e., not cold or excessively warm), and that permanent water was crucial for use of ponds by turtles. However, we observed few hatchlings, suggesting that populations at some ponds may represent sinks.
Field Studies: Oral

Habitat Description and Distribution Expansion of Guyanan Toad-headed Turtle (*Mesoclemmys nasuta*) to the Extreme North Region of Brazil

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The diversity of freshwater turtles in South America is very large. By 2022, Brazil will have 33 species of turtles, making it one of the countries with the greatest diversity in the world. Although some works have been published in recent years, there is still much to be known about the diversity of undescribed species and the natural history of species already known, especially for the Amazon region. And this information has great relevance for conservation actions and strategic planning for these reptiles. One of the species with very little information about biology and natural history is the Guyanan Toad-headed Turtle (*Mesoclemmys nasuta* SCHWEIGGER, 1812). Considered a rare species with a highly restricted distribution area to the extreme north of the Brazilian Amazon. For Brazil, there are records for two states and some points of occurrence. We describe the habitat of the species for the region of the municipality of Pedra Branca do Amapari, AP. Four adult individuals were captured: one male, one female, one sub-adult female and one calf. All animals were captured with the aid of species traps, 'trapo' (handmade artifact for capturing turtles) and the hatchling was captured in pit-fall. The natural habitat of the species is composed of typical lotic water environments for adult animals and lentic environments for smaller animals. Only the hatchling was found outside a body of water.
Poster Session

The Asian Turtle Conservation Program: An Expanding Initiative of the Saint Louis Zoo WildCare Institute

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In 2004, the Saint Louis Zoo WildCare Institute was launched to centralize and magnify the Zoo's conservation efforts. One pillar of the WildCare Institute's commitment to turtle conservation is the Asian Turtle Conservation Program (ATCP). This initiative, established in 2019, combined the Zoo's long-standing support for the Turtle Survival Alliance with additional assistance for the Asian Turtle Program of Indo-Myanmar Conservation. Funding from the ATCP supported the building of a dedicated facility for Southern Vietnam Box Turtle (*Cuora picturata*) in 2021 at the Turtle Conservation Centre in Cuc Phuong National Park, Vietnam. Field work in Southeast Asia, previously initiated and executed by the Zoo's Charles H. Hoessle Herpetarium, was incorporated under the umbrella of the ATCP in 2023. To date, this field work has focused on numerous species (including *Cuora* spp., Black-breasted Leaf Turtle (*Geoemyda spengleri*), Yellow-headed Temple Turtle (*Heosemys annandalii*), and Mekong Snail-eating Turtle (*Malayemys subtrijuga*) with an aim to carry out research benefitting the conservation of these species. This program is also aligned with *ex situ* conservation breeding efforts for *Cuora* spp., *G. spengleri*, Arakan Forest Turtle

(*H. depressa*), and other Asian turtle species within the Herpetarium. The ATCP is continuing to expand partnerships and collaborations throughout Southeast Asia to support and conduct additional *in situ* and *ex situ* conservation work in the future.
Zoos & Captive Management: Oral

Range, Movement and Habitat Use of the Alligator Snapping Turtle (*Macrochelys temminckii*) in the Mississippi Delta

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The Alligator Snapping Turtle (*Macrochelys temminckii)* is currently proposed for listing as threatened under the Endangered Species Act. In the 19th and 20th centuries, largescale habitat conversion and commercial harvest heavily impacted *M. temminckii* populations throughout much of their range. Previous trapping surveys of the Mississippi River alluvial plain (i.e., "Delta") in Mississippi located several populations that presumably showed little to no historical impact. Investigations into the spatial ecology of *M. temminckii* in unharvested areas will be unique in the literature and will serve as a benchmark for future recovery efforts. Our study assessed the movement, range, and habitat use of two relatively unaffected populations. We attached 27 radio transmitters from July to September 2022 on male, female, and juvenile *M. temminckii* at two sites. Telemetry was conducted as often as was feasible with historically low water levels causing logistical obstacles. Individuals ranged in size from 1.6 to 65.2 kg, with five individuals over 45 kg, an age class that is understudied. Linear range was significantly greater in Site Two. Males showed a significantly higher linear range than females and juveniles, both of which were not significantly different from each other. Movement between locations was determined using the riverdist package in R. Habitat use was associated with large woody debris where visibly ascertainable and overhanging dense canopy cover. Future work will include tracking throughout 2023, nesting surveys, and the use of side scan sonar to investigate habitat selection.
Turtles of the Southeastern United States: Oral

Population Estimates of the Pearl River Map Turtle (*Graptemys pearlensis*) in Mississippi

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The Pearl River Map Turtle (*Graptemys pearlensis*) is an emydid found in the Pearl River drainage system of Mississippi. Highly riverine and a habitual basker, *G. pearlensis* is vulnerable to anthropogenic habitat degradation, such as channelization, impoundments, and deadwood removal, as well as harvest for the pet trade. Runoff and sedimentation adversely affect the mollusk populations upon which mature female *G. pearlensis* feed. Due to these factors, *G. pearlensis* was federally listed as Proposed Threatened in November of 2021. However, *G. pearlensis* remains little-studied. Notably, no rigorous site-specific population estimates have been conducted. Between April 15th and October 15th, 2022, we trapped *G. pearlensis* at a total of 7 sites in the Pearl River drainage in Mississippi. We used mark-resight surveys to estimate the population per site. Trapping and surveying of Ringed Map Turtle (*Graptemys oculifera*), a sympatric federally listed species, occurred simultaneously. The population of *G. pearlensis* at all sites combined was estimated to be 849, with 24.3 turtles per river km (rkm). The population of *G. oculifera* was estimated to be 3,418, with 127.9 turtles per rkm. Our results suggest that *G. pearlensis* is significantly less abundant than *G. oculifera*, with the latter outnumbering the former at every site where population estimates were run (relative abundances ranging from 1.3:1 to 25.9:1). Basking densities of *G. pearlensis* were also low, with relative abundance at each main stem site ranging from 0.02 to 0.44. Due to a lack of comprehensive historical population data, our results for *G. pearlensis* should be understood as baseline data for future population monitoring efforts. Continued routine monitoring will allow us to establish whether *G. pearlensis* populations are currently decreasing. In this talk we will also discuss microhabitat assessment, morphometrics, and underutilized trapping techniques, as well as recent sonar imaging of the Pearl River, specifically concerning substrate correlation with population densities.
Turtles of the Southeastern United States: Oral

Evaluation of the Feasibility and Safety of Endoscopic Sex Identification in 467 Turtles and Tortoises of Ten Species

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This multi-institutional retrospective study evaluated the feasibility and safety of endoscopic sex identification in 467 turtles and tortoises, representing ten species: Blanding's Turtle (*Emydoidea blandingii*); Radiated Tortoise (*Astrochelys radiata*); Yellow-margined Box Turtle (*Cuora flavomarginata)*; Hermann's Tortoise (*Testudo hermanni*); Burmese Black Giant Tortoise (*Manouria emys phayrei*); Red-footed Tortoise (*Chelonoidis carbonaria*); Burmese Star Tortoise (*Geochelone platynota)*; Galápagos Tortoise (*Chelonoidis nigra)*; Impressed Tortoise (*Manouria impressa*); and Gopher Tortoise (*Gopherus polyphemus*). Medical records of turtles and tortoises that underwent endoscopic sex identification at the University of Georgia, New England Aquarium, and Turtle Conservancy were reviewed for pre-surgical management, anesthesia, endoscopic equipment and surgical techniques, endoscopic results, and complications. The majority of animals weighed < 200g, were fasted, and anesthetized using an injectable combination of ketamine, dexmedetomidine and morphine or hydromorphone, supplemented by local lidocaine at the prefemoral site. Anesthetic reversal using atipamezole alone or in combination with naloxone was routine. For uncomplicated procedures, mean total anesthesia, surgery, and recovery times were 22, 4 and 18 minutes, respectively. All animals were placed in lateral recumbency for a prefemoral endoscopic approach to the coelom using a rigid telescope and sterile fluid infusion to visualize the gonads. Sex identification was definitive in 99.4% (n=464) of the animals. Iatrogenic bladder perforation was the most common complication (n=5) which necessitated extended anesthesia and surgical time for repair. Only a single anesthetic-related death was reported and associated with human error and drug overdose. This is the first large scale study to retrospectively evaluate endoscopic sex identification in multiple chelonian species. Results suggest that endoscopic sexing is a safe, accurate and practical means for sex identification in turtles and tortoises, and represents a valuable tool in their reproductive management.

Veterinary Medicine and Explorations: Oral

The Role of Veterinary Medicine in Galapagos Tortoise Conservation and Welfare

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The Galapagos Tortoise (*Chelonoidis niger*), the largest terrestrial chelonian exceeding 400 kg, inhabits the archipelago of the Galapagos Islands, off the coast of Ecuador, and has important ecologic functions including seed dispersal. Populations crashed from pre-colonial estimates of >250,000 to around 15,000. Veterinary projects have included sterilization of captive hybrids by ovariectomy and phallectomy prior to release. Ovariectomy procedures were performed under medetomdine-ketamine and local lidocaine anesthesia via a bilateral prefemoral approach to the coelom. Rigid endoscopy with forceps were used to identify and exteriorize the ovaries for extracorporeal removal using a vessel sealing device and vascular clips. Insufflation was not required, and prefemoral closures were routine. A total of 24 large females were sterilized with two fatalities associated with post-operative hemorrhage. Phallectomy procedures were performed in males under intrathecal lidocaine using multiple mattress sutures prior to proximal amputation with the mucosa sutured over the exposed corpora cavernosa. A total of 25 males were sterilized without morbidity or mortality. The release of long-term captive (sterilized) animals have been helpful for ecosystem restoration (e.g. Pinta Island), and there are welfare benefits from moving these animals from suboptimal captive enclosures back into natural habitats. More recently, endoscopic sexing was performed in forty 2- and 3-year-old juveniles to assess the accuracy of incubation predicted sex. These procedures were successfully performed under medetomidine-ketamine, and all animals recovered. Initial results indicate deviation from expected sex ratios that warrants further investigation.

Veterinary Medicine and Explorations: Oral

Key Biodiversity Areas for Turtle and Tortoise Conservation in Bolivia

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Bolivia has a richness of 16 native species of turtles and tortoises; ten are in some category of threat. During a virtual workshop in 2020, twenty-three specialists identified conservation priorities for turtles and tortoises. Three species were determined to have high priority (the Giant South American River Turtle (*Podocnemis expansa)*, the Six-tubercled Amazon River Turtle *(P. sextuberculata)*, and the Chaco Side-necked Turtle (*Acanthochelys pallidipectoris*), ten with medium priority, two with low priority, and one was not evaluated, Wermuth's Toad-headed Turtle (*Mesoclemmys wermuthi*). During project development for "Key Biodiversity Areas: Establishing the Blueprint for 30x30," implemented in four countries in the Tropical Andes (Colombia, Ecuador, Peru, and Bolivia) by BirdLife International, one of the main objectives was to support countries in completing the identification of comprehensive KBA networks by using the KBA Standard. During the evaluation of the current KBA's under the Global Standard for the Identification of Key Biodiversity Areas, approximately ten KBA's were identified as important for turtle and tortoise conservation, six are located in the Amazon region (Rogaguado and Ginebra Lagoons Beni Biological Station Biosphere Reserve, Iténez Immobilization Reserve, Loreto, East of Río Mamoré, West of Río Mamoré); two in the Chaco (KAA-IYA of the Gran Chaco; Palmar of the Islands); and two in the Pantanal (San Matías Integrated Management Natural Area and Otuquis Integrated Management Natural Are). We will propose the modification of two KBA's (Iténez and Loreto Immobilization Reserve) based on Criterion A (threatened species) due to the presence of Yellow-spotted River Turtle (*P. unifilis*) and Criterion D (demographic aggregations) being important sites where large concentrations of *P. expansa* species that occur during the nesting cycle, being the first time that criterion D is proposed to be used to modify or propose a KBA. We also will propose the creation of a new KBA in the Chaco region, based on Criterion A (threatened species) to strengthen the conservation actions of *A.pallidipectoris.*

South American Turtles: Oral

The Generality of Turtles Using Nest Site Choice to Counter Climate Change Effects on Embryos

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Although turtle populations are mainly threatened by overexploitation and habitat loss, climate change looms as a ubiquitous threat. The egg is the most likely stage to be impacted by climate change because free-living stages can thermoregulate, but the immobile eggs cannot. As the climate continues to warm at an unprecedented rate, embryos in nests will eventually be exposed to sub-lethal and lethal temperatures, barring an unlikely shift in physiological tolerance or a more likely adjustment by nesting mothers. This brings nest site choice into focus as a key behavior(s) that may be in the repertoire for population responses to climate warming. Indeed, there is evidence that mothers nest in more open areas in cooler climates in one species of turtle and one species of lizard. Here, we discuss preliminary findings for a project designed to determine if North American turtles, in general, have used nest site choice, via openness, to offset climate differences, *in space* (from Florida to Canada). We combine these findings with those on nest site choice in single populations to address, and eventually determine, if mothers can use nest site choice, via evolutionary rescue, to offset climate warming effects on embryos, *in time*. Finally, we hope our talk will attract collaborators to our project with knowledge and access to turtle populations in eastern North America.

Plenary: Oral

Ranges on the Spectrum of Recovery: Conservation Action for the Spotted Turtle and Eastern River Cooter in Illinois

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Extinction rates in the Anthropocene are significantly higher than background and previous major events. The extinction process can occur when local populations become extirpated, particularly those on the range periphery where habitats are often sub-

optimal. Turtles are one of the most critically endangered taxa, with many anthropogenic factors triggering declines. Although jurisdictional boundaries can often complicate conservation, many North American turtles have peripheral populations of conservation concern. Within Illinois, peripheral populations of the Spotted Turtle (*Clemmys guttata*) and Eastern River Cooter (*Pseudemys concinna*) are protected as State Endangered; however, their apparent recovery is quite different. I discuss conservation prioritizations, status assessments, and conservation implementation needs for both species in Illinois. Finally, I compare the pathways to recovery for both species.
Conservation Tools and Actions: Oral

Movement Patterns and Home Range of Sonora Mud Turtles (*Kinosternon sonoriense*) in Central Arizona, USA

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Understanding of home range and movements of many freshwater turtle species continues to lag behind similar studies in other vertebrate groups, and recent reviews have emphasized the need for more sophisticated analysis methods in studies of activity ranges of turtles and other reptiles. The Sonora Mud Turtle (*Kinosternon sonoriense*) is a small turtle of streams and ponds in a limited range in southern Arizona and New Mexico and adjacent Sonora, Mexico. We used radio telemetry tracking in a study of this species in two contrasting habitats in central Arizona, near the northern end of the species' range. We compared patterns between males and females and between adults and subadults, in addition to comparisons between the two habitats—a small, perennial stream and an enclosed spring-fed pond. Some of the stream turtles undertook regular, short-distance migrations between winter and summer sites, and subadult male turtles moved about widely in both stream and pond habitats, traversing distances of over 3 km in a nomadic or exploratory pattern. We estimated range size using a variety of methods from minimum convex polygons to cluster analyses to the complex linear home range measure (used for describing ranges along winding, branching stream channels) and all methods showed that summer activity ranges in both the stream habitat and the pond habitat were quite small—consistently less than 0.1 ha. Some other studies that report kinosternid "home ranges" of over 10 ha included travels to and from hibernation sites and possibly wide-ranging dispersal movements. Based on our study and similar published results, we find that greater attention to details of sex, age, seasonality, and other aspects of life history is more important than simply using more sophisticated methods for assessing turtle habitat use and spatial patterns.
Kinosternids: Oral

Reproductive Aspects of One of the Southernmost Tortoise Population in the World

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The vulnerable Chaco tortoise (*Chelonoidis chilensis*), inhabits the Monte and Chaco regions of Argentina, Paraguay and southern Bolivia, having the southernmost populations of continental tortoises in the world. Little is known about the life history and reproduction of this species. The aim of this work is to describe observations of the reproductive aspects of one of the southernmost population of tortoises in the World, in San Antonio Oeste Argentina. Where the average monthly temperatures range from 1 to 30°C with minimum extremes of -11.5°C in winter and maximum extremes of 44.6°C in summer. Between 2018 and 2023 we have been monitoring a wild population and some individuals in semi-captivity, we have placed temperature sensors with data loggers in 3 nests, and we have recorded incubation periods in 6 nests. Mating was observed from October (spring) to February (summer), with a peak in December (N= 23). They lay up to 4 clutches per season from late December (summer) to April (autumn) with a peak in February (N= 6). Cluch size was from 1 to 5 (mean= 3.4) hard-shelled and nearly spherical eggs. Hatchlings emerged from 374 to 615 days later (average of 426 days), turning out to be the longest incubation period for a tortoise. The embryos of this Patagonian population experience nest temperatures ranging from 1.1°C minimum to 44°C maximum. It will be necessary to promote studies of temperature dependent sex determination and whether climate change will influence the distribution of this species. Since the production of both sexes is a limiting factor for the expansion of the distribution of the species. Likewise, the long incubation period makes the nests more likely to be trampled by cattle or to be preyed on by small mammals such as armadillos, skunks or foxes, and especially by wild boars, which are widely dispersed throughout the area, generating with this situation fewer chances. of survival for this species that already has great threats.
Poster Session

Survival Matters: Comparing the Demographic Traits of *Clemmys* and *Glyptemys* with Long-term Capture-recapture Data

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Freshwater turtles are one of the most threatened vertebrate groups, with over half of all species at risk of extinction. Overexploitation and habitat loss are the largest threats, with many turtle populations now small, isolated, and needing conservation action to ensure they persist. To enact informed conservation measures and monitor recovery efforts, managers benefit from information about demographic rates like survival and recruitment for highly threatened turtle species. Survival plays a particularly important role in population persistence, considering the life history of most turtle species is characterized by a long lifespan, delayed sexual maturity, and low fecundity. Thus, even small changes in adult annual survival rates can cause otherwise stable populations to decline. We analyzed three historical long-term capture-recapture datasets to estimate annual survival and recruitment for populations of Spotted Turtles (*Clemmys guttata*), Wood Turtles (*Glyptemys insculpta*), and Bog Turtles (*Glyptemys muhlengerbii*) that live in increasingly threatened wetlands and surrounding habitats. All three have ranges characterized by disjunct distributions and often small and isolated populations. Adult sex ratios in turtles can be affected by differences between the sexes in the timing of maturity, rates of mortality, sex-determining mechanism, or differential immigration/emigration. The two *Glyptemys* species have genetic sex determination while *Clemmys* has environmental sex determination. This latter distinction could affect each species responses under warming climate scenarios, since *Clemmys* might be expected to have female-biased populations as global temperatures increase. However, sex-specific differences in survival of *Glyptemys* species could also occur. Using multi-decadal data, we analyze sex-specific and species-specific survivorship from a site in eastern Pennsylvania where these turtles were sympatric. Our results help inform conservation efforts for three threatened freshwater turtle species and show the strengths of historic long-term data.

Poster Session

NGO Karumbé Activities for Turtles Conservation in Uruguay

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Uruguay is a country in South America with an area of 176,215 km². Almost all its territory is private lands used for agricultural production (livestock and forestry), and only has 1% of its territory with levels of protection in the form of protected areas (PA). Five species of freshwater turtles can be found in Uruguay, one from the *Emydidae* family, the D'Orbigny's Slider (*Trachemys dorbigni*); and four from the *Chelidae* family: Hilaire's Side-necked Turtle (*Phrynops hillari);* Williams' Side-necked Turtle (*Phrynops williamsi*); Black Spiny-necked Turtle (*Acanthochelys spixii*) and South American Snake-necked Turtle (*Hydromedusa tectifera*). Multiple factors threaten the wild populations; among them, we have detected the disappearance of natural areas, the extraction of specimens from the wild, incidental fisheries captures, and road kill. Karumbé's conservation efforts for wild populations are focused on *A. spixii* and *P. williamsi*, due to their conservation threats according to the IUCN at the local and regional level. For *A. spixii*, the last natural sites are in the Atlantic coastal zone, in four protected areas (PAs): Laguna Garzón, Laguna de Rocha, Cabo Polonio, and Cerro Verde. Population monitoring is carried out regularly supporting the action of park rangers in the four PAs. In 2019 the Uruguayan government created the Paso Centurión protected area, the only place with relict *P. williamsi* wild populations. Karumbé has been working in the area, conducting educational workshops with the local population. Regarding outreach activities, Karumbé manages two visitor centers located in La Coronilla, Rocha, and the capital Montevideo, receiving an average of 8,000 visitors annually. Since 2004, a successful awareness and education program has been carried out to inform the general public about the biological characteristics and threats to native freshwater turtles and other exotic turtle species. Annually, more than 100 tortoises and freshwater turtles are received. Of them 50% are wild turtles that appear on roads and home gardens and are relocated to nearby natural areas. The other 50% are pet turtles that

the owners no longer want to keep in captivity. School activities such as workshops and "turtle release ceremonies" are held annually in several educational institutions throughout the country.
South American Turtles: Oral

From Cages to Nature Reserves: Karumbé's Educational Program to Free Turtle Pets in Uruguay

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Uruguay is a South American country located on the coast of the Atlantic Ocean. Five species of freshwater turtles can be found in Uruguay, one Emydidae (D'Orbigny's Slider [*Trachemys dorbigni*]), and four Chelidae family species: Hilaire's Side-necked Turtle (*Phrynops hillari);* Williams' Side-necked Turtle (*Phrynops williamsi*); Black Spiny-necked Turtle (*Acanthochelys spixii*), and South American Snake-necked Turtle (*Hydromedusa tectifera*). Since 2004, the NGO Karumbé has been developing a program of research and *in situ* conservation of native species. Moreover, including conservation efforts of exotic species which are in risk and arrive in our country as a result of illegal trafficking, as the Chaco Tortoise (*C. chilensis*) and analysis of others like the Red-eared Slider (*T. scripta elegans*). A serious problem in the last two decades is the increase in the illegal sale of wildlife specimens and the lack of information on many aspects of their biology that has led to many animals not being properly cared for in captivity. Karumbé has created a program to eliminate the use of turtles as pets by donating them, offering a better quality of life by relocating them in controlled natural shelters. Karumbé works together with nature reserves and zoos to maintain the turtles in controlled environments. Between 2014 to 2022 were received a total number of 487 turtles: 79% *T. dorbigni* (n= 390); 4% *P. hillarii* (n= 20); 3% *H. tectifera* (n= 15); 1% *A. spixii* (n= 2); 12% *C. chilensis* (n= 55) and 1% *T. scripta* (n= 5), with an average of animals received of 50 per year. The average of captivity time was 10 years (range: 1-50). Regarding the origin of the turtles, 67% (n= 101) were purchased; 5% (n= 7) were inherited from a family member; 12% (n= 17) were given as gifts (origin unknown) and 16% (n= 23) were found "alone" in the streets, routs and different wetlands and kept in captivity for years. Analyzing the commercial acquired of turtles, 74% (n= 74) were acquired in fairs and street stalls; 12% (n= 12) in pet shops; 12% (n= 12) in veterinarians and 2% (n= 2) in other stores, all of them without legal documents. Regarding the place where the turtles were kept, 45% (n= 69) were kept in glass tanks; 40% (n= 62) in plastic cans; 12% (n=18) in grass backyards, and 3% (n= 5) on balconies of buildings. These results show that Uruguayan society still lacks information about the illegal nature of this trade. The exposed data also show the lack of knowledge about the real needs of animals kept in captivity, threatening their welfare.
Poster Session

Allometry and sexual dimorphism in the Central American River Turtle (*Dermatemys mawii)*

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The Central American River Turtle (*Dermatemys mawii*), locally known as the Hicatee in Belize, is one of the twenty-five most endangered turtle species in the world and is understudied in wild populations in its historical range of southern Mexico, Belize, and eastern Guatemala. A Critically Endangered species, much of their life history relies on historical records and often don't reflect present observations. Modern quantifying of morphology is necessary for continued monitoring and managing of the population. A total of 95 specimens from the New River region of the Orange Walk district were sampled. The aim of this project was to analyze natural allometry and sexual dimorphism across an assortment of morphometric variables from the perspective of maturity and function. Models were built to allow for trends in allometric growth of turtle shell features to be used for understanding growth, maturity, and sexual dimorphism. This analysis confirms sexual dimorphism in Central American River Turtle in carapace length and shell depth. Allometric trends between sexes and size class offer insight into resource partition for growth and survival. With a larger sample size comes a greater understanding of the natural breaks between size classes and their life histories.
Field Studies: Oral

Welcome to the Neighborhood: Habitat Selection of the Nonnative Red-eared Slider (*Trachemys scripta elegans*)

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The Red-eared Slider (*Trachemys scripta elegans*) is a riparian species found natively throughout much of the Midwestern and south-central United States. However, due to its popularity throughout the pet trade, it has proliferated throughout much of the world and, in the last few decades, established itself in Florida. The IUCN lists them as one of the top 100 worst invasive species globally. The nature of this species tends to lead to increased competition with native species and often displacement of the native species. To better understand Red-eared Slider habitat preference within the state, public records were observed in tandem with various variables. Habitat data was taken from present Florida Fish and Wildlife Conservation Commission (FWC) records of land usage. Habitat classifications were sorted into categories and simplified when necessary. Seasonality (wet and dry season) changes for habitat type and most adjacent habitat types aid in understanding potential distribution changes from nonnative populations. Specific regions where endangered or threatened native species populate were identified for further management efforts. Additionally, habitat comparisons to their native range were analyzed to confirm horizon scanning scoring within the state. Given the global impact this species has, further understanding behavior and habitat selection is vital for continued management and monitoring of the species.

Poster Session

How Many Times Do Giant South American River Turtles (*Podocnemis expansa*) Climb on the Beach Before Choosing a Nest Site?

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Giant South American River Turtle (*Podocnemis expansa*) social behavior during the nesting period has been described in detail. Although we do not know how the females choose the nest site and how many times the females climb on the nest site before nesting. The present study was carried out on a nesting sandbank (Beach 1) of the Guaporé (or Iténez) River, located on the border between Brazil and Bolivia, to count the number of times the females climb on the nest site before nesting. Between September to October 2021, the WCS team monitored *P. expansa* nesting behavior using aerial images and visual observations. Every dawn the turtles' carapace was marked with acrylic paints. For 12 days at 5:45 am, we flew the drone, the Mavic 2 Enterprise, with predetermined transects at a height of 25 m, covering the nesting beach. Each drone flight generates approximately 1,500 pictures. Those pictures allowed the creation of an orthomosaic. After 23 days monitoring the nesting females' behavior, we marked 1,462 females. 195 (13%) females were observed on the beach on more than one day, 167 females were observed on the beach on two different days, 24 females were observed on the beach on three different days, two females were observed on the beach four times, and two females were observed on five different occasions (days) on the beach. The interval days between the sightings was 1-14 days. Between the detected females, 153 (78%) were observed on beaches other than the place of first sighting (Beach 1), 85 observations at Beach 2, 64 observations at Beach 3, and four observations at Beach 4. Just one female was observed in three different beaches, Beaches 2, 3, and 4. These preliminary results suggest that the females invest in the choice nest-site selection before nesting, even though she is more vulnerable out of the water.

South American Turtles: Oral

Escaping the Habsburg Curse: Rescuing the Endangered Dahl´s Toad-Headed Turtle from the Dangers of Inbreeding

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Dahl´s Toad Headed Turtle (*Mesoclemmys dahli*) is an endemic, critically endangered chelid from northern Colombia. Recent genetic assessments across the species range have shown concerning patterns. The species has at least four populations that are very small (effective sizes <50) and isolated, with little to no gene flow among them. It also presents high levels of inbreeding, which could have deleterious effects on the already fragmented and reduced populations. To counteract this pressing threat, we designed and started implementing a genetic rescue program for the species, which involves translocating animals from other localities into the only existing reserve in order to augment gene flow across populations. We report on the first stages of the

program, which involved identifying source sites and translocating 20 individuals (12 females: 8 males) to a recently established protected area. We moved individuals from a genetically divergent but adaptively compatible population into the local population inhabiting the reserve. With this strategy, we expect to increase genetic diversity and reduce inbreeding without incurring a high risk of outbreeding depression. Half of the translocated animals were deposited in pond enclosures, paired with local individuals, and half of the translocated animals were released in the reserve, while being tracked with VHF transmitters. All individuals have survived after one year of translocations and are within the reserve. Some of the females were carrying eggs that hatched after ~170 days of incubation. There are no reproductive events yet originating from crossings between translocated and local turtles, but females are monitored for reproductive activity.
South American Turtles: Oral

Turtley Wild: Study Abroad as a Tool for Conservation and Education
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Turtles are fascinating creatures that hold mythical and cultural importance in many areas throughout the world. Unfortunately, this fame has brought with it the demand for turtles as pets, food, and traditional medicine. These threats have resulted in more than half of all turtle species being listed as threatened or endangered. Many organizations and institutions around the world are combating these threats with projects ranging from ecological studies to education programs. Educating local peoples on the current situation of local turtles and how they can help protect them is one of the most important tools we have for turtle conservation. In addition to educating local peoples, educating the general public on the demise of turtles helps to bring awareness and recruit future turtle conservationists. At Dalton State College, we use study abroad courses to give students a chance to explore the world, but also to learn hands on how turtle conservation works in various parts of the world. We have traveled to Belize, Vietnam, Mexico, and Taiwan. We have collected over 200 turtles ranging from non-threatened all the way up to critically endangered species. These personal experiences with turtles can leave lasting impressions on students and will hopefully provide motivation for participation in future turtle related conservation.
Conservation Tools and Actions: Oral

New Genomic Insights Offer Some Hope for the Recovery of the Critically Endangered Magdalena River Turtle
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The Magdalena River Turtle (*Podocnemis lewyana*) is an endemic species of Colombia and considered one of the most threatened turtles in the world. To guide management strategies for its conservation, several molecular studies using different markers (allozymes, mitochondrial DNA, and microsatellites) have been conducted. All these studies have consistently indicated that *P. lewyana* has excessively low genetic diversity and that despite being distributed in two hydrologically isolated rivers, genetic differentiation is subtle or non-existent. We used Restriction-site Associated DNA sequencing (RADseq) to revisit earlier molecular studies and gain new conservation insights by increasing the number of neutral markers by several orders of magnitude. Contrasting previous studies, we found discrete population structure that corresponds with the rivers and identified precise landscape breaks clearly delineating management units in the rivers. We also found that genetic diversity, despite being very low, is not overly deficient, and that the effective population sizes (Ne) are probably sufficient to maintain long-term evolutionary potential. Additionally, we found relatively large effective population sizes of approximately Ne=700 per population, suggesting that the census sizes could be higher than anticipated. Besides indicating real hope for a species thought to be on the brink of extinction, our genomic data suggest that management strategies for *P. lewyana* should move from active genetic rescue to more passive protection without extreme interventions, as this river turtle has the potential to recover if threats are mitigated.
Plenary: Oral

Long-term Capture-Mark-Recapture in a Small Urban Pond Complex in Louisiana

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Turtles are one of the most imperiled vertebrate groups in the world. With habitat destruction unabated in many places, urban and suburban greenspaces may serve as refugia for turtles, at least those species able to tolerate heavily altered landscapes. In south-central Louisiana, we have conducted a turtle capture-mark-recapture effort in two ponds in an urban greenspace for 13 years to understand turtle composition, survival, and growth rates. We had 574 total captures of 251 individuals of five species from 2009–2021, with Red-eared Sliders (*Trachemys scripta elegans*) and Eastern Musk Turtles (*Sternotherus odoratus*) being most common. Apparent annual survival for *T. s. elegans* (0.79) was similar to those found in other studies in altered habitats, whereas apparent annual survival for *S. odoratus* (0.89) was slightly or much higher than other published studies. Growth rates of *T. s. elegans* were comparable to other studies and showed both sexes have similar rates of growth until maturity, which is earlier and at a smaller size in males. The two ponds showed marked differences, with significantly more juvenile *T. s. elegans* captured in the pond with more vegetation, depth, and a softer bottom. Most *T. s. elegans* (78.5%) that were recaptured came from the same pond they were originally captured. The basic demographic data gained in this study can serve for broader questions on urbanization effects and as a comparison to more natural populations.

Turtles of the Southeastern United States: Oral

Evaluation of Boat Strike Injuries on Riverine Turtles with Emphasis on Demographic Variation

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Several turtle species of from freshwater, brackish, and marine environments are susceptible to boat strikes. Injuries caused by boat strikes can vary from chipped scutes to limb loss to death. While most studies of boat-related injuries focus on a single species, few studies have assessed multiple turtle species in the same system. Northern Florida's Santa Fe River hosts 11 native turtle species, including four emydids. During a 15-year mark-recapture study of the Santa Fe River turtle assemblage, we documented injuries attributed to boat strikes in numerous individuals representing multiple species. We reviewed our long-term data set to 1) quantify boat strike damage with a novel additive scoring system, 2) identify which species are susceptible to boat strikes, 3) examine whether demographic patterns exist within each impacted species, and 4) propose hypotheses for boat strike damage variation among species. Results from this study are presented herein.

Turtle Ecology: Oral

Pilot Augmentation of Elongated Tortoise (*Indotestudo elongata*) in a Protected Area in Cambodia

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The Elongated Tortoise (*Indotestudo elongata*) occurs throughout South and Southeast Asia in a variety of habitats. Once widespread, this species is ranked as Critically Endangered by the IUCN due to a range-wide population decline as a result of habitat loss and over-harvesting for subsistence purposes and the illegal wildlife trade. The Angkor Centre for Conservation of Biodiversity (ACCB) established and maintains an assurance colony for this species founded with tortoises obtained through wildlife rescue and rehabilitation efforts, with subsequent captive breeding, to aid in population recovery that will ultimately

contribute to ecosystem restoration in Cambodia. The first individuals of the headstarted F1 generation at the assurance colony at ACCB have reached a size suitable for release (carapace length >145mm, 4-10 years old). In this presentation, we describe our methods for the augmentation translocation of 100 captive-bred and head-started Elongated Tortoise into a secure protected area where the species is present, albeit rare from past over-exploitation. Our approach is based on reintroduction protocols developed by Wildlife Conservation Society (WCS) for the successful reintroduction of captive-bred and headstarted Burmese Star Tortoises (*Geochelone platynota*) in Myanmar. We will share how tortoises have been prepared for release through disease screening and pre-release acclimation, and how we will monitor post-release dispersal and survival among the translocated tortoises.

Headstarting and Translocation: Oral

Effectiveness of Animex® Exclusion Fencing at Intercepting Nesting Freshwater Turtles Along Lake Ontario and Lake Erie

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Road mortality and habitat loss are two of the top threats impacting freshwater turtle populations in Ontario, Canada. Often, we build exclusion fence to keep turtles away from vehicle traffic and to funnel animals to safe crossing structures under roads where roads bisect wetland habitat. In doing so, we often exclude turtles from using ideal road-side habitat that is well-drained, free of vegetation, and open providing optimal heat coverage. Therefore, it is very important to consider provisions for nesting habitat with safe crossings and exclusion fence strategies. Here we summarize the results of two such strategies—one along Lake Erie and another along Lake Ontario—that are being monitored for use by nesting turtles. The first site along Lake Ontario has 850 m of Animex® exclusion fence, two underpass crossing structures and 12 constructed nesting mounds that are approximately 1 m high, 3 m wide, and vary in length from 20 to 30 metres. Substrate mix varied between Mix 1 (60% Granular A and 40% sand) and Mix 2 (50% Granular A, 25% sand, and 25% pea gravel). In 2022, we found 63 Common Snapping Turtle (*Chelydra serpentina*) nests along the constructed mounds. Of the 32 covered nests on the mounds, 21 (66%) were predated (one partially) and 11 nests successfully emerged (34%). Of the 31 uncovered nests on the mounds, 28 (90%) were predated. The overall predation rate on the mounds was 49/63 (78%). We believe skunks were digging under the cages to find the nests. In 2023, we are investigating the use of two nest protection techniques: chain link and nest protection boxes with a skirt. The second site was comprised of 220 m of Animex® exclusion fence constructed to intercept turtles moving from a marsh ecosystem on Lake Erie, across a road, to dry upland habitat. We constructed two 20 m long gravel-sand mounds along the two ends of the fence, and we also removed sod and rototilled along a 1 m swath. The site was strategically located along a prairie grass field owned by a local Eco-Adventures operation that provided staff and in-kind resources to monitor the site for nesting turtles. Our community-based monitoring team found at least six turtles nesting along the fence, and safely carried turtles off the road to the safe nesting habitat along the fence. Here we will cover lessons learned and recommendations for the design and maintenance of mounds for turtles to ensure optimal use.

Conservation Tools and Actions: Oral

Achieving Proper Shell Growth in Captive Raised Box Turtles

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It is not uncommon to see box turtles raised in captivity in both the private and zoo sectors that are being grown with moderate to extensive shell deformities. Some of these are critically endangered species that are sometimes not fit for captive managed breeding programs due to the extent of their deformities. Turtles that are severely deformed also make poor exhibit animals. This is a real tragedy, considering most of these malformations are easily avoidable with proper husbandry. This presentation will cover how the simplicity of water is the primary requirement necessary to achieve smooth, well-formed box turtle shells in captivity.

Conservation Tools and Actions: Oral

Turtle Survival Center: Ten Years of Challenges and Successes

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Turtle Survival Alliance is a leader in transforming passion for turtles into effective conservation action through a global network of living collections and recovery programs. The mission of Turtle Survival Alliance is to protect and restore wild populations of tortoises and freshwater turtles through science-based conservation, global leadership, and local stewardship. March 2023 marks ten years of operation for Turtle Survival Alliance's Turtle Survival Center (TSC) in the South Carolina Lowcountry. The TSC is Turtle Survival Alliance's North American hub of captive turtle population management. The center maintains two dozen endangered and critically endangered turtle species that require captive management for their continued survival, with some presumed extinct in the wild. The center has produced over 900 offspring since its inception and participates in 18 Association of Zoos & Aquariums (AZA)-managed studbooks and Species Survival Plans. In our effort to incorporate at-risk North American species, the Flattened Musk Turtle (*Sternotherus depressus*) was recently added to the TSC's collection plan. This species fits all of our criteria for the necessity of a captive assurance colony, and we are working with state and federal authorities to develop this breeding program. The TSC maintains the only captive pair of *S. depressus* in the AZA. To further engage our staff in field research and conservation efforts in the Southeastern U.S., TSC staff members participate in turtle surveys and monitoring programs through the Turtle Survival Alliance–North American Freshwater Turtle Research Group, as well as the Carolina Diamondback Terrapin (*Malaclemys terrapin centrata*) monitoring program on Kiawah Island, SC, now in its 40th year.
Plenary: Oral

Diamondback Terrapin Conservation Needs and Recent Protective Actions in Florida

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The Diamondback Terrapin (*Malaclemys terrapin*) is an imperiled species restricted to brackish water habitats of 16 states along the Atlantic and Gulf coasts of the United States. Florida's coastline represents approximately 20% of their entire range and five of seven currently recognized subspecies occur in the state, including three endemics. Florida terrapin populations and habitats are critical to the species' conservation, and major threats include crab pot mortality, impacts of climate change, loss of nesting habitat, and predation. Conservation and management needs include strengthened crab pot regulations, habitat protection, field studies, and distribution surveys. The Florida Fish and Wildlife Conservation Commission (FWC) has the authority to issue rules that would mitigate some of these threats. Although FWC has not listed the terrapin as a state threatened species, it has listed them as a Species of Greatest Conservation Need in the State Wildlife Action Plan and has addressed some of the species' conservation and management needs. For example, in 2021, following a rulemaking petition submitted by three conservation organizations, FWC approved a suite of new conservation rules that prohibit collection of terrapins from the wild, bar possession of terrapins without a permit, and require all recreational blue crab pots to have bycatch reduction devices (BRDs) or rigid funnel entrances measuring no more than 2 x 6 inches. While FWC considered similar requirements in the commercial blue crab fishery, it ultimately opted for additional study of terrapin interactions within that fishery to be completed in late 2023. To curb threats to Florida's terrapins from crab pot mortality and give the species a chance at survival and recovery, FWC should adopt BRD rules in the commercial fishery.
Conservation Tools and Actions: Oral

2020-2022 Common Raven (*Corvus corax*) Density Trends Throughout California's Mojave Desert Tortoise (*Gopherus agassizii*) Conservation Areas: Signs of Initial Success in Five of Six Intensively Treated Areas

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We are implementing an adaptive Common Raven management program throughout seven California Tortoise Conservation Areas (area), to restore and maintain annual Common Raven (*Corvus corax*, raven) predation hazard rates experienced by Mojave Desert Tortoise (*Gopherus agassizii*, tortoise) juveniles (≤10-year-old) to <0.078. Between 2020 and 2022, raven densities declined in five of six intensively managed areas and remained stable at a low density in the Chemehuevi area where <5 adult ravens were removed annually. Linear trend estimates ranged between approximately -0.33 and 0.43 raven year^{-1} km^{-2} in the four areas where three years of monitoring data were available. Percent within-area raven abundance change estimates ranged between approximately -62 and 57 percent, for an average raven abundance change among areas of approximately -31 percent. Based on point count data collected in 2022, five of seven areas are below the target 0.89 ravens km^{-2} tortoise-raven conflict threshold (threshold). Consequently, desert tortoise populations in these areas are no longer expected to be limited by raven predation. Nevertheless, raven density remains above the threshold in two treated areas and is increasing at a rate of 0.43 raven year^{-1} km^{-2} in the Superior-Cronese area. According to our adaptive management strategy, we have begun transitioning to maintenance management strategies within areas where raven density is now below the conflict threshold and have modified subsidy denial strategies as well as take targets within the two areas where raven density estimates remain above the desert tortoise-common raven sustainable conflict threshold.
Conservation Tools and Actions: Oral

Turtle Conservation in Myanmar: Turtle Survival Alliance/Myanmar Biodiversity Fund Program Update (2020-23)

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In the early 2000s, Turtle Survival Alliance (TSA) and Myanmar Biodiversity Fund (MBF) initiated a number of conservation projects focused on threatened chelonians in Myanmar, most of which are endemic. A combination of *in* and *ex situ* methods proved effective in staving off extinction and recovering several species, including Burmese Star Tortoise (*Geochelone platynota*) and Burmese Roofed Turtle (*Batagur trivittata*). However, conservation efforts have been hampered and, in some cases, interrupted since 2020, first due to COVID-related restrictions, and later by a military takeover of the democratically elected government in February 2021. Nonetheless, our conservation efforts are continuing. Translocation of *G. platynota* at Minzontaung Wildlife Sanctuary (MWS) has ceased (1,050 released) owing to the small size of the protected area, although post-release monitoring continues. At Shwe Settaw Wildlife Sanctuary (SSWS), 1,000 headstarted tortoises were transferred to acclimation pens in March 2022. To date, 2,750 tortoises have been translocated into SSWS, although ca. 200 were lost to predators (Jackal and Wild Pig) and 100 were stolen from acclimation pens. Additional tortoises were stolen from the assurance colony when thieves penetrated the perimeter fence. These incidents indicate *G. platynota* remains in high demand among wildlife traffickers, being especially vulnerable when concentrated in captive situations. Reproduction by translocated tortoises has been confirmed at both MWS and SSWS. A nascent effort to translocate *G. platynota* to Chatthin Wildlife Sanctuary was suspended in late 2021 due to a deteriorating security situation in the area. Conservation efforts for *B. trivittata* continue along the upper Chindwin River; 40 headstarted turtles were released in early 2021 and at least one fertile clutch was collected in 2022. The assurance colony at the Mandalay Zoo (MZ) produced 175, 200, and 103 hatchlings in 2020, 2021, and 2022, respectively. In what we regard as a conservation milestone, captive-bred *B. trivittata* at Lawkanandar Wildlife Sanctuary (LWS) began laying eggs in 2021 and 35 hatched successfully. Additional clutches deposited at MZ, Yangon Zoo, and LWS in early 2023 are currently incubating. Furthermore, Asian Giant Tortoise (*Manouria emys*) and Big-headed Turtle (*Platysternon megacephalum*) are successfully reproducing at the Turtle Rescue Center near Pyin Oo Lwin.
Plenary: Oral

Increasing Institutional Chelonian Species Diversity by Utilizing Polycarbonate Food Containers: The Tennessee Aquarium Turtle Nursery

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The turtle gallery at the Tennessee Aquarium that opened in the mid-90s was intended to be a temporary exhibit. Despite that, it remained open until late 2019, when it was remodeled and reopened in March 2020. The original gallery included four small enclosures that were a display area for turtles that hatched at the Aquarium. The new Turtles of the World gallery includes a large display area with twenty-three nursery enclosures and active incubators. Hatchling turtles and tortoises are sourced primarily from other Association of Zoos & Aquariums institutions; individuals hatched at the Aquarium are also displayed. This exhibit allows visitors to see a much larger diversity of species than would be possible with standard large exhibits. This talk will present some of the challenges faced as this exhibit continues to develop and evolve. In addition, it will cover some of the many benefits that having a nursery exhibit provides.
Zoos & Captive Management: Oral

Evaluating Bycatch Reduction Devices for Diamondback Terrapin (*Malaclemys terrapin*) Exclusion and Blue Crab (*Callinectes sapidus*) Capture

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The Diamondback Terrapin (*Malaclemys terrapin*) is North America's only estuarine turtle and ranges along most of the Atlantic and Gulf coasts of the United States. The species faces a wide range of anthropogenic threats; however, drowning in crab traps is thought to be a major threat to the persistence of populations. Starting in the 1990s, researchers became concerned about the impacts of the Blue Crab (*Callinectes sapidus*) trap fisheries on terrain populations. Biologists have created and tested several different bycatch reduction devices (BRDs) for use on crab traps. However, there is hesitation among crab fishermen to implement BRDs on crab traps, mainly due to concerns that these devices limit crab captures. Therefore, we conducted controlled laboratory experiments to examine the efficiency of two different BRD designs at restricting terrapin entrance while maintaining normal crab captures. Here, we present our results and discuss conservation actions and potential management solutions.
The More You Know: Oral

Molecular phylogeny of the Indochinese box turtles *Cuora galbinifrons, Cuora bourreti,* and *Cuora picturata*

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The Asian box turtles of the Indochinese Box Turtle (*Cuora galbinifrons*) complex rank among the most endangered chelonian species in the world. Despite several previous studies, the phylogenetic relationships and species boundaries of this complex remain a matter for dispute due to a shortage of field-collected samples for genetic validation, observed discordance between mitochondrial and nuclear markers, and reported intergradation zones combined with a strong tendency of hybridization in the genus. Here, we re-investigate the relationships and potential hybridization between the species of the *C. galbinifrons* complex based on the most comprehensive dataset to date representing 394 individuals (138 morphologically identified *C. galbinifrons*, 199 Bourret's Box Turtle [*C. bourreti*], 49 Southern Vietnam Box Turtle [*C. picturata*], and seven individuals allegedly from Hainan) mainly from assurance colonies, zoological and private collections across the US and Europe. *Bayesian and* Maximum Likelihood analyses of a concatenated mitochondrial dataset (COI and ND4) yielded almost identical topologies, supporting three major clades corresponding to *C. bourreti*, *C. galbinifrons*, and *C. picturata* respectively. In accordance with previous studies, *C. bourreti* represented the sister clade to *C. galbinifrons* and these two clades together were sister to *C. picturata*. Haplotype networks revealed high genetic divergence and no shared haplotypes among the three species. Based on 12 microsatellite loci a STRUCTURE and PCA analyses confirmed three distinct clusters that are in agreement with the recognized species. Only seven

specimens with admixed ancestry (hybrids) were revealed indicating that geneflow among the distinct lineages was extremely limited, which could be related to the separate captive management of the individual taxa.
Conservation Tools and Actions: Oral

Monitoring of Ringed Sawback Populations in the Pearl River of Mississippi

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The Ringed Sawback (*Graptemys oculifera*), though often considered locally abundant, is listed as federally threatened, state endangered in Mississippi and state threatened in Louisiana. These listings are largely due to the species' limited range, multiple major anthropogenic alterations within the Pearl River watershed, as well as observed population declines at several long-term monitoring sites within the state of Mississippi. Population estimates have not been generated at these monitoring sites in five or more years. Therefore, our goal was to conduct mark-resight surveys to estimate population size at these five sites to assess the current status of *G. oculifera*. Additional time and resources allowed us to sample two additional sites. We collected turtles by hand and by basking trap, collected morphological data and a tissue sample. Each turtle was painted with non-toxic tree marking paint for subsequent mark-resight surveys using a combination of both spotting scopes and binoculars. We successfully generated Lincoln-Petersen population estimates for six sites, assuming closed population based on a limited 14-day sampling period. In a total of 30.51 river-kilometers surveyed, we calculated an average of 127 turtles per river-kilometer, indicating a 26.5% decline from 172.8 in 1988. We compared our results to previous site-specific estimates and found a trend of decline for 3 of the 5 monitoring sites. Our two most populous sites, however, generated numbers significantly higher than previously reported. In 2023, we plan to quantify site-specific habitat variables, potentially linking species recovery and/or decline to optimal/sub-optimal habitat.
Turtles of the Southeastern United States: Oral

Transcriptome Analysis of Muscle Tissues of the Chinese Softshell Turtle (*Pelodiscus sinensis*), Huai River Strain of Different Body Types and Sexes

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The Chinese Softshell Turtle (*Pelodiscus sinensis*) is commonly known as "soft-shelled turtle" in China. The local genetic strain of Chinese Softshell Turtle in the Huai River system, referred to by us as "Huai River soft-shelled turtle," was selected in this experiment. SSR molecular markers based on transcriptome were developed to evaluate the genetic diversity of Huai River soft-shelled turtle, providing theoretical support for the innovative utilization of its germplasm resources. Twelve Huai River soft-shelled turtles, consisting of males and females of different sizes, were sequenced for the first time using the Illumina HiSeq 4000 sequencing platform. A total of 26,618 non-redundant unigenes were generated by de novo assembly. 1,126 and 2,071 differentially expressed genes were obtained by comparing the differences between the larger and smaller Huai River soft-shelled turtles of both sexes. The KEGG functional enrichment analysis of the differentially expressed genes demonstrated that the actin cytoskeleton, smooth muscle, and other pathways related to muscle quality were significantly enriched. Finally, nine genes related to growth and muscle quality were selected, such as TNNT1, MSTN, and MyoD, and verified by RT-qPCR. The results were consistent with the sequencing results, which indicated that the transcriptome data were reliable. The candidate functional genes and SSR markers related to growth and development, reproduction, and muscle quality were screened by transcriptome to provide the basis for early sex identification and good breeding stock of Chinese Softshell Turtle.
Genetic Investigations: Oral

Home Range Sizes and Habitat Selection of Spotted Turtles (*Clemmys guttata*) in Northern Michigan

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Understanding an animal's spatial ecology is critical to developing effective management plans for the species. In Michigan, the Spotted Turtle (*Clemmys guttata*) is listed as a state-threatened species and regional studies on its spatial ecology have been limited. Spotted Turtles face many of the same threats as other turtle and tortoise species, such as habitat fragmentation, increased adult mortality, and reduced juvenile recruitment. The goal of this study is to provide baseline information on the spatial ecology of Spotted Turtles in Northern Michigan and inform conservation and management plans for Spotted Turtles both locally and throughout their northern range. We used radio-telemetry to track Spotted Turtles (n = 15) at two study sites across two active seasons (2022, 2023). This location data was used to estimate home range sizes and quantify habitat selection at multiple spatial scales. Home range areas were estimated and compared between sexes and between sites. Habitat selection was quantified at both 2nd and 3rd order spatial scales and compared between sexes and sites. The results of this study are preliminary and data collection will continue through the 2024 active season. Data collected in this study will be used to develop local management recommendations for Spotted Turtles in the study areas.

Poster Session

Changes in Composition and Structure of a Freshwater Turtle Assemblage Associated with Degradation of a Florida Spring Ecosystem: A 15-Year Perspective

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The richness and diversity of freshwater turtles in northern Florida's Santa Fe River ecosystem depend in part on habitats created by artesian springs. During the past 15 years, we have conducted mark-recapture studies to assess how degradation of these spring-fed habitats affects each of the 11 native turtle species that inhabit them. In May 2012, the largest spring in Alachua County (Hornsby Spring) temporarily stopped flowing and reversed flow. After the spring resumed flowing in July 2012, the submersed aquatic vegetation in its associated habitat shifted from primarily eelgrass to primarily macroalgae. We will present data taken during 2008–2022 that show temporal variation in the Hornsby Spring turtle assemblage. A distinct shift occurred in the assemblage after 2012. Two species (Loggerhead Musk Turtle [*Sternotherus minor*] and Stinkpot [*S. odoratus*]) declined in abundance, and one species [River Cooter (*Pseudemys concinna*]) exhibited a shift in demographic composition. This study demonstrates species-specific responses to habitat degradation and provides insight into potential changes in turtle populations that may be more widespread throughout the Santa Fe River ecosystem.

Turtle Ecology: Oral

Phyloregionalization of the World's Turtles Reveals Centers of Endemism and EDGE Species

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Defining geographic areas based on patterns of biodiversity, otherwise known as regionalization, is a standard method in biogeography. Early regionalization methods used easily observable patterns of geography, climate, and/or species distributions, however, modern regionalization studies often use a statistical approach to region inference. While these studies almost always use explicit species distributional data, they rarely incorporate the phylogenetic information for those same species. In doing so, they do not explicitly account for the unique evolutionary history of the taxa under question. Thus, we inferred phylogenetically informed regions (phyloregions) for the world's turtles. To better understand how phyloregionalization potentially differs from traditional methods that do not explicitly incorporate phylogenetic information, we utilized the same species distribution and HydroBASIN datasets as a recently published study on turtle regionalization. We used the TACT method to ensure full taxonomic coverage by placing missing taxon onto a time calibrated backbone phylogeny. Results define 61 phyloregions which highlight global centers of turtle evolutionary history and infer regions previously not captured by other investigations on the

regionalization of turtle biodiversity. A Categorical Analysis of Paleo and Neo Endemism (CANAPE) was conducted to visualize the global distribution of turtle endemism and how endemism directly influences turtle phyloregion inference. Finally, the Evolutionary Distinctiveness and Global Endangerment (EDGE) metric was calculated to showcase phyloregions of high conservation importance. Through the results of this study, we are able to: 1) see how the inferences from phylogenetically informed methods compare to traditional biogeographic methods; 2) view a collection of global regions directly influenced by the evolutionary history for the world's turtles; and 3) better understand global turtle conservation concerns in terms of their phylogenetic information.
Plenary: Oral

Endangered Southern Africa Dwarf Tortoises (*Chersobius* spp.): An Integrated Strategy for Threat Mitigation and Conservation

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The three diminutive and cryptic species of *Chersobius*, the Speckled Tortoise (*C. signatus*) and Dwarf Karoo Tortoise (*C. boulengeri*) in South Africa, and the Nama Tortoise (*C. solus*) in southern Namibia, inhabit rocky terrain (*Koppies*) in semi-arid to hyper-arid environments of the Nama-Karoo, Succulent Karoo, and Namib Desert. They typically occur in small, disjunct populations. Recent studies indicate rapid, range-wide declines and local extirpation in relation to a suite of evolving, primarily anthropogenic threats. The Turtle Conservancy, partnering with Endangered Wildlife Trust, has launched a project to both better document existing populations and integrate conservation actions for potentially sustainable surviving populations. Using past locality records and species-specific habitat models we have deployed robust field survey teams that include detection dogs, supplemented with new Environmental DNA methods (surface and soil detection). Simultaneous threat assessments and mitigation responses are being developed: 1) climate change and habitat degradation, because isolated colonies are typically small (<10 ha), domestic livestock exclusion and local habitat restoration can be realistically considered; 2) subsidized predators, mass predation by Crow/Raven (*Corvus* spp.) populations is well documented range wide, and Crow point-count surveys, nesting territory mapping, custom TechnoTortoise decoys, and population viability modeling will be leverages to provide adaptive management tools to address identified, unsustainable crow-tortoise interactions, including taste aversion, lasers hazing, drone hazing, and drone egg addling; 3) illegal collection for the international wildlife trade has occurred, particularly involving *C. signatus*, and a recent dramatic increase in the international smuggling of illegal succulent plants from South Africa and Namibia may further encourage opportunistic tortoise bycatch in *Chersobius* habitats, leading us to lobby for enhanced legal enforcement and international cooperation. All three tortoise species have been successfully maintained (long term) and bred in captivity. So, at least the possibility exists for future captive head-starting and supplementing declining or extirpated wild populations.
Plenary: Oral

Mapping Turtle Ranges: The Importance of Known Localities

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We report on progress updating and upgrading the EmySystem to be TurtlesOfTheWorld.org. Our original site was created in 1999 and is considerably out-of-date. We have updated our taxonomy to be in line with the Turtles of the World Checklist published by the Turtle Taxonomy Working Group. We have added 4,425 new localities to the 41,704 existing and estimate we will add about 10,000 more. Our initial focus is on data derived from the literature. Currently we have museum data for 66,939 specimens from the world's museums that are now often doing a good job of curating their data on the internet so that we may begin to incorporate them more rigorously. We are not yet using public databases such as iNaturalist or The Atlas of Australian Wildlife. The nearly infinite variety of turtle distribution models depend on these known point localities. These models include those to estimate the current range of a species and those attempting to predict how ranges will change under global climate change. We review this use of models, classifying them into: 1) geometric models such as the convex hull of points; 2)

discretization models that populate an equal area grid with species diversity; and 3) mapping points to polygons as is done in the Turtles of the World Checklist that uses Hydrologic Unit polygons or the GAP Analysis Program that uses vegetation polygons. The issue of the public display of localities given some accuracy and precision continues to be a major concern. Our original locality data was to the nearest minute of latitude and longitude so that localities were to the nearest 1mile at the equator. The ongoing debate is between the needs of the conservation policy maker and the downside of making localities known to poachers. We believe that the choice of precision to display will be species-specific and informed by workers on those species.
Plenary: Oral

Water Canal: A Deadly Trap for Patagonian Tortoises

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In the Patagonian region inhabits the Chaco Tortoise (*Chelonoidis chilensis),* the southernmost continental tortoise in the world. This species is considered vulnerable nationally and internationally. The species is subject to many threats in all their distribution, but in Rio Negro`s province, has special threats, as predation by dogs and wild boars, and, the most conspicuous one is the Pomona water canal, a 195 km long concrete-made canal that crosses the Patagonian plateau, supplying San Antonio Oeste and Las Grutas cities. We found high numbers of drowned individuals that had fallen into and died inside of the canal across the seasons, animals are attracted to the water, they fall and cannot come out again, due to their smooth, high and steep walls. Also, the canal would act as an ecological and physical barrier, preventing wildlife´s natural movements and dispersal. Our main goal was to determine the Pomona canal´s effect on the tortoise population, in order to reduce its negative impact. During December 2022 and February 2023 (summer season), 10 volunteers monitored the grid located at km 150, that filters garbage and plant debris, recording dead fauna and rescuing live animals. One hundred and twenty-five animals were extracted, including 39 Chaco tortoises. It is estimated that many animals were not detected, since the 68% of the days monitored the water level exceeded the grid, not fulfilling the containment function so the animals continued 16 km to a lagoon where it is difficult to detect them. The tortoises were the animals that resisted the most, however, most of them would have died if they had not been rescued in time. The number of deaths of native animals, many with some degree of threat, motivates us to intensify monitoring during the next season, along the entire canal in order to identify the most vulnerable sectors for fauna. Also, work will be done with the personnel of the company in charge of managing the canal and public officials to generate strategies to mitigate the impact of the canal on local fauna.
South American Turtles: Oral

A Yellow-Faced *Emydura* (Chelidae) in the Kimberley of Northern Western Australia— How Many *Emydura* Taxa Are Occurring There?

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After four decades of taxonomic controversies and despite several research groups working on it, confusions still remain regarding the correct species assignment and name of the Northern Red-faced Turtle (*Emydura victoriae* or *E. australis*?) for the red or orange or pink faced populations of the genus *Emydura* in the Kimberley and the western Northern Territory of Australia. No yellow-faced *Emydura* is generally known to occur west of the Daly River in the Northern Territory. The Kimberley species (Northern Red-faced Turtle) is considered wide-spread and Least Concern in the IUCN Red List as well as in the TFTSG Provisional Red List, thus the taxonomic and nomenclatural confusions surrounding it are considered academic and not of conservation concern. However, for over two decades now orange and yellow faced *Emydura* are known to be living side by side in one single river in the sandstone plateau of the western Kimberley, suggesting the possibility that a second localized taxon may occur there in sympatry with the wide-spread Northern Red-faced Turtle. A very localised taxon would potentially be of higher conservation concern, in particular should it be in competition with a more common taxon. Some researchers collecting *Emydura* tissue in the Kimberley in the past found in this river, but not in other rivers, a clade of highly divergent mDNA haplotypes together with wide-spread haplotypes of the Northern Red-faced Turtle, but did not record the face color of the turtles they sampled and did not draw taxonomic conclusions. I used my own records from a turtle survey in 2000 during which I recorded colors of the eye stripe, the nose, and the lower neck stripe of *Emydura* in this river and collected some tissues.

Preliminary mDNA results confirm the existence of two highly divergent haplotypes, but suggest those are not congruent with yellow or orange face colors. Further nDNA analysis will be necessary to establish if two taxa of *Emydura* co-occur and if hybridization should potentially be a conservation concern. This will require additional field work and more comprehensive sampling in a remote area.
Plenary: Oral

Assessing the Efficacy of Headstarting for Eastern Box Turtles (*Terrapene carolina carolina*) in Southwest Michigan Using Survival and Spatial Ecology Metrics

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Eastern Box Turtle (*Terrapene carolina carolina*) populations have severely declined in recent decades as anthropogenic activities and landscape alterations have reduced survival in all age classes. To offset these declines, wildlife managers have invested in conservation techniques like headstarting to augment local populations. However, many aspects of these headstarted individuals' post-release performance have not been fully analyzed. No studies have described the long-term survival (>2 years) or spatial ecology of headstarted Eastern Box Turtles, yet this information is critical to understanding the efficacy of headstarting for this imperiled species. To eliminate current knowledge gaps, we initiated a headstarting program in a southwest Michigan population in 2019. We released four annual cohorts of headstarted Eastern Box Turtles (n = 50) and observed one cohort of wild hatchlings (n = 10) with extensive radio telemetry monitoring. To assess the impact of headstarting on survivorship, we estimated post-release survival for each group using the Kaplan-Meier known fates estimator. Headstarted turtles had higher survival probability one- to three-years post-release (0.71) than the wild hatchlings after only eight months (0.42). We also estimated home range size and habitat use of headstarted and wild hatchling turtles to characterize their spatial ecology and compare with other studies. While the literature regarding juvenile Eastern Box Turtle spatial ecology is limited, we found that our turtles displayed similar patterns to those reported elsewhere. Accurately assessing the post-release performance of headstarted turtles before broadly implementing this technique is essential as headstarting has been found to have species-specific impacts. Describing the demographic and behavioral responses of headstarted Eastern Box Turtles will allow us to improve our management recommendations and conservation efforts for struggling populations in southwest Michigan and similar areas.
Headstarting and Translocation: Oral

Estimation of Habitat Suitability and Comparison of Home Range Sizes of Translocated Burmese Star Tortoises (*Geochelone platynota*)

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The Burmese Star Tortoise (*Geochelone platynota*) is endemic to the dry zone of central Myanmar. The species was considered functionally extinct in the wild in the early 2000s due to chronic subsistence harvesting, habitat loss and rampant collection for the international wildlife trade in the 1990s. It is one of the twenty-five most endangered turtles in the world and is listed as Critically Endangered by the IUCN. The captive population in *ex situ* facilities has been increased to over 10,000 tortoises by 2020. Restoration of a viable wild population through translocation is necessary and understanding the home range and habitat suitability of *G. platynota* is critical for successful translocation. The objectives of this study are to estimate habitat suitability and compare home range sizes of translocated *G. platynota* among three penning treatments (6, 12 and 18 months) and between sexes. We conducted our study in the Minzontaung Wildlife Sanctuary in Myanmar from 2014 to 2017. We performed ecological niche modelling (Maxent) using location data obtained from translocated tortoises using radio telemetry technology and environmental variables generated in R software. Home range sizes were calculated in R software using a 95% probability contour for minimum convex polygon (MCP) home range estimation, and 95% and 50% probability contours for kernel density estimator (KDE) home range estimation. We compared the home range size of individuals among the three treatments to determine the most cost-effective treatment and between sexes to develop management strategies for each sex. The training AUC and test AUC of Maxent were greater than 0.95, indicating that our training results can be used to predict the occurrence of *G. platynota* in a novel situation. Predictor variables: coastal aerosol spectral band, tree canopy cover (TCC) and near infrared (NIR) spectral band were found to contribute the occurrence of the species. Home range size was not statistically significantly different among individuals from the three penning treatments or between sexes. Our study concluded that the 6-month penning treatment is

sufficient for future reintroductions and that equal sex ratios can be reintroduced into the same habitat without having to consider the specific management for each sex.
Headstarting and Translocation: Oral

How Habitat Degradation Affects the Population Structure and Phenotype of the Mediterranean Pond Turtle (*Mauremys leprosa*)

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Anthropogenic changes can significantly impact the suitability of aquatic habitats for freshwater species. In this study, we examined the population structure and phenotype of the Mediterranean Pond Turtle (*Mauremys leprosa*) (N = 205 turtles) in relation to physico-chemical water parameters investigated in three rivers in southwestern France. While all rivers were impacted by agricultural activities, two of them also received effluents of wastewater treatment plant (WWTP). Our results revealed the presence of caffeine and pesticides in all rivers, and pharmaceuticals only in the downstream river sections of the WWTPs. Overall, both the diversity and concentration of pollutants were the highest in the WWTP downstream sections. Based on pollutant and organic matter concentrations, conductivity, and temperature, a principal component analysis and a hierarchical clustering defined three levels of habitat integrity. In the least altered habitats, characterized by cold waters and scarce trophic resources, although immatures were well represented, turtle growth and body size were the lowest. Conversely, in the highly degraded habitats characterized by warm waters and abundant trophic resources, although immature turtles were poorly represented, turtle growth and body size were the highest. Our results thus highlight the dichotomy between the profits derived from effluents induced organic pollution and the drawbacks related to the effects of pollutants on turtle physiology and reproduction. To better understand the adaptive capacities of *M. leprosa* to environmental degradation, future studies should focus on the bioaccumulation of organic pollutants in turtle follicles, and their effects on morphology and long-term survival.
Poster Session

Six Years of Monitoring: Investigating The Impacts of Wastewater Treatment Plant Effluents on the Mediterranean Pond Turtle (*Mauremys leprosa*)

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Aquatic pollution degrades ecosystems and biodiversity, yet little is known about its effects on population structure and dynamics of freshwater turtles. We investigated the contribution of wastewater treatment plant (WWTP) effluents to the pollution levels of a river located in southwestern France, and their effects on the Mediterranean Pond Turtle (*Mauremys leprosa*). Water samples collected in 2018 and 2021 revealed 16 pesticides in the river, with the highest diversity and concentrations detected downstream of the WWTP, exhibiting the contribution of WWTP effluents to the river pollution. We conducted capture-mark-recapture protocols on the turtle population (N = 358 individuals) from 2013 to 2018 and in 2021, using robust-design and multi-state models. The population was stable throughout the study period, with high year-dependent seniority, and a bidirectional transition occurring mainly from the upstream to the downstream river sections of the WWTP. It consisted mostly of adults, the largest females being captured downstream and having the highest body condition. Besides, a male-biased sex ratio was detected downstream of the WWTP neither related to sex-dependent survival, recruitment, nor transition. Although our results suggested that the population functioning was primarily driven by effluents induced resources, at least over the medium-term, the masculinization of the population could affect its long-term viability. Future studies should therefore focus on pesticides accumulation in follicles, and maternal contamination to investigate the effects of pollution on reproduction dynamics of *M. leprosa*.
Field Studies: Oral

Hurricane Ian Effects on Insular Populations of Terrestrial and Freshwater Turtles in Southwest Florida

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Severe tropical storms can have devastating effects on the natural habitats and wildlife populations, especially on islands where colonization rates are low. Hurricane Ian struck southwest Florida on September 28, 2022, as a strong Category 4 storm (150 mph). Several barrier islands experienced catastrophic damage to both natural habitats and developed areas that had effects on most wildlife species. One barrier island hosts eleven species of terrestrial and freshwater turtles that experienced a variety of challenges post-storm, namely storm surge resulting in saltwater inundation of previously freshwater bodies, mass dead vegetation, and man-made debris that littered natural lands and water bodies. Terrestrial species appeared to have been more successful immediately post-storm as opposed to more aquatic species. All species were verified within six weeks of Hurricane Ian; however, the long-term survival of several highly aquatic species is questionable due to low freshwater availability over the long dry season, as well as permanently altered habitats in many areas. Salinity readings at research sites showed drastic changes from what is considered freshwater (0-3 ppt) on the island to as high as 26 ppt with sea water averaging 35 ppt. Several individuals of three turtle species traversed the storm deployed with radio transmitters. The findings displayed a variety of behaviors and outcomes for these monitored turtles. Survival strategies are still being documented; however, the home ranges of these telemetered terrestrial species were mostly unaltered even with ≥ 2.4 m of storm surge. Aestivation of ephemeral species was shown to be an important survival strategy as individuals in temporary pools succumbed to toxic conditions from high bacteria counts and hydrogen sulfide concentrations, as well as high salinities.

Turtle Ecology: Oral

Extreme Nest Site Fidelity in a Unique Population of Diamondback Terrapin in Southern New Jersey

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For five years, the Terrapin Conservation Initiative (TCI) has closely monitored and collected data from a robust population of Northern Diamondback Terrapin *(Malaclemys terrapin terrapin)* in southern New Jersey. During the months of June and July, female terrapins leave their brackish waterways and take to land in order to find suitable nesting areas. It is during this peak in nesting activity that we collect our data by measuring, weighing, photographing, and PIT-tagging each female. While some nesting behaviors exhibited are not unlike that of other terrapin populations, we have observed rather interesting ones that may be specific to the animals at our main study sites. The mother terrapins show extreme nest site fidelity to the point where we can identify two "subpopulations » that occur less than 3 miles apart. These subpopulations appear to spend the winter, spring, late summer, and fall together in the same locations of Great Bay, yet they split up into two or more specific sites for nesting. In the last five years of tending to these Diamondback Terrapins we have never had any overlap between the subpopulations at the nesting sites. In fact, even notably young specimens, which may be first time mothers, reappear the following year(s) only at the initial site they were first encountered nesting at. In addition to this, we have also observed female terrapins making the exhausting attempt to break through stone or black top relentlessly, instead of moving to a different area where natural earth is still available for nest excavation and egg deposition. These more suitable areas are a very short distance away within the site. Their dedication to these historic nesting locations seems to override the instinct to search elsewhere. In this presentation, I will share the details of what appears to be pure nest site fidelity and why we believe the animals choose them. I will also share other unique observations we've witnessed regarding the breeding and timing of nesting behavior in these South Jersey Northern Diamondback Terrapins.

Turtle Ecology: Oral

***Chinlechelys tenertesta*: Conclusions Impacting Understanding of Turtle Origins**

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The Late Triassic turtle *Chinlechelys tenertesta* from the Bull Canyon Formation of New Mexico provides several important insights into the early morphology of turtles. Focusing just on where the placement and orientation of the shell bones are unquestionably known, several major conclusions are evident. The neural series suggests the presence of more than one costal row and that the costals are not parallel to the ribs. This is further supported by fragments with sutures at 45° to the ribs. The neurals also are notably broad and very similar in appearance to the adjacent costal plates with no clear distinction in structure. This leads us to suspect that, as other authors have suggested, this separation was eliminated over the course of the following 210 million years of evolution. Overall, the largest noteworthy observation about *Chinlechelys* is that there are far more pieces to the carapace than in any extant turtle. A number of sulci are present, so scutes were likely present in this early turtle. All of this raises the question that, if the turtle carapace evolved from broadened ribs, where did these lateral separations (multiple costal rows and a broad neural plate) come from? Given the available data, we suggest that it is far more plausible that broad ribs met an existing carapace of dermal bones and fused over evolutionary time. From this we conclude that dwarf pareiasaurs such as *Anthodon serriarus* are likely a more plausible ancestral form for turtles than the recently advocated putative ancestor *Eunotosaurus africanus*.

The More You Know: Oral

The Unusual Ontogeny of Baenid Turtles

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Baenids are a family of North American turtles found from the Cretaceous to Eocene and often compared with *Macrochelys* in general appearance. Examination of small juvenile specimens of baenids from the Cretaceous and Eocene of Utah and Wyoming suggests that the ontogeny of baenids proceeds differently than in testudinoids and other crown group turtles. Costal plate formation is delayed so that 200 to 300 mm long individuals have broadened ribs, but little more. In the Eocene *Baena arenosa*, some of these individuals without costal plates are nearly as large as the smallest specimens with open sutures and closed costal fontanelles. This suggests that this closure may happen in a relatively short period of time relatively late in life in comparison to extant turtles. This may also explain why nearly complete adult shells are relatively common and juvenile shells are almost unknown. Adult baenids co-ossify their shell bones so that the sutures are often totally indistinguishable, but if the juveniles retained large areas that aren't even loosely sutured this may explain the disparity in preservation. As baenids are generally considered to be the sister taxon to all living turtles, this suggest that this late formation of the carapace bones may be an ancestral trait of modern turtles.

Poster Session

Is There Habitat-Related Variation in the Body Sizes of Texas Map Turtles (*Graptemys versa*) and Cagle's Map Turtles (*Graptemys caglei*)?

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Four of the five narrow-headed species of the genus *Graptemys* achieve their largest recorded body sizes in slow-moving, sluggish river reaches near the coast: the Sabine Map Turtle (*G. sabinensis*), Yellow-blotched Sawback (*G. flavimaculata*), Black-knobbed Sawback (*G. nigrinoda*), and Ringed Sawback (*G. oculifera*). The first two of these species also occur at their highest recorded densities in these reaches, suggesting that coastal river reaches are exceptionally productive for these species. No similar analysis of habitat-related body size has been conducted for moderately or extremely broad-headed, molluscivorous species, but the Texas Map Turtle (*G. versa*) is known to occur at its highest densities in the lower Colorado River and varies in body size among habitats farther upstream. We report body sizes for *G. versa* from various locations in its range, including two reaches of the

lower Colorado, as well as body sizes from throughout the range of Cagle's Map Turtle (*G. caglei*) in the adjacent Guadalupe drainage, to determine whether their body sizes are similarly large at downstream range limits. Many lower Colorado *G. versa* approached the reported size records for the species (from upstream sites on the Edwards Plateau), but none surpassed them. Similarly, in the lower Guadalupe, *G. caglei* were large, but did not exhibit enhanced body sizes. The phenomenon of increased body size downstream near sea level may be unique to the narrow-headed species of the genus *Graptemys*, which feed largely on prey other than mollusks.
Turtle Ecology: Oral

Surveys of Basking Turtles in the Corn Wilderness of Southeastern and East Central Illinois, With Emphasis on Three Map Turtle Species (Genus *Graptemys*)

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The concept of a "Wallacean deficit" refers to the incomplete nature of our knowledge of the geographic distributions of animal and plant species globally. This deficit hampers studies of limiting factors that determine geographic ranges as well as effective conservation. I conducted basking surveys of freshwater turtles in four severely under-sampled tributary systems of the Wabash River drainage in southeastern and east central Illinois during late September 2022: the Little Wabash River, Bonpas Creek, the Embarras River, and the Vermilion River. With a long-lens camera, I obtained photo vouchers for 21 new county records of six turtle species (7 for False Map Turtle [*Graptemys pseudogeographica*], 6 for Ouachita Map Turtle [*G. ouachitensis*], 1 for Northern Map Turtle [*G. geographica*], 4 for Pond Slider [*Trachemys scripta*], 2 for Smooth Softshell Turtle [*Apalone mutica*], and 1 for Spiny Softshell Turtle [*A. spinifera]*), as well as 10 additional photos that are the first vouchers for species in various Illinois counties in 40+ years (1, 1, 3, 4, 0, and 0, respectively, plus 1 for Painted Turtle [*Chrysemys picta]*). I found the map turtles *G. ouachitensis* and *G. pseudogeographica* to be syntopic and broadly sympatric in the lower Embarras and Little Wabash rivers, where their similar head markings make them a challenge to distinguish in visual surveys. I did not record *G. geographica* at any of the sites where I saw the other two *Graptemys*, but it was moderately common in smaller streams, including Bonpas Creek, the upper Embarras, and the Vermilion. I recorded the softshells *A. mutica* and *A. spinifera* only in the lower Embarras.
Turtle Ecology: Oral

Known and Potential Impacts of Utility-Scale Renewable Energy Development on Agassiz's Desert Tortoises *(Gopherus agassizii*) and Their Habitat

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Renewable energy development in the desert southwest, primarily solar, started relatively recently but continues to experience meteoric growth. In the year 2000, California received only 11% of its energy from renewable sources. By 2018 it rose to 34%. Future goals call for 60% by 2030 and 100% carbon-free energy by 2045. The blueprint for opening up millions of acres of public land for solar energy development in the southwestern USA was published in a draft Environmental Impact Statement (EIS) in 2011 and finalized in 2012. Included was habitat occupied by conservation-reliant desert tortoise populations that were already declining and threatened due to a host of factors unrelated to renewable energy development. Despite the rapid pace of approved development, in 2011 a review of the peer-reviewed scientific literature found only one publication documenting the effects of solar energy development and operation on wildlife. Potential effects of solar and wind energy development include direct mortality; destruction and modification of habitat, including impacts of roads; habitat fragmentation and barriers to gene flow; effects due to dust and noise; impacts to local and regional climate; fire; and offsite impacts related to construction material acquisition, processing, and transportation. Despite state and federal efforts to focus development in areas of lower conservation value, an estimated 700 km^2 of tortoise habitat may be lost to solar development. Cause and effect relationships of solar energy development on tortoise populations are unknown because before-after-control-impact studies are still lacking. The standard mitigation technique since 1986 has been to translocate tortoises from the project footprint into another area, sometimes far away. This strategy has been controversial because translocation of tortoises is not always successful and has been criticized in the scientific literature. Research on tortoises moved because of solar energy development has focused on correlative studies of their biology based on short-term projects. Tortoises are emblematic of the tension between conservation and renewable energy development.
Conservation Tools and Actions: Oral

On Turtles and War: Nubian Flapshells in Northern Uganda

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The Nubian Flapshell Turtle (*Cyclanorbis elegans*) is the largest and most threatened chelonian species in Africa, where it currently survives only along the White Nile River course between southern South Sudan and northern Uganda. We developed four different habitat suitability distribution models (past, current, future 2050, and future 2070) with the MAXENT algorithm and compared all of them to each other in order to quantify the range contraction of this species throughout the last 30 years. We also analyzed the current threats to the species in northern Uganda via face-to-face interviews with fishers and field surveys. Our models (using all the historical presence records versus the ones known in 2017–2023) showed that, while in the past the potential habitat suitability distribution was very wide, the current habitat suitability shows a huge regression, with just part of South Sudan and northern Uganda being appropriate for the species' presence. In 2050, our model predicts that the percentage of high suitability will decrease and will still be high only in northern Uganda. Thus, northern Uganda will become the last area of occurrence for this turtle in the coming decades. However, the area is under heavy environmental pressure because of the presence of large refugee settlements. The refugees, who escaped from civil wars in South Sudan, Rwanda, and D.R. Congo during the last 30 years, represent a major threat to Nubian Flapshells due to their overfishing and habitat exploitation, with heavy degradation of the forested riverine banks that are necessary for these turtles to survive. Urgent monitoring of the refugees' effects is needed in order to develop appropriate management actions.

Plenary: Oral

Seventy *Platysternon*-years: An Account of Two Long-term Captive Big-headed Turtles (*Platysternon megacephalum*)

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Over the course of several months in 1988, I purchased two examples of Big-headed Turtles (*Platysternon megacephalum*) at a Wheat Ridge, Colorado, pet store. This pair, a male and a female, are both in my care today. I demonstrate here my experiences with the long-term care of the pair in light of current research into the biology and husbandry of the Big-headed Turtle.

Poster Session

How Dams Have Been Affecting Chelonians Through the Years in the Amazon Region

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The Amazonian chelonians have in their history a great deal of exploitation since the 19th century, mainly related to the consumption and use for various purposes, in addition to these, other threats directly affect this group of animals, and one of the directly affected groups is the Podocnemididae, which covers a large area of the Amazon biome, the most popularly known being the species Yellow-spotted River Turtle (*Podocnemis unifilis*) and Giant South American River Turtle (*Podocnemis expansa*). Both species have migratory behavior, traveling in large areas of rivers, in which they search for food and beaches for oviposition. However, this behavior is threatened by the construction of hydroelectric dams in the northern part of the country, precisely because of the size of the present rivers, which would generate profit and supply energy to a large part of the population, being planned and executed on a large scale from the 1950s to today. Brazil benefits directly from the construction and maintenance of hydroelectric dams, as it has large rivers in the northern part of the country, in addition to being able to negotiate the sale of electricity to border countries, considering the hydroelectric potential, despite some crises over the years due to low dams and outdated technology to take advantage of rivers greater potential. The hydroelectric dams affect the populations around the constructions, implying a direct conflict with the activities, in addition to the appropriation of the area by the government in order to profit, to the detriment of the conservation of natural resources. Despite considering palliative measures in the most current

plans, such measures do not serve all animal populations, and among these are chelonians, which already suffer from other threats of exploitation, with the Amazon region still being targeted for profit and assistance to other hydroelectric dams in the country. Alternative measures to these would be the switch to other types of use of renewable energies and the gradual decrease in the use of hydroelectric plants, later returning to the original courses of the rivers, allowing nutrient cycling and free movement of chelonian populations in these regions, aiming at balance between the monetary and the sustainable.
South American Turtles: Oral

Turtle Tracking: Behavioral Ecology of the Tabasco Mud Turtle (*Kinosternon acutum*) in a Tropical Rainforest in Belize

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Tabasco Mud Turtles (*Kinosternon acutum*) are small semi-aquatic turtles found in Central America in parts of Mexico, Guatemala, and Belize. This species is not well studied and faces conservation threats from local consumption, habitat loss, and changing climate patterns. This project, conducted in a seasonally dry tropical rainforest in the Toledo District of Belize, makes an analysis of the movement and behavior of *K. acutum*. We captured and affixed transmitters to the carapaces of 10 adult Tabasco Mud Turtles (4 males, 6 females) at the Belize Foundation for Research and Environmental Education (BFREE). Turtles were tracked via radio telemetry during two periods: near-daily at the end of the dry season (4 July–20 July 2022) and monthly over the Belizean wet season (August 2022–January 2023) until the transmitters expired. Mean linear distance traveled across both study periods for male turtles (n=4) was 34 m and 26 m for females (n=6). Maximum male straight line distance traveled between observations during the entire study period was 238 m and female maximum movement was 103 m. No statistically significant relationship was found connecting cumulative rainfall in between daily observations and daily linear distance traveled, with the exception of one female individual (Pearson's $r(13) = 0.76$, Spearman's $r(13)= .80$, $p>0.0005$) during the July study period. For each observation during the daily tracking period in July, we recorded the microhabitat feature where the turtle was located. Individual observations during the July period mostly occurred in leaf litter, at the base of trees, and beneath small woody debris. Notably, this semi-aquatic species was rarely observed in water. These findings expand on the understudied natural history of the Tabasco Mud Turtle and yield insights on microhabitat preference, home range, and potentially novel terrestrial habitat utilization.
Kinosternids: Oral

Identifying Drivers of Demand for Wild Turtles in the United States

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Turtles are threatened by overharvesting due to their slow growth rate, late maturity, low fecundity, and infrequent recruitment that make it hard for long-lived species to maintain population sizes when adults are unsustainably captured. The lack of records indicating the origin and harvest rate of traded individuals augments the harm to wild turtle populations resulting from their trade. Demand for food, pets, commodity goods, and medicine are likely drivers of illegal wildlife trade worldwide, but details surrounding drivers of turtle trade within the United States (U.S), a common outcome for many native North American turtles, remain largely unstudied. The objective of this research project was to understand the relationship between turtle acquisition and conservation knowledge, general turtle knowledge, attitudes towards turtles and turtle ownership, and wildlife value orientations. We used an online panel survey of 1500 adults living in the U.S, consisting of those who own turtles, those who have considered owning turtles, and those who have never owned or considered owning a turtle. To ensure that our sample reflected the U.S. population, we established sampling quotas for income, education, age, gender, ethnoracial identity, and degree of urbanization. We also collected data on species owned, quantity, and prices paid for the animals. We hypothesize that the likelihood of a person

acquiring a turtle is influenced by 1) prior knowledge of illegal trade impacts on declining turtle populations and 2) general attitudes towards turtles and turtle ownership. We will present results on consumers' motivations to own or use tortoises and freshwater turtles and inform strategies to reduce illegal turtle trade and increase responsible turtle ownership in the U.S.
Combating Wildlife Trafficking: Oral

Characterization of Innate Immunity of the Diamondback Terrapin (*Malaclemys terrapin littoralis*)

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Most ectotherms rely heavily on well-developed innate immune mechanisms that act as nonspecific but fast-acting and potent first lines of defense against infection. While conducting a mark-recapture study of Diamondback Terrapins (*Malaclemys terrapin littoralis*) in the coastal marshes of southeast Texas, we noticed a high incidence of severe injuries, including loss of limbs. Despite living in brackish aqueous environments that harbor a multitude of potentially pathogenic microorganisms, most injuries had completely healed without apparent negative effects on the health of the animals. To quantify this immune response, we collected whole blood samples from the subcarapacial sinus of 28 individual Diamondback Terrapins, isolated and pooled the plasma, and challenged it against bacteria and foreign cells. We measured the effects of the plasma on the growth and proliferation of a broad spectrum of bacterial species. Challenge of bacterial cultures with terrapin plasma resulted in strong and rapid antibacterial activities against both gram-positive and gram-negative species. Serum complement immune mechanisms have been shown to be an important component of innate immunity in reptilians. We used a sheep red blood cell (SRBC) hemolytic assay to assess terrapin serum complement activity. Hemolysis of SRBCs occurred in a titer-dependent fashion and transpired rapidly, with maximum activity occurring within 20 minutes of exposure. Hemolytic activity was temperature dependent with peak activity occurring at 25-30ºC and reduced activity seen at low (5-15ºC) and high 35-40ºC temperatures. We isolated a mannan-binding lectin from terrapin plasma using affinity chromatography. SDS-PAGE analysis and MALDI-TOF mass spectrometry analyses of these proteins revealed mass properties similar to those isolated in other ectothermic vertebrates. The results from this study show that Diamondback Terrapins have a potent innate immunity that allows for the survival of serious injuries in microbe-laden environments.
Veterinary Medicine and Explorations: Oral

Creating a Management Plan for Freshwater River Turtles for the Rupununi, Guyana

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Guyana is home to an abundance of biodiversity yet much of this remains unstudied, unmanaged or undiscovered. Since 2011, Caiman House Incorporated has been conducting ex-situ conservation of the Yellow-spotted River Turtle (*Podocnemis unifilis*) in Yupukari Village, Guyana, and from 2021, the South Rupununi Conservation Society (SRCS) started *in situ* monitoring of the same species in collaboration with the nearby community of Sand Creek. The purpose of these conservation interventions was to reverse the local population decline of the Yellow-spotted River Turtle by protecting the species from overconsumption of meat and eggs, disturbance by natural predators and flooding. Based on the results of the activities, interest from other communities and the need for widespread conservation of freshwater turtles in the region, the Sustainable Wildlife Management Programme provided support to the two organizations to create a management plan for freshwater turtles for the Rupununi. An inclusive and participatory process was facilitated where 26 indigenous communities from the Rupununi provided information on threats, priority actions and governance for freshwater turtles in the Rupununi, Guyana. The result of this process was the validation and adoption of a management plan by the communities for the six species of freshwater turtle that can be found in the region, including the Yellow-spotted River Turtle and the Giant South American River Turtle (Podocnemis expansa), which are respectively classified as Vulnerable and Endangered by the IUCN Red List. The findings from the creation of the management plan provide valuable suggestions for other organizations aiming to replicate a similar approach.
South American Turtles: Oral

Captive Breeding and Headstarting of Bog Turtles (*Glyptemys muhlenbergii*) at Zoo Knoxville

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Bog Turtles (*Glyptemys muhlenbergii*) are listed as Critically Endangered by the International Union for the Conservation of Nature (IUCN) and listed as Threatened or Similarity of Appearance, Threatened, based on location, under the Endangered Species Act. Causes for decline include habitat degradation and fragmentation as well as collection for illegal pet trade, both domestic and international. Bog Turtles were discovered in Tennessee in 1986 by Dennis Herman and Jim Warner and were later studied extensively by the late Bern Tryon for almost 30 years. Zoo Knoxville has worked with this species continuously for 37 years both *in situ* and *ex situ*. The *ex situ* work has included the breeding and rearing of turtles for reintroduction. *In situ* efforts have included general ecology and life history studies of this species in Tennessee as well as the collection of wild eggs for headstarting activities. As of May 2023, Zoo Knoxville has raised over 250 Bog Turtles for reintroduction efforts through captive breeding as well as field-collected eggs.

Zoos & Captive Management: Oral

Recording the Vocalizations and Associated Behavior of Burmese Black Mountain Tortoises (*Manouria emys phayrei)* in a Captive Setting

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Previous studies on vocalizations by Burmese Black Mountain Tortoises (*Manouria emys phayrei)* have focused on vocalization closely associated with courtship behavior. The purpose of this study is to examine whether *M. e. phayrei* vocalizes intraspecifically beyond courtship activities. Since November 2022 to present, recordings from a captive group of eight to nine adult *M. e. phayrei* have been made at the Turtle Conservancy's Behler Conservation Center. These audio recordings are supplemented by simultaneous video footage and relevant behavioral notes to contextualize the vocalizations. Behavior was also documented with ethograms before, during, and after recorded vocalizations. Study circumstances varied, including introduced novelty food items, enrichment objects, a new male added to the enclosure, or no added stimulation at all. Settings also alternated between the indoor and outdoor enclosure depending on local weather conditions. Recordings were made using a SwiftOne: Terrestrial and Autonomous Recording Unit recorder and then processed using Raven Pro 1.6 software. At least three discrete patterns of vocalizations have been identified. The range of vocalizations and associated behavior is evidence that *M. e. phayrei* vocalizes for more than just courtship purposes, and these vocalizations likely have a communicative purpose.

Poster Session

Reproductive Behaviour, Food and Microhabitat Characteristics of Forsten's Tortoise (*Indotestudo forstenii*), or "Bantiluku," Nests in Palu Valley Hills, Central Sulawesi, Indonesia

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Foresten's Tortoise (*Indotestudo forstenii*) is a reptile of the Testudinidae family endemic to Wallacea region which can only be found on limited land in the hills of Palu valley and the northern mainland to the border between the provinces of Central Sulawesi and Gorontalo. The local name is 'Bantiluku' taken from the local language of Kaili ethnicity which means moving slowly or lazy. The tortoise is under threat of extinction due to exploitation to meet the demand for exports, medicinal ingredients and pets, and also due to habitat loss (conversion of forest land into settlements, plantations, road construction, and expansion of mining areas). The study was conducted for seven years (2015-2022) to study reproductive behaviour, food, and microhabitat characteristics of bantiluku nests in the nature (the hills around Palu valley) and also in captivity in Palu. The study found that Bantiluku did not have a loyal mating partner, in natural habitats the sex ratio between males and females was 1:3, males could mate with several females and vice versa. In mating, the male will dominate the female through torture before courting. In nature, female individuals store their eggs in loose, dry soil or under piles of litter. In captivity in a year the female produces 1-2 eggs,

with a long hatching time of 40-50 days, and hatches at the beginning of the rainy season. Food in nature consists of young shoots of *Bryophyllum pinnatu*, *Chromolaena odorata*, *Cyanotis axillaris*, *Opuntia triacantha*, fruit of *Ziziphus oenopolia*, young shoots and fruit of *Opuntia* sp., ripe fruits of *Coccinia grandis*, the fungi of the Agaricales and Phalalles groups and young shoots of grasses. In captivity Bantiluku can adapt to a diet of a variety of fruits, vegetables, and food from eating insects, and fresh carcasses of other animals such as fish and chicken innards. Nests generally occupy shaded areas and are located in hollows near tree or shrub roots, the nest micro-habitat has a temperature of 26-29 °C, soil pH 4.5-7.0, soil moisture in the dry category, air humidity 65-68%, with low to high light intensity.
The More You Know: Oral

Identification of *Fusarium* Species From Captive-Raised Southern River Terrapins *(Batagur affinis)* in Malaysia

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The Southern River Terrapin *(Batagur affinis)* is large freshwater turtle species that can only be found in Cambodia and Malaysia. In Malaysia, *B. affinis* is the only species of freshwater turtles afforded the highest level of protection by the government through the Wildlife Conservation Act 2010. The Department of Wildlife and National Parks Peninsular Malaysia (DWNP) and Turtle Conservation Society of Malaysia (TCS) collectively operate and manage four *B. affinis* head-starting facilities in the country since the 1960s. However, in the decades of operation, the health status of the captive-raised *B. affinis* hatchlings had never been assessed prior to their release. This study was part of a larger conservation project to assess the health status of the *B. affinis* in the head-starting facilities in the country. The aim of this project was to determine the microbiota found in and on the terrapins, specifically *Fusarium solani*, which has been linked to a newly emergent fungal disease that caused sea turtle egg mortality called Sea Turtle Egg Fusariosis (STEF). Forty *B. affinis* from each of the facilities were swabbed. These individuals ranged in age from hatchlings, juveniles to adults. Swab samples were collected from their mouth, carapace, and cloaca. Genomic DNA was extracted using the STRATEC Molecular kit. Polymerase Chain Reaction (PCR) products or new strand copies of DNA were purified using QIAquick® PCR Purification Kit (QIAGEN). Two different primers, i.e. Primer ITS1 and ITS4, were used in the PCR to identify the fungi species. The purified PCR products were sent to an independent laboratory for sequencing. Three species were identified, i.e. *Fusarium solani*, *F. oxysporum and F. proliferatum.* While these *Fusarium* species have been linked to STEF in sea turtle eggs, further pathogenicity or molecular tests are needed to determine whether they would negatively affect the *B. affinis*. This study is also potentially the first record of STEF on freshwater turtles recorded in Malaysia.
Veterinary Medicine and Explorations: Oral

Assisted Colonisation of the Critically Endangered Western Swamp Turtle: Insights from Two Years of Post-Release Monitoring

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One of the greatest threats to biodiversity is climate change, which is affecting a variety of taxa through shifts in distribution, range contractions, and extinctions. Species with low reproductive rates, long generation times, and restricted ranges are particularly susceptible to climate change due to limited capacity to adapt or move. One proposed solution for these species is assisted colonisation: the intentional translocation of species outside their indigenous range to mitigate a threat. The critically endangered Western Swamp Turtle (*Pseudemydura umbrina*), a long-lived species endemic to southwest Australia, has experienced extensive habitat loss and fragmentation, and its remaining seasonal wetland habitat is threatened by a drying climate. Assisted colonisation trials south of the turtle's indigenous range commenced in 2016 and research is ongoing. When intentionally translocating species, it is essential to evaluate metrics associated with the translocated population (e.g., dispersal, growth, persistence, impacts to the recipient ecosystem). In this talk, we discuss two post-release monitoring approaches used to evaluate different metrics following the release of 92 turtles between 2021 and 2022. First, turtles carried biotags with inbuilt activity and temperature sensors, where data was used to create thermal and activity profiles. They spent a significant amount of time in their thermal niche (14°C - 30°C) throughout the hydroperiod but rarely reached their optimal thermal range (22°C - 28°C) in the first half of the hydroperiod. These results allow us to evaluate how cooler temperatures in these southern sites impact turtle activity potential and energy acquisition. Second, we successfully designed a sensitive *P. umbrina*-specific environmental DNA (eDNA) assay. We detected *P. umbrina* at the assisted colonisation wetland in 42% (7 / 17) of eDNA sample sites, and the probability of a positive eDNA detection was significantly associated with the distance from a turtle, reflecting spatial distribution of the target species. As demonstrated here, different monitoring approaches are necessary to evaluate different assisted colonisation performance metrics. Biotags can inform on short-term biological and physiological performance, and non-invasive eDNA approaches can be effectively implemented to monitor persistence and movement over the long-term.
Headstarting and Translocation: Oral

A Retrospective Assessment of Captive Breeding Efforts With the Madagascar Flat-Tailed Tortoise (*Pyxis planicauda*) in the United States and How to Increase Those Efforts Moving Forward

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Madagascar Flat-tailed Tortoises (*Pyxis planicauda*) have been in human care in the United States of America since 1975. The first known captive breeding did not occur in the US until 2002. This species has proven difficult to care for and breed successfully for many years. With the recent wildfires that have decimated portions of their remaining habitat, creating an *ex situ* population is an important tool to ensure this species does not completely disappear. We will review what has and has not worked regarding captive husbandry of this Critically Endangered species. Our goal is to increase captive breeding efforts in private and public collections as well as make a commitment to establish better communication between those collections to benefit this species.
Zoos & Captive Management: Oral

Dallas Zoo: Chelonians Past, Present, and Future

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The Dallas Zoo has a long history of studying, caring for, and incorporating shelled non-avian reptiles in its collection. Many events and activities shaped the size and appearance of the chelonian collection at the Dallas Zoo. These activities ranged from collection by university-level professors and other biologists to private donations, captive breeding at other facilities, unwanted charges, and more recently, large confiscations from the USFWS. Although many zoos went through these very same evolutions in their collections, the Dallas Zoo is fortunate enough to have had Dr. James B. Murphy as a former Curator of Herpetology for 30 years. Dr. Murphy documented many firsts, novel, and notable events and histories and has published many of these in both peer-reviewed and popular publications. Join us on this brief walk through zoological history into the post-pandemic era.
Zoos & Captive Management: Oral

Pollution and Risk Assessment of Heavy Metal Contamination in Aquatic Environments and Turtle Species in Nigeria

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Heavy metals are toxic pollutants to aquatic life. This study assessed the risk posed by heavy metal contaminants to turtle species populations in Nigeria. The study reviewed relevant literature and provided an overview of the sources of heavy metal contamination in Nigeria's freshwater and its effects on turtle species. The assessed data came from southern and northern Nigeria. The study revealed that heavy metals vary across the selected locations and are caused by the type of effluent discharged by industries closer to the waterbodies. It has been noticed that some industries violate the environmental regulations by not installing effluent treatment plants. The improper effluent discharge has caused turtle and other aquatic species to decline in their populations through heavy metal contamination in their systems, and this has caused the ecosystem to suffer great danger. The study concluded that it is of high importance to educate and re-educate industrial personnel and the general public on proper waste disposal management. This will go a long way toward saving turtle species and the freshwater ecosystem at large.
Field Studies: Oral

Detection and Occupancy of the Western Pond Turtle (*Actinemys spp.)*

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Low densities, followed by a secretive nature, create challenges for accurately estimating population estimates and site occupancy rates. The Western Pond Turtle (*Actinemys spp.*) faces range-wide declines and is currently a species of special concern in California. Our project aims to determine their status across 12 military installations using an occupancy/detection framework while attempting to maximize captures during one 50 aquatic trap/four trap night sampling session per installation. Because we sampled areas of known occupancy, we could focus on estimating detection rates. We aim to create an MS Excel tool to determine the detection probabilities while accounting for various environmental and habitat-related covariates.
Poster Session

Turtles and Tofu: Comparing Populations of Native Versus Introduced Turtles in Northern Taiwan

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Asian turtles face many anthropogenic pressures that threaten their survival. Overharvesting for the food, medicine, and pet trade, along with habitat destruction, have driven many turtle populations to the brink of extinction. In addition to the aforementioned threats, invasive turtle species could potentially have negative impacts on native Asian turtle species. The main island of Taiwan is home to four native turtle species: Yellow Pond Turtle (*Mauremys mutica*), Chinese Stripe-necked Turtle (*M. sinensis*), Chinese Softshell Turtle (*Pelodiscus sinensis*), and Yellow-margined Box Turtle (*Cuora flavomarginata*). The main island of Taiwan is now also home to the invasive Red-eared Slider (RES; *Trachemys scripta elegans*). RES have been shown to compete with native species in areas where they have become an established. In Taiwan, RES can share habitat with *M. sinensis* and *P. sinensis,* which could result in competition for resources with these native species. In this study, we surveyed urban and suburban wetlands in northern Taiwan to compare the abundance of native Taiwan turtles to the invasive RES. In total, we observed a higher number of the invasive RES, and they were also the more abundant species at the majority of sites. We also observed direct competition between RES and *M. sinensis* for vegetative foodstuffs. While we did not observe the invasive RES in rural areas, the abundance of them in urban and suburban habitats is a cause for concern as their established populations could spill over into more rural areas.
Poster Session

In- and *Ex Situ* Conservation of the Critically Endangered Burmese Roofed Turtle in Myanmar

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The Burmese Roofed Turtle (*Batagur trivittata*) is endemic to the larger rivers (Salween, Sittaung, and Ayeyarwady-Chindwin) of Myanmar. Historically abundant, precipitous population declines began in the mid-1960s following the widespread adoption of nylon and monofilament fishing nets in the late 1960s. By the late 1990s, *B. trivittata* was considered extinct in the wild. However, two small remnant populations were rediscovered in the Dokhtawady and Chindwin Rivers in 2001. The Dokhtawady River population was extirpated shortly after a hydropower reservoir was completed in 2010. An assurance colony was established at the Yadanabon Zoological Gardens in Mandalay in 2006. Founder stock consisted of adult turtles 1) recovered from pagoda ponds and 2) confiscated from fishermen. The colony began producing offspring for head-starting shortly thereafter. At the same time (2006), an *in situ* conservation program was initiated along the Chindwin River; eggs are collected from nesting sandbanks, transported to a secure site for incubation, and the offspring headstarted at our permanent basecamp. In 2010, a second assurance colony was established at Lawkanandar Wildlife Park using turtles hatched the Mandalay Zoo or from wild-collected eggs. Two additional colonies were established at Htamanthi Wildlife Sanctuary (2015) and Yangon Zoological Gardens (2019). A group of genetically high-value turtles was also transferred to the Singapore Zoo. Reproduction began at Yangon Zoo and Lawkanandar Wildlife Park in 2020 and 2021, respectively. Female *B. trivittata* thus appear to attain sexual maturity in captivity at age 14-15. Turtles in the assurance colony at Htamanthi Wildlife Sanctuary are expected to begin nesting within the next two years; those at Singapore Zoo are unlikely to reproduce under the current management regime, namely absence of seasonal photoperiod. The number *B. trivittata* nests along the upper Chindwin River has steadily declined from 2006, suggesting the loss of females. From 2020 to present, only two nests (one containing infertile eggs) were recovered each year. Headstarted turtles were released in 2015, 2018, and 2020. Monitoring released turtles, protecting nesting sandbanks, and collecting eggs is becoming increasingly difficult owing to the deteriorating political and security situation in Myanmar.

Plenary: Oral

Cases of Austwickiosis (*Austwickia chelonae*) and Testudine Intranuclear Coccidiosis (TINC) in Captive Tortoises from the Private Sector

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Relatively new and serious diseases present a major threat to facilities caring for large numbers of turtles and tortoises. In particular, cases of Austwickiosis (*Austwickia chelonae*) and Testudine Intranuclear Coccidiosis (TINC) now occur frequently within captive tortoise populations in the US. Once recognized, these diseases have mortality rates near 100%, and euthanasia of infected animals is commonly recommended. We find this course of action shortsighted, as it is critical to understand these diseases and develop successful treatment regimes to prevent the eventual loss of animals important to conservation. To this end, we report recent cases of Austwickiosis in Leopard Tortoise (*Stigmochelys pardalis)* and TINC in Bell's Hinge-back Tortoise (*Kinixys belliana)*, wherein sick animals have responded positively to treatment and are now asymptomatic. Both diseases present biosecurity challenges as they are resistant to some disinfectants, can persist in soils or on surfaces, and are likely carried over long periods of time by clinically healthy animals. The risk of vertical transmission (via external contamination of egg shells) is also considered, and may necessitate washing and disinfecting of eggs prior to incubation. We have confirmed that eggs of several tortoise species are not adversely impacted by this treatment.

Veterinary Medicine and Explorations: Oral

An Update of Collaborative Conservation Effort of the Critically Endangered Malaysian Giant Turtle (*Orlitia borneensis*) in Indonesia

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The Malaysian Giant Turtle (*Orlitia borneensis*) is protected under Indonesian law and is stated as Critically Endangered by IUCN. Distributed along Sumatra and Borneo regions, this species has very limited information on its biology, ecology, and localities. At least 80% of *O. bornensis'* population has declined over the last 90-years, with poaching and habitat loss as the most prominent threats. Wildlife Rescue Centre (WRC) Jogja is one of several wildlife rescue centers in Indonesia that house *O. borneensis* since 2003. In response to this situation, we began to identify the gap and problems about this and resulted in the need to immediately implement a holistic conservation strategy, involving both in-situ and ex-situ conservation actions to recover the population of *O. borneensis*. Turned out, we successfully convened a team of conservationist from different field (i.e. zoo, conservation NGOs) who have similar vision regarding turtle conservation. After identifying the major gap and measuring our team's capabilities, we recognized that establishing assurance colony through conservation breeding is one of the remaining options to prevent the species' biological extinction. A far as our knowledge, there is no programmed captive breeding for this species on its native range. Overseas captive population are scarce with known fewer founders. The goal of the collaborative effort for *O. borneensis* conservation is to build the assurance colony that can aid reintroduction in the wild. We will start with properly selecting founders from the *O. borneensis'* existing population in WRC Jogja and GembiraLoka Zoo (45 individuals with unknown relatives) which were known to be able to breed. Founder selection includes the development of vital information on each individual (i.e. sex, physical health, and relatedness among individuals through genetic analysis). We will also share our methods for the captive management including the health and daily husbandry care, pond conditioning, and behaviour monitoring of the *O. borneensis* in our facility and the challenges that have been encountered during providing the care for this species. Finally, we also plan to in parallel conduct in-situ study to seek the potential safe haven for this species, through collaborating with the fisherman community from Belitong Island, Sumatra.

Conservation Tools and Actions: Oral

The Fight Against Radiated Tortoise Trafficking Continues and Intensifies in the Southwest Region of Madagascar

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In 2011, a global action plan on endemic species was developed at the national level. Twelve years later its effectiveness is not yet detectable at the regional level and trafficking still continues. Our mission is always to fight against tortoise trafficking in the southwest region. Lobbying was carried out in Lazarivo in September 2016 (collector), at the workshop on the effective control strategy in Toliara in May 2017 (transaction for collected animals), and until October 2022 in Itampolo and Androka (collection points). An assessment of strengths and weaknesses as well as actions to be taken to reduce the trafficking of these endemic animals were made. Key elements include: (1) tortoises are no longer poached from their natural habitats, both from Protected Areas and Non-Protected Areas; (2) tortoises in rescue and rehabilitation centers contribute to the survival of the species with the ultimate objective of reintroducing species into their natural habitat; and (3) the release of tortoises into the natural environment is done in accordance with soft release protocols, whereby post-release movements and survival are monitored. Evaluating the data from seizures occurring since 2015, the number of tortoises seized is as follows: 2015: 636 seizures; 2016: 1,704 seizures; 2017: 357 seizures; 2018: 17,629 seizures; 2019: 815 seizures; 2020: 420 seizures; 2021: 272 seizures; 2022: 232 seizures.

Combating Wildlife Trafficking: Oral

Use of Point of Care and Local Laboratories to Facilitate and Expedite Decision Making for Rewilding Chelonians

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Assessing wellbeing of chelonians is fraught with challenges. When confronted with large numbers of turtles during confiscations or settings in which preparations for their rewilding are occurring, choices of diagnostic tests, availability of expertise, proximity to laboratories, transport and cold chain storages, costs and permit requirements all factor into consideration. Many tests have not been validated for all species and may be of limited use. Techniques used for hematologic tests vary among labs and some have inherent inaccuracies, biochemical analysis may require instrumentation not available in low resource settings, special analytes require meticulous handling and storage in the field, and serological antibody analysis is lacking for most pathogens. Molecular testing, may be available for a number of pathogens but data are sparse regarding pathogenicity and epidemiology of these pathogens in most chelonian species. Point of care diagnostics using small blood volume, minimal equipment and technical expertise requirements, and immediate results and information regarding functional assessment are ideal for improving the relevance of testing in or close to field conditions. Leukocyte coping capacity (LCC) testing uses 10 µl of blood, and provides a result in 20-25 minutes It measures production of reactive oxidation species (ROS) from heterophils providing a direct measurement of the ability of cells to respond to stressors. Preliminary data supports significant differences in magnitude of response among species, although further testing. and controlled studies using specific stressors are warrented to assess the value of LCC in predicting chelonian wellness. Lactate is an analyte requiring only 5 µl of blood, and has been shown to be an accurate predictor of release back to the wild after triage and treatment of trauma in aquatic turtles. Packed cell volume and total solids evaluations can be run with 20 µl of blood in just 2 minutes and provide information necessary for assessing hydration, nutritional, and reproductive status. In summary, in the face of large numbers of turtles, and limited expertise and resources, decision making using tests with low sample volume requirements, in-country laboratories and personnel, and rapid diagnostics allow sufficient and timely information that benefits chelonian conservation.

Veterinary Medicine and Explorations: Oral

Veterinary Considerations of Rewilding Radiated Tortoises (*Astrochelys radiata*) in Madagascar: Epidemiology and Management of an Old Pathogen in a Novel Environment

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Veterinary exams and testing of chelonians have become routine prior to rewilding individuals under care by the Turtle Survival Alliance (TSA). In Madagascar, health surveillance of free-living (FLT) and captive Radiated Tortoises (CT) (*Astrochelys radiata*), (AR), has been performed since 1998. Plasma ELISA for detection of *Mycoplasma spp.* were negative in FLT and CT in 1998 and 2010. Since 2016 molecular surveys for potential pathogens (herpesviruses, ranaviruses, adenoviruses, Testudine Intranuclear Coccidia and *Mycoplasma spp.*), in previously confiscated CT, and 20 FLT were all negative. In 2020 and 2022, 3,000 radiated tortoises, chosen for rewilding from TSA's collections, underwent pre-release evaluations. Hematology, plasma biochemical, and molecular testing were performed on statistically significant numbers of tortoises. All animals were in good weight and showed no external physical signs of disease or illness. In 2022, 4 individuals at the TCC, tested positive for *Mycoplasma spp.* via PCR. The isolates were determined to be 99.9% homologus to *M. agassizii (MA)* via Sanger sequencing. A group of juvenile AR, recently returned to Madagascar and now housed in Antananarivo, were similarly tested and found to have a 52% prevalence of MA. These are the first known positive molecular detections of MA in Madagascar. To assess potential threats to FLT the following were undertaken: All existing banked plasma samples from free living Radiated Tortoises from 1998 and 2020 underwent ELISA testing at the College of Veterinary Medicine Department of Infectious Diseases and Immunology at the University of Florida. Field sampling of 400 tortoises at 4 sites in far southern Madagascar was performed in April 2023. Choanal swabs and blood was collected, field processed and stored frozen. PCR for MA was performed at the Mahaliana Molecular Diagnostic Laboratory in Antananarivo. Samples for *Mycoplasma* culture and ELISA were exported to the USA and submitted to the University of Florida Laboratory. All positive radiated tortoises have been isolated from other individuals in the collections. Further surveys of CRT will continue to assess the impact on the collections and to use adaptive management for ongoing conservation efforts which use rewildling to enhance free-living populations.

Veterinary Medicine and Explorations: Oral

The Importance of Riparian and Aquatic Vegetation for Central American River Turtle (*Dermatemys mawii*) in a Lentic System in Southern Mexico

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The Central American River Turtle (*Dermatemys mawii*) is one of the of the most critically endangered turtle species worldwide, due to habitat loss and heavy hunting for food consumption. Research on *D. mawii* becomes more challenging as wild populations are disappearing, while basic ecological data are still required to inform conservation efforts. In this study, our aim was to analyze the diet of *D. mawii* based on sex, and compare the information provided by stomach flushing and fecal samples from individuals captured in 2017 and 2018 in a lentic system in the Lacantun River Basin, Chiapas, Mexico. We identified three broad categories (invertebrates, aquatic and riparian plants) and 12 different food items, of which four are new reports of vascular plants for the diet of this turtle. The principal food items consumed by *D. mawii* in both sexes were *Pistia stratiotes* (free-floating macrophyte) and *Ludwigia* sp. (riparian plant). A low index of relative importance (≤ 0.50) for invertebrates suggests that the latter may be ingested accidentally when feeding on the plants. We did not detect significant sex differences in the relative contribution of food items between the two sampling methods; additionally, we found a large dietary overlap ($C\lambda \geq 0.92$) between sexes that indicates a similar use of resources in this lentic system. We detected more broad categories from stomach flushing than from fecal samples; however, we did not find significant differences in the number of food items. The high consumption of *P. stratiotes* suggests that *D. mawii* may act as natural regulator of this aquatic macrophyte and prevent it from reaching severe nuisance population levels. The use of both post-ingestion sampling methods provides a more comprehensive view of the diet of this herbivorous freshwater turtle.

Field Studies: Oral

Post-release Movements and Survival of Soft- and Hard-released Long-term Captive Eastern Box Turtles (*Terrapene carolina carolina*) Relative to Sympatric Resident Turtles

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Translocation is a conservation tool with the potential to help mitigate some of the greatest threats facing turtle populations, including collection for the illegal pet trade. While translocation is a common technique in wildlife management, the subsequent monitoring efforts essential for evaluating success are often lacking. Soft-release is often employed to improve translocation outcomes by increasing site fidelity, but effectiveness can vary among species. In 2021, we released 35 long-term captive (i.e., former pets, animals sourced from wildlife rehabilitators) Eastern Box Turtles (*Terrapene carolina carolina*) that had been surrendered to the South Carolina Department of Natural Resources in compliance with new laws governing herpetofauna. We translocated these turtles to the Savannah River Site in west-central South Carolina, where we soft-released 25 individuals after nine months of penning and simultaneously hard-released 10 individuals to examine the efficacy of soft-release. We radio-tracked 26 translocated turtles (16 soft-released, 10 hard-released) for one year following their release, and radio-tracked 10 sympatric resident turtles as a control group. We found that translocated turtles had similar first-year home range sizes to resident turtles, regardless of release type. We found that soft release was effective in reducing home range size and the time it took for translocated turtles to "settle" before establishing a home range. However, soft-release did not reduce dispersal distance from the release site, which is often a desired outcome. First-year survival for translocated turtles was 88.5-92.5%, similar to the 100% survival observed in sympatric resident turtles. Notably, first year survival of long-term captive turtles in this release was much higher than first year survival of confiscated turtles previously released at the same site. Collectively, our results suggest that long-term captive Eastern Box Turtles can be successfully repatriated back into the wild and exhibit similar survival and movement behavior as resident turtles. Further, long-term captives performed better than did the recently released confiscated turtles, potentially indicating that following future confiscations, captive rehabilitation might improve translocation outcomes.

Headstarting and Translocation: Oral

Forensic Isotopic Approach to Trace Tortoise Trafficking in Brazil

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Besides habitat loss, poaching and illegal trade are the main threats to Neotropical chelonians. In Brazil, environmental law allows commercial breeding of the two native tortoise species, Red-footed Tortoise (*Chelonoidis carbonarius*) and Yellow-footed Tortoise (*Chelonoidis denticulata*), which are highly desired as pets. Despite such legal provision, high demand for these animals drives domestic and international trafficking. For example, in recent years, Brazilian wildlife law enforcement agencies have confiscated thousands of tortoises, including some large seizures of over 1,000 individuals. Forensic investigations of wildlife trafficking and laundering usually focus on tracing the geographic origin of the seized animals, as well as identifying whether they come from free-living or captivity. For such purposes, stable isotope analysis (SIA) stands out as an efficient scientific tool, since isotopes from diet and drinking water are related to feeding system and geographic area of occurrence, and such isotopic composition is reflected in animal tissues as an isotopic signature. The objective of this paper is to analyze the carbon (δ13C) and nitrogen (δ15N) isotopic composition of tortoises confiscated in wildlife law enforcement operations in Brazil and compare them to reference values obtained from captive, semi-captive and wild animals. We analyzed scute samples from 34 tortoises sampled from four different criminal cases, which together totaled more than 2,700 seized animals. These data were compared to those of wild tortoises collected in two Brazilian biomes, Amazonia and Cerrado (the Brazilian savanna), as well as animals housed in conservation institutions (captive tortoises) and private semi-intensive breeders (semi-captive tortoises). As a rule, the batches of seized tortoises showed less negative δ13C values when compared to the three reference groups (wild, captive and semi-captive). Moreover, they differed significantly from wild and semi-captive animals (Anova/Tukey Test, $p<0.05$), but not from captive ones. Regarding nitrogen isotopes, the groups of seized tortoises showed higher δ15N values and differed significantly from all reference groups ($p<0.05$). These results suggest that the seized tortoises are not of wild or semi-captive provenance, implying that breeders are participating in trafficking activity. This research demonstrated that a dual-isotopic carbon/nitrogen approach can be an efficient tool for the detection of trafficked tortoises in the Brazilian context, especially to draw inferences about their possible origin in terms of feeding and rearing system.

South American Turtles: Oral

A Genomic Assessment of the Utility of Using Subspecies for Diamondback Terrapin (*Malaclemys terrapin*) Conservation Management

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The Diamondback Terrapin (*Malaclemys terrapin*) is an emydid turtle endemic to the Atlantic and Gulf coasts of the Unites States. It is unique among all extant turtles in that it is the only that is restricted to brackish (sometimes completely salt) water estuarine and mangrove habitats. Although once relatively abundant, populations experienced significant declines in the 18th and 19th centuries caused by overharvesting for human consumption. Currently, many populations continue to be imperiled because of overharvesting for the pet trade, habitat loss, road mortality, predation from subsidized predators, and death as a result of incidental take in commercial and/or private crab traps. The species receives inconsistent levels of federal, state, and local protection throughout its distribution. There are currently seven described subspecies of diamondback terrapin – identified by differences in shell shape, body size, and coloration of the skin and shell. Here, we use whole-genome resequencing data to examine the correspondence between the seven currently recognized subspecies of Diamondback Terrapin and genetically distinct population clusters. Our goal is to determine the genetic validity of these subspecies and their utility as conservation units that mirror genetic diversity in the species. We also will quantify the relative levels of genetic diversity within each discovered genetic population cluster since diversity is a key attribute of genetic health. We sequenced 45 complete Diamondback Terrapin genomes from the center and edges of the distribution of all seven subspecies, generated a data set of over 20,000,000 single nucleotide polymorphisms, and subjected this dataset to phylogenetic analysis, principal component analyses, and Bayesian assignment tests. Our results indicate that five of the seven currently recognized subspecies are also reflected in our genomic data and that there is evidence of gene flow between genetic clusters, consistent with the general interpretation of a single species with well-defined subspecies. Our results also provide insight into the history of lineage diversification within the species. Our findings provide a novel resource for the conservation community that can be used to ensure that future conservation efforts protect the morphological and genetic diversity of this unique species.

Genetic Investigations: Oral

Distribution and Abundance of Ringed Sawback (*Graptemys oculifera*) and Pearl Map Turtle (*Graptemys pearlensis*) in the Pearl River System of Louisiana

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The Ringed Sawback (*Graptemys oculifera*) and Pearl Map Turtle (*G. pearlensis*) are riverine turtles that are endemic to the Pearl River drainage of central Mississippi and southeastern Louisiana. *Graptemys oculifera* is listed as Federally threatened, and *G. pearlensis* was recently proposed for Federal listing, yet most of the information on their status comes from the Mississippi portion of their range. During May/June 2020 and 2021, I documented the population status of both species in Louisiana using a combination of methods. Point count surveys detected both *Graptemys* primarily in the Bogue Chitto and Pearl rivers, with *G. oculifera* observations exceeding *G. pearlensis*. *Graptemys oculifera* and *G. pearlensis* were found in 3 and 4 previously undocumented creeks, respectively, and a large range extension in a drainage was observed for *G. pearlensis*. Mark-resight population estimates at six sites for *G. oculifera* averaged 99/river km (rkm, range: 49–158/rkm), while *G. pearlensis* estimates at three sites averaged 10.6/rkm (3–23/rkm). Basking densities at 22 sites were ~4.5× greater for *G. oculifera* (14/rkm) compared to *G. pearlensis* (3.1/rkm). Trapping at six sites in 2020 and 2021 yielded a total of 111 *G. oculifera* and 14 *G. pearlensis*. In summary, *G. oculifera* appears secure in Louisiana, while *G. pearlensis* is rare, and it appears to be more sensitive to riverine modifications. Threats are myriad for both species in the Pearl River system and include gravel mining operations, excessive off-road vehicle usage on sandbars and stream bottoms, municipal/industrial effluents, and illegal harvesting of turtles for the pet trade.

Turtles of the Southeastern United States: Oral

Somatic Growth and Maturity for Four Species of River Cooter Including Suwannee Cooter (*Pseudemys concinna suwanniensis*), Florida Red-bellied Cooter (*P. nelsoni*), Peninsula Cooter (*P. peninsularis*), and Texas Cooter (*P. texana*)

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River Cooters (*Pseudemys* spp.) are a genus of commonly occurring freshwater turtles but with limited information about growth across their long lifespans. Here, we use 11,361 mark-recaptures from 421 sampling events by TSA-NAFTRG staff and volunteers between 1999 and 2020 to estimate the somatic growth rates of Florida Red-bellied Cooter (*P. nelsoni*), Peninsula Cooter (*P. peninsularis*), Suwannee Cooter (*P. concinna suwanniensis*), and Texas Cooter (*P. texana*) from Fanning Springs, Manatee Springs, Volusia Blue Springs, and Wekiwa Springs in Florida and Comal Springs-Landa Lake in Texas. We present a Bayesian von Bertalanffy growth model to jointly estimate the species-specific, site-specific, and individual effects of the 2,469 recaptured individuals on somatic growth, sexual dimorphism, and derived age at maturity. We corroborated evidence for fast juvenile growth and slower adult growth in River Cooters but found uncommonly fast growth rates in these spring systems. Three species' females and Suwannee Cooter males grew 50–61 mm in the first year while males for the other three species grew 31–36 mm. Females of Florida Red-bellied Cooter and Texas Cooter and males of Peninsula Cooter and Suwannee Cooter grew to similar asymptotic sizes (L_∞ between 309–313mm). Females of Peninsula Cooter and Suwannee Cooter females had larger L_∞ (363 and 423 mm, respectively) while males of Florida Red-bellied Cooter and Texas Cooter had the smallest L_∞ (274 and 243 mm, respectively). The site-specific environmental conditions had significant effects on k but not L_∞. Lastly, we estimated, using a ratio of L_{mat} to L_∞ (71.7% and 87%, males and females), that females matured 1.15–3.88 years later (1.15–1.57x older) than males for all species except for Suwannee Cooter where females matured 9.79 years later, over three-times older than males. This study provides important baseline life history information for *Pseudemys* species for use in ongoing conservation efforts and presents a novel hierarchical modeling approach for handling individual growth variation and environmental drivers using a long-term mark-recapture dataset.

Turtle Ecology: Oral

The Impact of Low Head Dams on Freshwater Turtle Species Assemblages

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Turtles are an extremely important component of many freshwater ecosystems. The impact of dams on freshwater turtle assemblages is an understudied topic globally, and has particular relevance to Indiana, as the state contains a large number of low head dams that no longer serve their original purpose. There is an effort within Indiana to remove low-head dams due to ecological and safety concerns. While no previous literature has studied the impact of dams on turtle assemblages in depth, dams affect turtles and their habitat by altering water flow, ecological communities (e.g.: plants, invertebrates, fish), turtle nesting and basking sites, and turtle movements. These changes could lead to differences in turtle species assemblages, abundance, demographics, contaminant exposure, and stress levels in river stretches above and below dams. Our project aims to study the impacts of impoundments on freshwater turtle ecology. We will hoop net trap turtles May through July 2023 in river stretches above and below low head dam impoundments in Indiana to investigate whether species assemblages, demographics, or biomass above and below the impoundments differ. In addition, claw clippings and blood will be taken for future PFAS, contaminant, and stress hormone analysis and shells will be swabbed for analysis of diatom communities. We will discuss our results from summer 2023 fieldwork and future directions of this project.

Poster Session

Effects of Habitat Alteration and Co-Occurrence With Introduced Red-Eared Sliders on Southwestern Pond Turtle Abundance in a Southern California Urban Creek

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Species inhabiting urban waterways face numerous threats including water pollution, invasive species, and habitat alteration. While virtually all water bodies are at risk of significant human modification, urban waterways are subject to a unique set of human modification practices to reduce flood risk. The vast amount of impervious surface in urbanized areas can dramatically increase storm runoff and the risk of catastrophic flooding. As a result, management agencies often implement flood and erosion control measures such as creation of drop structures, riprapping, deadwood removal, and manual modification to streamline watercourses to expedite the flow of water away from urban areas. These efforts can reduce the habitat quality for native species. The added effects of other urban habitat alterations, such as invasive species introduction, could further exacerbate any negative effects associated with an already physically altered habitat. Aquatic turtles can be especially prone to such disruptions due to their reliance on many microhabitats to survive and varying tolerance to external stressors. We conducted 250 hours of surveys over the course of approximately six months investigating the distribution of native Southwestern Pond Turtles (*Actinemys pallida*) and non-native Red-Eared Sliders (*Trachemys scripta elegans*) in an urban creek in Orange County, California. We used a series of Bayesian hierarchical models to investigate what environmental variables predict where Southwestern Pond Turtles and Red-Eared Sliders occur in highest abundance. Results are interpreted in context of urban stream management, and the effects both heavy human modification of a creek system and introduced species can have individually, and together, on Southwestern Pond Turtles. We also recommend management practices that may benefit declining Southwestern Pond Turtles based on the results obtained herein.

Field Studies: Oral

Fishing Gear and the Southern River Terrapin (*Batagur affinis)*: Effective Conservation Approaches for Reducing Mortality—A Case Study in Cambodia

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The critically endangered Southern River Terrapin (*Batagur affinis)*, known locally as the Royal Turtle, is Cambodia's National Reptile and is one of the world's 25 most endangered chelonians. In Cambodia, *B. affinis* is found only in the Sre Ambel River system in Koh Kong Province. Since 2015, the project has released 166 headstarted turtles, with approximately the same sex ratio, into the Sre Ambel river. Here, we try to investigate and determine what types of fishing gear are being used that threaten the survival of these released turtles following release. We also evaluate conservation interventions that effectively contribute to the species conservation. As of April 2023, 54 turtles were captured by fishermen in fishing gear at different locations. The method used to gather information on captures is an informal interview with fishermen, including locations and fishing gear. The two common fishing gears that regularly entangle *B. affinis* are fishing hooks and active and ghost fishing nets, which are legal gear under Cambodian Fisheries Law. Some were captured by bamboo traps, cast nets, mosquito nets, or hand capture during night-vision fishing, and some were unknown. Of the 54 turtles, four individuals were native wild turtles, and the rest were released headstarted turtles. Forty-seven out of 54 turtles were reported or handed over to the project and seven cases of captured turtles were handed over by restaurant owners, rich Cambodians, conservation NGOs, and the Ministry of Environment. Although a high number of turtles were captured, we still consider reintroduction efforts a success when these turtles are voluntarily returned to the project. Fishermen are aware of the species conservation and the importance of the species within their community. We can conclude that our conservation incentives and awareness-raising efforts play a vital role in spreading conservation messages about this rare species within local communities. These include the organization of turtle release events, local school training, community meetings, consultation, and livelihood alternatives (aquaculture and livestock).
Conservation Tools and Actions: Oral

Southern Pacific Pond Turtles (*Actinemys pallida*) in Different Habitats of the Same River Drainage

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Populations of Southern Pacific Pond Turtles (*Actinemys pallida*) are in decline and vulnerable to further reduction. As conservation efforts on the recovery of this species advance, interventions should be tailored to the needs of each population—even within the same river drainage. The Turtle Conservancy's Pond Turtle program is designed to focus on the monitoring and recovery of Southern Pacific Pond Turtles in Ventura County, California. From May–July of 2022, we commenced mark-recapture field surveys at two sites: 1) a wetland system in Fillmore, along the Santa Clara River, severely altered by decades of watercress farming and invasive plants now undergoing extensive ecological restoration; and 2) a montane tributary stream of the Santa Clara River (elevation >760 meters above Fillmore) in the Sespe Wilderness of Los Padres National Forest. In Fillmore, we discovered a small population (n=24) persisting in habitat significantly altered by human activity and surrounded by development and agriculture. The turtles showed a range of body conditions. Many displayed evidence of previous trauma or possible shell infections. The Sespe Wilderness surveys also revealed a population of pond turtles (n=44), with body conditions being overall healthy and few individuals showing signs of trauma. Body size (as defined by carapace length and mass) of turtles captured in the Sespe Wilderness was significantly smaller than those in Fillmore. Our pilot field season in 2022 was successful in 1) documenting populations of Southern Pacific Pond Turtles at each site; 2) establishing long-term survey methods to monitor demography, density, population trends, health, movement, and population persistence; 3) identifying potential threats specific to each study site; and 4) providing field research experience for high school students and interns. We are continuing population monitoring and will explore how extreme rainfall and floods from multiple "atmospheric river" events in January–March of 2023 may have impacted resident populations of Southern Pacific Pond Turtles in the drainage.
Field Studies: Oral

Sherlock Bones: Utilization of Wildlife Detection Dogs to Locate Eastern Box Turtles (*Terrapene carolina carolina*) in Upstate South Carolina

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The Eastern Box Turtle (*Terrapene carolina carolina*), also known as the Carolina or Woodland box turtle, is a species of conservation concern in many urbanized areas. Areas with loss of traditional box turtle habitat and increasing development and are seeing declines in box turtle populations. The cryptic habits and highly effective camouflage of this species makes them a prime candidate for detection by specially trained wildlife detection dogs and their handlers. Thus, I elected to train a 2-year-old

mixed-breed dog to track and locate Eastern Box Turtles in various sites across Pickens County. In this poster session, I will explain the training methodology to ensure ethical handling for the dog and turtles, and safe field practices for the handler. I will describe how I trained my box turtle detection dog and the troubleshooting that led to us training in a less traditional manner. I will then explain why the project has utilized a wildlife detection dog to search for Eastern Box Turtles, and the problem-solving we have done to streamline the detection process and ensure efficiency. The dog has proven to be able to locate turtles which are visually obscured and has reduced survey time and increased project success. My work on training a wildlife detection dog and the subsequent field experience has demonstrated the effective use of detection canines to locate box turtles, and possibly other chelonian species in the future.

Poster Session

The Turtle Trafficking Dedicated Data Centre

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Today, in 2023, demand for turtles is thriving and shows very little sign of abating. This demand comes in several forms which can include consumption for medicine and food as well as live individuals for the pet trade and whilst some is being met through legal means, a more critical proportion is being met through criminal means. The Turtle Trafficking Dedicated Data Centre (DDC) is a centralised collection of information and crime data that specifically relates to trade and trafficking through a dashboard. The DDC facilitates greater insights about the scope, scale and nature of criminal elements servicing international demand for turtle trafficking. The data is compiled and visualised in a way that will enable the observation of four areas of focus: Trade, Trafficking, Species and Profiling. Each are available for viewing across different geographical zones and across periods of time at a species and genus level. Insights will be provided on how trade occurs through a criminal lens to inform conservation and law enforcement needs. This will help provide indicative insights that illustrate longer-term trends but also highlight emerging trends. These insights are also geared towards gaining more understanding about demand and through this resource we can observe general trends as it affects individual species. Data sharing and insights achieved through the dashboard aim to encourage more collaboration between researchers and the law enforcement community, which can result in important new findings and partnerships in the field. The DDC will present an amalgamation of these data which provides an opportunity to allow for richer, contextualised analysis. The discovery of threatened turtle species in illegal trade is sadly not seldom, often occurring in high numbers. However, each turtle has a street value and until this situation subsides, criminality will continue to supply this demand. One means to redress this, is to be data driven and intelligence-led to embrace a collaborative, coordinated approach to disrupt crime and to prevent further damage to the conservation status of turtles around the world.

Combating Wildlife Trafficking: Oral

Transfer of Potential Pathogen Bacteria Between Southeast Asian Box Turtle (*Cuora amboinensis*) and Sulawesi Forest Turtle (*Leucocephalon yuwonoi*) In a Captive Habitat

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The study was aimed at examining the diversity and prevalence of bacteria in Southeast Asian Box Turtle (Cuora amboinensis) and Sulawesi Forest Turtle (Leucocephalon yuwonoi) caught from the wild and reared in captive habitats and determining the presence of bacterial transmission, especially those that can cause disease between the two. This research was conducted from December 2019 to July 2020 and was carried out in the field and in captivity to take samples of bacterial isolates as well as in the laboratory of the Fish Quarantine Station, Quality Control, and Safety of Fishery Products in Palu to identify the types of bacteria. The results showed that there were turtles that had been infected with pathogenic bacteria in nature and had symptoms of shell rot prior to captivity. The bacteria carried by the turtles are then transferred to other turtles during the horizontal captivity process through several ways, including direct physical contact, especially through the habit of the box turtle, which likes to take refuge in piles and overlap each other. Another method of transmission is indirect transmission or through intermediaries such as through feed. The two species become more aggressive during the feeding session so that they fight with each other; even food

can move to other turtles after being bitten by another turtle. The water in the pond as a bathing place also has a role in the process of indirect bacterial transmission because there is only one bathing place and it is used in turns by all turtles.
The More You Know: Oral

Juvenile Survival and Growth Probability in the Suwannee Alligator Snapping Turtle (*Macrochelys suwanniensis*)

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The Suwannee Alligator Snapping Turtle (*Macrochelys suwanniensis*) is confined to the Suwannee River drainage in Florida and Georgia, where it is listed as threatened in both states. It is currently being considered for listing under the Endangered Species Act. Researchers from the University of Florida and the Florida Fish and Wildlife Conservation Commission initiated a capture-mark-recapture (CMR) study in 2011, and a recent population assessment found an "uncertain" population status in the river mainstem in Florida. This finding is likely due to the large amount of uncertainty around estimates of juvenile apparent survival and a low juvenile to adult growth probability. After 12 years of CMR sampling, researchers have recaptured turtles that were marked as juveniles and have since matured into adults. Here, we present a multi-state model for *M. suwanniensis* that could: 1) provide better estimates of juvenile apparent survival, 2) estimate the juvenile to adult growth probability directly from the CMR data, and 3) help clarify this species' status.
Poster Session

Tracking Turtles: An Overview of SnapperGPS and Potential Applications for Turtle Research and Conservation

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Understanding how animals use their environment is an important component of understanding their ecology, and tracking systems are a vital tool to help us study these movements. Perhaps the most common tracking system for turtles is radio and acoustic telemetry, but satellite systems such as GPS are becoming more common. However, many of these tags are too large, too expensive, and are simply not feasible for use on smaller species of turtles and tortoises. Recently, researchers in the Department of Computer Science at the University of Oxford developed a small, affordable, low-power tracking system called "SnapperGPS." This novel receiver employs "snapshot" GNSS technology that takes advantage of multiple satellite constellations (e.g., GPS, Galileo, BeiDou) to obtain accurate positional data. In addition, the unit can operate for a year on a tiny 40 mAh LiPo battery. We believe this open-source technology possesses enormous potential for better understanding freshwater turtle and tortoise ecology. Here, we present a review of this technology, some modifications for use on turtles, and discuss potential applications for turtle research and conservation.
Plenary: Oral

Descriptive Morphology of the Striped Mud Turtle (*Kinosternon baurii*) in Delaware, the Northern Edge of Its Range

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The Striped Mud Turtle (*Kinosternon baurii*) is a well-known inhabitant of the southeastern coastal plain that, until very recently, was not known to exist in Delaware. Individuals from populations north of peninsular Florida often lack the diagnostic carapace stripes, and as a result, they can easily be mistaken for the closely related and often sympatric Eastern Mud Turtle (*K. subrubrum*). The goal of my research in Delaware was to describe the morphology and phenotype of *K. baurii* at the northern edge of its range, with particular emphasis on their body size, carapace/facial striping, and head width. In this talk, I'll first give a background on the discovery of *K. baurii* in Delaware and my primary study site. I'll then examine my trapping and data collection methodology. My talk will focus on the results of my phenotypic analysis, with extensive comparison to other *K. baurii*

populations in lotic and lentic systems throughout their entire range. I found that *K. baurii* in Delaware are very large and exhibit megacephaly. While most adults do not possess carapace stripes, a notable portion of them do. All juveniles possessed carapace stripes, and the canthal stripe (the facial stripe that runs from the eye to the nostril), was present on all turtles captured. This stripe is not present in *K. subrubrum.* Towards the end of my talk, I'll discuss the future of my research.
Kinosternids: Oral

Nesting Behavior and Reproduction of Arakan Forest Turtle (*Heosemys depressa*) in the Rakhine Yoma Elephant Range, Western Myanmar

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Arakan Forest Turtle (*Heosemys depressa*) is a medium-sized (carapace length [CL] to ca. 300 mm) terrestrial turtle endemic to the mountains of western Myanmar and adjacent areas of Bangladesh and ranked as Critically Endangered on the IUCN Red List of Threatened Species. We studied nest construction, reproductive phenology, and clutch attributes among a group of captive *H. depressa* maintained at the headquarters of the Rakhine Yoma Elephant Range in Gwa, Myanmar. The assurance colony is located with the natural geographic range of *H. depressa*. Altogether 7 males and 7 females were kept together for purposes of propagation. Mating behavior of the turtles was first observed during the month of May (dry season) and mating continued until July (wet season). The nesting season of *H. depressa* is between November and December (early dry season). Female turtles laid a single clutch of eggs each year during the nesting season. Female turtles selected nesting sites under the leaves and also choose bare ground to dig the nest. The mean depth of nest was 94 ± 3.9 mm with a variation of 90 mm to100 mm, and the diameter was 47.4 ±6.9 mm with a variation of 40 mm to 57.5 mm. The mean time taken by the females to dig the nest hole amounted to 3 hours and 21minutes and took 5 hour and 55 minutes to refill. Total time required for nesting was usually > 8 hours. Clutch size varied from 3-7 eggs (4.5±1.66). The eggs of *H. depressa* were elongated and slightly tapered in one end and the other anterior end was slightly pointed. The mean weight of eggs 44.6 ± 6.7 g (range 32 g - 51 g), egg width was 34.5± 2.7 mm (range 31-37.9 mm) and egg length 59.6±2.6 mm (range 54.1-62.7 mm). The incubation period varied between 185 and 206 days with a mean of 195 ± 10.5 days.
Poster Session

Using Automated Radio Telemetry to Track the Movement and Habitat Use of Diamondback Terrapins (*Malaclemys terrapin*) on a Barrier Island in Southeast Louisiana

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The Diamondback Terrapin (*Malaclemys terrapin*) is an estuarine turtle found along the Atlantic and Gulf Coasts of the United States. Historically overharvested, Diamondback Terrapins continue to be threatened range-wide by anthropogenic activities, such as coastal development and the blue crab fishery. In Louisiana, the Diamondback Terrapin is listed as a Species of Greatest Conservation Need. Knowledge regarding terrapin movement and habitat use, imperative information for conservation efforts, is minimal throughout their range due to limitations of standard tracking methodologies in salt marsh systems. We employed an automated ultra-high frequency radio telemetry system to track terrapin movement on a barrier island within the Barataria Estuary in southeast Louisiana. The system was deployed in August 2022 and consists of 36 receiver nodes placed 100 meters apart in a 6 x 6 grid and a central receiver station. Thus far, we have tagged 35 terrapins with radio transmitters set at a beep rate of 3 beeps per minute. Raw beep data collected by nodes have been filtered based on signal strength and triangulated using a determined relationship between signal strength and distance. Over 280,000 locations have been triangulated with an average error of 16.2 meters. We explored the effects of body size, sex, and time of year on estimates of home range size, movement patterns, and habitat use from August 2022 to June 2023. Our findings will increase our understanding of the spatial and temporal habitat use of Diamondback Terrapins in Louisiana and aid in developing habitat conservation strategies for the species.
Poster Session

Reproductive Integration of Gopher Tortoises Following Multiple Population Augmentations

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Gopher Tortoises (*Gopherus polyphemus*) are declining throughout their range and habitat management alone is unlikely to ensure persistence. At the same time, species biologists have determined that the minimum viable population size (≥ 250 adults; MVP) is larger than previously appreciated. Population augmentations are increasingly being used as recovery tools, but multiple augmentations are often necessary to achieve an MVP. Although translocated tortoises can exhibit high site fidelity and long-term survivorship, more recently translocated animals may have lower reproductive success than resident or previously released tortoises. The effects of multiple augmentations on reproductive success are largely unknown but have important implications for population viability. We will describe efforts to build a viable population of Gopher Tortoises from multiple releases of primarily waif tortoises (origin unknown, formerly captive or rehabilitated tortoises) and provide an assessment on the extent to which tortoises from different release groups have become reproductively integrated. From 2006 – 2018, we released >185 subadult and adult Gopher Tortoises at a protected site in South Carolina that supported a relict population of <15 residents. We placed tortoises in one of 11 soft-release pens where they were held for at least 12 months prior to release, with penning timing, duration and group composition dependent on when we received waifs. We collected blood samples from all founders (n=201) and 116 hatchlings recruited from 2010-2018 and genotyped them at 18 microsatellite loci. We were able to determine parentage of 103 offspring from 19 clutches, which were assigned to 33 females (mothers) and 26 males (fathers). From these, we observed that: 1) reproductive success varied among males, with 1-16 assigned offspring but only ~20% candidate males represented; 2) most clutches were sired by a single father; 3) for females that had >1 clutch genotyped, the same male(s) were attributed to her clutches in both sampling years; 4) 30% of offspring were sired by either resident males or males from the first release group (Pen 1); but that 5) both males and females produced offspring with animals from other release groups. Although limited sampling constrains interpretation, our results demonstrate some reproductive integration following multiple augmentations.

Plenary: Oral

Mortality Among Juvenile and Adult Wood Turtle Populations in Massachusetts Increases During Drought Years

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Zoo New England's Field Conservation Team has radio-tracked juvenile and adult Wood Turtles (*Glyptemys insculpta*) at several sites in northeastern Massachusetts since 2012 to learn more about movements, habitat usage, and survival of this species in a largely suburban landscape. Since 2019, we have also headstarted and released more than 70 hatchlings across all sites. Although we have found that annualized survival rates (89.7%) overall mirror figures reported from other New England populations, we have observed high mortality in both adults and headstarted juveniles during years of significant drought. Of 26 confirmed mortalities since 2019, 85% occurred during two severe drought years, and a comparison via Fisher's exact test between the two wettest and two driest years since the project began found a significant difference in mortality ($p = 0.03$). Similarly, annual survival rates largely track rainfall during the active season for Wood Turtles (April–October) across the years. This paper outlines trends in both recorded rainfall and stream flow measurements as related to Wood Turtle mortality, while proposing mechanisms and other possible explanations for the observed trends. The likely increase in unpredictable precipitation and severe drought associated with climate change could pose a serious threat to Wood Turtle populations across the species' range.

Field Studies: Oral

It's turtle time.