



# JOINT MEETING OF ICHTHYOLOGISTS AND HERPETOLOGISTS

JULY 24-28, 2019

SNOWBIRD, UT - SNOWBIRD SKI AND SUMMER RESORT



## ABSTRACTS

Imhoff - Myers

## **694 AES Trophic Ecology II, Alpine A,B,C – The Snowbird Center, Sunday 28 July 2019**

Johanna Imhoff<sup>1</sup>, Dean Grubbs<sup>2</sup>

<sup>1</sup>*Florida State University, Tallahassee, FL, USA*, <sup>2</sup>*FSU Coastal and Marine Laboratory, St. Teresa, FL, USA*

### **Trophic Relationships and Mercury Contamination of Deep Sea Sharks in the Gulf of Mexico**

Deep sea sharks have received relatively little research attention despite being potentially important predators in their communities, representing nearly half of all global chondrichthyan fauna, and their vulnerability to fishery exploitation. Six relatively common shark species that partially overlap in depth habitat and demonstrate a range of feeding habits and movement patterns provide an interesting system for detailed investigation of trophic ecology and potential for competition or niche partitioning of these coexisting mesopredators. Trophic ecology will be investigated using stomach contents and light stable isotopes. Potential for competition between coexisting species will be determined by comparing spatial niche metrics in depth habitat sympatry to depth habitat allopatry, with the expectation that competition would cause a shift in niche size and overlap. Long-lived mid to upper trophic level predators are also susceptible to carrying high loads of bioaccumulating toxicants and may facilitate their long-term persistence in marine food webs. There is special interest in mercury in northern Gulf of Mexico food webs because of the potential for increased ambient mercury methylation after the 2010 Deepwater Horizon Oil Spill. Preliminary data show relatively high concentrations of MeHg and the typical bioaccumulation pattern of increasing MeHg contamination with fish length, but high individual variation and differences in slope between species. MeHg bioaccumulation patterns can be influenced by multiple factors, such as size, sex, taxon, trophic ecology, ontogeny and depth habitat. MeHg bioaccumulation patterns for sharks feeding in different food webs (benthic, mesopelagic) and on different dominant prey categories will be investigated.

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## **389 ASIH STORER ICHTHYOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Callie Ingram

*University of North Carolina Wilmington, Wilmington, NC, USA*

### **Estimating Elasmobranch Presence of Calabash Caye, Belize, Using Underwater Video Census**

There are many methods for determining abundance and distribution of a species; however, not all of these practices are ecologically considerate. Current methods include mark and recapture surveys, which are disruptive to the targeted species and bycatch. Underwater visual census (UVC) is a relatively new way to estimate species abundance and distribution in a manner that is not significantly disruptive to the ecosystem or the target species. This study's UVC was

conducted at the Calabash Caye Field Station (CCFS). Calabash Caye, Belize, is an island located approximately 33 miles east of Belize City, Belize, on the southeastern side of the Turneffe Atoll. This atoll is the largest of the three offshore atolls that comprise the Belize Barrier Reef System. The goal of this study was to conduct a UVC to determine which species of sharks and rays were viewed in the sample locations of Calabash Caye, along with a select few other sampling locations. This survey was implemented solely by a group of undergraduate researchers performing a coastal studies course at CCFS. This project will display the findings of this UVC, as well as compare UVC methodology to other more established methods for determining abundance and distribution.

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### **332 Herpetology Biogeography II, Ballroom 3 – Cliff Lodge, Friday 26 July 2019**

Krone Isaac

*UC Berkeley, Berkeley, California, USA*

#### **Ecological and Phylogenetic Patterns in Lizard Range Size**

A central question in biogeography is why some species are widespread while others have very limited distributions. While the reconstruction of evolutionary and biogeographical histories of individual species is essential to our understanding of this question, the topic can also be approached from an aggregate perspective, by investigating large-scale trends in range size over many species. Using large published datasets containing ecological, anatomical, and biogeographic data on over 6,500 lizard species, I examine phylogenetic patterns of range size as well as the relationship between range size and various aspects of lizard ecology and anatomy. My results reveal a strong phylogenetic signal in range size and a strong relationship between body size and range size, as well as unintuitive relationships between range size and substrate use, reproductive mode, and limb morphology. These results bolster our understanding of how range size is related to lizard anatomy and ecology and help contextualize how anatomy and ecology might affect the evolutionary success of lizard taxa.

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### **523 ASIH STOYE PHYSIOLOGY & PHYSIOLOGICAL ECOLOGY AWARD, Primrose A&B – Cliff Lodge, Friday 26 July 2019**

Kathleen Ivey<sup>1</sup>, Hayley Crowell<sup>1</sup>, Heather Neldner<sup>1</sup>, Michael Westphal<sup>2</sup>, Emily Taylor<sup>1</sup>

<sup>1</sup>*California Polytechnic State University, San Luis Obispo, California, USA*, <sup>2</sup>*Bureau of Land Management, Marina, California, USA*

#### **Thermal ecology of the federally endangered Blunt-nosed Leopard Lizard (*Gambelia sila*)**

Recognizing how climate change will impact populations can aid researchers and managers in making decisions about the conservation of endangered species. The Blunt-nosed Leopard Lizard (*Gambelia sila*) is a federally endangered lizard found in the arid deserts of the San Joaquin Valley and the Carrizo Plain. It has been extirpated from most of its range due to habitat destruction and alteration. We collected field-active body temperatures of *G. sila*, combined with operative temperature model data, preferred body temperatures (34.7 °C), and thermal tolerance (panting threshold, 40.8 °C) data for the population, which allowed us to (1) calculate the thermal quality of the microhabitats and the thermoregulatory accuracy and thermoregulatory effectiveness of the lizards, (2) calculate the number of hours lizards are thermally constrained, (2) project how this number and thermal indices will change in the future as ambient temperatures rise, and (3) assess the importance of shade-providing shrubs and burrows in the current/future thermal ecology of *G. sila*. Lizards maintained body temperatures just below the panting threshold but exceeded their preferred body temperature throughout most of the day. While shrubs have a lower thermal quality, they serve as a buffer that allows *G. sila* to stay active above ground during the hottest times of day. Burrows provide the best thermal quality, but their thermoregulatory effectiveness indicates that *G. sila* is avoiding burrows and this could be indicative of them utilizing shrubs in order to stay above ground to forage and defend territory.

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**50 ASIH STOYE ECOLOGY & ETHOLOGY AWARD II, Primrose A&B – Cliff Lodge, Friday 26 July 2019**

Michael Izumiyama<sup>1</sup>, Satoshi Awata<sup>2</sup>, Karen Crow<sup>1</sup>

<sup>1</sup>San Francisco State University, San Francisco, CA, USA, <sup>2</sup>Osaka City University, Osaka, Japan

**Is the number of fathers a good approximation for the number of mates? Examining the reproductive strategy of *Ditrema temminckii***

Sexual selection is a driving force of evolution and is a subject of intense interest to evolutionary biologists. One measurement often used to quantify sexual selection is the statistical relationship between mating success and reproductive success, which is referred to as a Bateman gradient. In studies of female Bateman gradient, the number of fathers is often used as an approximation for the number of mates, due to the intractability of observing all mating encounters in a natural population. However, it is possible that some mates do not receive paternity and would not be detected in the offspring. Therefore, if mating success is underestimated, the correlation between mating success and reproductive success may be incorrectly inferred. One unique system that provides the opportunity to address this problem is the Japanese surfperch *Ditrema temminckii*. Surfperches have a unique reproductive strategy of internal fertilization, sperm storage, prolonged gestation, and live birth. This system allows us to test if the number of fathers is a good approximation for the number of mates by utilizing hypervariable microsatellites to compare the number of unique alleles present in the uterine sac at the end of the mating season and the number of unique alleles from all offspring within the brood. We collected *D. temminckii*

from the end of the mating season and gravid females to determine the number of mates as well as the number of fathers within a brood.

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**136 General Ichthyology I, Cottonwood A-D – The Snowbird Center, Saturday 27 July 2019**

SeoHa Jang, JinKoo Kim

*Pukyong National University, Busan, Korea, Republic of*

**Molecular and Morphometric Variations in the sea raven, *Hemitripteris villosus* from Korea: Implication on Biogeographic Barrier**

The sea raven, *Hemitripteris villosus* is a cold-water demersal fish. It inhabits the mud, sand, gravel or rocks bottom, ranging in depth to 550 m, off the coast of Korean Peninsula, the Sea of Okhotsk and the Bering Sea, off the Pacific coast of Japan, the Kuril Islands, and southeastern Kamchatka. To clarify the geographic variations of the Korean sea raven, we investigated molecular and morphometric characters of 147 individuals (in morphs) and 175 individuals (in molecules) collected from three locations in the Yellow Sea, one location in the Korea Strait, and two locations in the East Sea. Kruskal-Wallis test showed there were no significant differences in meristic characters among locations, except the number of vertebrae (mean, 39.7 in the East Sea vs. and 38.4-38.8 in the remaining locations). A canonical discriminant analysis based on 25 morphometric characters showed that two groups were separated by the center value “0” of CAN1: Yellow Sea and Korea Strait individuals had positive values, whereas East Sea individuals had negative values. An analysis of molecular variance based on 801 base-pair sequences of the mitochondrial DNA cytochrome *b* gene showed that two lineages were separated by fixation index. A pairwise  $F_{ST}$  test revealed moderate genetic differentiation between the middle East Sea individuals and the remaining locations individuals except southern East Sea individuals. Our findings indicate that there exist two populations in the Korean sea raven, and their admixture zone may be located between the East Sea and the Korea Strait.

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**CANCELLED**

**427 General Herpetology I, Primrose A&B – Cliff Lodge, Sunday 28 July 2019**

Eric Januszkiewicz<sup>1,2</sup>, Nicole Chinnici<sup>3,2</sup>, Thomas LaDuke<sup>1</sup>

<sup>1</sup>East Stroudsburg University, Greentown, PA, USA, <sup>2</sup>Northeast Wildlife DNA Laboratory, East Stroudsburg, PA, USA, <sup>3</sup>East Stroudsburg University, East Stroudsburg, PA, USA

**Detection of Snake Fungal Disease Caused by *Ophidiomyces ophiodiicola* Among Timber Rattlesnakes (*Crotalus horridus*) in Pennsylvania**

Snake Fungal Disease (SFD) is a recently emerging disease caused by infection from *Ophidiomyces ophiodiicola*. Free-ranging snake populations are being affected by this fungal

pathogen throughout many Eastern and Midwestern U.S. states. Characteristically, infected individuals display swelling, lesions, crusts, and nodules of the skin that are generally found on the head but can also be found throughout the body. The fungus is difficult to identify based solely on symptoms and was not definitively identified in the state of Pennsylvania prior to this analysis. One hundred and thirty-five total timber rattlesnakes (*Crotalus horridus*) from twelve different counties in the northeastern and northcentral regions of Pennsylvania were captured and swabbed to test for the presence of SFD. Real-time PCR was used to detect the pathogen DNA. Of the 135 snakes, 24 (18%) tested positive with six individuals being infected on both the head and body, nine individuals infected on just the head, and nine individuals infected on just the body. There were no relationships found between infection rates and color phase, sex, length, or county captured. The cause of emergence and spread of this pathogen is largely unknown. Timber rattlesnakes have been listed as a candidate species in Pennsylvania in the past and are currently considered a species of special concern. The presence of SFD in these populations raises concerns. Long term monitoring studies may be helpful to examine the effects this fungal pathogen may have on individuals and populations.

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#### **147 Ichthyology Lightning Talks, Alpine A,B,C – The Snowbird Center, Saturday 27 July 2019**

Sylvia Jiménez-Rosenberg<sup>1</sup>, María Clara Arteaga<sup>2</sup>, Clara Galindo-Sánchez<sup>2</sup>, Anaid Saavedra-Flores<sup>2</sup>, Javier Robles-Flores<sup>2</sup>, Miguel Martínez<sup>2</sup>, Jaime Gasca<sup>2</sup>, Sharon Herzka<sup>2</sup>

<sup>1</sup>*Instituto Politécnico Nacional-CICIMAR, La Paz, Baja California Sur, Mexico,* <sup>2</sup>*Centro de Investigación y Estudios Superiores de Ensenada, Ensenada, Baja California, Mexico*

#### **Fish larvae diversity in the deep water region of the Gulf of Mexico**

In recent years, the Gulf of Mexico has call the attention of research groups and governmental agencies due to both, the catastrophic oil spills that have threaten and are a potential danger to the environment and all the productive activity in the gulf. This promotes the creation of a regulatory framework setting the directions regarding the process to determine the environmental impact of the potential damage the exploration, exploitation, and processing of natural resources entails throughout the entire coastal and oceanic ecosystem. For this, we need to know the most of the biodiversity of the Gulf of Mexico and then, understand the variability patterns of the entire ecosystem. Zooplankton communities have probe to be useful pelagic bioindicators. The fish larvae community is the most frequently used indicator of environmental variability at different scales of space and time. Correct taxonomic identification is crucial in order to obtain the most refined signals of variability. Next generation sequencing offers a suite of tools that have become accessible to do fine scale diagnosis and, therefore, to understand plankton community composition. This work shows the first results of project "Ichthyoplankton and Zooplankton diversity in the Gulf of Mexico: a Metagenetic and Taxonomic approach" (CIGoM; [www.cigom.info](http://www.cigom.info)). The goal is to combine morphological taxonomic tools with molecular taxonomic techniques in order to facilitate and/or corroborate the knowledge of the fish larvae diversity for a better understanding of the oceanic ecosystem of the deep water region of the Gulf of Mexico.

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## 222 Herpetology Lightning Talks, Ballroom 3 – Cliff Lodge, Saturday 27 July 2019

Kasey L. Jobe<sup>1</sup>, Carmen G. Montaña<sup>2</sup>, Christopher M. Schalk<sup>1</sup>

<sup>1</sup>*Stephen F. Austin State University, Nacogdoches, Texas, USA*, <sup>2</sup>*Sam Houston State University, Huntsville, Texas, USA*

### **Caudates as prey: Predator diversity and size-relationship patterns**

Predators play important roles in ecological communities that can affect both their structure and function. Salamanders are prey to a variety of predators that differ in their foraging tactics (e.g. specialists vs. generalists), morphology, behavior, and ecology. Salamanders are an ideal group to explore and quantify patterns that may affect the evolution and persistence of defensive strategies. Here we examined patterns of predator diversity and body-size relationships of salamander species and its predators. We compiled observations predator-prey interactions using natural history notes from *Herpetological Review* (1975-2018) and *Herpetology Notes* (2008-2018). Our database contains 156 salamander predator-prey interactions comprised of 68 salamander species that were preyed upon by 88 predator species from 30 orders. Snakes were the most frequently reported predators (35% of predations reported), followed by salamander predators (24% of predations reported), and birds (16% of predations reported). Exploring the body-size relationship of the salamander prey, and both snake and salamander predators were consistently eating salamander prey that were smaller than themselves. This pattern is likely attributed to the fact that both types of predators are gape-limited, and are unable to eat prey that attain a certain size refuge. These patterns can serve to help generate hypotheses on the defensive strategies of salamanders.

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## 220 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019

Kasey L. Jobe<sup>1</sup>, Nick Schiwitz<sup>1</sup>, Krista Ward<sup>1</sup>, Dan Saenz<sup>2</sup>, Christopher M. Schalk<sup>1</sup>

<sup>1</sup>*Stephen F. Austin State University, Nacogdoches, Texas, USA*, <sup>2</sup>*U. S. Forest Service, Nacogdoches, Texas, USA*

### **On the Diversity of Erosion Control Products: Implications for Snake Entanglement**

The negative impacts of roads on biodiversity are well known. Roads fragment habitat and cause mortality via wildlife-vehicle conflicts. The construction and maintenance of roadways is often followed by the placement of the erosion control products (ECPs [e.g., erosion control blankets, spray-on mulch]) on the landscape. The Texas Department of Transportation's (TXDOT) approved products list (APL) contains 110 different ECPs that a contractor can install on a construction site. Only two criteria must be met for an ECP to be listed on the APL: 1) the ECP must promote vegetation growth, and 2) the product must adequately prevent soil loss. There are

no criteria that consider the impacts ECPs on wildlife. Recent studies have found that snakes are vulnerable to entanglement in ECPs with certain traits (e.g., plastic netting with fused corners). We conducted a meta-analysis to quantify the diversity of traits of the 110 ECPs (i.e. material type, aperture size, mesh type). In addition to identifying the ECPs that would put snakes at a high risk to entanglement, we also identified those ECPs that would likely be the most snake-friendly based on their traits (e.g., woven mesh with a large aperture size). These results can be used to inform and mitigate against the entanglement of snakes and other wildlife in ECPs and limit an additional source of mortality.

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**301 General Ichthyology II, Cottonwood A-D – The Snowbird Center, Saturday 27 July 2019**

G. David Johnson

*Division of Fishes, National Museum of Fishes, Smithsonian Institution, Washington, DC, USA*

**Revisions of Anatomical Descriptions of the Pharyngeal Jaw Apparatus in Moray Eels of the Family Muraenidae (Teleostei: Anguilliformes)**

Fishes of the anguilliform family Muraenidae (moray eels) comprise two subfamilies of highly specialized benthic forms. As first documented and described in two earlier papers, morays have a highly specialized raptorial feeding apparatus in which they move their upper pharyngeal jaws forward into the oral cavity to grasp prey and transport it back into the oesophagus. As stated by the authors, the primary goals of the second paper were to provide a detailed analysis of the protraction and retraction mechanics and in so doing to offer a unifying terminology for the branchial muscles involved in order to clarify purported confusion of the terminology used in earlier descriptions. Here I revisit the descriptive aspects of the second paper and compare them to my own investigations of the topographic anatomy of this apparatus. Regrettably, my observations of the relevant anatomical details and terminology differ markedly from those presented in that paper. Discrepancies include identity of bony and muscular components (homologies), terminology, reports of presence or absence of elements and attachment (insertion and origin) sites. Accordingly, I describe and illustrate my observations, compare them to previous descriptions and discuss possible functional implications. In contrast to the earlier paper I offer detailed argumentation and justification for my terminology and identification of relevant gill-arch muscle in muraenids. Based on my re-interpretation of the topographic anatomy of the pharyngeal musculature, three conspicuously different anatomical mechanisms of pharyngeal jaw protrusion and retraction are identified.

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**369 SSAR RABB UNDERGRADUATE AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Josiah Johnson



Colby College, Waterville, Maine, USA

## **Conservation assessment of the Northern Black Racer, *Coluber constrictor constrictor*, in Maine**

The Black Racer (*Coluber constrictor*) is a large-bodied snake species found across North America. One subspecies, the Northern Black Racer (*C. constrictor constrictor*) is listed as State Endangered in Maine, which marks the northern extent of its range, and is restricted to four small sub-populations in southern York County. Although Northern Black Racers have generally been found to prefer open habitats and ecotones, much remains to be learned about the specific habitat preferences of racers in Maine. To address this knowledge gap, the Maine Department of Inland Fisheries and Wildlife (MDIFW) is conducting a multi-year telemetry study at four sites habited by racers. I analyzed racer habitat use at one of these sites during the summer of 2018 to determine location, habitat preferences, and behavior. Racers preferred open habitat dominated by sweet fern, lowbush blueberry, and *Rubus* species. Habitat preferences were further assessed using compositional analysis and Euclidean distance analysis models. Seasonal or individual roaming behavior did not vary significantly. Snakes exhibited strong anti-predator behavior, fleeing upon sight and crossing between open and forested areas to avoid being followed. To evaluate potential differentiation among three of the four known sub-populations, previously developed microsatellites were assessed for differences in the number of repeated motifs. DNA was extracted from previously collected ventral scales and analyzed using 6-FAM labelled primers. Results indicate that conservation of Maine's racer population should focus on maintaining open, spatially heterogenous habitat with sufficient cover for racers to hide from predators.

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## **63 AES Conservation & Management IV/Behavior, Rendezvous A&B – The Snowbird Center, Sunday 28 July 2019**

Christian Jones<sup>1</sup>, William Driggers<sup>1</sup>, Kristin Hannan<sup>2</sup>, Eric Hoffmayer<sup>1</sup>, Diva Amon<sup>3</sup>, Brian Kennedy<sup>4</sup>

<sup>1</sup>National Marine Fisheries Service, Pascagoula, MS, USA, <sup>2</sup>Riverside Technology Inc., Pascagoula, MS, USA, <sup>3</sup>Natural History Museum, London, United Kingdom, <sup>4</sup>Boston University, Boston, MA, USA

## **Deepwater remotely operated vehicle surveys document rare and obscure chondrichthyans in the northern Gulf of Mexico**

Surveys of deepwater habitats are rare and opportunities to make *in situ* observations of deepwater fauna are even rarer. As a result, our knowledge of deepwater chondrichthyan fauna is, in general, very limited. As human activities push farther into the deep ocean and potentially threaten deepwater ecosystems, data concerning the biology and habits of these species will become increasingly important. During the winter of 2017-2018, two expeditions were

conducted aboard the National Oceanic and Atmospheric Administration's Research Vessel Okeanos Explorer utilizing a remotely operated vehicle to explore deepwater habitats in the United States waters of the northern Gulf of Mexico. Over the course of the two expeditions, 32 dives were conducted to depths ranging from approximately 300 to 3000m. During nine of these dives, 21 separate observations were recorded of eight chondrichthyan species ranging in depth from 400 to 1918m. In several cases, distinct differences were noted between observed individuals and previous morphological descriptions. These observations will enable us to clarify several aspects of the biology and ecology of these poorly understood species.

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#### **491 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Gavin Jones, Gavin Munson, Kyson McBride, Joshua Sigg, William Heyborne

*Southern Utah University, Cedar City, UT, USA*

#### **Dietary Analysis of Invasive Spiny Softshell Turtles (*Apalone spinifera*) in Colorado River Tributaries: An Ecological Impact Investigation**

The Spiny Softshell Turtle (*Apalone spinifera*) is native to the Midwest and Southeast United States. However, these turtles were introduced into the Gila-Colorado River System in the early 20<sup>th</sup> century and have since expanded their range north and west into tributaries of the Colorado River in southern Nevada and southwestern Utah. Initial observations suggest that the Muddy and Virgin Rivers support a population numbering in the thousands, yet no study has been conducted to investigate their impacts on the system – including their diet. Hence, we determined to explore the diet of *A. spinifera*, collected from these rivers, in order to examine how this exotic invasive impacts native species. We hypothesized that these turtles are feeding heavily on fish, notably threatened and endangered species, and pose a threat to the sustainability of these native endemic species. Stomach content analyses have provided a comprehensive view of the diet of this invasive species in previously turtle free systems. Here we report on those findings as well as future goals for this project.

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#### **113 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Katherine Jones, John Peterson

*University of Wisconsin-Platteville, Platteville, WI, USA*

#### **Environmental variation in Green Frog (*Lithobates clamitans*) tadpole body morphology**

Many studies have observed that environmental variables, such as predators, can influence tadpole body morphology. Fewer studies have evaluated the natural variation among aquatic habitats. We quantified Green Frog (*Lithobates clamitans*) tadpole body morphology at large and

small retention ponds and a fen in Platteville, WI as part of a comparative anatomy course. Tadpoles at the fen had significantly longer total body lengths and tail lengths, but significantly smaller bodies. Several different variables may be attributable to these differences. We suggest that professors interested in bringing undergraduate research into the classroom, should consider doing projects in their courses observing variation in tadpole body morphology.

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**539 ASIH STOYE CONSERVATION AWARD, Cottonwood A-D – The Snowbird Center, Friday 26 July 2019**

Kenny Jones II<sup>1</sup>, Michael Sandel<sup>1</sup>, Bernie Kujahda<sup>2</sup>

<sup>1</sup>The University of West Alabama, Livingston, Alabama, USA, <sup>2</sup>Tennessee Aquarium Conservation Institute, Chattanooga, Tennessee, USA

**Conservation Genomics of the Mobile Basin Endemic Coal Darter (*Percina brevicauda*)**

The Coal Darter (*Percina brevicauda*) is endemic to three watersheds in the upper eastern part of the Mobile Basin in Alabama (Suttkus et al. 1994). Populations of Coal Darters have been declining (Warren et al. 1997, 2000), and are facing threats within the Cahaba River, Hatchet Creek, and Locust Fork watersheds. Tissue samples (n=66) were collected from the three extant populations for population genomic analyses. Analysis of mitochondrial DNA (mtDNA) and nuclear single nucleotide polymorphisms (SNP's) provide molecular evidence that Coal darters are a monophyletic species within the *Cottogaster* subgenus, and that all three populations of Coal Darters represent monophyletic clades. Hatchet Creek is the most isolated population according to our genomics survey, and our results indicate significant genomic structure in the Hatchet Creek samples with mtDNA and nuclear SNP evidence. Samples collected from the Locust Fork of the Black Warrior River reveal strong genomic structure in the population as well as little to no retention of ancestral polymorphisms. Cahaba River samples resulted in notable genomic structure, but they exhibit more genomic diversity and have retained more ancestral polymorphisms than Hatchet Creek and Locust Fork samples. Our genomics survey has resulted in the identification of three separate evolutionary significant units (ESU's), and these units should be treated as priorities for conservation and management to prevent further habitat loss and fragmentation that will lead to the extirpation of this species.

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**755 ASIH STOYE GENETICS, DEVELOPMENT & MORPHOLOGY AWARD II, Primrose A&B – Cliff Lodge, Friday 26 July 2019**

Leonard Jones<sup>1</sup>, Adam Leache<sup>1</sup>, Frank Burbrink<sup>2</sup>

<sup>1</sup>University of Washington, Seattle, WA, USA, <sup>2</sup>American Museum of Natural History, New York, NY, USA

## **Range wide Phylogeography and Demography of the Common Garter Snake *Thamnophis sirtalis***

The evolutionary history of widely distributed species can elucidate the impacts of biogeographic breaks on gene flow across time and space and on phenotypic variation within species. The common garter snake *Thamnophis sirtalis* is among the most well studied reptiles in the world for its reproductive and behavioral ecology and extensive phenotypic variation, but its range wide demographic and phylogeographic history have yet to be deeply explored. Here we characterize the effects of ecology and historical glacial cycles on intraspecific genetic variation using a combination of population genetic, phylogenetic, and demographic modeling methods across high throughput sequence data. We present previously undetected deep divergence events unfettered by contemporary gene flow and discuss the confounding impact of different bioinformatic pipelines on the phylogenetic placement of spatially adjacent lineages. Finally, we comment on the taxonomic status of populations within *T. sirtalis* and the impact of regional ecology and phylogenetic history on its present day population structure.

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### **175 Reptile Conservation, Ballroom 2 – Cliff Lodge, Saturday 27 July 2019**

Jillian Josimovich<sup>1</sup>, Amy Yackel Adams<sup>1</sup>, Melia Nafus<sup>1</sup>, Charlotte Robinson<sup>1</sup>, Austin Fitzgerald<sup>1</sup>, Robert N. Reed<sup>1</sup>, Bryan Falk<sup>2</sup>, M. Rockwell Parker<sup>3</sup>

<sup>1</sup>U.S. Geological Survey, Fort Collins, CO, USA, <sup>2</sup>National Park Service, Homestead, FL, USA,

<sup>3</sup>James Madison University, Harrisonburg, VA, USA

### **Exploring the Potential for Hormone Manipulation and Pheromonal Attractants to Improve Detection and Control of Invasive Burmese Pythons in Florida**

Cost-effective control tools are lacking for invasive Burmese pythons (*Python bivittatus*) in the Florida Everglades, largely due to their extremely cryptic nature and low detectability (i.e., < 1%). Female Burmese pythons produce pheromones that attract breeding aggregations of males, providing an opportunity to develop tools that take advantage of reproductive physiology and behavior to improve detection and control. For example, radio-telemetered male “Judas” snakes can lead us to breeding aggregations. Pheromones are excreted through the skin to communicate qualities such as sex, health, and reproductive interest. Although sex pheromones are probably species specific, expression appears to be activated by 17 $\beta$ -estradiol in all snakes. Male red-sided garter snakes (*Thamnophis sirtalis parietalis*) implanted with estradiol express female sex pheromones and elicit courtship behaviors from other males. Estradiol implantation has also induced female-typical methyl ketone production and subsequent attractiveness in males in another invasive snake species, the brown treesnake (*Boiga irregularis*). Estradiol implantation into male pythons may “feminize” them and result in breeding aggregations around these Judas males, improving overall detection and representing a novel early detection or rapid response tool for pythons. Consequently, we are conducting research in south Florida to characterize seasonal sex hormone and pheromone profiles in pythons, assess python behavioral responses to sex pheromones during the breeding season, and evaluate whether we can manipulate hormones

in male pythons to simulate female sex pheromone expression. We view this research as a step towards understanding the basic reproductive biology of Burmese pythons and developing novel control tools such as pheromonal attractants.

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**524 ASIH STOYE GENERAL HERPETOLOGY AWARD II, Primrose A&B – Cliff Lodge, Thursday 25 July 2019**

Kathlene Joyce<sup>1,2</sup>, Malorie Hayes<sup>2</sup>, Jacqueline Potter<sup>3</sup>, Craig Guyer<sup>2</sup>

<sup>1</sup>University of Alabama Birmingham, Birmingham, AL, USA, <sup>2</sup>Auburn University, Auburn, AL, USA, <sup>3</sup>East Tennessee State University, Johnson City, TN, USA

**Phylogeography of the slimy salamander complex (*Plethodon*, Plethodontidae) in Alabama**

The state of Alabama is purported to be home to three of the sixteen lineages of slimy salamanders (the *Plethodon glutinosus* complex): *P. glutinosus*, *P. grobmani*, and *P. mississippi*. The distribution of these species roughly correlates with known biogeographic regions in Alabama such as the Apalachicola River discontinuity, the Tombigbee River discontinuity and the Fall Line. The boundaries of the three species across the state are poorly defined, and the monophyly of the species has been questioned. In this study, we test the monophyly of the three species by sampling 40 individuals of slimy salamander from across the state. We genetically analyzed the specimens using two genes: mitochondrial cytochrome b and nuclear RPL12. For the mitochondrial data, our samples were combined with unpublished sequences of 55 additional specimens from Alabama. We see no evidence for three monophyletic lineages of slimy salamander in the state of Alabama. Instead, we see evidence of a single, widespread population. We conclude that Alabama contains a single species of slimy salamander, *Plethodon glutinosus*, with complex genetic connectivity within the state.

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**284 Herpetology Lightning Talks, Ballroom 3 – Cliff Lodge, Saturday 27 July 2019**

Nathalie Jreidini

McGill University, Montreal, Quebec, Canada

**Population dynamics of an endangered amphibian across a changing landscape**

Fowler's toad (*Anaxyrus fowleri*) has been assessed as Endangered in Canada by both COSEWIC and COSSARO. The population under study resides in Long Point, Ontario, along the northern shore of Lake Erie, and is one of very few Fowler's toad populations in Canada. Nightly surveys during the spring and summer seasons over the past 30 years (1989-2018) have been conducted to monitor this population, whereby individual toads were identified based on the pattern of their warts. The species decline has been determined to be initially due to loss of breeding habitat resulting from the invasion of *Phragmites australis* reeds. However, contrary to previous predictions, the toad population abundance has not bounced back following

conservation initiatives such as the eradication of reeds and the creation of additional breeding ponds near occurrence sites. Instead, the population at Long Point continues to decline in numbers, and toad breeding attempts are low based on the minimal number of calling males reported during breeding seasons in more recent years. The objectives of this study are to: (1) explain the variation in annual rate of change in Fowler's toad population abundance at Long Point by subjecting our 30-year dataset to a time series analysis, and (2) quantitatively analyze Fowler's toad movements with the use of occurrence data and a biased correlated random walk model to detect a potential movement bias.

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### **397 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Bryan Juarez<sup>1</sup>, Daniel Moen<sup>2</sup>, Dean Adams<sup>1</sup>

<sup>1</sup>*Iowa State University, Ames, Iowa, USA*, <sup>2</sup>*Oklahoma State University, Stillwater, Oklahoma, USA*

#### **Does Morphology Predict Interspecific and Intraspecific Jumping Performance in Frogs?**

Ecological and evolutionary processes depend on individual fitness. Oftentimes, organismal performance is a more accurate predictor of individual fitness than morphology. Recent work has shown that organismal performance, such as feeding performance in fishes, can sometimes be estimated from morphology. Here we test whether morphological proxies can predict jumping performance 1) at the interspecific level across 44 species of frogs, and 2) at the intraspecific level within 5 different species of frogs. First, we used biological and physical principles to mathematically derive three anatomical proxies for three aspects of jumping performance: jumping velocity, energy, and power. These morphological proxies use non-invasive anatomical measurements such as the tibiofibula length, leg length, body size, and mass of frogs to estimate jumping performance. Second, we used ordinary least squares regression methods (and phylogenetically generalized least squares regression, where applicable) to assess the precision with which these morphological proxies allow us to predict jumping performance across the morphological, ecological, and geographical diversity of frogs. Preliminary analyses indicate that we are reasonably able to estimate all three aspects of jumping performance: jumping velocity, energy, and power. The ability to predict jumping performance from morphology (using live animals or museum specimens) allows the rapid sampling of many individuals. Therefore, relative to traditional laboratory methods, this new method enables us to more easily collect the large sample sizes necessary to test different population- and macroevolutionary-level hypotheses regarding the jumping performance of frogs.

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### **349 Ichthyology Conservation, Cottonwood A-D – The Snowbird Center, Saturday 27 July 2019**

Dovi Kacey<sup>1,2</sup>, Luke Thompson<sup>3</sup>, Kelly Goodwin<sup>3</sup>, Anne Freire de Carvalho<sup>1</sup>, Andrew Thompson<sup>1</sup>

<sup>1</sup>*Southwest Fisheries Science Center, La Jolla, California, USA*, <sup>2</sup>*Southern California Coastal Water Research Project, Costa Mesa, California, USA*, <sup>3</sup>*Atlantic Oceanographic and Meteorological Laboratory, Miami, Florida, USA*

## **Metabarcoding to Increase Ichthyoplankton Sampling Capacity**

Pelagic ecosystems are difficult to study due to their scale, vagility of their inhabitants, and myriad of stochastic processes. Quantifying the spatio-temporal distribution of ichthyoplankton is useful to better understand marine dynamics and assess ecosystem health. Traditionally, the study of ichthyoplankton is a laborious process; increasing sampling capacity, would allow for more accurate assessment of population and assemblage structure. The morphology of many species at these life stages also makes ichthyoplankton analyses prone to identification errors. DNA-based identification can more accurately identify morphologically indistinguishable species. Technological advances in high-throughput genetic sequencing have the potential to increase the spatio-temporal coverage of ichthyoplankton surveys. To implement these molecular tools in a management framework, they need to be validated relative to traditional methods. Here, we utilize traditional, morphological and single-specimen sequencing approaches to identify ichthyoplankton, analyze the samples using metabarcoding, and evaluate the similarity of those methods. Next, we test the detection threshold for particular species to provide information on both presence and pseudo-absence. Finally, we test the sensitivity of the metabarcoding approach to extraction variability. We aim to apply metabarcoding to improve fishery stock assessments and ecosystem assessments and enable the development of bioassessment indices to understand anthropogenic impacts on pelagic ecosystems.

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**174 AES Symposium: The Sensory Biology of Elasmobranch Fishes, Rendezvous A&B – The Snowbird Center, Saturday 27 July 2019**

Stephen Kajiura

*Florida Atlantic University, Boca Raton, FL, USA*

## **Impact on Elasmobranch Research of the Donald R. Nelson Award**

The Donald R. Nelson award was established in 1999 to facilitate the study of sensory biology and behavior of elasmobranch fishes. Since then, 16 research grants have been awarded for a total value of nearly \$16,000. Awards have been granted to students throughout the United States and in Australia with award recipients being biased toward females (63%). The Nelson award has supported research resulting in at least 29 publications in peer reviewed journals. Award recipients have gone on to various positions both inside and outside of academia. Eight recipients are currently tenured or in tenure track positions. Three are currently post-doctoral researchers, two are in academic support positions, one is a student, and two are in the private sector outside of academia. Nelson award recipients are now found in 9 US states, and in

England and Germany. Research projects supported by the Nelson award include topics in both sensory biology (lateral line, vision, hearing, olfaction, electroreception, magnetoreception) and behavior (feeding, defensive, stress). The Nelson award fund has grown by over three hundred percent since inception and continues to both grow and generate sufficient surplus to support an annual award. The broad mandate of the Nelson fund allows grants to be awarded in a variety of fields making it accessible to many students throughout the American Elasmobranch Society.

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**177 ASIH STOYE PHYSIOLOGY & PHYSIOLOGICAL ECOLOGY AWARD, Primrose A&B – Cliff Lodge, Friday 26 July 2019**

Larry Kamees, Steven Beaupre

*University of Arkansas, Fayetteville, Arkansas, USA*

**Balancing Foraging and Thermoregulation: Can Thermal Conduction Counter Frequent Solar Exposure in an Ectothermic Ambush Predator?**

Ectothermic ambush predators face the unique challenge of balancing thermoregulatory needs with an ambush foraging strategy in thermally heterogeneous environments. For example, the Timber Rattlesnake (*Crotalus horridus*) must avoid frequent movements to prevent revealing itself to potential prey while avoiding recurring exposure to direct solar radiation (thermal transients). We asked, how does the Timber Rattlesnake offset frequent thermal transients while remaining relatively motionless while foraging? We hypothesized thermal conduction from the body core ( $T_b$ ) to the ground-venter interface ( $T_g$ ) played a significant role in countering incoming radiation heat loads on the dorsal skin surface ( $T_s$ ). We gathered temperature data from field active Timber Rattlesnakes along with incoming short-and long-wave radiation and calculated conduction rates from  $T_s$  to  $T_b$  and from  $T_b$  to  $T_g$ . Mean  $Q_{cond}$  for  $T_s$  to  $T_b$  and  $T_b$  to  $T_g$  were relatively similar ( $\bar{x}$  = 2.21 W, SD = 0.09 and  $\bar{x}$  = 3.65 W, SD = 0.11, respectively). We did not observe a linear relationship between the two conduction rates (Pearson's  $r$  = -0.198,  $df$  = 15,  $p$  = 0.447). Our data also indicate a decoupling between  $T_s$  and  $T_g$  and therefore, the two conduction rates as total incoming radiation on the dorsal surface increases. Thus, thermal conduction to the ground apparently plays a relatively insignificant role in balancing incoming heat loads from direct solar radiation: offering quantitative support for a heat storage mechanism (mass) that appears to buffer rapid increases in heat load.

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**529 SSAR SEIBERT SYSTEMATICS AND EVOLUTION AWARD I, Ballroom 2 – Cliff Lodge, Friday 26 July 2019**

Benjamin Karin<sup>1</sup>, Michael Lough-Stevens<sup>2</sup>, Sean Reilly<sup>3</sup>, Anthony Barley<sup>4</sup>, Jimmy McGuire<sup>1</sup>, Indraneil Das<sup>5</sup>, Todd Jackman<sup>6</sup>, Aaron Bauer<sup>6</sup>

<sup>1</sup>*University of California Berkeley, Berkeley, CA, USA*, <sup>2</sup>*University of Southern California, Los*



Angeles, CA, USA, <sup>3</sup>University of California Santa Cruz, Santa Cruz, CA, USA, <sup>4</sup>University of California Davis, Davis, CA, USA, <sup>5</sup>Universiti Malaysia Sarawak, Kuching, Sarawak, Malaysia, <sup>6</sup>Villanova University, Villanova, PA, USA

## **Seafaring Skinks? Range-wide phylogeography of *Eutropis multifasciata* and the role of genetic priority effects in shaping mainland-island dispersal dynamics**

The many-lined sun skink, *Eutropis multifasciata*, is one of the most widespread and common reptiles in Southeast Asia, and previous studies have identified genetic structuring between samples on opposite sides of its range. We investigated historical biogeography and tested for the source and extent of human-mediated dispersal by sequencing 330 individuals from across the entire range for mitochondrial ND2, and a subset of 61 individuals for restriction site associated DNA sequencing (RADseq). The RADseq and mitochondrial trees show strong concordance and uncover differential patterns on mainland Southeast Asia and the Sunda Shelf when compared with patterns in Wallacea. Contrary to expectations of high connectivity on the mainland versus low dispersal on the islands, mainland Southeast Asia and the Sunda Shelf contain distinct and non-overlapping geographically structured clades, while the Wallacean islands show rampant colonization and overlap of mitochondrial haplotypes. We use this system to model how a strong versus weak genetic priority effect on the mainland versus the islands could have led to different probabilities of allele colonization success after dispersal. In addition, using a species distribution model informed with species-specific thermal physiological data, we show that there have been multiple cases of human-mediated dispersal into previously uninhabitable parts of its range, including the islands of Hainan and Taiwan.

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## **217 Turtle Conservation/Amphibian Conservation, Ballroom 3 – Cliff Lodge, Friday 26 July 2019**

Nancy Karraker<sup>1</sup>, Mirza Kusri<sup>2</sup>, Jessica Atutubo<sup>1</sup>, Ryan Healey<sup>1</sup>, Aini Yasratul<sup>2</sup>

<sup>1</sup>University of Rhode Island, Kingston, RI, USA, <sup>2</sup>Institut Pertanian Bogor, Bogor, Indonesia

## **Ecological Roles of One of the World's Most Heavily Traded Turtles**

The Southeast Asian box turtle (*Cuora amboinensis*) is numerically the most important turtle exported from Indonesia. Listed as Vulnerable by the IUCN, this turtle is heavily harvested in Indonesia for food and traditional medicine trades largely in China and for the pet trade in the US, Japan, and Europe. Despite its significance in global markets, very little is known about the species' importance to ecosystems. We conducted our research in a national park in Sulawesi, Indonesia, and our objectives were to document food habits, capacity for seed dispersal, and whether ingestion of seeds by *C. amboinensis* enhances germination. We obtained feces from 200 individual turtles and found that the species is omnivorous, feeding on crustaceans, mollusks, insects, vertebrates, and plants. In a seed passage experiment, turtles passed seeds for 3–9 days after ingestion. Radio-tracked turtles moved, on average, about 35 m per day, between terrestrial and aquatic habitats, indicating that seeds from ingested fruits could be dispersed

moderate distances from the parent tree. In a seed germination experiment, we found that ingestion by turtles increased germination success of seeds of three of six plant species tested, as compared with control seeds. Two of the tree species that benefited from ingestion are two of the most common trees in the national park and are also highly valued outside of the park for their lumber for house and furniture building. Protection of *C. amboinensis* populations may be essential for maintaining important ecological roles that benefit biodiversity and local economies.

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**126 SSAR SEIBERT CONSERVATION AWARD I, Ballroom 1 – Cliff Lodge, Friday 26 July 2019**

Emily Karwacki, Katherine Martin, Anna Savage

*University of Central Florida, Orlando, Florida, USA*

**100 Years of Infection With Three Global Pathogens in Amphibian Populations of Florida, USA**

Anuran populations have been documented declining and experiencing mass mortality events since at least the 1970s, and pathogens have played major roles in these declines. In particular, the fungus *Batrachochytrium dendrobatidis* (*Bd*), the iridovirus *Ranavirus* (*Rv*), and the protist *Perkinsea* (*Pr*) have been implicated as affecting global anuran populations most severely. Despite the extensive bodies of research on *Bd* and *Rv*, and the growing body of research on *Pr*, we don't know enough. In many cases it remains unknown how long these pathogens have been present, which species are more susceptible, and whether they have evolved over time. Here we used time series of museum specimens, specifically those of the genus *Rana* from Florida, to detect and quantify pathogens in anurans dating back to 1922. We found that *Bd* and *Pr* have been present in Florida anurans since at least 1928, and *Rv* since at least 1922. This also represents the first documented case of tri-infection with these three pathogens, which we were able to detect in three different individuals dating back to 1928. In addition, Sanger sequencing of *Bd*- and *Pr*-positive specimens revealed few SNPs or indel changes over time, indicating that these pathogens have undergone little pathogen evolutionary change since the 1920s. Overall, these three pathogens were found present in at least six out of seven species tested, in every region of Florida, throughout every decade since the 1920s, and in every life stage, changing and adding to current knowledge about these pathogens in the state.

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**724 Reptile Ecology, Primrose A&B – Cliff Lodge, Saturday 27 July 2019**

Anna Kase, Jacob Kerby

*University of South Dakota, Vermillion, South Dakota, USA*

## **Turtle Distribution and Abundance in a Modified River Habitat in South Dakota**

Five turtle species are native to the South Dakota portion of the Missouri River: smooth softshell turtles (*Apalone mutica*), spiny softshell turtles (*Apalone spinifera*), painted turtles (*Chrysemys picta*), common snapping turtles (*Chelydra serpentina*), and the state threatened false map turtles (*Graptemys pseudogeographica*). While historically *G. pseudogeographica* were found in the northern stretches, damming of the river formed Lake Oahe where *G. pseudogeographica* are now seldom found. During 2017 and 2018, we conducted surveys along the northern and southern stretches of the river to estimate the distribution and abundance of these species. We performed visual surveys from boats driven along the shoreline, set baited hoop-net traps, and collected habitat data both during surveys and from satellite imagery. We detected all five species of turtles and found strong associations between different turtle species and specific habitat features. *A. mutica* and *C. picta* were associated with rock and gravel basking substrates found in the reservoir, while *G. pseudogeographica* with deadwood basking substrates found in riverine habitats. We found 0.21 deadwood basking sites per shoreline mile surveyed in Lake Oahe, compared to 5.0 basking sites/shoreline mile downstream of the Oahe Dam and 9.0 basking sites/shoreline mile in a more southern reach. The association of suitable basking habitat with *G. pseudogeographica* abundance suggests that the loss of this habitat feature may play an important role in their reduced distribution. While removal of dams is unlikely, the implementation of woody debris might contribute to maintaining any small population still persisting in Lake Oahe.

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## **100 ASIH STORER ICHTHYOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Jerry Kattawar III, Kyle Piller

*Southeastern LA University, Hammond, LA, USA*

## **Comparative population genetics of two Darters (*Etheostoma: Catonotus*) in western Kentucky**

The Relict Darter, *Etheostoma chienense*, is endemic to the Bayou du Chien drainage of western Kentucky. It is currently listed as a federally endangered species due to its limited distribution, lack of suitable spawning habitat, habitat fragmentation, and historically poor land-use practices in the basin. A previous five-year status review suggested that information on the levels of genetic exchange among populations within the basin was needed. Therefore, we undertook a comparative population genetic study to investigate the genetic structure and levels of gene flow among populations of the *E. chienense*. For comparison, we also gathered population genetic data from a closely related, but non-imperiled congener, *E. c.f. oophylax*, from the East Fork Clarks River (Tennessee River basin). Tissue samples were obtained from ten populations of *E. chienense*, as well as samples from 8 populations of *E. c.f. oophylax*. A comparative framework, like the one incorporated in this study, offers the best approach to understand genetic diversity of

these two closely related species, that are at opposite ends of the conservation spectrum. Next generation sequence data (ddRADseq) was gathered, and multiple SNP loci were extracted and analyzed using multiple population genetic software packages. The results from this study have important conservation implications and fills in a needed data gap for a federally protected species.

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**169 ASIH STOYE GENERAL ICHTHYOLOGY AWARD I, Cottonwood A-D – The Snowbird Center, Thursday 25 July 2019**

Jerry Kattawar<sup>1</sup>, Kyle Piller<sup>1</sup>, Rich Harrington<sup>2</sup>, Dan MacGuigan<sup>2</sup>, Tom Near<sup>2</sup>

<sup>1</sup>*Southeastern LA University, Hammond, LA, USA*, <sup>2</sup>*Yale University, New Haven, CT, USA*

**Phylogenetics of *Stigmacerca*: Resolution of a Group of Egg-Clustering Darters**

Darters (Percidae: Etheostomatinae) are one of the most diverse groups of fresh water fishes in North America with over 250 described species. The spottail darters (*Stigmacerca*) are a group of 11 recognized species that are characterized by a reproductive mode that includes egg-clustering and male nest guarding. Previous molecular phylogenies using concatenated nuclear markers and mtDNA, have shown some inconsistent results leaving the clade's evolutionary history unresolved and in need of further examination. The development of next generation sequencing technologies has allowed for thousands to hundreds of thousands of loci to be used to infer phylogenetic relationships. Here we take advantage of this technology and use ddRADseq data to build a phylogeny of the 11 recognized species, including multiple populations of *E. nigripinne*, within *Stigmacerca*. The data were aligned using iPyrad and analyzed using a maximum likelihood approach in IQtree. The relationships of previously unresolved nodes of the *Stigmacerca* phylogeny, including the placement of *E. forbesi*, *E. olivaceum*, and the undescribed *E. cf. oophylax* from the Clarks River of Kentucky and Tennessee, are now resolved and highly supported. Our results highlight the effectiveness of ddRADseq data and its ability to tease apart the evolutionary relationships of closely related congeners within an extremely diverse group of fishes.

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**480 ASIH/HL/SSAR Symposium: Professional Women in Herpetology: Lessons and Insights, Ballroom 1 – Cliff Lodge, Saturday 27 July 2019**

Maureen Kearney

*American Association for the Advancement of Science, Washington, DC, USA*

**Structural Reform and Systemic Culture Change for STEMM**

Advancing science and science policy for the benefit of society requires a well-resourced and healthy scientific enterprise, with an inclusive culture welcoming to all who wish to pursue

STEMM careers. Numerous research studies demonstrate that innovation, creativity and productivity are enhanced by having a diverse STEMM workforce. That ideal is hampered, however, by continuing barriers such as explicit and implicit bias, and the harassment of women and underrepresented groups. Science has a well-known and serious harassment problem that has resulted in a costly loss of talent. A 2018 National Academies of Sciences, Engineering and Medicine report documented what many already knew from history and experience - that gender and sexual harassment are rampant in academia, and that women and underrepresented groups continue to be driven away from scientific careers. Further, current efforts to address the problem of sexual harassment in science are failing. The entire scientific community has a responsibility to create an inclusive culture and to uphold professional standards of behavior. To achieve sustainable success in this endeavor, significant structural transformations will be required and leadership at every level must commit to incentivizing behaviors, projects, and programs that support this goal. Change must be implemented across multiple sectors – such as institutional and/or departmental programs, professional scientific societies conduct codes, funding agency policies, and legislative action. To that end, promising new initiatives that have the potential to transform STEMM to a ‘*science for all and by all*’ culture will be highlighted.

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## **109 AES GRUBER AWARD II, Rendezvous A&B – The Snowbird Center, Thursday 25 July 2019**

Bryan Keller<sup>1</sup>, Bryan Frazier<sup>2</sup>, Dean Grubbs<sup>1</sup>

<sup>1</sup>Florida State University Coastal and Marine Lab, St. Teresa, FL, USA, <sup>2</sup>South Carolina Department of Natural Resources, Charleston, SC, USA

### **The Spatiotemporal Ecology of the Bonnethead (*Sphyrna tiburo*): Nearshore Parturition, Site Fidelity and the Effect of SST on Migration**

Bonnetheads, *Sphyrna tiburo*, have been shown to exhibit high site fidelity through conventional tagging data, returning exclusively to specific estuaries in South Carolina. To investigate the degree of site fidelity as well as timing and duration of migrations, we tagged 44 bonnetheads with coded acoustic transmitters in the North Edisto River, SC (NER). Results show bonnetheads exhibit temperature driven migrations, returning annually to the NER. During migratory periods, the emigration date from the NER shows little interannual variation, with some individuals leaving the estuary on the same day across multiple years. Sea-surface Temperature (SST) was found to have a significant effect on migration distance and duration. In 2017-18, which was 1.3 °C degrees colder than 2016-17, the mean one-way migration distance was over 80% longer than the year prior (470.85km v. 259.75km). These longer trips also took more time, differing by 37.44 days on average. We also tracked females throughout parturition during multiple reproductive cycles and identified a unique behavior where individuals leave their summer residence, swim ~ 50 miles south, likely giving birth in nearshore waters, and return to the NER. These acoustic data were corroborated with nearshore trawls and examination of reproductive tracts. Collectively, these results have important conservation implications for Bonnetheads, as delineating pupping grounds and the spatiotemporal variation in migration can allow for the

effective implementation of management strategies. Additionally, by documenting the effect of SST, we can estimate the impact of climate change and how overall energetics vary based upon climatic conditions.

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**354 ASIH STOYE CONSERVATION AWARD, Cottonwood A-D – The Snowbird Center, Friday 26 July 2019**

Allison Kelley<sup>1</sup>, Shane Welch<sup>1</sup>, John Holloway<sup>2</sup>, Will Dillman<sup>3</sup>, April Atkinson<sup>4</sup>, Jayme Waldron<sup>1</sup>

<sup>1</sup>Marshall University, Huntington, WV, USA, <sup>2</sup>Parris Island Marine Corps Recruit Depot, Port Royal, SC, USA, <sup>3</sup>SCDNR, Columbia, SC, USA, <sup>4</sup>James W. Webb Wildlife Center and Management Area, Garnett, SC, USA

**The Effectiveness of Long-Distance Translocation of Eastern Diamondback Rattlesnakes (*Crotalus adamanteus*)**

Eastern diamondback rattlesnakes (*Crotalus adamanteus*) have a limited ability to adapt to habitat loss and fragmentation due to the species' slow life history and limited dispersal ability. Translocations have the potential to help mitigate the effects of habitat loss on a species with life history constraints that limit the species' ability to respond to landscape change. In July 2018, we translocated twelve adult eastern diamondback rattlesnakes from Parris Island to a wildlife management area. We radio located the rattlesnakes approximately three times weekly during the active season and once per week during the inactive season for one year following translocation. We created 95% minimum convex polygons for each individual and used a paired t-test to compare pre- and post-translocation home ranges. Post-translocation home ranges ( $38.2 \pm 34.3$  ha) tended to be larger than the pre-translocation home ranges ( $14.6 \pm 10.3$  ha), but we failed to detect a significant difference between the two groups, reflecting limited power due to small sample size. We suspect that large post-translocation home ranges reflect an increase in long-distance and erratic movements when a snake is introduced to a novel environment, as well as the difference in coastal and inland woodland habitats. In order for translocations to be a viable conservation strategy for eastern diamondback rattlesnakes, more research is needed to determine the effects of larger home ranges on the long-term viability of translocated populations.

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**726 Herpetology Ecology & Behavior, Primrose A&B – Cliff Lodge, Saturday 27 July 2019**

Meghan Kelley, Che Ka, Mary Mendonca

Auburn University, Auburn, AL, USA

**Multimodel Signal Use in Gopher Tortoises**

Multimodal signaling in social interactions can backup or reinforce specific messages in intraspecific communication. For example, in gopher tortoises, the chin gland may serve as a visual signal by its enlargement during the mating season, or a chemical signal in which its secretions can provide information about species, sex, and possible individual recognition. In this study, we used sexually mature gopher tortoises (*Gopherus polyphemus*) in two separate experiments to examine chemical presentations of the chin gland secretions vs. distilled water on cotton swabs and also, chemical and visual presentations with chin gland secretions vs. distilled water on resin tortoise models in paired-choice experiments. Using these two experiments, we had the ability to examine tortoise behavioral responses towards the simple chemical presentation to assess if chin gland secretions are in fact a social cue recognized by tortoises and then, to assess the interplay of chemical and visual presentation of cues with the actual presence of a tortoise model. We found that tortoises of both sexes spent more total time ( $p < 0.001$ ) and performed a higher number of behaviors ( $p < 0.001$ ) with the chin gland-treated model, relative to the negative control distilled water-treated model. Also, the model experiment showed a significant difference in total numbers of behaviors towards the chin gland-treated model. This chin gland-treated model preference was further examined in multivariate analyses, which ultimately suggested that tortoises may prioritize chemical cues but do use both modality types in intraspecific communication.

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**728 SSAR HUTCHISON ECOLOGY, NATURAL HISTORY, DISTRIBUTION, & BEHAVIOR AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Audrey Kelly, Karin Pfennig

*University of North Carolina, Chapel Hill, NC, USA*

### **Spadefoot toad females do not avoid mating with sterile F1 hybrid males.**

Reinforcement predicts that selection should act to prevent the production of un-fit hybrids. It follows that selection should also act to prevent pure-species individuals from mating with those un-fit hybrids. In the spadefoot toads *Spea bombifrons* and *Spea multiplicata*, F1 hybrid males are sterile, yet still attend breeding aggregations and call to attract potential mates. We predicted that if selection is acting to reinforce species boundaries, females of both species should avoid mating with F1 hybrid males, even when presented with heterospecific calls as an alternative, as doing so would be a dead-end for fitness. We tested this prediction in laboratory phonotaxis experiments where individual females (both *S. bombifrons* and *S. multiplicata*) were presented with two different stimulus pairs, all using synthesized male calls: (1) conspecific vs. F1 hybrid, and (2) heterospecific vs. F1 hybrid. Contrary to our expectations and the predictions of reinforcement, females of both species showed no significant preferences for either con- or heterospecific calls over F1 hybrid calls. Consequently, females may end up mating with sterile hybrid males, resulting in no offspring. However, hybridization between these two species is selectively favored for *S. bombifrons* females under certain environmental conditions, as hybrid tadpoles develop faster than pure *S. bombifrons* tadpoles, and female F1 hybrids are fertile.

Selection promoting hybridization in some situations may in turn affect female preferences in such a way that they make deleterious choices when confronted with F1 hybrid male calls.

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#### **464 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Megen Kepas<sup>1</sup>, Ted Turner<sup>2</sup>, Al Savitzky<sup>1</sup>

<sup>1</sup>Utah State University, Logan, UT, USA, <sup>2</sup>VA Dept. of Environmental Quality, Harrisonburg, VA, USA

#### **Adrenal histology among snakes with differing levels of toad consumption**

Increased adrenal size has been reported in several species of snakes that consume toads as a major element of their diet. However, the physiological mechanisms and histological characteristics underlying adrenal hypertrophy are not fully understood. Toads (Bufonidae) produce steroid toxins known as bufadienolides, and snakes that prey on toads possess a resistant paralogue of Na<sup>+</sup>/K<sup>+</sup>-ATPase, the sodium-potassium exchanger that is antagonized by bufadienolides. Although that mutation confers tolerance to toad toxins by lowering the binding affinity of bufadienolides, genetic resistance does not closely correlate with toad specialization, suggesting that additional mechanisms of resistance may be involved. Adrenal glands are comprised of two main cell types: chromaffin cells, which secrete the catecholamines epinephrine and norepinephrine; and interrenal cells, which produce corticosteroids, such as aldosterone and corticosterone. Aldosterone in particular plays a large role in ion regulation. The interrenal cells comprise most of the squamate adrenal gland, whereas chromaffin cells occur as scattered islets throughout the gland and, in most species, also as a dense chromaffin cap. Here we compare the proportion and distribution of chromaffin and interrenal cells in the adrenal glands of a toad specialist, *Heterodon platirhinos*; a genetically resistant and facultative toad-eater, *Thamnophis sirtalis*; and a nonresistant species that does not prey on toads, *Pantherophis alleghaniensis*.

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#### **255 Amphibian Disease, Ballroom 3 – Cliff Lodge, Sunday 28 July 2019**

Jacob Kerby

University of South Dakota, Vermillion, SD, USA

#### **An update on the Bsal Task Force**

*Batrachochytrium salamandrivorans* (Bsal) is an emerging infectious disease that has caused recent die offs in Europe. To mitigate negative effects to North American amphibian populations, a task force was formed in 2015. This Bsal Task force is comprised of experts from many fields of biology and is open for participation by interested academics. As the current chair



of this group, I will highlight the recently released Strategic Plan and provide updates from each of the established sub-committees regarding topics on Surveillance/Monitoring, Diagnostics, Data Management, Response, Outreach, Research and Decision Support. The task force has developed many useful assets for both researchers and managers including an online database of Bsal sampling, diagnostic recommendations for determining the presence of Bsal, and a detailed response plan for how to deal with a verified positive animal. These efforts are focused on preventing the invasion of Bsal into North America for as long as possible, and providing guidance to identify and reduce the effects of any infected animals as quickly as possible to contain any potential outbreak.

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### **143 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Emily Kerns, Kyra Cipolla, Dehiam Gonzalez, Matthew Gilg

*University of North Florida, Jacksonville, FL, USA*

#### **Landscape Genetics of a *Fundulus* spp. Hybrid Zone in Northeastern Florida**

Hybrid zones are excellent locations to study the ecological and evolutionary interactions between species. In zones where hybrid fitness is related to environmental differences hybrid zones may shift due to environmental perturbations like climate change. A hybrid zone between *Fundulus grandis* and *F. heteroclitus* roughly coincides with an ecotone between *Spartina* dominated salt marshes and mangrove swamps. While mangroves have been encroaching northward over the last decade or more it is unknown the extent to which the location of the *Fundulus* spp. hybrid zone is tied to the position of the ecotone. A spatial genetic analysis on populations that span the breadth of the hybrid zone was conducted and allele frequency data compared to environmental components in the area, including proportions of different vegetative cover. The hybrid zone appears to show a mosaic genetic pattern as opposed to a smooth latitudinal cline, suggesting the presence of an underlying environmental factor. A loose relationship was found between the proportion of either mangrove or marsh grasses and the genetic patterns at a location. Interestingly, the more Southern of the two species, *F. grandis*, tended to be most abundant in areas with greater marsh grass even though its range encompasses areas that have predominantly mangrove cover.

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### **775 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Steven Kessel<sup>1</sup>, Natasha Hinojosa<sup>2</sup>, Henry Wilson<sup>3</sup>, Gina Clementi<sup>4</sup>, Chuck Knapp<sup>1</sup>

<sup>1</sup>*Shedd Aquarium, Chicago, IL, USA*, <sup>2</sup>*Smithsonian Tropical Research Institute, Panama City, Panama, Panama*, <sup>3</sup>*University of Southern California, Los Angeles, CA, USA*, <sup>4</sup>*Florida International University, Miami, FL, USA*

## **Varied Response of Garden Eels to Potential Predators and Other Large-Bodied Organisms**

Garden eels live in burrows from which they protrude their bodies to feed on planktonic organisms, show courtship behavior and reproduce, and in which they seek refuge from predators. Despite universal acceptance that garden eels retract into their burrows for predator avoidance, a surprising lack of published accounts of this behavior exists. Here, opportunist observations made during shark abundance video surveys, show reactions of garden eels during encounters with potential predators and other large-bodied organisms. Brown garden eels (*Heteroconger longissimus*) were observed during ten encounters with larger fish and showed variable responses to five different large-bodied species. Varied responses suggested an ability to discriminate between organisms and react according to relative predation risk and proximity. The largest reactions were in response to encounters with piscivorous teleosts, the most likely predators of garden eels. Multiple encounters with two species of sharks, both improbable predators, resulted in a less pronounced reaction, consistent across encounters but variable with proximity. An encounter with a non-predator teleost resulted in the mildest response, despite very close proximity. These observations suggest that garden eels have the ability to discriminate between large-bodied organisms and react according to relative predation risk.

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### **105 Ichthyology Lightning Talks, Alpine A,B,C – The Snowbird Center, Saturday 27 July 2019**

JinKoo Kim, JungHwa Ryu

*Pukyong National University, Busan, Korea, Republic of*

### **Spatio-temporal variations of giant and large fish in Korean waters inferred from daily observer reports**

To elucidate the patterns of giant and large fish occurrences, which are highly important in the marine ecosystem, we analyzed daily reports made by observers at 57 fishery landing sites around the Korean peninsula over 6 years, from 2011 to 2016. In total, 153 species were re-identified based on photos and descriptions recorded by Korean observers, of which 5 species were classified as giant fish over 5 m in maximum total length (MTL) and 17 species as large fish between 3 and 5 m MTL. Among the giant and large fish, *Mola mola* was the most abundant species, with 75 individuals landed as by-catch. The second most abundant species was *Isurus oxyrinchus* (31), followed by *Mobula japonica* (23), *Lamna ditropis* (17), *Masturus lanceolatus* (16), *Sphyrna zygaena* (14) and *Prionace glauca* (12). As a result of cluster analysis based on species composition of giant and large fish by year and sea, six years were separated into two clusters (2011–2013 vs. 2014–2016), with high contribution of *M. mola*, *I. oxyrinchus*, and *M. lanceolatus*; and three seas were separated into two clusters (East Sea–Korea Strait vs. Yellow Sea), with high contribution of *M. lanceolatus*, *L. ditropis*, and *I. oxyrinchus*. Our study highlights distribution of giant and large fish species in Korea, and can help to establish their conservation measures and management strategy with relation to recent climatic change.

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**798 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Daniel Kimball<sup>1</sup>, Michael Minicozzi<sup>2</sup>, Alice Gibb<sup>2</sup>

<sup>1</sup>Northern Arizona University, Flagstaff, AZ, USA, <sup>2</sup>Northern Arizona University, Flagstaff, AZ, USA

**Bonytail, the Arizona tuna, convergence in muscle and tendon anatomy in scombrids and *Gila cypha***

Bonytail (*Gila elegans*) are an Arizona native endangered species that have unusual morphology thought to have evolved for high flow riverine environments. The shallow peduncle and crescent shaped tail appear to allow them to reduce drag and increase swimming efficiency. We describe the anatomical features associated with body shape in the caudal peduncle region. We compared the peduncle morphology of two closely related native species, Roundtail (*Gila robusta*) and Humpback chub (*Gila cypha*), to that of Bonytail. We cleared and stained ten individuals from each species to measure the neural and hemal vertebral spine angles (angle the spine creates with the vertebral centra) and size normalized spine lengths (spine length/standard length of fish) of the last twelve vertebrae. Bonytail have more acute spine angles in the caudal peduncle compared to Humpback and Roundtail. We also examined the soft tissues (muscle and tendon) of the caudal peduncle. We found evidence for paired lateral tendons in Bonytail that appear to be absent in the other *Gila* species. The total volume of muscle in the peduncle region of Bonytail appears to be reduced when compared to Humpback and Roundtail. Reduced musculature and new tendons are also seen in scombrid (tunas) fishes, where their long lateral tendons transmit force from the anterior musculature to the tail. For Bonytail, this morphology is likely beneficial during historic seasonal flooding events, where they can maintain position in the flow with relatively low energy expenditure.

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**654 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Laura Kimmel, Joy Lauffenberger, Allyson Fenwick, Paul Stone

University of Central Oklahoma, Edmond, OK, USA

**Communal Nesting and Reproductive Phenology of Mediterranean Geckos (*Hemidactylus turcicus*) at the University of Central Oklahoma**

Mediterranean geckos (*Hemidactylus turcicus*) are a nocturnal species originally found in the Middle East that has spread worldwide due to purposeful and accidental introductions. Central Oklahoma is close to the northern edge of the continuous U.S. range and cold winters affect activity and reproduction of geckos, which cope with colder temperatures by moving inside buildings. Although many studies have utilized follicle data in determining reproductive timing, there is a lack of methodical survey data available spanning the reproductive season. Here we

conducted weekly surveys of two campus buildings to determine proportions of adults, juveniles, and hatchlings throughout the reproductive season and bi-weekly surveys of a known communal nest site. Hatchlings began to emerge in early July and peaked in late August. Across all years, gravid females were observed late April to early September. However, during 2018, the communal nest site only held eggs from mid June to late July. Reduced reproductive and activity seasons in central Oklahoma may cause geckos to reach sexual maturity slower and produce fewer clutches than southern lizards. Cooling fall temperatures and inclement weather likely impact clutch success in Oklahoma. Our results provide a comparable framework for future studies across the U.S. to better understand how climatic factors impact the reproduction and success of Mediterranean geckos.

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### **38 SSAR SEIBERT SYSTEMATICS AND EVOLUTION AWARD II, Ballroom 2 – Cliff Lodge, Friday 26 July 2019**

Randy L. Klabacka<sup>1,2</sup>, Perry L., Jr. Wood<sup>1,3,2</sup>, Jimmy A. McGuire<sup>4</sup>, Jamie R. Oaks<sup>1</sup>, L. Lee Grismer<sup>5</sup>, Jesse L. Grismer<sup>5</sup>, Anchalee Aowphol<sup>6</sup>, Jack W., Jr. Sites<sup>2</sup>

<sup>1</sup>Auburn University Department of Biological Sciences and Museum of Natural History, Auburn, AL, USA, <sup>2</sup>Brigham Young University and M.I. Bean Life Sciences Museum, Provo, UT, USA, <sup>3</sup>University of Kansas, Lawrence, KS, USA, <sup>4</sup>University of California Museum of Vertebrate Zoology, Berkeley, CA, USA, <sup>5</sup>Herpetology Laboratory, Department of Biology, La Sierra University, Riverside, CA, USA, <sup>6</sup>Department of Zoology, Faculty of Science, Kasetsart University, Chatuchak, Bangkok, Thailand

### **Riverine barriers as potential drivers of biodiversification in the *Draco maculatus* species complex of Indochina**

Southeast Asia hosts a rich concentration of biodiversity within multiple biodiversity hotspots. Indochina, a region with remarkably high levels of *in situ* diversification, possesses five major rivers (Chiang Mai, Irrawady, Mekong, Salween, and Red), several of which coincide with reproductive barriers of terrestrial taxa. *Draco maculatus* possesses a range that stretches across Indochina, and the widespread geographic distribution and potential discrete variation within putative subspecies allude to the possibility of this taxon constituting multiple divergent lineages. Using sequence data from three mitochondrial (*12S*, *16S*, and *ND2*) and three nuclear (*BDNF*, *CMOS*, and *PNN*) genes, we examine the phylogeographic architecture of this hypothesized species complex with maximum likelihood and Bayes factor delimitation (BFD) approaches. Our results support multiple divergent lineages whose reproductive boundaries coincide with river barriers, indicating that river barriers may be contributing to the elevated levels of *in situ* diversification of Indochina.

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### **637 Herpetology Ecology, Primrose A&B – Cliff Lodge, Saturday 27 July 2019**

Paul Klawinski

*William Jewell College, Liberty, MO, USA*

### **Strangers in a Strange Land: 27 Years of Competition among Exotic Geckos**

Interspecific competition can lead to resource partitioning by competing species. Testing whether interspecific differences in resource utilization develop as a result of competition is difficult because observing resource utilization of the interacting species in sympatry *and* allopatry is often difficult. Klawinski et al. (1994) utilized the introduction of two species of exotic geckos in Galveston, TX, to test whether the two species partition resources differently in allopatry and sympatry. Based on stomach contents, the two species had different diets in sympatry but similar diets in allopatry. In addition, the diet of *Cyrtopodion scabrum* was similar in allopatry and sympatry while *Hemidactylus turcicus* experienced a dietary shift from allopatry to sympatry. In 2018, I repeated the 1994 study to map the progress of the spread of *C. scabrum* into Galveston and to determine if the asymmetry of competitive interactions has led to further displacement of *H. turcicus*. In the last 27 years, *C. scabrum* has advanced only 150 meters and has not displaced *H. turcicus*. I found that all categories of geckos were different from one another but the differences in sympatry were greater than differences in allopatry and the competitive asymmetry observed in the 1994 study remained. *H. turcicus* had fewer prey items per stomach (compared to *C. scabrum*) and had even fewer prey items in sympatry with *C. scabrum* while *C. scabrum* did not differ from allopatry to sympatry. I conclude that competitive interactions remain important in Galveston but that species turnover is occurring more slowly than expected.

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### **123 AES Symposium: The Sensory Biology of Elasmobranch Fishes, Rendezvous A&B – The Snowbird Center, Saturday 27 July 2019**

Peter Klimley

*Retired, University of California, Davis, Davis, California, USA*

### **In Memoriam, Donald Nelson, Ph.D., Shark Researcher and Teacher**

Donald Nelson, a Professor at the California State University, Long Beach, served as a member of my doctoral committee, and I worked closely with him for many years even after graduating from Scripps Institution of Oceanography. We spent many a joyful day together free diving within schools of scalloped hammerhead sharks while observing their behavior and placing ultrasonic transmitters on them to record the extent of both their daytime and nighttime movements. Many young researchers are unaware of the many contributions of this gifted scientist and teacher to shark biology. For this reason, I will describe some of his early studies on the sensory biology of sharks, others on their aggressive behavior, and highlight his pivotal role in the use of acoustic telemetry to study the movements of sharks. He served as a mentor to many outstanding scientists, two of which, Drs. Christopher Lowe and Stephen Kajiura, have played prominent roles in the American Elasmobranch Society, of which he was a co-

founder. They are now in turn building upon his legacy and are also mentoring students in studies of elasmobranchs. In addition to highlighting the research accomplishments of him and his students, I will share with you some of my photographs of him at work, and relate some stories about our working together in the field. This will give you an idea of the personality of this man so that you can incorporate some of his attributes in your work to become even better scientists.

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### **128 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Peter Klimley<sup>1</sup>, James Ketchum<sup>2</sup>, Mauricio Hoyos-Padilla<sup>2</sup>, Frida Lara-Lizardi<sup>2</sup>

<sup>1</sup>*Retired, University of California, Davis, Davis, California, USA,* <sup>2</sup>*Pelagios Kakunja, La Paz, Baja California Sur, Mexico*

#### **The Creation of the Revillagigedos Islands National Park**

North America's largest marine protected area is Mexico's Revillagigedos Islands National Park. This no-capture zone for sharks, manta rays, and other pelagic fish was expanded seven-fold by the Mexican government based on shark tracking data collected by researchers at Pelagios Kakunjá and the University of California, Davis. Located 556 km southwest of the Baja Peninsula, it encompasses 10,556 km<sup>2</sup> around a series of four volcanic islands, San Benedicto, Socorro, Roca Partida, and Clarion, in the Revillagigedo Archipelago. First, individually coded beacons were placed on members of seven species of sharks, and the migration of three, the Galapagos, silvertip, and tiger sharks were shown to move between the islands based on detections by autonomous receivers moored at each of the islands. Sharks were initially tagged during an expedition in 2010 by OSEARCH to film *Shark Men* for National Geographic Films; the tagging was continued until 2015 by members of Pelagios Kakunjá. The results from the automated receiver study indicated to Mexican resource managers that protection should be extended around the entire archipelago. Finally, satellite tagging indicated that the sharks moved to a distance of 74 km from the islands, thus leading to further expansion of the reserve. Environmental protection means little if not enforced. The Mexican Navy is currently patrolling the area with boats and drones to help ensure the protections are enforced, and this seems to be working. Shown will be satellite tracks of commercial fishing boats to demonstrate that fishing is being limited to outside the park boundaries.

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**CANCELLED**

### **732 General Herpetology I, Primrose A&B – Cliff Lodge, Sunday 28 July 2019**

Blake Klocke<sup>1,2,3</sup>, Brian Gratwicke<sup>1,2</sup>, Roberto Ibañez<sup>1,2</sup>, Jorge Guerrel<sup>1,2</sup>, Orlando Garces<sup>1,2</sup>, Elliot Lassiter<sup>1,2</sup>, Heidi Ross<sup>2</sup>

<sup>1</sup>*Smithsonian Tropical Research Institute, Panama City, Panama,* <sup>2</sup>*Panama Amphibian Rescue and Conservation Project, Panama City, Panama,* <sup>3</sup>*George Mason University, Fairfax, Virginia,*

USA

### **Reintroduction efforts for two species of Panamanian Harlequin frogs (Genus: *Atelopus*) threatened by amphibian chytrid fungus**

The emergence of the amphibian chytrid fungus in Panama resulted in catastrophic population declines or extinction in the six species of *Atelopus* that occur within the country. The Panama Amphibian Rescue and Conservation Project is an *ex-situ* captive breeding project that was established to prevent the extinction of the most susceptible Panamanian amphibians. Captive assurance populations of five *Atelopus* spp. (*Atelopus certus*, *Atelopus glyphus*, *Atelopus limosus*, *Atelopus varius*, and *Atelopus zeteki*) have been successfully maintained and bred in Panama. Release trials with captive bred F1 individuals of two species, *Atelopus limosus* and *Atelopus varius*, were completed to understand dispersal patterns, survivorship, susceptibility to chytrid. We equipped several adult *A. limosus* and *A. varius* with VHF radio transmitters to track daily movements, obtain weekly weight measurements, sources of mortality, and monitor chytrid status post release. We attempted mark and recapture surveys with animals that did not have a radio transmitter with limited success. Soft release enclosures to determine if there was difference in survivorship between hard and soft release individuals. These initial efforts will guide the development of future reintroduction strategies.

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### **296 SSAR SEIBERT ECOLOGY AWARD I, Ballroom 2 – Cliff Lodge, Thursday 25 July 2019**

Ashley Kobisk, Matthew Kwiatkowski

*Stephen F. Austin State University, Nacogdoches, TX, USA*

### **Effects of Artificial Light at Night on Anuran Calling Behavior**

The natural environment can be negatively impacted by a variety of human activities, including the production of artificial light at night. Recent studies suggest that anthropogenic light pollution alters animal behavior. Despite their nocturnal activity, little attention has been given to anurans and the effects artificial light at night has on their behavior. We are investigating the effects of artificial light at night on anuran breeding systems in eastern Texas. To determine if artificial light alters calling behavior in male anurans, we are quantifying ambient light and male call variables at sites that vary in urbanization and, therefore, artificial light levels. Calling males are recorded and then ambient light is measured at the call site. Light levels of these microhabitat call sites are then compared to the general light environment measured at 30 random points at each site. Effects of artificial light varied among species. For example, Spring Peepers (*Pseudacris crucifer*) selected call sites that were darker than the general light environment in urbanized areas with higher light levels. In contrast, Green Treefrogs (*Hyla cinerea*) selected darker call sites at a more rural site with lower light levels, but at a more urbanized site with higher light levels, selected call sites that had the same light levels as the general environment. These results suggest anuran species may vary in their sensitivity and response to artificial light

at night. Additional variables are being analyzed for differences among urbanized and natural sites, including call dominant frequency, call duration, and call rate.

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### **633 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Paige Koehler<sup>1</sup>, Marcus Drymon<sup>2</sup>, Emily Seubert<sup>2</sup>, Simon Gulak<sup>3</sup>, Brent Winner<sup>4</sup>, Toby S. Daly-Engel<sup>1</sup>

<sup>1</sup>*Florida Institute of Technology, Melbourne, FL, USA*, <sup>2</sup>*Mississippi State University, Mississippi State, MS, USA*, <sup>3</sup>*Riverside Technology Inc./NOAA Fisheries Southeast Fisheries Science Center, Panama City, FL, USA*, <sup>4</sup>*Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL, USA*

### **Not a Load of Bull: Polyandry and Relatedness in Bull Sharks (*Carcharhinus leucas*) in the Northern Gulf of Mexico**

Reproductive strategies can impact genetic diversity, which in turn affects the ability of populations to respond to selection pressure and adapt to changing environmental conditions. Bull sharks (*Carcharhinus leucas*) are the largest of the sharks of the speciose genus *Carcharhinus*, and an important apex predator in shallow coastal environments throughout the world. Though it is well-documented that bull sharks make extensive use of inshore habitats for parturition, relatively little is known about adult mating strategies, or what drives population dynamics among resident pups. We used 15 microsatellite DNA loci to estimate kinship among 56 juvenile bull sharks caught in a ghost net that washed up in Mobile Bay, Alabama. We compared these to adults caught the same year to investigate relatedness and non-random mating (inbreeding). Finally, we examined patterns of multiple paternity in four litters of bull sharks to evaluate the degree of relatedness (siblings vs. half-siblings) within broods, and how this may influence kinship and genetic diversity among young-of-the-year. Reproductive strategies that reduce effective population size and biodiversity may increase extinction risk and lower rebound potential, especially in slow-growing predators such as sharks.

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### **554 Herpetology Lightning Talks, Ballroom 3 – Cliff Lodge, Saturday 27 July 2019**

Michelle Koo<sup>1</sup>, Carol Spencer<sup>1</sup>, David Blackburn<sup>2</sup>, David Cannatella<sup>3</sup>, Alessandro Catenazzi<sup>4</sup>, Ann Chang<sup>1</sup>, Joyce Gross<sup>5</sup>, Rebecca Tarvin<sup>1</sup>, Vance Vredenburg<sup>6</sup>, David Wake<sup>1</sup>

<sup>1</sup>*Museum of Vertebrate Zoology, Berkeley, CA, USA*, <sup>2</sup>*Florida Museum of Natural History, Gainesville, FL, USA*, <sup>3</sup>*University of Texas, Austin, TX, USA*, <sup>4</sup>*Florida International University, Miami, FL, USA*, <sup>5</sup>*Berkeley Natural History Museums, Berkeley, CA, USA*, <sup>6</sup>*San Francisco State University, San Francisco, CA, USA*

### **New Updates on AmphibiaWeb: All Amphibians, All the Time**



AmphibiaWeb, motivated by alarming global declines of amphibians noted as far back as the 1980s, created and maintains an online resource (<https://amphibiaweb.org>), which synthesizes information on amphibian biology, taxonomy, and declines from scientists and experts for education, research, and conservation. We aim to use biodiversity informatics and web tools for sustainability and access, resulting in a data-driven approach to producing a web page for every species of amphibian (8,000 and counting), including range and voucher maps, media files of calls, videos, and images. We provide the ability to browse by family, phylogeny, and geography (including by country and state), and current literature lists on new species, disease and declines. Other projects include a new Trait Database for amphibian life history traits and the Amphibian Disease portal (<https://amphibiandisease.org>) to track fungal pathogen sampling. We present some of our latest data visualizations and recent developments in AmphibiaWeb to invite collaboration with data partners and to inspire research and possible conservation actions.

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#### **49 AES GRUBER AWARD III, Rendezvous A&B – The Snowbird Center, Friday 26 July 2019**

Derek Kraft<sup>1</sup>, Melanie Hutchinson<sup>2,3</sup>, Brian Bowen<sup>1</sup>

<sup>1</sup>Hawai'i Institute of Marine Biology, Kailua, HI, USA, <sup>2</sup>Hawai'i Institute of Marine Biology, Kaneohe, HI, USA, <sup>3</sup>Joint Institute of Marine and Atmospheric Research, University of Hawai'i, Honolulu, HI, USA

#### **Global Genetic Inventory of the Silky Shark (*Carcharhinus falciformis*), the Shark Finning Industry, and DNA Fingerprinting**

Silky sharks (*Carcharhinus falciformis*) occur in all oceans and are subject to the second highest elasmobranch harvest on the planet. Their habitat overlaps with commercial tuna fisheries, and they account for over 90% of the shark bycatch in tropical purse seines of the western and central Pacific. Silky sharks are also one of the most exploited species in the shark fin trade. As a result, this formerly abundant species has declined by >85% in the last 20 years and is now listed as vulnerable and Declining by International Union for Conservation of Nature (IUCN). Despite this dramatic population crash, there is little information on genetic stock structure to identify this basic units of wildlife management. This project provides a global genetic inventory with 657 specimens from 11 globally distributed locations. Using restriction site-associated DNA polymorphisms (ezRAD) in whole genome scans, 16,000 single nucleotide polymorphisms (SNPs) were identified to calculate population structure. We show distinct genetic differences between and within major ocean regions, suggesting this species is not as cosmopolitan as previously thought. Finally, we are using this global genetic inventory as a baseline to identify the origins of Silky sharks fin products. Samples from the fin market in Hong Kong, China will be compared to our global baseline using DNA fingerprinting. This will allow the identification of sharks in the fin trade to both the species-level and oceanic region of origin, identifying which Silky sharks populations are falling victim to the shark fin trade.

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## 612 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019

Alexandra Krak, Kenshu Shimada

*DePaul University, Chicago, Illinois, USA*

### **Geometric morphometric analysis of teeth in the extant megamouth shark, *Megachasma pelagios*, and its potential paleontological application**

*Megachasma pelagios* (Lamniformes: Megachasmidae) is a large filter-feeding fish with a dentition commonly characterized as ‘homodont.’ We used landmark-based geometric morphometrics to investigate whether or not sufficient variation in tooth morphology is present in *M. pelagios* that may aid in reconstructing the dentition of *M. applegatei*, a fossil (late Oligocene–early Miocene) megamouth shark known from isolated teeth. We examined the upper right and lower right dental series of the holotype of *M. pelagios* (BPBM 22730: 4.5 m TL male). Each dental series was divided into the ‘mesial half’ (upper = tooth rows 1–24; lower = tooth rows 1–33) and ‘distal half’ (upper = tooth rows 25–48; lower = tooth rows 34–66) to determine if teeth of the four groups are distinguished quantitatively. Although a slight overlap exists, our analysis shows two distinct clusters of plots, one consisting of upper teeth, and another, lower teeth. Within each cluster, teeth from the mesial half of the dental series are found to be morphologically less variable than teeth from the distal half. Ten randomly selected teeth of *M. applegatei* housed in the Natural History Museum of Los Angeles, California, preliminarily plotted with teeth of *M. pelagios* not only show that the two megachasmids are morphometrically distinct, but that teeth of *M. applegatei* exhibit a wider morphological range than those of *M. pelagios*. Remarkably, two clusters similar to those seen for *M. pelagios* are also recognized for *M. applegatei* that may reflect the difference between upper and lower teeth.

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## 500 AES Ecology, Rendezvous A&B – The Snowbird Center, Friday 26 July 2019

Andrea Kroetz<sup>1</sup>, Dean Grubbs<sup>2</sup>, John Carlson<sup>1</sup>, Mark Bond<sup>3</sup>

<sup>1</sup>*NOAA Fisheries Service, Panama City, FL, USA*, <sup>2</sup>*Florida State University Coastal and Marine Laboratory, St. Teresa, FL, USA*, <sup>3</sup>*Florida International University, Miami, FL, USA*

### **Endangered Smalltooth Sawfish, *Pristis pectinata*, Habitat Use and Residency in Andros, the Bahamas**

The smalltooth sawfish (*Pristis pectinata*) is listed as Critically Endangered on the IUCN Red List of Threatened Species and Endangered under the United States’ Endangered Species Act. The species is restricted to the Atlantic Ocean and populations declined throughout the range due to overfishing and habitat loss. Southwest Florida (U.S.) and the western side of Andros Island (Bahamas) harbor perhaps the only known viable populations of smalltooth sawfish. These two regions may serve as potential lifeboats for recovery and it is unknown if mixing occurs. We used a combination of passive acoustic (implanted coded transmitters) and satellite (towed and fin-mounted SPOT) telemetry to assess movements, habitat use, and residence time of large

juvenile and adult sawfish in Andros West Side National Park. For all animals tagged, we documented heavy use of the mangrove creeks along the northwest coast of Andros. Preliminary data suggest that juvenile sawfish may be year-round residents of Andros using mangrove tidal creeks and shallow backcountry waters. Data suggest that adult sawfish move greater distances over longer periods of time between Andros and the island of Bimini (Bahamas; ~147 km); though it is likely that adult sawfish do not leave the Great Bahama Bank during these migrations. Long-term acoustic monitoring will better inform us on habitat requirements and migration patterns across ontogeny, which can ultimately lead to the recovery of this critically endangered species.

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**97 ASIH STORER ICHTHYOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Aaron Krolow, Kyle Piller

*Southeastern Louisiana, Hammond, LA, USA*

**Assessing Diversity of Fish Communities on Artificial Reefs along the Louisiana Coast through the use of Environmental DNA (eDNA)**

Globally, estuarine and marine fisheries have declined over the past century and a variety of approaches have been employed to improve fisheries including the implementation of gear restrictions, development of protected areas, catch regulations, stocking, and habitat augmentation. The focus of this study is the reintroduction of habitat (i.e. artificial reefs). Louisiana, the sportsman paradise contains some of the greatest coastal fisheries in the world. As a result, intense fishing pressure has necessitated the growth of fish populations along the coast via the deployment of artificial reefs. Unfortunately, assessing the success of these reefs has been problematic due to the high turbidity of the region and the difficulty of using traditional sampling gears at reef sites. Therefore, the goal of this study was to utilize environmental DNA (eDNA) techniques to monitor fish diversity at nine artificial reefs along the Louisiana coast. These reefs are comprised of concrete/limestone rubble, derelict oil/gas structure, and crushed shell materials. An eDNA metabarcoding approach was undertaken to examine fish community diversity at each reef and paired control site. To accomplish this, water samples were taken from nine reefs and were filtered, DNA was extracted, and PCR amplified (12S mtDNA) using a previously published protocol. PCR amplicons were Illumina sequenced and the recovered data was submitted to the MiFish pipeline. The results indicate significant differences among reef materials and location along the Louisiana coast and suggest that this technique is a viable method that can be used to monitor fish species on artificial reefs.

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**66 ASIH STOYE CONSERVATION AWARD, Cottonwood A-D – The Snowbird Center, Friday 26 July 2019**

Chelsea Kross, John Willson

University of Arkansas, Fayetteville, AR, USA

### **Rearing Habitat influences Larval Density-Dependence and Population Dynamics in Crawfish Frogs**

Density-dependence is a key aspect of population regulation for many species, especially for species with complex life cycles. For this reason, amphibians have often been used as model organisms for addressing questions related to density-dependence. However, patterns of density-dependence have been characterized for only a few species and little work has evaluated how rearing habitat might alter density-dependent interactions. Specifically, changes in land-use surrounding larval habitats might alter density-dependent relationships through changes in vegetation used as food and cover for developing larvae. We used a mesocosm approach to investigate how vegetation composition (native prairie or non-native agriculture-associated vegetation [tall fescue grass; *Festuca arundinacea*]), surrounding breeding wetlands affected density-dependence in larval Crawfish Frogs (*Lithobates areolatus*), a species of conservation concern. We measured survival, time to metamorphosis, and snout-vent-length and mass at metamorphosis of larvae reared at densities of 5, 15, 45, 135, and 405 per mesocosm in the two different litter treatments. Overall, density dependence was overcompensatory, suggesting that *L. areolatus* exhibit scramble competition as larvae. Both vegetation treatments had low survival at high densities, but more individuals survived to metamorphosis at moderate densities in fescue treatments compared to prairie treatments. We evaluated the implications of our experimental results using a density-dependent stage-structured population model to estimate adult population size and long-term dynamics. Prairie wetlands supported a larger and more stable density of adult frogs. Differences in density-dependence at the larval stage have important implications for population regulation and dynamics in stochastic environments.

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### **43 Amphibian Ecology, Ballroom 2 – Cliff Lodge, Friday 26 July 2019**

Ariel Kruger, Peter Morin

*Rutgers University, New Brunswick, NJ, USA*

### **Predators Induce Morphological Changes in Tadpoles of *Hyla andersonii***

Predators can affect the development, fitness, and survival of prey species in myriad ways. In response to the threat of predation, tadpoles can alter growth rate, phenotype, and foraging behavior. In particular, changes to tadpole development have the potential to alter life history characteristics beyond metamorphosis and are therefore of interest in species of conservation concern. We explored how non-lethal predators affected the larval development of the Pine Barrens tree frog, *Hyla andersonii*, a near-threatened species in the United States. Predator-induced changes in morphology occur in some hylid tree frogs, but had not been explored in *H. andersonii*. We used experimental mesocosms to evaluate the effect of predator presence on tadpole morphology, behavior, and development. We found that caged dragonflies (*Anax*

*junius*) induced darker tail coloration and deeper tail fins in *Hyla andersonii* tadpoles, but did not affect tadpole activity level, survival, or size at metamorphosis. Nonlethal predator presence also induced greater within population variation in the tail color trait compared to populations without predators, suggesting there may be underlying genetic variation in the ability to express phenotypically plastic traits, a concept that should be explored further because it has implications for the evolution of inducible defenses. These findings support the existence of an adaptive syndrome among hylid tadpoles, where tadpoles express tail flagging in response to larval dragonfly predators.

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**310 ASIH STORER ICHTHYOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Kole Kubicek<sup>1</sup>, Ralf Britz<sup>2</sup>, Kevin Conway<sup>1</sup>

<sup>1</sup>Texas A&M University, College Station, TX, USA, <sup>2</sup>Natural History Museum, London, United Kingdom

**Ontogeny of the Pectoral-fin Radials in Siluroid and Loricarioid Catfishes**

Catfishes (Siluriformes) are characterized by a number of skeletal autapomorphies including the modification of several elements of the pectoral-girdle. In particular, the pectoral-fin radials of catfishes differ markedly from the condition found in other otophysan fishes by possessing fewer proximal radials (2-3 vs. 4), of which one is an enlarged element that is commonly referred to as the “complex” radial. Despite numerous anatomical studies on the skeleton of catfishes, the homology of this element remains unresolved. Additionally, most previous studies have only focused on describing the adult condition, while comprehensive information on ontogeny remains scarce. In order to further our understanding of the identity of the supporting skeletal elements of the pectoral fin in catfishes, we document and describe the earliest stages of pectoral-fin radial formation in cleared and double stained representative siluroid (*Noturus gyrinus*, *Ictalurus punctatus*, *Silurus glanis*, *Akysis vespa* and *Tatia* sp.) and loricarioid (*Megalechis personata*, *Corydoras panda* and *Ancistrus* sp.) catfishes. We also compare the formation of the pectoral-fin radials in these eight species to each other and to *Danio rerio* in order to determine homology of these elements.

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**312 ASIH STOYE GENETICS, DEVELOPMENT, & MORPHOLOGY AWARD I, Cottonwood A-D – The Snowbird Center, Thursday 25 July 2019**

Kole Kubicek<sup>1</sup>, Ralf Britz<sup>2</sup>, Kevin Conway<sup>1</sup>

<sup>1</sup>Texas A&M University, College Station, TX, USA, <sup>2</sup>Natural History Museum, London, United Kingdom

## **Developmental Osteology of Two Loricarioid Catfishes, *Corydoras panda* and *Ancistrus* sp. (Teleostei:Siluriformes).**

Sequence heterochrony, or an evolutionary shift of events within an ontogenetic sequence, has been shown in tetrapods to lead to major changes in morphology, life history, and function. Surprisingly, however, studies of sequence heterochrony in bony fishes are lacking. Catfishes (Siluriformes) possess a number of skeletal autapomorphies, including the extreme modification of certain elements (i.e. pectoral-fin spine). Despite the vast number of anatomical investigations of the adult skeleton in catfishes, comprehensive information on early development remains scarce. This is surprising given the number of species currently being reared for aquaculture or the aquarium trade. In order to further our understanding of the siluriform skeletal system, we document the development of the entire skeleton in two species of loricarioid catfishes, *Corydoras panda* and *Ancistrus* sp. Our investigation is based on approximately 125 cleared and double-stained specimens and 25 specimens cleared and stained with alizarin red S only for both *C. panda* (4.3–28.6 mm NL/SL) and *Ancistrus* sp. (4.6–24.2 mm NL/SL). We examined and scored each of the 150 individuals of each species for the presence/absence of 136 skeletal elements and generated a sequence of ossification for the entire skeleton. We compare the ossification sequences generated for both species to that of two siluroid catfishes (*Noturus gyrinus* and *Ictalurus punctatus*) and other otophysans (*Barbus holotaenia* and *Salminus brasiliensis*) to determine which heterochronic changes in skeletal development, if any, characterize loricarioid and siluroid catfishes as well as siluriforms in general.

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### **709 Herpetology Lightning Talks, Ballroom 3 – Cliff Lodge, Saturday 27 July 2019**

Shawn Kuchta

*Ohio University, Athens, Ohio, USA*

#### **Paraphyly and species delimitation in the *Plethodon wehrlei* species complex**

Species delimitation is critical for biodiversity studies, yet species complexes characterized by high levels of population structure and subtle phenotypic differentiation can be challenging to delimit. Here, I report on a molecular systematic investigation of woodland salamanders in the *Plethodon wehrlei* species complex. In an earlier study using mitochondrial DNA and five nuclear loci, I found substantial phylogeographic diversity in this complex, including multiple geographically cohesive clades. Moreover, the endangered species *P. punctatus* was recovered as deeply nested within *P. wehrlei*, rendering the latter paraphyletic, and populations formerly ascribed to *P. dixi* were highly distinctive, suggesting this may be a valid species. However, the degree to which these findings are driven by a strong mtDNA signal is unclear, and studies that are highly influenced by a single locus should be viewed with caution. In this study, I revisit patterns of genetic variation in the *P. wehrlei* complex using 350 orthologous genes sequenced using anchored hybrid enrichment. Using species tree approaches, maximum likelihood estimation of genetic clusters (Admixture), nonparametric Discriminant Analysis of Principle Components (DAPC), and other methods, I evaluate phylogeographic history and species

delimitation in the *P. wehrlei* complex. The taxonomic status of *P. punctatus* and *P. dixi* will be briefly discussed.

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## CANCELLED

### **567 Herpetology Genetic Diversity, Ballroom 1 – Cliff Lodge, Thursday 25 July 2019**

Nathan Kudla, Eric McCluskey, Jen Moore

*Grand Valley State University, Allendale, Michigan, USA*

#### **Using landscape genetics to understand connectivity of an island population of eastern massasauga rattlesnakes (*Sistrurus catenatus*)**

Populations with low gene flow can become negatively influenced by increased levels of inbreeding, lower genetic diversity, and reduced adaptive potential. Landscape genetics allows for spatial and genetic information to be analyzed simultaneously to better understand how the landscape influences gene flow. This information is then used to estimate population connectivity and identify landscape features which act as barriers or promoters of gene flow. The eastern massasauga rattlesnake (*Sistrurus catenatus*) is a federally threatened viper typically found in wetlands throughout the Great Lakes region. Due primarily to a loss of habitat, many remaining populations are small and isolated. This lack of connectivity brings into question the survival of these populations into the future. Unlike many other populations, the population of eastern massasauga rattlesnakes on Bois Blanc Island, Michigan lives in a relatively undisturbed habitat with a potential for high connectivity across the 88 km<sup>2</sup> landscape. We used landscape genetics to estimate genetic connectivity of eastern massasauga rattlesnakes across Bois Blanc Island. 102 individuals were genotyped at 15 microsatellite loci and pairwise genetic distances were calculated as the proportion of shared alleles ( $D_{ps}$ ). We used resistance surface modeling to assess how the island landscape is influencing gene flow. Our research will be completed by the summer of 2019. The results will provide insight as to how eastern massasauga rattlesnake populations function in areas with limited human presence and minimal landscape alteration and if population connectivity can be maintained across a well-connected landscape with high abundance.

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### **20 Amphibian Ecology, Ballroom 2 – Cliff Lodge, Friday 26 July 2019**

Sarah Kupferberg<sup>1</sup>, Alessandro Catenazzi<sup>2</sup>

<sup>1</sup>*Questa Engineering, Berkeley, California, USA*, <sup>2</sup>*Florida International University, Miami, Florida, USA*

#### **Between Bedrock and a Hard Place: Riverine Frogs Navigate Tradeoffs of Pool Permanency and Disease Risk During Drought**

The river-breeding Foothill Yellow-legged Frog (*Rana boylei*) has survived countless extreme droughts and floods across its evolutionary history, but today contends with other existential threats. The spread of non-native species and the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) combine to endanger this California/Oregon endemic. Museum specimens indicate that *Bd* has been present on *R. boylei* for several decades, but field study indicates that its virulence emerges in a multi-stressor environment such as when the effects of invasive North American Bullfrogs (*Lithobates catesbeianus*) interact with drought. In San Francisco Bay Area watersheds, we have observed Bullfrogs colonize streams from upland ponds during high precipitation years. Bullfrog offspring, which must over-winter as tadpoles, persist through the dry season downstream of bedrock and large boulder outcrops in deep scour pools that remain wet while the rest of the channel dries. As pools shrank in Coyote Creek during autumn 2018, qPCR analysis of skin swabs revealed that *Bd* infection in *R. boylei* became ubiquitous, shifting from prevalence of 28% (14-32%, n = 33) to 96% (91-100%, n = 58) in just six weeks. We found many dead *R. boylei* when mean ( $\pm$  SE) infection intensity had increased 50-fold from  $1,743 \pm 808$  to  $86,306 \pm 29,914$  zoospore equivalents ( $Z_e$ ). In bullfrogs, prevalence remained around 26-28% and intensity did not vary significantly ( $Z_{e1} = 192 \pm 138$ ,  $Z_{e2} = 88 \pm 78$ ). Monthly wet-dry mapping of the channel reveals that native frogs breeding in shallower alluvial reaches can avoid the *Bd*-tolerant bullfrogs, but risk stream drying before completing larval development.

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#### **465 Ichthyology Reproduction, Development, and Morphology, Cottonwood A-D – The Snowbird Center, Sunday 28 July 2019**

Shannon Kuznar

*University of Louisiana, Lafayette, LA, USA*

#### **Ontogenetic development of *Sphyrna lewini* (Chondrichthyes: Sphyrnidae) head morphology**

As animals grow and mature, aspects of their morphology can vary between the juvenile and the adult life stages. This process can be as dramatic as the metamorphosis juvenile tadpoles undergo to mature into adult frogs, or can be more gradual in nature. Particularly interesting is the allometric development of morphologically unique structures, an excellent example of which is the cephalofoil of hammerhead sharks, formed from dorsoventral compression and lateral expansion of the rostral portion of the head. This morphology is found in all hammerhead species and is highly distinctive of the family Sphyrnidae. Previous studies have used 2D geometric morphometrics to examine the differences in head morphology between the eight species of Sphyrnidae, but this study seeks to use these methods to quantify the differences between adults and juveniles of one hammerhead species, the scalloped hammerhead (*Sphyrna lewini*). This species is a larger sphyrnid with a medium degree of lateral cephalofoil expansion (compared to other sphyrnids). Though some morphological alterations are evident when comparing the overall head shape between juvenile and adult life stages, this study is the first to quantify them. Photographs were taken of 25 adults and 32 juvenile scalloped hammerheads taken as fishermen's catches off the Pacific coast of Panama. Each individual's head was photographed



dorsally, laterally, anteriorly, and laterally (from the left). Geometric morphometrics are used to determine the distinguishing structural features of juveniles and adults. As *S. lewini* is a larger sphenid, adults are expected to have overall more robust structural features than juveniles.

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## **788 Herpetology Lightning Talks, Ballroom 3 – Cliff Lodge, Saturday 27 July 2019**

Matthew Kwiatkowski

*Department of Biology, Stephen F Austin State University, Nacogdoches, Texas, USA*

### **Association Between Color Polymorphism and Habitat in Ornate Tree Lizards**

Color polymorphism in sexually selected signals has evolved in a variety of lizard taxa. While the genetic basis of color polymorphism is becoming clearer, maintenance of polymorphisms can be complex. In at least one well-studied species with three male color morphs, Side-blotched Lizards, intrasexual frequency-dependent selection appears to result in a “rock-paper-scissors” cycle among the morphs which exhibit different mating strategies. However, a rock-paper-scissors mechanism may not easily explain geographic variation in color morphs in other species where populations can vary considerably in the number of morphs present. For example, Ornate Tree Lizards exhibit polymorphism in gular color patches and the number of morphs can vary among populations from one to five. This wide variation in morph number may be a consequence of environments being more or less conducive to maintaining polymorphism. Recent evidence suggests that microhabitat complexity may facilitate polymorphism. Similarly, because the different color morphs exhibit different spatial behaviors, they also exhibit trophic polymorphism as a consequence. Areas with higher resource abundance may allow multiple morphs to persist since there will be adequate food resources to support the trophic polymorphism. Conversely, harsher environments, or less complex microhabitats, may limit the number of morphs that can co-exist. Hence, there may be an association between habitat type and the number of color morphs present in a population. To test this hypothesis, this study will investigate whether Ornate Tree Lizard populations near riparian areas, with presumably more resources, have more throat color morphs than populations in more xeric habitats.

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## **730 AES Conservation & Management II, Rendezvous A&B – The Snowbird Center, Sunday 28 July 2019**

Peter Kyne<sup>1</sup>, Rima Jabado<sup>2</sup>, Cassandra Rigby<sup>3</sup>, Dharmadi<sup>4</sup>, Mauvis Gore<sup>5</sup>, Caroline Pollock<sup>6</sup>, Katelyn Herman<sup>7</sup>, Jessica Cheok<sup>8</sup>, David Ebert<sup>9</sup>, Colin Simpfendorfer<sup>3</sup>, Nicholas Dulvy<sup>8</sup>

<sup>1</sup>Charles Darwin University, Darwin, NT, Australia, <sup>2</sup>Gulf Elasmobranch Project, Dubai, UAE, <sup>3</sup>James Cook University, Townsville, QLD, Australia, <sup>4</sup>Center for Fisheries Research, Ministry of Marine Affairs and Fisheries, Jakarta, Indonesia, <sup>5</sup>Marine Conservation International, South Queensferry, United Kingdom, <sup>6</sup>IUCN Global Species Programme - Red List Unit, Cambridge,

United Kingdom, <sup>7</sup>Georgia Aquarium, Atlanta, GA, USA, <sup>8</sup>Simon Fraser University, Burnaby, BC, Canada, <sup>9</sup>Pacific Shark Research Center, Moss Landing Marine Laboratories, Moss Landing, CA, USA

### **Extremely high extinction risk in wedgefishes and giant guitarfishes**

The process of understanding the rapid global decline of sawfishes (Pristidae) has revealed great concern for their relatives, the wedgefishes (Rhinidae) and the giant guitarfishes (Glaucostegidae), not least because all three families are targeted for their high-value and internationally-traded 'white' fins. The extinction risk of all 10 wedgefishes and six giant guitarfishes was assessed by applying the International Union for Conservation of Nature (IUCN) Red List of Threatened Species Categories and Criteria. This process involved a review of species' biogeography and habitat, life history, exploitation, use and trade, and population status. Wedgefishes and giant guitarfishes have overtaken sawfishes and are now the most imperilled marine fish families globally, with all but one of the 16 species facing an extremely high risk of extinction. This is due to a combination of traits including limited productivity and presence in shallow coastal waters primarily of the Indo-West Pacific and West Africa (with one species occurring in the Mediterranean Sea). These areas overlap with some of the most intense and increasing coastal fisheries in the world, with overexploitation of wedgefishes and giant guitarfishes in target and bycatch fisheries driven by the need for animal protein and food security for coastal communities and trade in meat and high-value fins. To conserve populations and permit recovery, a suite of measures will be required which will need to include species protection, spatial management, bycatch mitigation, and harvest and international trade management, all of which will be dependent on effective enforcement.

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### **229 ASIH STORER ICHTHYOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Emily S. Ladin<sup>1</sup>, Larry G. Allen<sup>2</sup>, Crystal D. Rogers<sup>1</sup>

<sup>1</sup>California State University Northridge, Northridge, California, USA, <sup>2</sup>California State University Northridge, Northridge, California, USA

### **Developmental Ontogeny of Giant Sea Bass, *Stereolepis gigas***

The Giant Sea Bass, *Stereolepis gigas*, is listed as critically endangered by the IUCN, and is the largest boney fish of the coast of Southern California. After fertilization, Giant Sea Bass larvae develop in the plankton, but little is known about their early life history stages or what mechanisms drive their recruitment. This study aims to examine, in detail the first critical stages of this species including the egg, yolk sac, pre-flexion, flexion, post-flexion, and the transformation stages. I will be imaging the eggs and larvae using Zen software. Once this is completed the fixed larvae will be dehydrated and cartilage will be stained with Alcian Blue. Following the staining of the cartilage the bone will be stained using Alizarin Red. After the staining is complete and skeletal data collected, some specimens will be destained and then

preserved. These will be used to analyze neurological development in the future. Knowledge of these developmental stages will give us a better understanding of what is driving Giant Sea Bass larval recruitment, thus allowing better protection of nursery areas and rational fisheries management.

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**752 ASIH/HL/SSAR Symposium: Citizen Science in Herpetology: Productive Past and Promising Future, Ballroom 2 – Cliff Lodge, Sunday 28 July 2019**

Travis LaDuc<sup>1</sup>, Drew Davis<sup>2</sup>, James Christiansen<sup>1</sup>

<sup>1</sup>University of Texas at Austin, Austin, Texas, USA, <sup>2</sup>University of Texas Rio Grande Valley, South Padre Island, Texas, USA

**Citizen Science CSI: Better understanding the distribution of an undescribed turtle shell disease condition through citizen observations**

During the course of a 13-year study on the population demographics of *Kinosternon flavescens* in the Chihuahuan Desert of west Texas, we recognized the presence of a progressive and degenerative shell condition in our turtle population. This undescribed condition is mediated by the growth of blue-green algae that penetrate the pores of the carapacial keratin, eventually causing the keratin to slough off, exposing dermal bone. To assess whether this shell condition was unique to this west Texas population of turtles or whether this condition had a wider distribution across the range of the species, we reviewed all 300+ *K. flavescens* photos on the iNaturalist.org platform. Although ~20% of the observations lacked the necessary dorsal photos, two-thirds of the remaining observations (including road-killed specimens) with good dorsal photos serendipitously documented the presence of this shell condition across the entire north–south distribution (Nebraska to northern Mexico) of *K. flavescens* over the last ten years. Combining data from these photographic vouchers with data from museum voucher specimens collected over the last century provides strong evidence for both the spatial and temporal persistence of this previously unrecognized shell condition across the geographic range of *K. flavescens*. These results demonstrate the ability to glean additional scientific utility from seemingly random and unique point observations. Additionally, these data stress the collective power of single observations made over time and space by both non-professionals and professionals alike.

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**534 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Krista Laforest, Emily Peele, Kara Yopak

University of North Carolina Wilmington, Wilmington, NC, USA

**Older and Wiser? Ontogenetic Shifts in the Brains of the Atlantic sharpnose shark, *Rhizoprionodon terraenovae***

Throughout an animal's life, species may occupy different environments and exhibit distinct life stages, known as ontogenetic shifts. The life histories of most sharks (Class: Chondrichthyes) are characterized by these ontogenetic shifts, which can be defined by changes in habitat and diet, as well as behavioral changes at the onset of sexual maturity. In addition, fishes experience indeterminate growth, whereby the brain and body grow throughout the organism's life. Despite lifelong neurogenesis in sharks, very little work has been done on ontogenetic changes in the brain, which may be informative about functional shifts in sensory and behavioral specializations. This study quantified ontogenetic changes in brain-body scaling and the scaling of three major brain regions (olfactory bulbs, telencephalon, and optic tectum) in 35 specimens of the Atlantic sharpnose shark, *Rhizoprionodon terraenovae*. Brain size increased significantly with body mass throughout ontogeny in this species, and most major brain regions scaled with negative allometry against the rest of the brain. However, notably, the olfactory bulbs scaled hyperallometrically to the rest of the brain, whereby this structure occupies a larger proportion of total brain size as the animal ages. Changes in the relative size of the olfactory bulbs throughout ontogeny may reflect an increased reliance on olfaction at later life history stages in *R. terraenovae*, which may correspond to shifts in habitat, diet, or behavior.

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### **731 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Jaedyn Lalonde, Lindsey Swierk

*Binghamton University, Binghamton, New York, USA*

#### **Impacts of Climatic Factors on Wood Frog (*Rana sylvatica*) Calling Activity**

Amphibian populations are facing global declines. They are sensitive to changes in temperature and moisture, making them particularly susceptible to climate change. Previous studies have shown that climate change can alter the breeding phenology of anurans (frogs and toads). As ectotherms, producing mate advertisement calls is temperature-dependent. This research explores how climatic factors influence the calling activity of wood frogs (*Rana sylvatica*). We determined how changes in temperature and precipitation impacted the number of wood frog vocalizations during the breeding season. Understanding these patterns can help us identify the overall implications of climate change on amphibian reproductive success.

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### **797 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Jennifer Y. Lamb, Matthew P. Davis

*St. Cloud State University, St. Cloud, Minnesota, USA*

#### **Shining a New Light on Salamanders: Survey of Biofluorescence Across Caudata**

Biofluorescence, the absorption and subsequent remission of light at longer wavelengths from living tissues, has been documented in a variety of vertebrates including cartilaginous and ray-finned fishes and some tetrapods. Within Osteichthyes, broad surveys for the presence of biofluorescence have been conducted in ray-finned fishes, however the extent to which this phenomenon occurs in tetrapods has not been thoroughly explored. In this study, we conduct the first survey for the presence of biofluorescence across salamanders (Caudata). Our results indicate that several lineages of caudates exhibit biofluorescence and that the pattern of fluorescence varies significantly among different species of salamanders. We also document the presence of biofluorescence across different life history stages (i.e., larvae and adults) of salamanders. Patterns of biofluorescence across caudates, and differences in these patterns among closely related species, have the potential to shed new light on numerous aspects of the biology of this fascinating lineage of aquatic and terrestrial vertebrates.

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**107 ASIH/HL/SSAR Symposium: The Expanding Role of Natural History Collections, Ballroom 1 – Cliff Lodge, Sunday 28 July 2019**

Max Lambert<sup>1</sup>, Adam Roddy<sup>2</sup>, Christian Gosser<sup>3</sup>, Charles Mettler<sup>3</sup>, William Robinson<sup>3</sup>, Brad Carlson<sup>3</sup>

<sup>1</sup>*University of California-Berkeley, Berkeley, CA, USA*, <sup>2</sup>*Yale University, New Haven, CT, USA*,

<sup>3</sup>*Wabash College, Crawfordsville, IN, USA*

**Reptile sex ratios in museum collections are associated with climate change and phylogeny**

Sex ratios can reflect biases in mortality or sex determination mechanisms. Hypotheses about potential drivers of sex ratios and sex ratio shifts are difficult to test, requiring demographic data spanning a broad geographic and temporal range. Though these data are difficult to obtain directly, museum collections provide a unique trove of information, provided important caveats are considered. We used sex ratios in museum collections for 87 US reptile species to examine change in sex ratios and relationships between sex ratio and phylogeny, conservation status, and county-level climate and land use. We found that sex ratios in museum collections were female-biased for turtles and natricine snakes but male-biased for other squamates, which suggests different and relatively conserved sex ratio dynamics among reptile clades. Warmer climates tended to have higher proportions of males overall. The proportion of males in populations tended to increase over time, possibly due to real demographic change and/or collecting bias. In turtles, however, counties that increased in temperature more over the past 40 years had populations in which this trend towards more males was reduced or reversed, consistent with temperature effects on sex determination in turtles. These patterns of sex ratio variation among species and shifts over time are consistent with hypothesized drivers and suggest further avenues of research in population ecology and the use of museum collections. Whether the phylogenetic differences in sex ratios reflect biological differences, or are due to sampling bias, or a combination of the two is unclear, but warrants further research.

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**374 HL GRADUATE RESEARCH AWARD, Ballroom 1 – Cliff Lodge, Thursday 25 July 2019**

Zachary Lange<sup>1</sup>, James Watling<sup>1</sup>, Andres Aponte<sup>2</sup>

<sup>1</sup>John Carroll University, University Heights, Ohio, USA, <sup>2</sup>National University of Colombia, Bogota, Colombia

***Pristimantis* Frogs Experience Shifting Patterns of Thermal Quality with Elevation and Forest Cover in the Colombian Andes.**

As anthropogenic climate change and habitat destruction progress, it is critical to understand how species interact with rising temperatures and loss of forest habitat. We assessed the interaction between thermal biology and habitat associations of three terrestrial-breeding anurans (*Pristimantis medemi*, *P. savagei*, and *P. frater*) along an elevation gradient (415-1350 m asl) in Colombia. From mark-recapture surveys conducted in forest and adjacent clearings, we established that *Pristimantis* individuals do not commonly switch habitats, and that with increasing elevation, a greater proportion of *P. medemi* and *P. frater* occupy clearings rather than forest. We then assessed the thermal quality of the habitat by comparing thermal preference ( $T_{\text{pref}}$ ) to environmental temperature ( $T_{\text{env}}$ ) measurements. For both *P. medemi* and *P. frater* we found better thermal quality ( $T_{\text{pref}} - T_{\text{env}}$ ) in clearings compared to forest at higher elevations, which corresponded to increasing proportions of each species in high-elevation clearings. Anthropogenic disturbance of forest habitat greatly reduces thermal quality for some species in the lowlands but can improve thermal quality for those same species at higher elevations.

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**771 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

John Larrimore, Michael Sandel, Kayla Fast

University of West Alabama, Livingston, AL, USA

**Metabarcoding Freshwater Fishes of the Mobile River Basin**

Alabama has the greatest diversity of freshwater fishes among the United States, many of which are currently imperiled. The process of effectively surveying imperiled freshwater fishes can be expensive and time-consuming. The use of environmental DNA (eDNA) is an ideal alternative to standardized field surveys, used to determine which species are present within a particular watershed. eDNA metabarcoding simultaneously estimates community diversity for a given watershed/water sample. Despite its advantages, metabarcoding requires a reference database to calculate relative abundance of species. We report the first reference library of mitochondrial DNA sequences for all freshwater fishes native to the Mobile River Basin. The library is constructed from a combination of publicly available and de novo DNA sequences. For the amplification of the sequences using polymerase chain reaction (PCR), we focused on the mitochondrial cytochrome oxidase I (COI) gene and the 12S ribosomal RNA genes. The mitochondrial DNA sequences obtained were aligned using the BioEdit software, and the

alignments were used to create a phylogenetic tree with the Mega7 software. The first eDNA samples were characterized using the QIIME custom library pipeline. The implications of metabarcoding are not only to efficiently determine the presence/absence of a particular species but would also determine the relative composition of a particular watershed.

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### **337 Ichthyology Lightning Talks, Alpine A,B,C – The Snowbird Center, Saturday 27 July 2019**

Matthew Larsen<sup>1</sup>, Daniel Abel<sup>1</sup>, Derek Crane<sup>1</sup>, Bryan Keller<sup>2</sup>, Dean Grubbs<sup>2</sup>

<sup>1</sup>Coastal Carolina University, Conway, South Carolina, USA, <sup>2</sup>Florida State University, Tallahassee, Florida, USA

#### **Evidence of Reduced Metabolic Activity in Bathypelagic Sharks Determined by Heart Ventricular Mass**

A paucity of information exists on the biology of deep-sea sharks due to logistical constraints on their study. These sharks are subjected to increasing pressure from deep-sea fisheries, driving the need to rapidly examine their life histories, physiology, and ecology. In this study, we determined heart ventricular dry mass-body mass ratio of nine species of sharks from coastal (*Carcharhinus acronotus*, *Carcharhinus isodon*, *Carcharhinus limbatus*, *Rhizoprionodon terraenovae*, and *Sphyrna tiburo*) and deep-sea (*Centrophorus uyato*, *Mustelus canis*, *Squalus cubensis*, and *Squalus clarkae*) habitats as indicators of metabolism. The coastal, obligate ram ventilator *Carcharhinus limbatus* had the highest ratio (ANOVA;  $R^2=0.94$ ;  $df=8, 182; 190$ ,  $F=102.47$ ;  $P<0.0001$ ), while the bathydemersal species *Centrophorus uyato* had the lowest (ANOVA;  $R^2=0.94$ ;  $df=8, 182; 190$ ,  $F=102.47$ ;  $P<0.0001$ ). While preliminary, this study, the first of heart mass in deep-sea sharks, supports previous studies of activity levels in deep-sea sharks using white and red muscle enzymes as proxies for metabolism that have shown that activity levels decrease with depth following the visual interaction hypothesis. New biologging technology and further plasma lipid analysis may continue to clarify the relationship between depth and shark metabolism.

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### **338 AES CARRIER AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Matthew Larsen<sup>1</sup>, Daniel Abel<sup>1</sup>, Derek Crane<sup>1</sup>, Scott Parker<sup>1</sup>, Bryan Keller<sup>2</sup>, Dean Grubbs<sup>2</sup>

<sup>1</sup>Coastal Carolina University, Conway, South Carolina, USA, <sup>2</sup>Florida State University, Tallahassee, Florida, USA

#### **Negative Allometric Growth in the Digitiform Rectal Gland Morphology: Mitigating NaCl Influx in Small Sharks**

We examined rectal gland dry mass and weight-specific rectal gland dry mass among 10 species of sharks (*Carcharhinus acronotus*, *Carcharhinus isodon*, *Carcharhinus limbatus*, *Centrophorus uyato*, *Mustelus canis*, *Mustelus sinuatus*, *Rhizoprionodon terraenovae*, *Sphyrna tiburo*, *Squalus clarkae*, *Squalus cubensis*) with digitiform rectal gland morphology to test if the published negative allometric relationship seen in rectal glands in *Scyliorhinus canicula* applied. Rectal gland dry mass increased linearly with shark body mass (Regression;  $R^2=0.77$ ;  $df=1, 266; 267, F=874.75$ ;  $P<0.0001$ ). There was a negative relationship between weight-specific rectal gland dry mass and shark body mass indicating that glands did not increase proportionally to shark body mass (Regression;  $R^2=0.12$ ;  $df=1, 266; 267, F=37.09$ ;  $P<0.0001$ ). Smaller sharks have a greater gill surface area-body volume ratio than larger sharks and thus a higher influx of NaCl. Correspondingly, smaller sharks have larger rectal glands compared to body size to mitigate the proportionally higher ion uptake.

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## 21 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019

Halee Larson, James Gelsleicher

*University of North Florida, Jacksonville, Florida, USA*

### **Reproductive Endocrinology of the Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, off the Coast of Northern Florida**

Plasma testosterone (T) concentrations are commonly used as a non-lethal approach for studying reproduction in male elasmobranchs (sharks and rays). However, little research has been conducted on the exact roles that T plays in sexual maturity and reproduction in sharks and their relatives. Therefore, the current study investigated these factors in male Atlantic sharpnose sharks, *Rhizoprionodon terraenovae*, the most abundant species of shark present off the southeastern U.S. coast. The objectives of this study were to examine patterns in plasma T concentrations in relation to sexual maturity and the seasonal reproductive cycle in male *R. terraenovae*, as well as examine the location of androgen receptors in reproductive organs of this species. Blood was collected from >100 neonate to mature male Atlantic sharpnose sharks from the southeastern U.S. Atlantic coast and plasma T concentrations were measured using chemiluminescence immunoassays (CLIA). The location of androgen receptors was examined in histological sections of reproductive organs using immunocytochemistry. Plasma T concentrations increased with sexual maturity and the period of spermatogenesis, which was found to occur from fall to late spring. Androgen receptors were immunolocalized in various cell types in the testis and reproductive ducts, reflecting important roles in both sperm production and copulation. The distribution of androgen receptors in the male intromittent organs, the claspers, was also examined to evaluate the potential role of testosterone in the marked growth and calcification that occurs in these secondary sex structures during sexual maturity.

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## **579 SSAR SEIBERT CONSERVATION AWARD I, Ballroom 1 – Cliff Lodge, Friday 26 July 2019**

Elliot Lassiter<sup>1</sup>, Orlando Garces<sup>1</sup>, Jorge Gurrel<sup>1</sup>, Roberto Ibañez<sup>2</sup>, Brian Gratwicke<sup>3</sup>

<sup>1</sup>*Smithsonian Tropical Research Institute, Gamboa, Panama*, <sup>2</sup>*Smithsonian Tropical Research Institute, Panama, Panama*, <sup>3</sup>*Smithsonian National Zoological Park, Front Royal, Virginia, USA*

### **Identifying the Cause of Spindly Leg Syndrome in Captive Amphibian Assurance Colonies**

In response to global amphibian declines, captive assurance colonies and breeding programs for reintroduction have become a crucial part of amphibian conservation. Spindly Leg Syndrome (SLS) is a fatal developmental disease affecting captive frogs in all taxonomic groups with tadpole stages. SLS is diagnosed by thin, underdeveloped limbs that greatly inhibit mobility and feeding. While there are many anecdotal recipes to prevent SLS, there is little replicated experimental data to identify the cause of this fatal disease. One recent study found that SLS frequency was greatly reduced by rearing tadpoles in reconstituted reverse-osmosis water. In this study, we conducted a fully factorial, replicated design experiment to test the effects of calcium and phosphate concentrations in water on SLS prevalence. We utilized 600 critically endangered *Atelopus varius* reared at the Panama Amphibian Research and Conservation Project in Gamboa, Panama. Tadpoles were separated into six treatment groups of with high, medium and low levels of calcium and medium and low phosphate concentrations, then monitored until metamorphosis. With this study we were able to determine the optimal water quality for tadpole survivorship and reduce the prevalence of SLS in metamorphosed froglets and provide recommendations to other captive-breeding efforts.

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## **676 Herpetology Biogeography I, Ballroom 3 – Cliff Lodge, Friday 26 July 2019**

Adam Leache<sup>1</sup>, Matt Fujita<sup>2</sup>, Jamie Oaks<sup>3</sup>

<sup>1</sup>*University of Washington, Seattle, Washington, USA*, <sup>2</sup>*University of Texas, Arlington, Texas, USA*, <sup>3</sup>*Auburn University, Auburn, Alabama, USA*

### **Mechanisms of Diversification in West African Amphibians and Reptiles**

Identifying the processes that have promoted the accumulation of tropical rainforest biodiversity has been an important goal for evolutionary biologists and ecologists who seek to understand global patterns of diversification. The tropical rainforests of West and Central Africa contain spectacular species richness and endemism, yet the factors responsible for generating this diversity are understudied. This collaborative project aims to investigate the diversification of 20+ species of frogs, lizards, snakes, and crocodiles that are endemic to the Guineo-Congolian forests. Our project uses genomic methods to discover and describe species, model population dynamics through time, and investigate how these diverse communities developed. We find that forest-obligate species in this region are typically composed of genetically distinct populations or cryptic species with geographic distributions that mirror the locations of major forest blocks. By

leveraging genome-wide SNPs and inferences from phylogenetics, demography, and ecological models, our project takes an integrative approach to test among major hypotheses regarding the population genetic consequences of climatological fluctuations, forest fragmentation, and river barriers. In addition, we are developing new tools and techniques for accelerating the pace of biodiversity discovery, including new methods to delimit species with genomic data and new phylogenetic approaches to test whether populations share the same divergence time. Understanding diversification processes is important for describing the composition of biodiversity, interpreting how ecosystems and biomes develop over time, and guiding decisions on how to preserve threatened biotas.

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### **283 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Javion Lee<sup>1</sup>, Caleb McMahan<sup>2</sup>, Christopher Murray<sup>1</sup>

<sup>1</sup>Tennessee Technological University, Cookeville, TN, USA, <sup>2</sup>The Field Museum of Natural History, Chicago, IL, USA

#### **Patterns of Morphological Convergence among Members of the Genus *Naja* with Identification of Ecomorphs**

A common goal in evolutionary biology is to assess the role of environment as a constraint on trait evolution, revealed by the presence of analogous traits that hypothesize convergence. Convergent evolution has elucidated the development of ‘ecomorphs, then ‘ecomodes’ among *Anolis* lizards, correlating phenotype to microhabitat use. Cobras in the genus *Naja* exhibit a large distribution across African and Asian continents and occupy a disparity of habitats and ecological niches and among species. Here, we test the hypothesis that members of the four subgenera within *Naja* are phenotypically more similar to members of different subgenera than members of their own. Therefore, we hypothesize that morphological convergence, as opposed to phylogenetic constraint, is a driver for morphological evolution among *Naja*, and the presence of ecomorphs are diagnoseable. We quantified meristic, morphometric and geometric morphometric characters among 17 species. Preliminary cluster and multi-dimensional scaling analyses revealed convergent morphology among the four subgenera using both meristic and morphometric characters with the exception of the subgenus *Afronaja*, that appears to be phylogenetically constrained in form. Canonical variate analysis also revealed convergence using geometric morphometric shape data, although the optimization of shape data on the phylogeny is ongoing. This research tests the repeatability of the ecomode concept and provides further evidence of broad scale convergent morphological evolution in widely distributed clades.

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### **271 AES GRUBER AWARD III, Rendezvous A&B – The Snowbird Center, Friday 26 July 2019**

Ryan Lehman<sup>1</sup>, Jill Hendon<sup>2</sup>, Dr. Gregg Poulakis<sup>3</sup>, Rachel Scharer<sup>3</sup>, Dr. Nicole Phillips<sup>1</sup>

<sup>1</sup>The University of Southern Mississippi, Hattiesburg, Mississippi, USA, <sup>2</sup>The University of Southern Mississippi, Ocean Springs, Mississippi, USA, <sup>3</sup>Florida Fish and Wildlife Conservation Commission, Port Charlotte, Florida, USA

### **Finding Fragments: Using eDNA to assess the occurrence of Critically Endangered Smalltooth Sawfish outside its core range in U.S. waters**

The Critically Endangered Smalltooth Sawfish, *Pristis pectinata*, historically occurred from Texas to North Carolina in U.S. waters, but experienced significant reductions in range and abundance over the last century, with the core population currently restricted to Southwest Florida. As a result of these declines, *P. pectinata* gained federal protection on the Endangered Species Act of 1973 (ESA) by the National Marine Fisheries Service (NMFS) in 2003, and the core population may have stabilized due to over 15 years of ongoing research and education initiatives. Within the past decade, recreational fishers outside of the core range of *P. pectinata* have sporadically reported encounters with juveniles in historically occupied areas, implying population recovery and/or re-establishment; however, their current status in these non-core waters is not well understood by scientists and managers. To assess the status of this species in non-core waters (e.g., northern Gulf of Mexico, Indian River Lagoon), we developed and validated a species-specific environmental DNA (eDNA) assay for the detection of *P. pectinata* DNA from water samples, even at minute quantities (< 1 pg/μL). EDNA is a rapid-assessment, cost-effective, powerful tool for monitoring global sawfish recovery through early detection of species presence. Using the developed eDNA assay, we analyzed water samples collected in locations with recent encounter reports that had been verified (e.g., reports included photograph evidence). If *P. pectinata* are re-establishing in historic portions of their range in U.S. waters, it is imperative to designate and protect any critical region(s) to maximize recovery planning.

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### **35 Amphibian Conservation, Ballroom 2 – Cliff Lodge, Saturday 27 July 2019**

Richard Lehtinen, Christopher Gumpper, Linnea Johnson, Mackenzie Kellar, Nathan Weltman

*The College of Wooster, Wooster, OH, USA*

### **A Comparison of Diversity and Abundance of Glass Frogs (Centrolenidae) in Primary and Secondary Rainforests in Costa Rica**

As primary (old-growth) tropical rainforests are destroyed, the importance of second growth rainforests to biodiversity conservation becomes more critical. Often, second growth forests are regarded as poor substitutes for old-growth but for many taxa this is not a topic that has been investigated in detail. To help fill this gap, we assessed the diversity and abundance of glass frogs (Centrolenidae) along streams at five study sites in Costa Rica that contain both old-growth and second growth forest in close proximity. We sampled these stream breeding amphibians multiple times during the breeding season using standardized night surveys along thirty-three 200 m transects (18 in old-growth, 15 in second-growth). We also used dataloggers to assess the

abiotic environments (temperature and humidity) along these transects. Our results to date suggest that species richness of glass frogs does not differ significantly between old-growth and second growth rainforests even though secondary rainforests were significantly warmer and drier than old-growth forests. Thus far, we have detected nine species of glass frogs in our surveys but the abundance of these did not significantly differ between old-growth and second-growth. These data suggest that second-growth forests support similarly diverse and abundant glass frog communities as compared to old-growth forests. Thus, second growth forests may be capable of supporting more tropical biodiversity than has previously been appreciated. However, most of the second-growth forests we sampled were over 30 years old. Younger forests, or those not in close proximity to old-growth forests, may not exhibit similar patterns.

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### **596 AES Physiology I, Alpine A,B,C – The Snowbird Center, Sunday 28 July 2019**

Matthew Levendosky, Molly Lanier, Christine Bedore

*Georgia Southern University, Statesboro, Georgia, USA*

#### **Effect of Anesthesia Immersion on the Coral Catshark, *Atelomycterus marmoratus***

Sensory experiments on elasmobranchs require adequate anesthesia and sedation so that the animal's position is maintained during the experiment. Traditional fish anesthetics (e.g. tricaine) depress sensory systems, although the degree to which results are affected remains unclear. Newer anesthetics, such as propofol, may offer the same anesthetic relief as tricaine, but the action of propofol differs from tricaine, so sensory responses may not be affected. Propofol has been used intravenously on several species of small elasmobranchs, but it may provide prolonged effects if used as an immersion anesthetic. Because of its potential to maintain a surgical plane of anesthesia for the duration of time required for sensory physiology experiments, investigation of propofol as an alternative anesthetic warrants investigation. Therefore, the objectives of this study were to 1. Determine the appropriate dose of anesthesia which minimizes both induction and recovery time for animals anesthetized at a surgical plane of anesthesia and 2. Measure physiological responses of the pupil to light stimuli during low-dose tricaine or propofol immersion. To address our objectives, we used a small benthic shark, the coral catshark *Atelomycterus marmoratus*. After 1.5 hours of dark adaptation in a water bath with low-dose anesthesia (either 50mg L<sup>-1</sup> tricaine or 0.5mg L<sup>-1</sup> propofol) or no anesthesia (control), there was no difference in the percent constriction in response to a light stimulus ( $p>0.5$ ; ANOVA). Though these results suggest anesthetics don't affect pupillary responses, higher doses that induce a surgical plane of anesthesia will be tested for a dose-response effect.

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### **695 ASIH/HL/SSAR Symposium: Citizen Science in Herpetology: Productive Past and Promising Future, Ballroom 2 – Cliff Lodge, Sunday 28 July 2019**

Enjie Li<sup>1,2</sup>, Gregory Pauly<sup>1</sup>, Sophie Parker<sup>2</sup>, John Randall<sup>3</sup>, Brian Brown<sup>1</sup>, Brian Cohen<sup>3</sup>

<sup>1</sup>Natural History Museum of Los Angeles County, Los Angeles, CA, USA, <sup>2</sup>The Nature Conservancy, Los Angeles, CA, USA, <sup>3</sup>The Nature Conservancy, San Diego, CA, USA

### **The value of citizen science for urban biodiversity research: An example from the Biodiversity Analysis in Los Angeles (BAILA) Project**

The lack of species occurrence data is often cited as a major impediment to effective urban conservation planning and management. However, the explosive growth in citizen science projects has greatly increased the availability of species occurrence data from urban areas and opened up new opportunities for urban biodiversity research. We use citizen science generated data from the iNaturalist platform to examine biodiversity distribution patterns across the highly-urbanized portion of Los Angeles County, California, USA. We term this effort BAILA, Biodiversity Analysis in Los Angeles. Although BAILA focuses on all taxa, for this talk, we focus primarily on reptile and amphibian distribution patterns. First, we compare citizen science records to museum records to highlight the novelty and success of using citizen science generated species occurrence data for urban biodiversity assessments. We then use these citizen science observations to examine how urbanization structures reptile and amphibian distributions. With increasing participation in citizen science projects, we believe citizen science generated species occurrence data within and beyond the field of herpetology, offer unique advantages for urban biodiversity assessments.

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### **83 Reptile Ecology, Primrose A&B – Cliff Lodge, Saturday 27 July 2019**

Peter V. Lindeman

*Edinboro University of Pennsylvania, Edinboro, Pennsylvania, USA*

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

I studied growth in common map turtles (*Graptemys geographica*) at Presque Isle from 1999–2017. I captured 1724 individuals with 1–9 recaptures for 529 turtles (888 total). Plastral annuli were a reliable indicator of age for up to 10 years in females and up to 6 years in males in 236 of 248 recapture events (95%) that spanned an average of 2.2 years (range 1–6). Recaptured turtles of known age were up to 19 years old in both sexes and adults <math>\leq 19</math> years of age spanned the entire range of adult body sizes for each sex, although growth continued for many adults of all sizes. I measured medial widths of completed growth annuli for 1937 annulus widths from 381 females and 910 annulus widths from 224 males. Regression modelling related annulus width of each sex to age (declining width with age, as per the von Bertalanffy growth model) and to year. Years that had poorer or better growth were highly congruent between the sexes and the amount of growth was positively correlated with growing degree days during the period when turtles exhibited new growth, 11 June–19 August. Climatic data indicate warming of Presque Isle and data from 18 *G. geographica* specimens collected at Presque Isle in 1900 suggest that

contemporary growth is enhanced by the warming environment. Variation in body condition was weak interannually, but body condition was highest in September, when turtles were not growing and were nearing the onset of the lengthy winter brumation in Erie.

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### **606 Amphibian Disease, Ballroom 3 – Cliff Lodge, Sunday 28 July 2019**

Luke Linhoff<sup>1</sup>, Roberto Ibanez<sup>2</sup>, Brian Gratewicke<sup>3</sup>

<sup>1</sup>*Smithsonian's National Zoo and Conservation Biology Institute, Washington, DC, USA,*

<sup>2</sup>*Smithsonian Tropical Research Institute, Panama City, Panama,* <sup>3</sup>*Smithsonian Conservation Biology Institute, Washington, DC, USA*

#### **Exploring individual variation in chytridiomycosis susceptibility within a reintroduction program and the potential for artificial selection**

The Panama Amphibian Rescue and Conservation Project has established captive populations of twelve highly threatened amphibian species that experienced catastrophic declines because of the fungus. Understanding how much variation in susceptibility to amphibian chytrid chytridiomycosis exists between individuals is useful to understand the potential for adaptation and in mechanistic studies of disease tolerance. Assessing variation of disease susceptibility has typically proved difficult without lethal disease exposure trials. Thus, understanding susceptibility in highly threatened species is problematic due to the rarity and conservation value of the animals. Our study first utilizes a small number of surplus captive-bred offspring (N=20) in experimental live-pathogen exposure trials paired with a newly developed non-invasive assay of mucosome effectiveness to inhibit the chytrid fungus to correlate predicted to observed disease susceptibility. We then non-invasively profile the mucosome effectiveness of hundreds of frogs (N >400) within the captive breeding program. We are currently working to rank our captive species by disease susceptibility and explore individual variation of mucosome effectiveness throughout the populations. Additionally, we are exploring whether observed differences in skin secretion effectiveness are transferred from parent to offspring by comparing effectiveness within known pedigrees of captive-bred animals. By identifying individual variation in skin secretion effectiveness, and demonstrating if these traits can be inherited, it may provide a framework to selectively-bred lines of frogs with greater disease tolerance. Our results may have broad conservation implications for managing captive amphibian populations.

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### **263 ASIH/HL/SSAR Symposium: Professional Women in Herpetology: Lessons and Insights, Ballroom 1 – Cliff Lodge, Saturday 27 July 2019**

Karen Lips

*Department of Biology, University of Maryland, College Park, MD, USA*

## **Coordinating Global Efforts in Research, Education, and Policy to Address Amphibian Population Declines**

The global amphibian crisis has long been a case study of how important collaborations are in understanding global change, as by its very nature, studying a pandemic involves expertise from many disciplines and any solutions will require cooperation from many countries. Women have played key roles in all aspects of the amphibian decline phenomenon – from the initial description of the pathogen, to early discovery, to key breakthroughs in the field and in the lab, to engagement with communities, students, and policymakers. Initially dominated by amphibian ecologists, this field has grown tremendously since the first declines were reported in the 1980s and today is characterized by multidisciplinary, international research collaborations. From the beginning researchers have been active in engaging with policymakers, educators, the media, and public groups. Additionally, the topic has engaged writers, journalists, and artists to produce popular books, video documentaries, magazine articles and other media coverage. Recently, new breakthroughs have changed the research questions, conservation activities, and communication efforts related to this issue. These new findings have also influenced the forms and types of engagement with other stakeholder groups, such as the media, policymakers, citizens, and student groups. I will highlight the contributions of women in this field, the importance of diversity in addressing global challenges, relevant skills and career trajectories, and lessons learned as a woman in herpetology.

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### **90 SSAR HUTCHISON PHYSIOLOGY & MORPHOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Allison Litmer<sup>1</sup>, Christopher Murray<sup>2</sup>

<sup>1</sup>University of Arkansas, Fayetteville, Arkansas, USA, <sup>2</sup>Tennessee Technological University, Cookeville, TN, USA

#### **Critical Thermal Tolerances of *Hyla chrysoscelis* in Relation to Season and Proximity to Water**

As global climate change persists, ectotherm viability is of concern due to their reliance on the external thermal environment for phenology and body temperature regulation. Thermal tolerances are useful parameters typically reflected in the behavior and ecology of an organism, providing indication of activity time and location. For tree frogs, emergence from brumation, activity time, and proximity to water may be influenced by individual thermal tolerances. Here, we assessed critical thermal tolerance of the Cope's gray treefrog (*Hyla chrysoscelis*) in Cookeville, Tennessee, in relation to capture date and distance from the breeding pond. Critical thermal maximum ( $CT_{max}$ ), minimum ( $CT_{min}$ ), and breadth were assessed for *H. chrysoscelis* using a water bath and testing for righting reflex every three minutes. While,  $CT_{max}$  and  $CT_{min}$  were not significantly correlated with capture date, we found that frogs detected later in the season had significantly increased thermal breadths. Additionally, there was a slight trend of increased cold tolerance later in the season. No trends were detected in thermal tolerance parameters and distance from the breeding pond. Thus, this study demonstrates that variability may exist in

thermal tolerances within a population, resulting in slightly differing activity periods. Variation in thermal tolerance within a population may allow for persistence through climate change if evolution can act upon these traits. Whereas many factors influence an organism's thermal tolerance and activity period, critical thermal tolerances may proxy fundamental niche, providing insight to how thermal changes could potentially impact survival, improving understanding of organismal responses to climate change.

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### **630 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Aimee Little<sup>1</sup>, Jim Gelsleichter<sup>1</sup>, Christine Bedore<sup>2</sup>

<sup>1</sup>University of North Florida, Jacksonville, Florida, USA, <sup>2</sup>Georgia Southern University, Statesboro, Georgia, USA

#### **Androgen Receptors in the Olfactory Epithelium of the Atlantic Stingray, *Hypanus sabina***

Based upon previous observations of elasmobranch mating, it has long been suggested that sharks and rays may use the olfactory system to detect suitable mates. For example, both male sharks and batoids have been observed to display “nosing” behavior during courtship, in which males approach females from behind and underneath, seemingly using their snouts to “investigate” the female cloaca. However, despite such observations, little work has been conducted on the role that olfaction plays in elasmobranch mating. Therefore, as a prelude to a larger investigation on this topic, this study examined androgen receptor distribution in the olfactory system of the Atlantic stingray (*Hypanus sabina*), a species unique for their protracted mating cycle. Olfactory organs were obtained from male and female *H. sabina*, processed using paraffin histology, and examined for the presence and localization of androgen receptors using immunocytochemistry. The goal of this preliminary study was to determine if the male stingray olfactory organs are targets for androgens, which are known to increase in circulation during the mating period and have been hypothesized to alter the sensitivity of other sensory systems believed to be involved in mating (e.g., Ampullae of Lorenzini). Based on the results obtained, future studies will examine how genetic expression of these receptors change throughout *H. sabina*'s extended mating cycle, and investigate how hormone-mediated changes in olfaction alter the physiological and behavioral responses of elasmobranchs during courtship.

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### **437 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Michaela Livingston<sup>1</sup>, Jonathan Davis<sup>2</sup>, Jessica Dutton<sup>1</sup>

<sup>1</sup>Texas State University, San Marcos, TX, USA, <sup>2</sup>Texas Parks and Wildlife Department – Coastal Fisheries Division, Port Arthur, TX, USA

#### **Mercury Accumulation in Young-of-the-Year and Juvenile Bull Sharks (*Carcharhinus leucas*)**



Sharks can accumulate mercury (Hg) to high concentration because they are long-lived top predators. The majority of previous studies measured Hg concentrations in adult sharks because samples are relatively easy to obtain from commercial and recreational fisheries. Young-of-the-year (YOY) and juvenile sharks are often overlooked due to the difficulty of obtaining samples from immature sharks; however, the concentration of Hg in these life stages needs to be examined since elevated Hg exposure can result in deleterious health effects and impact development. Estuaries along the Texas coast are important nursery grounds for several shark species, including the bull shark (*Carcharhinus leucas*), allowing for a unique opportunity to investigate Hg concentrations in YOY and juvenile life stages. This study investigated the concentration of Hg in tissues and organs (muscle, fin, heart, liver, kidney, brain, and skin) collected from YOY and juvenile bull sharks (n = 45) in Sabine Lake (Texas and Louisiana) in relation to body length using a Direct Mercury Analyzer. The average Hg concentration was highest in the muscle and heart and lowest in the skin and fin. A positive relationship was observed between Hg concentration and body length in the muscle, heart, liver, and kidney, whereas no relationship was observed for brain, skin, and fin. Future studies need to focus on the maternal transfer of Hg in this species because YOY individuals had a higher than expected Hg concentration for their age and this could be due, in part, to exposure *in-utero*.

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### **158 AES Conservation & Management IV/Behavior, Rendezvous A&B – The Snowbird Center, Sunday 28 July 2019**

Ryan Logan<sup>1</sup>, Jeremy Vaudo<sup>1</sup>, Lara Souza<sup>2</sup>, Bradley Wetherbee<sup>1,3</sup>, Mark Sampson<sup>4</sup>, Mahmood Shivji<sup>1</sup>

<sup>1</sup>Guy Harvey Research Institute, Nova Southeastern University, Dania Beach, FL, USA, <sup>2</sup>The Laboratory, Marine Biological Association of the United Kingdom, Plymouth, United Kingdom, <sup>3</sup>University of Rhode Island, Kingston, RI, USA, <sup>4</sup>Fish Finder Adventures, Ocean City, MD, USA

### **Seasonal Movements and Area Use of Juvenile Smooth Hammerhead Sharks *Sphyrna zygaena* in the Western North Atlantic Ocean**

Upper trophic level marine predators may serve important roles in ecosystem functioning, but often face increased risks from fisheries. One group hit particularly hard by fisheries worldwide are the large-bodied hammerhead sharks. Successful management of these predators will require detailed information about their movements and distributions. This information is lacking for smooth hammerhead sharks *Sphyrna zygaena*. In this study, we examined the seasonal movement patterns and space use of juvenile smooth hammerhead sharks in the western North Atlantic using satellite telemetry. Six juvenile smooth hammerhead sharks were tagged with fin-mounted satellite tags and tracked for an average of 187 days (49–441 days), representing the longest spatially-explicit tracks of this species to date. Individuals showed surprisingly low intraspecific variation in seasonal movements, displaying area-restricted movements in the waters of the New York Bight during the summer before traveling south during autumn. Most sharks tended to overwinter in an area centered off Cape Hatteras, North Carolina and one individual returned to the New York Bight the following spring. Sharks were more likely to

engage in area-restricted movements at the northerly extent of their range in areas of high primary productivity, strong sea surface temperature fronts and elevated sea surface temperature. Findings from this study provide the first information on movements and behavior of this species in the western North Atlantic and should guide future conservation efforts and fishery management for an important life stage of this poorly understood predator.

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## 116 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019

Cody Long, Dustin Siegel

*Southeast Missouri State University, Cape Girardeau, MO, USA*

### **All *-gnathus* salamanders lack nasolacrimal ducts.**

Nasolacrimal ducts are a terrestrial adaptation that drain excess fluids secreted by orbital glands to the nasal cavities. A previous study demonstrated that nasolacrimal ducts were present on the branch leading to Plethodontidae; however, nasolacrimal ducts were lost on the branch leading to Desmognathini (*Desmognathus* + *Phaeognathus*) within Plethodontidae. Unfortunately, only two members of Desmognathini (*D. fuscus* and *D. monticola*) have ever been examined histologically to unequivocally conclude the lack of nasolacrimal ducts. In the current study we searched for nasolacrimal ducts in the majority of taxa comprising *Desmognathus* (over 90% coverage) and the monotypic *Phaeognathus*. We found no evidence of nasolacrimal ducts in any of the taxa through examination with traditional histology and diceCT. Although a formal ancestral state reconstruction was not conducted at this juncture, we are comfortable in assuming that nasolacrimal ducts were lost on the branch leading to Desmognathini.

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## 791 Ichthyology Genetics, Cottonwood A-D – The Snowbird Center, Sunday 28 July 2019

Gary Longo<sup>1</sup>, Krista Nichols<sup>1</sup>, Jameal Samhour<sup>1</sup>, Kelly Andrews<sup>1</sup>, Greg Williams<sup>1</sup>, Laurel Lam<sup>2</sup>, Bonnie Brown<sup>2</sup>, Scott Hamilton<sup>2</sup>

<sup>1</sup>NOAA, Seattle, WA, USA, <sup>2</sup>CSUMB, Moss Landing, CA, USA

### **A break by the bay: marked population differentiation between lingcod in the eastern Pacific Ocean**

We evaluated genetic structure in lingcod (*Ophiodon elongatus*), a North Pacific marine fish, using 16,749 RADseq markers in 629 individuals from throughout the species range. We found strong evidence for two distinct genetic clusters separated latitudinally with a break near The Gulf of the Farallones off California and a high frequency of admixed individuals on either side. F-statistics corroborate this genetic break between northern and southern sampling sites, although most loci are characterized by low  $F_{ST}$  values suggesting high gene flow throughout most the genome. Outlier analyses identified 142 loci putatively under divergent selection. These

loci appear to be driving the signals of strong differentiation between northern and southern clusters as population structure analyses excluding these loci fail to differentiate individuals. When individuals were grouped by cluster assignment (northern, southern, and admixed) 69 loci were fixed between the northern and southern cluster, all of which were identified in the outlier scans. All individuals identified as admixed exhibited near 50:50 assignment to northern and southern clusters and were heterozygous at the 68 of the 69 fixed loci. Alignments of RADseq loci to three other teleost genomes with chromosome level assemblies show that outlier and fixed loci are heavily concentrated on a single chromosome. Similar genomic patterns recently seen in other taxa with genome-wide data have been attributed to chromosomal inversions. Regardless of the evolutionary mechanism these results represent novel observations of genetic structure in lingcod and clearly show distinct evolutionary units in this important fishery.

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### **193 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Keira Lopez

*University of Northern Colorado, Greeley, CO, USA*

#### **Characterization of Serine Proteases from Prairie Rattlesnakes (*Crotalus viridis viridis*) venom: potential medical applications**

Toxicology explores the biochemistry and pharmacology of venom, like *Crotalus viridis viridis* (Prairie Rattlesnake) venom, common in eastern Colorado. Prairie Rattlesnake venom have kallikrein-like (KAL) and thrombin-like (THR) enzymes, serine proteinases with specific and differing activities. These enzyme toxins cause several symptoms in prey, including hemorrhage and vasodilation resulting in hypotension. Studies have shown that thrombin-like enzymes have the potential to diminish clot formation during surgeries and kallikrein-like enzymes may be useful to treat high blood pressure. This is an attempt to catalog all major toxins and activities in the venom of the Prairie Rattlesnake. Analyzing the venom can identify specific compounds that can treat coagulopathic illnesses. Relationships among these serine proteinases are determined by fractionation of the venom by size exclusion (SE) and high-performance liquid chromatography (HPLC) to purify serine proteinases further. My work purified and characterized five distinct serine proteinases, focusing on KAL and THR activities. Gel electrophoresis confirmed the sizes and purity of the toxins and biochemical analyses are in progress. Paradoxically, these same enzyme toxins may have utility in regulating aspects of the same coagulation cascade with which they interfere, but in a controlled fashion whereby they can have therapeutic rather than pathological effects.

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### **239 AES Symposium: The Sensory Biology of Elasmobranch Fishes, Rendezvous A&B – The Snowbird Center, Saturday 27 July 2019**

Christopher Lowe

*California State University Long Beach, Long Beach, CA, USA*

### **We have come a long way in 20 years - Influence of rapidly evolving technology in studying elasmobranch behavior and ecology**

Early study of elasmobranch behavior was limited to visual observations of captive animals or in water observations of wild animals, which were temporally and spatially restrictive, and often experimentally biased. Development of remote sensing technologies (e.g., sonar, acoustic and radio telemetry) in the early 1940s, eventually led to animal-borne applications for quantifying behavior. Early pioneers in the development and use of this technology included Drs. Donald R. Nelson and Frank Carey. Miniaturization and reduced power consumption of electronics, sensor development, and data storage capacity have resulted in a significant surge in new technology that has dramatically changed biotelemetry (multisensory telemetry - 1-5 Hz) and biologging (e.g., 3D accelerometry, 3D magnetometry - 10-25 Hz) applications. Advances in video technology (e.g., crittercam, BRUVS) has also greatly improved collection of elasmobranch biodiversity and behavioral data. Historically, quantifying high spatial resolution movement patterns relative to environmental variable required labor-intensive active tracking and simultaneous environmental monitoring, whereas UAVs and AUVs can allow for autonomous tracking of focal animals, while gathering considerable surrounding high-resolution environmental data. Advances in satellite telemetry technology has greatly improved our knowledge of migration cues and paths. This increased data stream has also led to a surge in computing power and more automated data processing using machine learning approaches, as well as significant advances in the mathematics associated with signal processing and pattern recognition. While many of the same limitations still plague field-based research, continued technological advances have rapidly increased our knowledge of behavior and ecology of elasmobranch fishes under natural conditions.

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### **347 Ichthyology Systematics I, Cottonwood A-D – The Snowbird Center, Sunday 28 July 2019**

William Ludt<sup>1</sup>, Bruce Collette<sup>2,1</sup>, Carole Baldwin<sup>1</sup>

<sup>1</sup>*Smithsonian NMNH, Washington, DC, USA*, <sup>2</sup>*NOAA, Washington, DC, USA*

### **Osteology of paired and median fins in Hemiramphidae and Exocoetidae with taxonomic comments**

The superfamily Exocoetoidea comprises the families Zenarchopteridae, Hemiramphidae and Exocoetidae. The last two families have been hypothesized to be closely related to one another and contain 129 currently recognized species, including all known marine fishes that can glide considerable distances over water. While the close relationship between these two families has been recognized for some time, there are still considerable discrepancies among hypothesized relationships within them. These discrepancies center on two main topics, the first of which

involves the taxonomic affinity of the genus *Oxyporhamphus*. Molecular and some morphological analyses suggest *Oxyporhamphus* is part of the Hemiramphidae, but this genus has also been recovered as an early diverging flying fish based on caudal anatomy. The second source of confusion regards the monophyly of the Hemiramphidae, which is recovered in morphological studies, but has yet to be recovered by any molecular approaches. Here we examine osteological structures associated with the paired and median fins to gain insight on these two areas of conflict. We find several characters that suggest a close relationship of *Oxyporhamphus* with *Hemiramphus*, *Euleptorhamphus* and *Rhynchorhamphus*. Furthermore, some of these characters are consistent with previous molecular studies that recover a non-monophyletic Hemiramphidae. We discuss these results in concert with previously collected data and mention taxonomic considerations for these two families.

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### 31 AES Physiology II, Alpine A,B,C – The Snowbird Center, Sunday 28 July 2019

Kady Lyons<sup>1</sup>, Katherine Wynne-Edwards<sup>2</sup>

<sup>1</sup>Georgia Aquarium, Atlanta, GA, USA, <sup>2</sup>University of Calgary, Calgary, AB, Canada

#### **Legacy PCB Contamination Negatively Impacts Osmoregulatory Biomarkers in Pregnant Female Stingrays and their Embryos**

Elasmobranchs utilize a unique osmoregulatory strategy enabling them to be hyperosmotic relative to the marine environment by sequestering urea and other solutes. Because this strategy is energetically expensive, perturbations to homeostasis, such as that presented by legacy PCB contaminant exposure, may be detectable in osmoregulatory biomarkers. This study characterized osmoregulation in pregnant Round Stingrays (*Urobatis halleri*) with matrotrophic histotrophy, and their embryos, over gestational development. In the course of a larger study examining embryonic development, maternal stress responses, and their uterine/histotroph steroid environment, solutes (urea, TMAO, proteins) were quantified in matched pairs of maternal plasma and histotroph and activities of enzymes indirectly and directly related to urea synthesis were measured in maternal and embryonic liver tissue. Pregnant females from the reference site maintained stable plasma urea concentrations, whereas plasma urea declined over the course of pregnancy in females from the contaminated site. In addition, muscle protein content significantly declined in contaminant-exposed, but not reference, females, indicating a potential loss of substrate for urea formation. Embryonic enzymes involved in the urea cycle and protein processing were functional, in contrast to the hypothesis that internal gestation (matrotrophic histotrophy), would delay the developmental onset of embryonic osmoregulation. While embryos were able to maintain urea and TMAO concentrations comparable to reference embryos, their liver protein content also significantly decreased over development, suggesting that osmoregulatory costs were higher. Increased costs for osmoregulation join other physiological measures adversely affected by legacy PCB contamination in these stingrays.

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**560 AES CARRIER AWARD, Poster Session I, Event Center – The Snowbird Center,  
Friday 26 July 2019**

Amanda Macek<sup>1</sup>, Bryan Franks<sup>1</sup>, Steven Kessel<sup>2</sup>

<sup>1</sup>*Dept of Biology and Marine Science, Jacksonville University, Jacksonville, Florida, USA,*

<sup>2</sup>*Daniel P. Haerther Center for Conservation and Research, John G. Shedd Aquarium, Chicago, Illinois, USA*

**Effects of Three Circle Hooks on Coastal Sharks Using Recreational and Commercial Fishery Techniques**

Modern circle hooks have become popularized over the past few decades by commercial and recreational fishers. The terminal gear design has proven effective in reducing deep hooking, injury, mortality, and by-catch in a limited number of studies. Prior research on circle hook effectiveness has generally focused on pelagic longlines with limited hook styles involving mostly non-elasmobranch species such as sportfish and turtles. Inconsistencies in study design, results, and a lack of targeted shark sampling inhibits our understanding on the effects of circle hooks on sharks. The goal of this research is to expand the knowledge of circle hook performance and to quantify the effects of three hook types on sharks using commercial and recreational gear by evaluating injury, hook location, catch rates, and mortality. Three common circle hook styles, offset, inline, and weak are used to determine hook morphological characteristics that have conservational benefit to sharks. Bait, hook size, and sampling methods have been standardized using common deployment techniques of bottom longlines, and a repetitive time drop method of recreational gear in attempts to reduce bias and improve quantitative data from this study. Research is focused in Northern Florida in-shore and nearshore waters, with additional data coming from planned sampling in Bimini, Bahamas during the summer of 2019.

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**162 Herpetology Physiology, Ballroom 3 – Cliff Lodge, Saturday 27 July 2019**

Stephen Mackessy<sup>1</sup>, Cassandra Modahl<sup>2</sup>

<sup>1</sup>*University of Northern Colorado, Greeley, CO, USA,* <sup>2</sup>*National University of Singapore, Singapore, Singapore, Singapore*

**Rear-fanged snake venoms: prey specificity, three finger toxins and novel structural variants**

Rear-fanged snakes (“colubrids”) include a remarkable diversity of species that are found more broadly distributed across the globe than any other group of snakes. Part of their tremendous ecological and evolutionary success resulted from the production of venoms containing homologs of toxins found in front-fanged snakes, conveyed via a venom delivery system unlike that seen in front-fanged species. Formerly considered primitive, delivery systems and venoms of

colubrids are proving to be very diverse variants of a familiar theme. For example, snakes in the genus *Boiga* produce numerous three-finger toxins (3FTxs), and some of them, such as iriditoxin, are dominant venom components with taxon-specific effects directed toward lizard prey. This motif is proving to be common among the rear-fanged Colubridae – *Oxybelis* also shows this pattern, and we have recently characterized a lizard-specific dimeric 3FTx, with high homology with iriditoxin, in the venom of *Pseustes sulfureus*. The venom gland transcriptome of *Pseustes* is dominated by 3FTxs, and the expressed venom consists of >92% 3FTxs, higher even than the vast majority of elapid venoms. However, *Pseustes* venom also contains a mammal-specific monomeric neurotoxin, sulmotoxin, which is non-toxic to lizards. This is a unique toxin among 3FTxs and snake venoms generally, and it illustrates further the extent to which selection has favored diversification of a single toxin scaffold among snake venoms. *Pseustes* was formerly considered to lack a Duvernoy's venom gland, and these results strongly suggest that a diversity of novel structural and functional variants of familiar toxins exist among rear-fanged colubrids.

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## **586 SSAR SEIBERT CONSERVATION AWARD II, Ballroom 1 – Cliff Lodge, Friday 26 July 2019**

Andrew MacLaren<sup>1</sup>, Paul Crump<sup>2</sup>, Michael Forstner<sup>1</sup>

<sup>1</sup>Texas State University, San Marcos, Texas, USA, <sup>2</sup>Texas Parks and Wildlife Department, Austin, Texas, USA

### **Using Automated Audio Recorders to Optimize Human Performed Audio Surveys for Monitoring the Endangered Houston Toad**

Most male anurans vocalize to attract females during breeding periods. This behavior is often exploited by parties interested in monitoring the occurrence of these species. The Houston Toad (*Anaxyrus houstonensis*) is one of the few endangered anurans for which guidelines for conducting human performed audio surveys are provided by the U.S. Fish and Wildlife Service. Here, we examine the efficacy of the existing protocol using a robust set of data collected using automated recording devices (ARD). To collect these data we chose two sites, known to be occupied by the Houston Toad, and equipped them with ARDs programmed to record continuously, without pause. We used the software Kaleidoscope to analyze all recordings for the presence of the Houston Toad's call. The protocol provided by the Fish and Wildlife Service defines a set of environmental conditions, and temporal boundaries, under which surveys should be conducted. We subset our data to reflect the conditions under which surveys would take place, and simulated 10,000 survey seasons using the guidelines as a template. Currently, surveyors are required to conduct 12 5-minute surveys each season, for 3 seasons. Our findings indicate that detection probability for the Houston Toad is lower than previously reported. We detail how the guidelines can be improved to increase detection probability, and offer recommendations on the number of surveys required to be 95% confident in conclusions of absence from a given site.

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## 651 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019

John Maerz, Coles Ehlers, Angela Burrow

*University of Georgia, Athens, Georgia, USA*

### **Creating Plaster Models of the Gopher Frog, *Lithobates capito***

The Gopher frog (*Lithobates [Rana] capito*) is a rare frog native to the longleaf pine ecosystem of the Southeastern United States. Adult Gopher frogs live in Gopher tortoise and small animal burrows located in pine flatwoods and sandhills. Breeding takes place in isolated wetlands and after metamorphosis juvenile frogs must travel from the wetlands to locate upland burrows. There are many risks during this journey, one of which is dehydration. Juveniles travel through different microclimates, such as shaded areas under plants versus open areas, that differentially affect their rate of water loss. Accurately predicting water loss in the field is important for development of biophysical models of survival, population models, and for assessing microclimate suitability. We developed a physical model of juvenile Gopher frogs and tested their rate of water loss and internal temperature alongside real frogs. We developed a 3D model based on measurements taken from actual Gopher frogs; we then used these printed 3D models to create plaster-cast models. We tested plaster-cast models in environmental chambers against live animals. Once validated, these models can be used in place of live animals in field trials to assess dehydration risk in variable microclimates.

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## 639 Amphibian Ecology, Ballroom 2 – Cliff Lodge, Friday 26 July 2019

John Maerz<sup>1</sup>, Vanessa Terrell<sup>1</sup>, Nathan Engbrecht<sup>2</sup>, Rochelle Stiles<sup>3</sup>, Brian Crawford<sup>1</sup>, Michael Lannoo<sup>2</sup>

<sup>1</sup>*University of Georgia, Athens, GA, USA*, <sup>2</sup>*Indiana University School of Medicine, Terre Haute, IN, USA*, <sup>3</sup>*Indiana State University, Terre Haute, IN, USA*

### **Population dynamics of Threatened Crawfish Frogs Informs Targets for Management**

Managing species with complex life cycles and complementary habitat requirements requires identifying vital rates and processes that constrain population growth and are sufficiently malleable for management. We used data from a 5-year intensive drift-fence study at two focal breeding wetlands of a single Crawfish frog (*Rana areolatus*) population to estimate the relative importance of tadpole survival to population growth and as a target for management. We used field estimates of stage-specific vital rates, including temporary immigration, to estimate elasticity of demographic rates, and we simulated stochastic population dynamics at each wetland. Elasticity of tadpole survival was second only to juvenile survival and approximately double that of adult survival. Sensitivity of population growth ( $\lambda$ ) to tadpole survival was an order of magnitude greater than any other vital rate. Stochastic simulations of breeding sites confirmed the large effect of larval survival on population growth and viability. Importantly,



tadpole survival rates were significantly more variable than other vital rates in relation to factors that can be targeted by management including wetland vegetation and predator and competitor abundance. Two additional important findings of this study were that adult annual survival following an individual's first breeding season was comparable to juvenile survival and 48% lower compared to survival among adults who had bred in two or more prior years, and adult temporary emigration rates were moderately high. Our results indicate that efforts to identify and manage breeding sites that are population sinks will be important for the sustainable recovery of threatened anuran species.

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**108 ASIH/HL/SSAR Symposium: Professional Women in Herpetology: Lessons and Insights, Ballroom 1 – Cliff Lodge, Saturday 27 July 2019**

Anne Maglia

*University of Massachusetts Lowell, Lowell, MA, USA*

**Career Mapping: Charting the Course for Traditional and Alternative Science Careers**

Although securing a traditional tenure-track academic position is more difficult than ever, the career pathway to the professoriate remains most familiar to students and faculty alike. Those who pursue alternative careers associated with academia and/or science often follow convoluted, and sometimes unexpected, career trajectories. In my current position as Associate Vice Chancellor of Research, my responsibilities include helping researchers intentionally navigate their career trajectories. To assist them in achieving their professional goals, I provide strategic career mapping resources to help them identify opportunities for professional growth and advancement. With this type of intentional planning, non-traditional academic careers can become more accessible and alternative career pathways can become less convoluted. In this talk, I will reflect on my own alternative academic career path, share career mapping tools, and highlight career milestones as opportunities for assessment, introspection, and strategic planning.

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**656 Herpetology Genetic Diversity, Ballroom 1 – Cliff Lodge, Thursday 25 July 2019**

Michael Mahr<sup>1</sup>, Justin Autz<sup>1</sup>, Jennifer Buchanan<sup>1</sup>, Alexis Powell<sup>1</sup>, Lynnette Sievert<sup>1</sup>, David Edds<sup>1</sup>, J. Daren Riedle<sup>2</sup>

<sup>1</sup>*Emporia State University, Emporia, KS, USA*, <sup>2</sup>*Kansas Department of Wildlife, Parks, and Tourism, Pratt, KS, USA*

**Morphologic variation, geographic distributions, and taxonomic boundaries of map turtles (*Graptemys* spp.) in Kansas**

Kansas lies at the western extent of the distributions of four map turtle taxa—the Northern (*Graptemys geographica*), Ouachita (*G. ouachitensis*), Northern False (*G. p.*

*pseudogeographica*), and Mississippi (*G. p. kohnii*). The occurrence and geographic distributions of these taxa in the state are poorly documented because many museum specimens lack diagnostic features, authorities disagree on what constitute diagnostic characters, and species limits are in dispute. Being morphologically and behaviorally similar, these turtles can be confused with one another in areas where their distributions overlap, resulting in unreliable identifications. Currently, the Ouachita, Northern False, and Mississippi map turtles are treated as an unresolved species complex in Kansas's herpetological literature. Our goal is to document and analyze the geographic distribution of morphological variation related to criteria for species and subspecies diagnoses. To obtain reliable locality records of each map turtle taxon in Kansas, we are conducting visual surveys (using telescope with camera) and catching turtles with baited traps. We are also reviewing historic records of these species' occurrence by examining voucher specimens in museum collections. In 2017–2018, we captured 110 map turtles, all of which were easily assigned to taxa, with none having ambiguous or intermediate morphological features used in taxonomic diagnoses. We found seven Northern Map Turtles in the Missouri, Marias des Cygnes, and Neosho river drainages. We captured 13 Northern False Map Turtles, in the Missouri River drainage. Both the Ouachita (73 captures) and Mississippi Map Turtle (16 captures) occurred in the Neosho, Verdigris, and Marais des Cygnes river drainages.

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**77 ASIH STORER ICHTHYOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Alex Maile, Matthew Davis

*St. Cloud State University, St. Cloud, MN, USA*

**Patterns of Biofluorescence in the Rabbitfishes (Siganidae)**

The family Siganidae includes 29 species in the genus *Siganus*. Rabbitfishes are distributed throughout the Indo-Pacific in shallow marine habitats. Recent studies have identified that many inshore marine fishes are biofluorescent and further work is needed to survey and document the variation of biofluorescence among fishes. In this study we identify that rabbitfishes exhibit prominent fluorescent emission patterns on their venomous spines, particularly those associated with the first dorsal fin. Rabbitfishes are herbivorous fishes that possess prominent venom glands associated with venomous spines on their dorsal and anal fins used predominantly for defensive behaviors. We document that rabbitfishes exhibit highly prominent green fluorescent patterns on their venomous spines compared to that on their body. To date no patterns of biofluorescence have depicted intense biofluorescence on venomous spines and it is possible these emission patterns serve an aposematic warning pattern to organisms that can visualize fluorescence in marine systems.

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**234 ASIH STOYE ECOLOGY & ETHOLOGY AWARD I, Cottonwood A-D – The Snowbird Center, Friday 26 July 2019**

Jennifer Main, Ginny Adams, Reid Adams

*University of Central Arkansas, Conway, Arkansas, USA*

### **Have Fish Assemblages Changed in the Strawberry River Over the Last 30-40 Years?**

The Strawberry River watershed (SRW) is a highly speciose river in Arkansas having 104 documented fishes. Historical SRW fish collections by Dr. H. Robison (1974 and 1976) and D. Hilburn (1986) using seines were compared to contemporary collections using similar methods (2017-2018) to study patterns of stability and persistence of fish communities at 16 sites. SRW has a variation in land use and land cover that can influence fish assemblages by changing fluvial geomorphology, sedimentation rates, and water quality. Fish assemblage persistence (0.83-0.43) and stability (0.66-0.17) calculations suggested some sites experienced little change, while others exhibited noteworthy changes, particularly four tributary sites having higher pasture land use within the upstream catchment. In fact, persistence and stability were negatively associated ( $r_s = -0.59$  and  $r_s = -0.56$ , respectively) with the amount of pasture upstream within 200 m of the stream. Expansions of tolerant species included *Gambusia affinis*, *Lepomis macrochirus*, and *Lepomis megalotis*. By monitoring fish assemblages within the SRW, impacts of additional anthropogenic perturbations on fish assemblages can be better understood and provide a framework for understanding how fishes in the Ozarks respond to disturbance.

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### **541 General Ichthyology I, Cottonwood A-D – The Snowbird Center, Saturday 27 July 2019**

Justin Mann, Henry Bart

*Tulane University, New Orleans, LA, USA*

### **The Neil H Douglas Collection of Fishes: an unfortunate example of an all too common trend**

In the summer of 2017 the University of Louisiana Monroe decided it would no longer house and maintain the Neil H. Douglas collection of fishes. When the collections community was first made aware of this, the initial reaction was a combination of sadness, surprise and disappointment. The idea that such a regionally important collection was destined for the dumpster motivated the community as a whole to find a permanent home for the approximately 80,000 lots that made up the fish collection. In partnership with Arkansas State University, The Mississippi Museum of Science, Louisiana State University, Southeastern Louisiana University and the University of Texas at Austin, Tulane University put a plan into action to rescue the collection. In this presentation we will address that plan, including the logistics and practicalities that arise with the movement and dissemination of an orphaned collection, as well as the problem orphaned collections can create for the broader biodiversity collections community, the special importance of regional biodiversity collections to the institutions that house them, the actions this community must take to hopefully prevent, but certainly to better prepare for, more instances of

abandoned collections in the future, and, most importantly, steps institutions should take to sustain their collections.

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## **CANCELLED**

### **501 ASIH STORER ICHTHYOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Rachel Manning<sup>1</sup>, Luke Tornabene<sup>2</sup>, Carole Baldwin<sup>3</sup>

<sup>1</sup>*School of Aquatic and Fishery Sciences, University of Washington, Shelton, Washington, USA,*

<sup>2</sup>*School of Aquatic and Fishery Sciences, Burke Museum of Natural History and Culture, University of Washington, Seattle, Washington, USA,* <sup>3</sup>*Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA*

### **A New Genus of Caribbean Deep-reef Gobies (Teleostei: Gobiidae) of the *Priolepis* Lineage with Descriptions of Six New Species**

Tropical mesophotic and deeper coral reefs (< 50 m) have been largely understudied to date; preliminary studies suggest that approximately twenty percent of fishes on these reefs are still undescribed. Efforts to begin rigorously exploring mesophotic and deeper reef biodiversity have been conducted from 2011 to present by both the Smithsonian Institution's *Deep Reef Observation Project* and more recently, the University of Washington Burke Museum, across 5 Caribbean locations via two manned submersibles, *Curasub* and *Idabel*. As a result, Tornabene et al. (2016) identified a putative new gobiid genus comprising three species, though additional sampling and phylogenetic analysis indicate a total of six to seven undescribed species. Herein we present phylogenetic data from four molecular markers and morphological data for specimens of the new genus. We discuss the interspecific relationships and some diagnostic characters within the genus. Lastly, we provide a cursory osteological comparison of the genus to other closely related genera, including *Trimma*, *Lythrypnus*, *Priolepis*, *Paratrimma*, and *Feia*.

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### **73 ASIH STOYE CONSERVATION AWARD, Cottonwood A-D – The Snowbird Center, Friday 26 July 2019**

Elizabeth Marchio

*Texas A&M University, College Station, TX, USA*

### **The Art of Aquarium Keeping Communicates Science and Conservation**

In technology-driven societies, scientists and educators flounder in making science interesting and applicable. Communicating science, defined as communicating scientific facts as well as teaching and using the scientific process, can be done informally through leisure activities. In this qualitative study, I examined the leisure activity of aquarium keeping and its ability to communicate relative aquatic facts and processes. This study examined aquarium keepers across

the United States via interviews, participant observation, and an ongoing analysis of aquarium hobby literature. Thus, this study indicates (1) caring for a home aquarium communicates science latently, (2) over time, latent science communication becomes activated, and (3) long-term aquarium keeping leads to a personal response in science, as well as conservation. In addition, artistic expression and innovation intersect with scientific knowledge and application to create beautiful, biodiverse, ecosystems. Through the process of successfully maintaining an aquarium, continued participation leads to a proficiency in applicable scientific facts, a better understanding of scientific processes, and an improved conservation ethic for aquatic resources. Further, this intersectionality motivates participation by providing new challenges and various forms of satisfaction. The human dimensions of the aquarium hobby and the values of aquarists are important to understand for many purposes, most notably because it encompasses an enormous sample of the American population and is extremely lucrative to those along most of the supply chain. Aquarium keeping is not only a hobby, but because of the relationship between science and art, it can communicate, as well as spark conservation efforts in serious aquarists.

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## **525 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Madeline Marens<sup>1,2</sup>, Dewayne Fox<sup>3</sup>, Bradley Wetherbee<sup>4</sup>, Amanda Southwood-Williard<sup>1</sup>, Frederick Scharf<sup>1</sup>

<sup>1</sup>University of North Carolina Wilmington, Wilmington, NC, USA, <sup>2</sup>North Carolina Aquarium at Fort Fisher, Kure Beach, NC, USA, <sup>3</sup>Delaware State University, Dover, DE, USA, <sup>4</sup>University of Rhode Island, Kingston, RI, USA

### **Movement and Habitat Use of Female Sand Tiger Sharks (*Carcharias taurus*) in North Carolina Coastal Waters**

In the western north Atlantic, sand tiger sharks (*Carcharias taurus*) range from the Gulf of Maine to the Gulf of Mexico. The reproductive cycle of *C. taurus* includes seasonal migrations extending hundreds of kilometers. Coastal waters off North Carolina serve as a migratory corridor, but the degree of residency in these waters is unknown. Aggregations of *C. taurus* have been observed near previously hypothesized birthing areas along southern US Atlantic waters and are presumed to be associated with seasonal reproduction. However, patterns of seasonal residency, habitat use, and migration at finer spatial scales are lacking. It is hypothesized that pregnant females may utilize habitats differently than resting females and that residency of mature female sand tigers exist in North Carolina coastal waters. From 2016-2019, mature female sand tiger sharks were equipped with internal acoustic transmitters to identify movement patterns. On-board ultrasound imaging confirmed pregnant sharks at the time of tagging in various stages and residence time was quantified to identify essential reproductive habitats using passive tracking techniques. Preliminary findings of seasonal residency have been found in North Carolina surrounding Cape Lookout. Individual sharks showed patterns of residency in North Carolina over 7 days (CRT= 9-124 days) during Nov 2017-May 2018. More extensive movements were also observed in individuals along the western North Atlantic during spring and fall months. Tracking will continue in 2019 to refine our understanding of habitat use patterns off

the North Carolina coast as well as compare habitat use between active and resting mature female sharks.

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### **53 ASIH/HL/SSAR Symposium: Citizen Science in Herpetology: Productive Past and Promising Future, Ballroom 2 – Cliff Lodge, Sunday 28 July 2019**

Robin Maritz<sup>1</sup>, Luke Verburgt<sup>2</sup>, Andre Coetzer<sup>3</sup>, Bryan Maritz<sup>1</sup>

<sup>1</sup>*University of the Western Cape, Cape Town, South Africa*, <sup>2</sup>*Enviro-Insight, Pretoria, South Africa*, <sup>3</sup>*ProtoClea Advanced Image Engineering, Johannesburg, South Africa*

#### **Sharing for Science: Social Media Provides New Insights into the Feeding Ecology of African Snakes.**

Interesting and important ecological observations are shared by the public every day in the form of photos on social media. Social media platforms are comprised of thousands of potential observers making the study of difficult to sample ecological events more feasible. In reptiles, detection rates are often low which makes studying their behavior and their associated ecological interactions a significant challenge. To date, feeding studies in reptiles have typically required destructive survey methods and are limited in scale due to feasibility. In our studies, we harnessed the power of Facebook as a crowdsourcing platform to collect photo records of predation events involving reptiles and amphibians in sub-Saharan Africa. Feeding events in snakes were particularly well-represented with over 800 feeding events recorded. We reviewed all available literature on the diets of wild southern African snakes and made comparisons between the literature and social media datasets. We demonstrate how effectively and rapidly information on difficult to detect ecological phenomena can be collected at broad spatial, temporal, and taxonomic scales through the use of shared images on Facebook.

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### **304 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Mariana Marques<sup>1,2</sup>, Luis Ceríaco<sup>3,2</sup>, Edward Stanley<sup>4</sup>, Matthew Buehler<sup>5</sup>, Aaron Bauer<sup>5</sup>

<sup>1</sup>*CIBIO-InBIO, University of Porto, Porto, Porto, Portugal*, <sup>2</sup>*Museu Nacional de História Natural e da Ciência, Lisboa, Lisboa, Portugal*, <sup>3</sup>*Museu História Natural e da Ciência, Universidade do Porto, Porto, Portugal*, <sup>4</sup>*Florida Museum of Natural History, Gainesville, FL, USA*, <sup>5</sup>*Villanova University, Villanova, PA, USA*

#### **A new species of Girdled Lizard (Squamata: Cordylidae) from Serra da Neve, Southwestern Angola**

The Girdled Lizards of the genus *Cordylus* are the most diverse group in the Cordylidae family and have been the subject of several studies in recent times. Three species of Girdled Lizards are

currently recorded for Angola: the endemic *C. angolensis* from the central escarpment of Angola, the endemic *C. namakuiyus* from the arid lowlands of Namibe Province, and *C. machadoi*, occurring in southwestern escarpment of Angola and extending to northwestern Namibia. Recent surveys to Serra da Neve, an inselberg located in the northern limit of the Namibe Province, revealed a previously unknown population of the genus. In order to understand the phylogenetic and biogeographic relations of the new population, molecular (mitochondrial and nuclear genes) and morphological (CT-Scans, scalation and body measurements) analysis were conducted. Our results suggest that the Serra da Neve population represents an undescribed species closely related with both *C. namakuiyus* and *C. machadoi*. This species belongs to the “northern-clade” of the genus, which represents one of its oldest diverging lineages. The discovery of this new species provides new comparative data to the study of southwestern African inselbergs and highlights their role on the promotion of diversification and speciation processes. This also contributes to a better understanding of the complex biogeographic patterns of the region, especially to the importance of the Angolan escarpment as barrier between different biomes.

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## **281 Amphibian Ecology, Ballroom 2 – Cliff Lodge, Friday 26 July 2019**

David Marsh, Alexa Caffio, Anna Daccache, Margaret Dewing, Kathryn McCreary, Nathan Richendollar, Parker Skinner

*Washington and Lee University, Lexington, VA, USA*

### **Range Limits and Demography of a Mountaintop Endemic Salamander and its Widespread Competitor**

Salamanders of the genus *Plethodon* often exhibit distinct range boundaries where the distributions of competing species meet. Across contact zones between the mountaintop endemic Peaks of Otter Salamander (*Plethodon hubrichti*) and the widespread Eastern Redback Salamander (*Plethodon cinereus*), we measured changes in three salamander traits: 1) Body condition, 2) Frequency of tail loss, and 3) Proportion of hatchlings. We then used hierarchical Bayesian models to compare these traits among allopatric sites, sites where that species was dominant, mixed sites containing high densities of both species, and sites where that species was rare. For Peaks of Otter Salamanders, we found no consistent changes in body condition across contact zones. However, rates of tail loss increased continuously from allopatric sites (21%) to rare sites (54%). We also found evidence of reduced hatchling proportions at sites outside of allopatric areas (15-16% versus 30% at allopatric sites). For Redback Salamanders, body condition was higher at allopatric sites compared to sites within the contact zone. As with Peaks of Otter Salamanders, frequency of tail loss increased continuously from allopatric sites (27%) to sites where Redbacks were rare (50%). For Redback salamanders we did not find evidence of reduced hatchling numbers towards the edge of their range margin. Our results suggest that direct interactions between the species are associated with reduced fitness for each species as they approach the edge of their range margin, and that tail loss may be an important factor in stabilizing range boundaries, at least over shorter time scales.

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**203 SSAR SEIBERT SYSTEMATICS AND EVOLUTION AWARD II, Ballroom 2 – Cliff Lodge, Friday 26 July 2019**

Thomas Marshall<sup>1</sup>, Drew Davis<sup>2</sup>, David Hillis<sup>1</sup>

<sup>1</sup>University of Texas at Austin, Austin, Texas, USA, <sup>2</sup>University of Texas Rio Grande Valley, South Padre Island, Texas, USA

**Investigating Mitonuclear Discordance in North American Corn Snakes (*Pantherophis guttatus* complex)**

Mitochondrial markers have been widely used over the past 30 years to study phylogeography and infer species boundaries. The utility of these markers for such studies is based on the premise that variation within mitochondrial genes is largely neutral. However, evidence that different mitochondrial haplotypes within species confer differential fitness, and thus should undergo selection, challenges this assumption. This, along with other factors, such as sex-biased dispersal and mitochondrial introgression across species, can lead to discordant genetic structure between mitochondrial and nuclear genomes. Mitonuclear discordance has been increasingly observed in a wide range of organisms, calling into question mitochondrial-based inferences of species boundaries. Here, we use a cytochrome-b sequence fragment and nuclear SNPs to investigate the presence of mitonuclear discordance in the North American corn snakes (*Pantherophis guttatus*), a complex that has been taxonomically defined by mitochondrial genetic structure. We have identified five geographically partitioned mitochondrial haplotypes, indicating greater mitochondrial diversity than was previously recognized. However, based on morphological similarity and the lack of apparent reproductive barriers between many of these haplotypes, we expect to find discordant nuclear genetic structure and evidence of nuclear gene flow across mitochondrial boundaries. This study should lay the groundwork for further exploring the factors that contribute to mitonuclear discordance in this group.

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**267 Herpetology Ecology, Primrose A&B – Cliff Lodge, Saturday 27 July 2019**

Amanda Martin, Karen Root

Bowling Green State University, Bowling Green, OH, USA

**Fine-scale Reptilian Movement Patterns within a Fragmented and Heterogeneous Landscape**

The Oak Openings is a regional biodiversity hotspot which includes endangered, threatened and potentially threatened species, including vulnerable herpetofauna. Currently research on short-range animal movements relative to fine-scale environmental characteristics is scarce. Our objective was to examine fine-scale reptilian movement patterns and link them to ecological and



environmental processes. We expected that individuals would have more tortuous pathways and travel longer distances with increased habitat fragmentation. We tracked *Terrapene carolina carolina* and *Thamnophis sirtalis* using fluorescent powder in protected areas from 2017-2019. Hand captured individuals were treated with fluorescent powder then released. Powder trails were illuminated with a UV light and analyzed by placing flag markers at directional changes greater than 10°, and we recorded GPS coordinates and ground vegetation at each flag marker. We used several metrics in FRAGSTATS of habitat structure within known and expected home ranges. Box turtles traveled around 32 m/d (mean home range 5.54 ha), which included 1-22 distinct land cover patches. Snakes traveled 30 m/d on average and traversed prairie, deciduous and swamp forest habitats. We found for snakes that the habitat used ranged from 27-74 patches within 14 ha surrounding each trail. Home ranges had low connectivity for turtles that traveled more linear trails, while snakes had more tortuous trails. Management actions are applied at a local scale, however many modeling tools are developed at a regional scale. Fluorescent powder, though, highlights the least costly pathways, providing a local scale view of connectivity.

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### **318 ASIH STOYE GENETICS, DEVELOPMENT & MORPHOLOGY AWARD II, Primrose A&B – Cliff Lodge, Friday 26 July 2019**

Bradley T. Martin<sup>1</sup>, Marlis R. Douglas<sup>1</sup>, Tyler K. Chafin<sup>1</sup>, John S. Placyk Jr.<sup>2</sup>, Roger D. Birkhead<sup>3</sup>, Chris A. Phillips<sup>4</sup>, Michael E. Douglas<sup>1</sup>

<sup>1</sup>University of Arkansas, Fayetteville, AR, USA, <sup>2</sup>University of Texas at Tyler, Tyler, TX, USA, <sup>3</sup>Auburn University, Auburn, AL, USA, <sup>4</sup>University of Illinois, Champaign, IL, USA

#### **Introgression and Selection in *Terrapene* from the Southeastern United States**

Introgressive hybridization can have evolutionary consequences (e.g., increased adaptive potential) or impact demographic parameters (e.g., population decline due to outbreeding depression). Importantly, introgression can occur differentially across the genome, with some loci experiencing elevated levels of admixture whereas others appear resistant to it. Empirical and statistical identification of genome-wide introgression in natural populations has been limited, but with recent advances in sequencing technologies such studies are now feasible. To assess introgression and selection in three *Terrapene* taxa inhabiting the southeastern United States we screened genome-wide variation across thousands of Single-Nucleotide-Polymorphism (SNP) loci in 392 individuals. Population structure was evaluated using ADMIXTURE, and individuals with mixed ancestry were statistically evaluated for introgression using HyDe, followed by classification into hybrid generations using NewHybrids. Finally, SNP loci were aligned to the *Terrapene* transcriptome to infer genomic clines indicative of loci putatively under selection. Across four discrete populations, 157 individuals were statistically corroborated as admixed (HyDe  $P < 0.05$ ). Introgressed individuals were primarily assigned to the F2 and backcross generations, and admixture patterns generally reflected spatial clines, possibly indicating exogenous selection for admixed genotypes in intermediate habitats. Ten unique loci under selection ( $P < 0.001$ ) aligned to the transcriptome, with the majority seemingly associated with temperature tolerance and anoxia. These data illuminate gene flow and reproductive

isolation across the genomes of three *Terrapene* taxa inhabiting the southeastern United States. Furthermore, having a better understanding of the dynamics of hybridization and introgression occurring in the region will help facilitate effective conservation management strategies.

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**264 ASIH STOYE GENERAL HERPETOLOGY AWARD I, Primrose A&B – Cliff Lodge, Thursday 25 July 2019**

Katherine R. Martin, Kate L. Mansfield, Anna E. Savage

*University of Central Florida, Orlando, FL, USA*

**Disease and the Evolution of the Major Histocompatibility Complex in Nearshore Juvenile Sea Turtles**

The Major Histocompatibility Complex (MHC) is a critical component of the acquired immune system in vertebrates, and genetic variation in MHC is often predictive of disease resistance in pathogen-challenged organisms. Genomic tools have made it increasingly possible to assess the level of immunogenetic variation in populations affected by infectious disease. However, such tools have yet to be fully leveraged to answer standing questions in herpetology. This is especially so with respect to the evolution of sea turtle immune systems and the prevalence of the infectious tumor disease, fibropapillomatosis (FP). Using next-generation sequencing techniques, we characterized multiple class I and class II MHC gene copies from juvenile green turtles (*Chelonia mydas*) and loggerheads (*Caretta caretta*) with and without FP from the Indian River Lagoon in Florida, USA. We conducted genealogical analyses to assess evolutionary relationships among MHC alleles within and between each species, and converted these alleles to functional supertypes to assess differential antigen binding functionality. Using generalized linear models, we inferred whether significant associations exist between MHC supertypes and FP occurrence. We also evaluated the role of positive selection in shaping turtle immune diversity over time. Our results suggest that MHC allelic diversity in *C. mydas* and *C. caretta* is much greater than previously thought. Our study is the first to characterize class I MHC gene diversity in *C. mydas* and for any sea turtle species for class II MHC genes, and contributes to a growing understanding of pathogen and host interactions in these organisms.

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**761 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Kelsey Martin, Greg Stunz

*Texas A&M University - Corpus Christi, Corpus Christi, Texas, USA*

**Characterizing Large Predatory Fish Across Gulf of Mexico Habitats: Proposed Methods and Preliminary Results**

Widespread overexploitation of predatory fish has resulted in an estimated 90% decline in their populations since the dawn of the industrial age (Myers and Worm 2003). Artificial reefs and natural banks act as predictable aggregation sites for predatory fish and other marine species (Dennis & Bright 1988, Rooker et al. 1997, Hobday & Campbell 2009, Hoffmayer et al. 2014) making them especially vulnerable to exploitation (Kajiura et al. 2016). We used a combination of remotely operated vehicle (ROV), baited remote underwater video systems (BRUVS), and bioacoustics to characterize fish communities between and within artificial reefs and natural banks. Videos were analyzed for species richness, Shannon's diversity index, and Pielou's evenness index. I examined variation in fish community structure across and within habitat types based on a Bray-Curtis similarity matrix of fish abundance. Species composition from video analyses were then applied to the bottom 10 m of the bioacoustics data to determine and compare benthic fish biomass between and within habitat types. With the majority of field data being conducted from May – July, 2019, preliminary results will be presented. We expect fish community abundance to be greater and more diverse at artificial reef habitats than natural banks and to be heterogeneous with depth within habitat types. Results from this research will provide managers with population demographics of recreational and commercially important fish species at commonly exploited fishing sites.

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## **734 AES GRUBER AWARD II, Rendezvous A&B – The Snowbird Center, Thursday 25 July 2019**

Kelsey Martin<sup>1,2</sup>, Dan Abel<sup>2</sup>, Derek Crane<sup>2</sup>, Neil Hammerschlag<sup>3</sup>, Erin Burge<sup>2</sup>

<sup>1</sup>Texas A&M University - Corpus Christi, Corpus Christi, Texas, USA, <sup>2</sup>Coastal Carolina University, Conway, South Carolina, USA, <sup>3</sup>University of Miami, Miami, Florida, USA

### **Blacktip Shark *Carcharhinus limbatus* Presence at Fishing Piers in South Carolina: Association and Environmental Drivers**

We tagged 12 *Carcharhinus limbatus* with acoustic transmitters and monitored their presence at five piers along the NE coast of South Carolina in 2016 and four piers in 2017 using acoustic receivers. Data were analyzed with pier association indices (PAI), mixed models and fast Fourier transformation analyses to identify potential factors related to residence time and presence at piers and any cyclical patterns in visits to piers. While the majority of monitored *C. limbatus* were infrequently detected at piers, three (25.0%) were highly associated with piers (PAI > 0.50). Of the *C. limbatus* that were detected after initial capture, three (25.0%) recorded detection events only at the pier where they were tagged and two individuals (16.7%) recorded at least one detection event at all monitored piers. The best-fit model explaining *C. limbatus* residence time at piers included terms for pier location and diel cycle ( $w_i = 0.88$ ), whereas the best fit model explaining presence-absence of *C. limbatus* at piers included terms for tidal height, diel cycle, barometric pressure and angler count ( $w_i = 0.98$ ). *Carcharhinus limbatus* did not appear to display cyclical patterns in their visits to piers. Along the north-east coast of South Carolina, association of *C. limbatus* with piers is a phenomenon for a proportion of mature individuals, but continued research is necessary to understand if this behavior is driven by attraction to and

feeding on angler discards or increased foraging opportunities resulting from the attraction of potential prey to the physical structure provided by piers.

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### **536 ASIH STOYE GENERAL ICHTHYOLOGY AWARD II, Cottonwood A-D – The Snowbird Center, Friday 26 July 2019**

Rene Martin<sup>1</sup>, Abbey Dias<sup>2</sup>, Adam Summers<sup>3</sup>, Mackenzie Gerringer<sup>3</sup>

<sup>1</sup>*University of Kansas, Lawrence, KS, USA*, <sup>2</sup>*Whitman College, Walla Walla, WA, USA*,

<sup>3</sup>*University of Washington, Seattle, WA, USA*

#### **Assessment of Bone Density Reduction within Deep-Sea Grenadiers (Macrouridae)**

Abiotic factors of deep-sea habitats including high hydrostatic pressure and cold temperatures act profoundly on organisms living in these realms. Many fishes use gas bladders for buoyancy, and species living in the deep-sea deal with increased gas compression and density in these highly pressurized systems. Notwithstanding, many retain gas bladders but may employ other buoyancy aiding adaptations. One possible mechanism includes decreasing bone mineralization in skeletal tissues. To explore the association between bone density and depth, Micro-computed tomography scanning was performed on species in the family Macrouridae (grenadiers) spanning a wide range of habitat depths (100 – 7,000 m). Scans included hydroxyapatite phantoms of known-density standards to correlate voxel brightness to bone density. Density was compared across four bones (i.e. 11th vertebra, pelvic girdle, lower jaw, 1st pterygiophore), maximum depths, and within a phylogenetic framework. Bone density varied among macrourid species, with the lower jaw being significantly denser than other bones. There was no correlation between bone density and depth or between bone density and phylogeny. Previous work examining adaptations in deep-sea fishes describe trends of reduced skeletal density; we found no correlation between these variables in the wide-ranging grenadiers. A lack of correlation could be explained by other adaptations such as reduced skeletal elements or increased lipid storage that may supplement buoyancy in the grenadiers. The lack of bone loss with depth may be revealing a more complicated story. Given the observed variation and questions raised by this study, quantifying bone density across depth and phylogeny is worth substantial investigation.

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### **127 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Lindsey Martin-Krikorian<sup>1</sup>, Tristan Bulice<sup>1</sup>, Matthew Gifford<sup>2</sup>, Lorin Neuman-Lee

<sup>1</sup>*Arkansas State University, Jonesboro, Arkansas, USA*, <sup>2</sup>*University of Central Arkansas, Conway, Arkansas, USA*

#### **Physiological tradeoffs in reproductive collared lizards**

With increasing anthropogenic environmental changes such as climate change and habitat fragmentation, there is an urgent need to characterize physiological trade-offs and define biological markers to assess health in traditionally understudied taxonomic groups. Because organisms have limited amounts of energy, they must use energetic tradeoffs to accomplish life history events like reproduction, self-maintenance, and growth. We examined these tradeoffs in the Missouri Ozark population of collared lizards (*Crotaphytus collaris*), which is a reintroduction success story and has undergone population monitoring for almost 40 years. Working with a system that has such a rich historical data set provides an opportunity to quantify the interconnected response between stress, endocrine, and immune function within the context of historical events, population shifts, and ecological trends. We took monthly blood samples from individuals throughout the active season to determine how physiological patterns, such as stress responsiveness, innate immunity, testosterone, and performance, change and interact with each other in this reptilian model.

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## **589 General Ichthyology II, Cottonwood A-D – The Snowbird Center, Saturday 27 July 2019**

Angel L. Martínez-González

*Fishery Biology Research Laboratory-FBRL, Department of Aquatic Sciences. University of Cordoba, Lorica, Cordoba, Colombia*

### **Feeding ecology of Mojarra amarilla *Caquetaia kraussii* in the Ciénaga de Ayapel, San Jorge River System**

To study the feeding ecology of Mojarra amarilla *Caquetaia kraussii* in the Ciénaga de Ayapel, Colombia, between August 2009 and July 2010, we analyzed 412 stomachs of individuals collected with sizes between 14.0 and 30.0 cm total length (TL) and total weight (TW) between 48.0 and 510.0 g. The stomach content was analyzed using the Proportion of empty stomachs, Grade of digestion, Frequency of occurrence, numerical Frequency, Gravimetry and relative importance Index. The Proportion of empty stomachs was high and most of the foods were half digested, identifying three food groups: Fishes, vegetable Rests and Insects. Fishes were consisted by species like *Astyanax* sp., *Cynopotamus magdalenae*, *Andinoacara pulcher*, and were the most common group (87.4%), the most abundant group (86.7%) and the greatest group composition in weight (97.5%) and the main food in the Mojarra amarilla's diet. The relative importance index also indicates that Fishes is a food group of high relative importance in the species' diet, while other food groups are classified as occasional food groups with low relative importance. The results suggest that Mojarra amarilla is a carnivorous fish with a piscivorous trend, which keeps its food preferences as it grows, and independent of water level of Ciénaga de Ayapel.

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## 578 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019

Ángel L. Martínez-González<sup>1</sup>, Fredys F. Segura-Guevara<sup>1</sup>, Glenys Tordecilla-Petro<sup>2</sup>, William A. Pérez-Doria<sup>1</sup>, Charles W. Olaya-Nieto<sup>1</sup>

<sup>1</sup>Fishery Biology Research Laboratory-FBRL, Department of Aquatic Sciences. University of Cordoba, Lorica, Cordoba, Colombia, <sup>2</sup>Institución Educativa Lácides C. Bersal. Alcaldía de Lorica, Lorica, Cor, Colombia

### Length–Weight relationship of Bagre rayado *Pseudoplatystoma magdaleniatum* in the San Jorge River, Colombia

The length–weight relationship of Bagre rayado *Pseudoplatystoma magdaleniatum* collected in the San Jorge River, Colombia, was estimated. The length-weight relationship and condition factor were estimated with the equation  $TW = a TL^b$  and  $K = TW/TL^b$ , respectively. The size ranged between 32.1-101.5 cm TL, the total weight between 158.0-9131.0 grams, and the mean length in the catch estimated was 49.4 cm TL. Length-weight relationship estimated was  $TW = 0.001 (\pm 0.12) TL^{3.52 (\pm 0.07)}$ ,  $n = 168$ ,  $r = 0.99$ , where the monthly growth coefficient ranged between 3.27 (September) and 4.05 (August), being positive allometric for the study year, with statistically significant differences; while the condition factor ranged from 0.00009 (August) and 0.0019 (September), without statistically significant differences. The information analyzed suggests that the striped catfish is a large fish with positive allometric growth associated with the condition factor and the hydrological cycle of the San Jorge River.

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## 663 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019

Ángel L. Martínez-González<sup>1</sup>, Jesús Vargas-González<sup>1</sup>, Fredys F. Segura-Guevara<sup>1</sup>, Glenys Tordecilla-Petro<sup>2</sup>, William A. Pérez-Doria<sup>1</sup>, Charles W. Olaya-Nieto<sup>1</sup>

<sup>1</sup>Fishery Biology Research Laboratory-FBRL, Department of Aquatic Sciences. University of Cordoba, Lorica, Cordoba, Colombia, <sup>2</sup>Institución Educativa Lácides C. Bersal. Alcaldía de Lorica, Lorica, Cordoba, Colombia

### Length–Weight relationship of Cachagua *Trachelyopterus insignis* in the Ciénaga de Ayapel, Colombia

The length–weight relationship of Cachagua *Trachelyopterus insignis* in the Ciénaga de Ayapel, San Jorge River System, Colombia, during 2013 year was estimated. The length-weight relationship and condition factor were estimated with the equations  $TW = a TL^b$  and  $K = TW/TL^b$ , respectively. The length and total weight of the individuals collected were 11.8-27.1 ( $19.0 \pm 2.7$ ) cm TL and 17.0-250.0 ( $86.4 \pm 38.3$ ) grams, and the mean length in the catch estimated was 19.2 cm TL. Length-weight relationship estimated was  $TW = 0.008 (\pm 0.12) TL^{3.12 (\pm 0.09)}$ ,  $r = 0.96$ ,  $n = 403$ , where the growth coefficient was positive allometric for the study year, ranged between 2.74 (February) and 3.74 (August), with statistically significant differences; while the condition factor ranged from 0.001 (August) and 0.027 (February), without statistically

significant differences. Correlation between the condition factor and the gonadosomatic index with the levels of the cienaga was not found, because these body indices are independent of the annual hydrological cycle.

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**129 AES CARRIER AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Mariana Martins<sup>1,2</sup>, Patrícia Costa<sup>1</sup>, Otto Gadig<sup>2</sup>, Adalto Bianchini<sup>1</sup>

<sup>1</sup>Universidade Federal do Rio Grande, Rio Grande, Rio Grande do Sul, Brazil, <sup>2</sup>Universidade Estadual Paulista "Júlio de Mesquita Filho", São Vicente, São Paulo, Brazil

**Contamination by Non-essential Metals in Early Life Stages of Elasmobranchs from Southeastern Brazil**

Industrial and urban activities in São Paulo coastal zone increased in the past decades. Despite the known importance of this region as primary habitat for newborn to juvenile elasmobranchs, such impacts in early life stages need to be evaluated. We aimed to determine the concentrations of non-essential metals in young of the year and juvenile elasmobranchs caught in this area. Concentrations (mg Kg<sup>-1</sup> dry weight) of Cd, Hg and Pb in liver of *Pseudobatos horkelii* (n=4), *Rhizoprionodon lalandii* (n=6), *Squatina guggenheim* (n=2), and *Sphyrna lewini* (n=4) were determined using atomic absorption spectrometry. Species' differences were tested with Kruskal-Wallis and Dunn's Test. Results were expressed as mean ± standard deviation. Pb concentration was similar among species (p=0.06) and was lower than that reported in the literature, suggesting that Pb contamination might not be a concern for these species in this area. Difference in Cd concentration was only observed between *S. lewini* and *R. lalandii* (p=0.006). Hg concentration was higher in *P. horkelii* (0.27±0.22) and *S. guggenheim* (0.26±0.31) but not different between these species (p=0.864), as well as between *R. lalandii* (0.03±0.01) and *S. lewini* (0.02±0.01) (p=0.230). Habitat and diet might influence the bioaccumulation of metals analyzed, since their concentrations are generally higher in sediments than in water column. It is worth noting that *P. horkelii* and *S. guggenheim* are bottom-dwelling species, thus feeding mainly on benthic preys. In conclusion, elasmobranchs from the studied area are mainly impacted by Hg during their early life stages. Therefore, long-term physiological effects might be expected.

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**148 ASIH/HL/SSAR Symposium: The Expanding Role of Natural History Collections, Ballroom 1 – Cliff Lodge, Sunday 28 July 2019**

Katherine Maslenikov

University of Washington Fish Collection, Seattle, WA, USA

**Specimens by the millions: managing large, specialized collections at the University of Washington Fish Collection**

The University of Washington Fish Collection is a state-funded collection shared between the UW School of Aquatic and Fishery Sciences and the Burke Museum of Natural History and Culture dating back to 1919. Early collecting followed the interests of curators and university class field trips, with a slow and steady growth rate up until the 1980's. At that time, recognizing that State and Federal agencies routinely collect specimens as part of their fishery and resource management efforts, we sought out partnerships with several local agencies, most notably NOAA Fisheries, to provide collections support for the natural history specimens collected through their survey work. The millions of specimens collected through these efforts, including adults, juveniles, eggs, larvae, otoliths, and tissue samples, along with their detailed locality data, are now freely available to researchers around the world. Vouchering specimens adds value to agency research by allowing for verification of results of work critical to the management of our resources, including supporting forensic vouchering for law enforcement. Our collection benefits not only from the huge number and diversity of specimens we can make available to researchers, but also through training opportunities for our students who help to curate the collections and often participate in survey field work along with agency scientists. I outline these partnerships and the benefits to both parties as we curate these vast specialized collections.

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**377 Session Honoring Contributions and Retirement of Pat Gregory, Ballroom 3 – Cliff Lodge, Sunday 28 July 2019**

Robert T. Mason, Leslie Blakemore

*Oregon State University, Corvallis, OR, USA*

**Reproduction and Anti-microbial Defense in the Red-sided Garter Snake, *Thamnophis sirtalis parietalis***

Red-sided garter snakes (*Thamnophis sirtalis parietalis*) of Manitoba, Canada provide a compelling model to study the possible trade-off between reproduction and antimicrobial plasma proteins that are a part of the innate immune system and serve as the 'first line of defense' in vertebrates. We quantified seasonal and sexual variation in bacterial killing abilities of diluted plasma from red-sided garter snakes by measuring the relative amount of anti-microbial proteins in circulation. Our results support the hypothesis that the reproduction and immune function trade-off is facultative as antimicrobial capabilities of plasma were greatest during seasons of active foraging and lowest during seasons where foraging was not taking place. The only sexual variation detected was found in reproductive animals with reproductive animals demonstrating reduced antimicrobial capabilities during some seasons. We also conducted an observational field study on naturally injured red-sided garter snakes during the mating season to investigate if differences in antimicrobial protein levels exist in naturally injured, compared to healthy individuals, during the energetically costly mating season. This design also served to determine if the sex of the animal or the severity of the injury was a factor contributing to any differences in the bacterial killing ability of the snakes' plasma following natural injury. In this study, we found that injured individuals had reduced antimicrobial abilities but neither sex of the animal nor severity of the injury had any correlation with this difference. These results suggest that



either prioritization on reproduction or prioritization within the immune system is occurring in injured animals.

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## **649 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Alice Masper<sup>1</sup>, Jose E. Pérez-López<sup>2</sup>, Hector Espinosa-Pérez<sup>3</sup>

<sup>1</sup>CIAD, Guaymas, Sonora, Mexico, <sup>2</sup>Facultad de Ciencias, UNAM, México, México, Mexico,

<sup>3</sup>Instituto de Biología, UNAM, México, Mexico

### **Identification Guide of the Gulf of California Fish Otoliths**

The Gulf of California represents a high diversity ecosystem that harbors more than 800 fish species. Differences in local environmental conditions cause a diverse geographical distribution of endemic and migratory species. Due to ecosystem complexity and to the presence of high biodiversity, including various commercial species, it is important to improve the knowledge on species identification and distribution along the Gulf, generating an exhaustive fish otolith identification guide. We collected 1013 California sea lion (CSL) scats found in the shoreline of five rookeries distributed along Gulf of California during summers 2015-16. We filtered scats with different sized meshes and stored the extracted otoliths in vials. We identified otoliths with the use of a stereomicroscope and through several classification guides; then took high-resolution pictures with scanning electron microscope and created a dichotomous key. We have currently analyzed 215 scats and found otoliths in 155 of them. These otoliths belong to approximately 69 genera of 43 fish families, with a predominance of the families: Myctophidae (*Diaphus theta*), Batrachoididae (*Porichthys notatus*), Haemulidae (*Haemulopsis nitidus*), Serranidae (*Hemanthias signifer*), Carangidae (*Caranx caballus*) and Paralichthyidae (*Etropus crossotus*). Our current data show that the CSL's diet well represents fish biodiversity and distribution of the fish fauna from the Gulf of California and the scats offer a cheap and simple tool to create a fish otolith identification guide.

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## **746 SSAR SEIBERT ECOLOGY AWARD II, Ballroom 2 – Cliff Lodge, Thursday 25 July 2019**

Emily Mausteller<sup>1</sup>, Jayme Waldron<sup>1</sup>, John Holloway<sup>2</sup>, Will Dillman<sup>3</sup>, Alex Foote<sup>1</sup>, Nicholas Bolin<sup>1</sup>, Elizabeth Johnson<sup>1</sup>, Shane Welch<sup>1</sup>

<sup>1</sup>Marshall University, Huntington, WV, USA, <sup>2</sup>Marine Corps Recruit Depot Parris Island, Beaufort, SC, USA, <sup>3</sup>South Carolina Department of Natural Resources, Columbia, SC, USA

### ***Crotalus adamanteus* Ambush Site Selection in Coastal South Carolina Salt Water Marshes**

The eastern diamondback rattlesnake (*Crotalus adamanteus*; EDB) is a species of conservation concern associated with the imperiled longleaf pine ecosystem (LLP). The LLP is characterized by an open canopy and rich ground cover. Researchers have speculated that the vegetation

structure of salt marshes may serve as a surrogate habitat for longleaf pine savannas. Although these marshes have little topography, they provide a heterogeneous landscape with patches of mud flats, sandy hard marsh along upper tidal areas, and salt marsh hummocks throughout. We used radio telemetry to monitor free-ranging EDBs on a South Carolina sea island. The goal of our analysis was to examine EDB habitat use within salt marsh habitats. Preliminary analyses indicate that EDBs tend to use hummocks and shoreline habitat-patches when hunting in salt marshes. Our study illustrates a potential interaction between EDB habitat use along coastal river ways and extreme tidal inundations that would result in a down-river dispersal pattern. Tidally-biased dispersal may misguide EDB conservation if high EDB densities along coastal islands mischaracterize critical habitat for the species.

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**533 ASIH STOYE GENETICS, DEVELOPMENT, & MORPHOLOGY AWARD I,  
Cottonwood A-D – The Snowbird Center, Thursday 25 July 2019**

Zachary May, Matthew Davis

*St. Cloud State University, St. Cloud, MN, USA*

**Evolutionary Relationships and the Evolution of Body Shape among Deep-Sea  
Hatchetfishes (Sternoptychidae)**

The meso-bathypelagic zones of the oceans encompass an incredible biodiversity that includes the dragonfishes and their allies (Stomiiformes). This species-rich order of fishes (440 species) have evolved fascinating adaptations in their pelagic environment. All 440 species produce and emit light through bioluminescent structures (photophores) which are positioned around their bodies. In contrast to the more elongated body plans of most stomiiforms, species within the family Sternoptychidae (hatchetfishes, 78 species) possess a range of body shapes from a distinct hatchet to fusiform shape. In this study we examine the evolutionary relationships among the deep-sea hatchetfishes incorporating a combination of ultraconserved elements (UCEs), protein-coding gene fragments, and morphological characters. We integrate this hypothesis of evolutionary relationships with landmark-based geometric morphometric data to explore the evolution of body shape among the hatchetfishes.

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**622 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Logan McCardle, Clifford Fontenot

*Southeastern Louisiana University, Hammond, LA, USA*

**Demographic Patterns of Activity and Road Mortality in a Wetland Snake Assemblage**

Road mortality represents a global threat to animal populations. In many cases animals vary in their susceptibility to road mortality not only at the species level, but also intraspecifically, at the level of life stage or demographic group. These variations are dependent on demographic specific movements and ecologies that influence timing and frequency with which different intraspecifics come into contact with roads. These variations can be especially pronounced within snake species. Analysis of a data set generated by an 11-year quantitative road survey of snakes in southeastern Louisiana indicated that intraspecific groups within snake species experience differential road mortality risk, which may be influenced by historical processes related to phenology, ontogeny, and reproductive mode (oviparous vs viviparous; annual vs. biannual). Observations of snakes on the road transect were significantly influenced by phenological/historical pressures such as emergence, breeding, parturition, hibernation, and large scale major weather events (e.g., hurricanes, tropical storms, winter storms, and regional flooding), as well as fine scale changes in environmental conditions, which varied between species and demographic groups.

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### **384 AES GRUBER AWARD II, Rendezvous A&B – The Snowbird Center, Thursday 25 July 2019**

Margaret McClain<sup>1</sup>, J. Marcus Drymon<sup>2</sup>, Bryan Frazier<sup>3</sup>, Austin Gallagher<sup>4</sup>, R. Dean Grubbs<sup>5</sup>, Tristan Guttridge<sup>6</sup>, Neil Hammerschlag<sup>4</sup>, Matt Smukall<sup>6</sup>, Toby Daly-Engel<sup>7</sup>

<sup>1</sup>University of West Florida, Pensacola, FL, USA, <sup>2</sup>Mississippi State University, Biloxi, MS, USA, <sup>3</sup>Department of Natural Resources, Columbia, SC, USA, <sup>4</sup>University of Miami, Coral Gables, FL, USA, <sup>5</sup>Florida State University, Tallahassee, FL, USA, <sup>6</sup>Bimini Biological Field Station, South, Bahamas, <sup>7</sup>Florida Institute of Technology, Melbourne, FL, USA

### **Ohana means Family: Kinship analysis of Tiger Sharks reveals natal philopatry and age-dependent structure in the Western North Atlantic**

Tiger sharks (*Galeocerdo cuvier*) are large, circumglobal apex predators capable of making long (>1000 km) pelagic movements. Despite these treks, tiger sharks are known to exhibit philopatry and some degree of site fidelity. The purpose of this is not completely understood, though reproduction, particularly parturition, is considered a main driver. We set out to examine how reproduction impacts movement patterns of tiger sharks in the Western North Atlantic, where years of tracking data have contributed to a wide body of knowledge on tiger shark migration. This study compiles DNA analysis, telemetry, and demographic data from 362 sharks (72.5 to 416 cm TL) caught between 2010 and 2017 in the northern Gulf of Mexico (Dauphin Island n=55; Big Bend n=60), Southern Florida/Keys (n=74), Bahamas (n=118), and coastal South Carolina (n=55). Using nine microsatellite primers, we found evidence for significant population structure between sampling locations, but only among individuals under 260 cm TL (females: age ~5; males: age ~6). Kinship analysis revealed evidence of natal philopatry at several sites (siblings from different cohorts caught in the same location), and parent-offspring relationships linking distant locations despite fine-scale structuring between sites. These data are consistent

with previous studies showing site fidelity in small tiger sharks, as well as repeated use of specific habitats for the purpose of parturition by adults.

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**696 ASIH STOYE PHYSIOLOGY & PHYSIOLOGICAL ECOLOGY AWARD, Primrose A&B – Cliff Lodge, Friday 26 July 2019**

Sara McClelland, Sarah Woodley

*Duquesne University, Pittsburgh, PA, USA*

**Impacts of Developmental Exposure to Ecologically Realistic Pesticide Concentrations on Amphibian Larval and Juvenile Neurodevelopment**

Pesticides are one of the main causes of the global decline in amphibian populations. Due to the ramifications of pesticide exposure, regulations are intended to keep concentrations of pesticides in nature low enough to have no observable effects on non-target organisms. However, the question remains whether these low concentrations of pesticides are safe for amphibians. This study aimed to better understand how ecologically relevant levels of pesticides may be affecting amphibians. We exposed an amphibian model, the Northern Leopard Frog (*Lithobates pipiens*), to 0, 1, or 10 ppb of an organophosphorous pesticide (chlorpyrifos) during development in a controlled laboratory study (chlorpyrifos most commonly contaminates natural habitats at concentrations less than 10 ppb). We then measured standard body and brain morphometrics and behavior in both tadpoles and metamorphs. Exposure to chlorpyrifos resulted in changes in brain mass and alterations in brain shape in tadpoles. Specifically, tadpoles that were exposed to chlorpyrifos during development had wider and longer telencephala and longer olfactory bulbs. Tadpoles that were exposed to chlorpyrifos developed into metamorphs with alterations in brain shape. Specifically, metamorphs had wider, longer optic tecta, and shorter medullas. This study provides evidence that exposure to low, ecologically relevant doses of pesticides causes neurological effects in tadpoles that are able to carry over into the juvenile life history stage of amphibians. Our results indicate that the concentrations of organophosphorous pesticides that are found contaminating natural habitats are impacting amphibian physiology.

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**246 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Ashlie McIvor, Collin Williams, Michael Berumen

*King Abdullah University of Science and Technology, Thuwal, Saudi Arabia*

***Taeniura lymma* Population Structure in the Red Sea**

Blue-spotted ribbontail rays (*Taeniura lymma*) are commonly found among coral reefs and mangroves in the Indo-Pacific. However, little is known of their basic life history, leaving it

unclear just how vulnerable this species may be to habitat loss and fisheries harvest. In this study, we collected *T. lymma* individuals from various locations along the Eastern Red Sea to fill current knowledge gaps of the species. Our primary aims were to determine levels of genetic diversity and patterns of habitat usage. This was accomplished through molecular analysis of tissue samples taken from each individual and multiple tagging studies, including dart tag mark-recaptures and an ongoing acoustic telemetry project. With major coastal development planned along the Red Sea, building an understanding of this abundant elasmobranch species will be necessary for its conservation.

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## **822 Amphibian Disease, Ballroom 3 – Cliff Lodge, Sunday 28 July 2019**

Donald McKnight<sup>1</sup>, Deborah Bower<sup>2</sup>, Lin Schwarzkopf<sup>1</sup>, Ross Alford<sup>1</sup>, Roger Huerlimann<sup>1</sup>, Leah Carr<sup>1</sup>, Kyall Zenger<sup>1</sup>

<sup>1</sup>James Cook University, Townsville, QLD, Australia, <sup>2</sup>University of New England, Armidale, NSW, Australia

### **How do epizootics become enzootics? Clues from rainforest frogs**

Emerging infectious diseases are a serious threat to wildlife populations, with some taxa, such as amphibians, being particularly threatened. These diseases often cause severe outbreaks, but in many cases, initial epizootics subside and the pathogen and host co-exist in an enzootic state, often with host population recoveries. To enhance our understanding of the dynamics of these outbreaks, we have been studying Australian rainforest frog populations that experienced a large chytridiomycosis outbreak 30 years ago. For some species, the disease has shifted to being enzootic and recoveries have occurred, but for others, such as the Australian lace-lid (*Litoria dayi*), no recoveries have taken place. We examined the population genetics and microbiomes of these species to test the following hypotheses for a lack of recovery in *L. dayi*: low dispersal rates, a loss of genetic diversity, and a lack of beneficial bacteria. We found that *L. dayi* has dispersal rates and genetic diversity levels that are equivalent to sympatric species that have recovered from the outbreak; however, *L. dayi* had lower microbial richness than recovered species for both its bacterial and fungal microbiomes. Further, there was a negative association between microbial richness and infection intensity. This suggests that microbiomes may be playing a role in population recoveries, and rich communities may provide a protective effect for some species.

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## **254 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Samantha McPherson<sup>1</sup>, Joseph Agugliaro<sup>2</sup>, Craig Lind<sup>3</sup>, Terence Farrell<sup>1</sup>

<sup>1</sup>Stetson University, DeLand, Florida, USA, <sup>2</sup>Farleigh Dickinson University, Madison, New Jersey, USA, <sup>3</sup>Stockton University, Galloway, New Jersey, USA

## **Assessing the Metabolic Cost of Pregnancy in Pygmy Rattlesnakes (*Sistrurus miliarius*)**

Energetic tradeoffs associated with metabolically costly reproductive events can impact future reproductive success of an organism. Although yolk allocated to offspring during vitellogenesis in pitvipers is thought to be the primary fuel for embryonic growth, there may be additional maternal energetic costs during pregnancy associated with exchange of gas, nutrients, and waste between maternal and fetal tissues. This maintenance cost of pregnancy (MCP) may be reflected by an increase in maternal resting metabolic rate (RMR) during gestation in excess of the metabolic demands of embryos. If the fecundity-independent MCP is relatively high, it may contribute to a low frequency of reproduction (LFR) observed in pygmy rattlesnakes and other viperid species. To investigate energetic costs of pregnancy in *S. miliarius*, we used flow-through respirometry to measure RMR (CO<sub>2</sub> production) of 23 late pregnant and 15 non-reproductive females collected July-August, 2018. We determined the difference in RMR between pregnant and non-reproductive snakes ( $\Delta\dot{V}CO_2$ ), and used non-linear regression of  $\Delta\dot{V}CO_2$  against total litter mass to estimate MCP as the y-intercept of this curve. RMR was significantly higher in pregnant snakes compared to non-reproductive females. Furthermore, there was a significant relationship between maternal RMR and the number of days before parturition; RMR of pregnant females increased when measured closer to parturition. Preliminarily, estimates of MCP were not significantly different from zero; these results indicate that MCP is a minor component of reproductive effort in pygmy rattlesnakes, and that LFR in this species may be a result of other costs associated with reproduction.

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**511 SSAR HUTCHISON ECOLOGY, NATURAL HISTORY, DISTRIBUTION, & BEHAVIOR AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Jessica McQuigg, Erin Overholt, Craig Williamson, Michelle Boone

*Miami University, Oxford, Ohio, USA*

## **Catching Some Rays: The Effect of Varying UV Radiation Exposure on an Amphibian-Disease System**

The effects of wildlife diseases are moderated by environmental conditions, such as water availability, temperature, and ultraviolet (UV) radiation, which influence the host, pathogen, and their interactions. UV radiation, particularly UV-B (wavelengths 280-320nm), can be damaging to cells and DNA, ultimately leading to cell death in some cases. This study aimed to investigate the effects of varying intensities of UV radiation on the infectious amphibian pathogen *Batrachochytrium dendrobatidis* (*Bd*) and its interactions with a midwestern amphibian host, American toads (*Anaxyrus americanus*). This was achieved by exposing *Bd* in pure culture to ecologically relevant levels of UV radiation (100%, 50%, and 20% incident natural solar UV radiation) and exposing toad metamorphs to surviving zoospores. The UV transmittance gradient generated three distinct *Bd* doses to which unique experimental groups of toads were exposed,

whereby higher rates of UV transmittance resulted in greater *Bd* mortality and a lower total number of zoospores in the exposure dose. Three additional experimental groups were exposed to equivalent doses of *Bd* never exposed to UV radiation to elucidate whether amphibian response was due strictly to exposure dose or a difference in the way UV exposed *Bd* interacts with amphibian hosts. Results suggest higher doses of *Bd*, irrespective of UV exposure, cause reduced terrestrial growth and increased likelihood of toad mortality. This suggests that UV is moderating these disease interactions indirectly through alterations to the amount of *Bd* present in the environment. These results could inform wildlife and conservation management decisions aimed towards decreasing exposure to this pathogen.

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## **270 AES Conservation & Management III, Rendezvous A&B – The Snowbird Center, Sunday 28 July 2019**

Hannah Medd<sup>1</sup>, Gretchen Arndt<sup>1,2</sup>, Deborah Azevedo<sup>1</sup>, Kaitlyn Isaacson<sup>1</sup>, Dan Tabatabai<sup>3</sup>, Steven Cooke<sup>4</sup>, Steven Kessel<sup>5</sup>, Vivian Nguyen<sup>6</sup>, Jacqueline Chapman<sup>4</sup>, Jill Brooks<sup>4,1</sup>

<sup>1</sup>American Shark Conservancy, Palm Beach Gardens, Florida, USA, <sup>2</sup>Elasmobranch Research Laboratory, Florida Atlantic University, Boca Raton, Florida, USA, <sup>3</sup>Private Angler, Boca Grande, Florida, USA, <sup>4</sup>Fish Ecology and Conservation Physiology Lab, Carleton University, Ottawa, Canada, <sup>5</sup>Daniel P. Haerther Center for Conservation and Research, John G. Shedd Aquarium, Chicago, Illinois, USA, <sup>6</sup>Natural Resources Canada, Ottawa, Canada

### **A Multi-pronged and Collaborative Approach to Solving a Conservation Issue: the Plight of the Shore-angled Great Hammerhead (*Sphyrna mokarran*)**

Managing marine resources effectively requires not only knowledge of the biological characteristics of the target species, but also an understanding of and engagement with stakeholders that value that species. Shore-based recreational catch-and-release shark fishing (SBSF) is an open-access, increasingly popular and controversial activity in Florida, USA and anglers value and target large charismatic species like the great hammerhead shark (*Sphyrna mokarran*), categorized by the IUCN as Endangered with Extinction and particularly susceptible to Fisheries-Related Incidental Mortality. With risk of mortality high and an understanding of the fishery low, we took a multi-pronged approach to this shark conservation issue. Firstly, through collaboration with a group of 'technique-setting specialist' anglers, our pilot satellite tagging project determined rates of post-release mortality for the unique conditions of shore-based angled great hammerheads. Secondly, to compile the perspectives of all stakeholders involved and to further understand the multi-dimensional aspects of angler attitudes and behavior, the level of participation and fishing effort in SBSF, and the gear types used, we have developed an online angler survey and conducted a content analysis of the public comments submitted to Florida Fish and Wildlife Conservation Commission. To date, we have engaged with 20 anglers, analyzed over 500 comments, tagged and released 4 great hammerheads, and worked with State managers to communicate best-handling practices. Here we describe the conservation and management issue and present our methods and preliminary results from our tagging efforts and socioeconomic study.

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**473 AES Symposium: The Sensory Biology of Elasmobranch Fishes; and AES GRUBER AWARD, Rendezvous A&B – The Snowbird Center, Saturday 27 July 2019**

Emily Meese, Christopher Lowe

*CSULB Shark Lab, Long Beach, CA, USA*

**Movement strategies and fine-scale activity patterns of the California horn shark, *Heterodontus francisci***

California horn sharks (*Heterodontus francisci*) are nocturnally active sharks in kelp bed habitats that play an important ecological role in regulating invertebrate communities. Since nocturnally active invertebrates can be patchily distributed along isolated rocky reefs, it is suspected horn sharks will use a movement strategy that allows them to locate resource dense patches. Active tracking methods and accelerometers were used to quantify the diel fine-scale spatial movements and activity patterns of horn sharks. Results demonstrate that individuals remained inactive during the day, then travelled to multiple reefs throughout the night, traversing through depths of 2 – 112 m and temperatures of 10.0 – 23.8 °C. First passage time was used to identify the scale and locations of area restricted search patterns indicating patch use and patch activity was assessed using overall dynamic body acceleration (ODBA). All sharks arrived at their first patch approximately  $3.4 \pm 2.2$  hrs (mean  $\pm$  SD) after sunset. ODBA peaked while sharks were swimming through relatively deeper (~30 m), colder channels when traversing from one patch to the next. Sharks exhibited moderate, consistent activity in 53% of the patches used, episodic burst activity in 32%, and few (15%) were identified as resting. While patches spatially overlapped on isolated rocky reefs, patch use within those areas was highly variable. We hypothesize that prey specialization could be driving intra-specific differences in patch use and reef fidelity. By understanding how horn sharks partition their resources, we provide new insight to how a kelp bed meso-predator spatially and temporally uses its habitat.

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**418 Ichthyology Lightning Talks, Alpine A,B,C – The Snowbird Center, Saturday 27 July 2019**

Bruno F. Melo<sup>1</sup>, Fabio F. Roxo<sup>1</sup>, Luz E. Ochoa<sup>1</sup>, Brian L. Sidlauskas<sup>2</sup>, Brant C. Faircloth<sup>3</sup>, Thomas J. Near<sup>4</sup>, Jonathan Chang<sup>5</sup>, Jairo Arroyave<sup>6</sup>, Melanie L. J. Stiassny<sup>7</sup>, Ricardo C. Benine<sup>1</sup>, Michael D. Burns<sup>2</sup>, Kendra Hoekzema<sup>2</sup>, Natália C. Sanches<sup>8</sup>, Michael E. Alfaro<sup>5</sup>, Claudio Oliveira<sup>1</sup>

<sup>1</sup>São Paulo State University, Botucatu, SP, Brazil, <sup>2</sup>Oregon State University, Corvallis, OR, USA, <sup>3</sup>Louisiana State University, Baton Rouge, LA, USA, <sup>4</sup>Yale University, New Haven, CT, USA, <sup>5</sup>University of California, Los Angeles, CA, USA, <sup>6</sup>Universidad Nacional Autónoma de México, Ciudad de México, Mexico, <sup>7</sup>American Museum of Natural History, New York, NY, USA, <sup>8</sup>São Paulo State University, Botucatu, SP, Brazil



## **Phylogenomics and temporal diversification of characiform fishes**

South America and Africa host two of the richest freshwater fish faunas on Earth, elements of which can trace their early roots to the ancient continent Gondwana. Most families are restricted to one or the other, and uncertainties in phylogenetic reconstruction and dating have made it difficult to determine whether these major faunistic differences originated before or after the continental fragmentation. To obtain a clearer picture of the history of characiform diversification before, during and after the fragmentation of Gondwana, we used more than a thousand nuclear ultraconserved element loci (UCEs) to reconstruct and time-calibrate the most densely sampled phylogeny for the diverse order Characiformes yet produced, including 312 species spanning 221 genera and all families. We reconstruct Citharinodei as sister to a clade containing Siluriformes and the remainder of Characiformes, and place this split in the Jurassic approximately 165 million years ago, far before the final breakup of Gondwana. The ancestors of five other modern characiform lineages appear to have existed prior to 100 million years ago. Subsequent diversification in the Cretaceous yielded 17 of the 23 modern characiform families, most of which originated on South America. Though the reasons for the much greater taxonomic diversification of the four major Neotropical characiform lineages relative to the two African lineages are not entirely clear, analysis of diversification processes reveal accelerated rates in the South American families Anostomidae and Serrasalminidae. Thus, faster speciation in two of the four Neotropical lineages may provide at least part of the answer.

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### **320 AES Symposium: The Sensory Biology of Elasmobranch Fishes, Rendezvous A&B – The Snowbird Center, Saturday 27 July 2019**

Tricia Meredith, Stephen Kajiura

*Florida Atlantic University, Boca Raton, Florida, USA*

### **Stop to smell the rosettes: reflecting on the diversity of the elasmobranch olfactory system**

Elasmobranch fishes are well known for their reputation as “swimming noses”. Elasmobranch olfaction research has increased dramatically in the past twenty years and has included studies of the morphology, physiology, behavior, and fluid flow through the olfactory organ. These studies have revealed the critical role of olfaction in the life of these fishes, from mediating homing to enabling prey tracking. The noses of elasmobranchs are as diverse as the species themselves. The size, position, angle, and spacing of the nares are highly variable among species, all of which shape the way that odors enter the olfactory capsule. The olfactory organ also differs in overall organ size, shape, and surface area. The lamellar number ranges from 31 to over 300, and the degree of secondary folding is highly variable among species. Interspecific differences in the size or surface area of the olfactory organ, as well as the olfactory bulb of the brain, are hypothesized to correlate with phylogeny, ecology, or olfactory sensitivity. The variation in olfactory anatomy among species dictates the internal flow of odors through the organ, and thus their binding to the molecular receptors on the olfactory receptor neurons.

Despite their diverse olfactory morphology, the elasmobranch species tested to-date demonstrate comparable olfactory thresholds to each other and to teleost fishes. Future research will integrate studies of the olfactory morphology, with physiology, behavior, and ecology. Advances in 3D imaging and computational fluid dynamics will reveal how fluid flows within the olfactory organ and assist in the development of bioinspired sensors.

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**172 ASIH STOYE GENETICS, DEVELOPMENT, & MORPHOLOGY AWARD I,  
Cottonwood A-D – The Snowbird Center, Thursday 25 July 2019**

Alexandra Meyer<sup>1</sup>, Chris L. Chabot<sup>1</sup>, Andrew Nosal<sup>2</sup>, Daniel Cartamil<sup>2</sup>, Felipe Galván-Magaña<sup>3</sup>, Larry G. Allen<sup>1</sup>

<sup>1</sup>California State University, Northridge, Northridge, CA, USA, <sup>2</sup>Scripps Institution of Oceanography, San Diego, CA, USA, <sup>3</sup>Instituto Politécnico Nacional, La Paz, Baja California Sur, Mexico

**Assessment of the Population Genomic Structure of the Shovenose Guitarfish, *Pseudobatos productus*, from Southern California to Baja California Sur**

The Shovelnose Guitarfish, *Pseudobatos productus* (Ayres 1854), is a benthic elasmobranch that lives in shallow waters from Monterey Bay, California to the Gulf of California, Mexico, and is targeted by fisheries throughout Baja California and the Gulf of California. In many cases, localized fishing pressure can lead to a loss of genetic diversity, a reduction in effective population size, and local extinction. The most recent IUCN assessment of *P. productus* lists the species as Near Threatened with a decreasing population trend and a continuing decline in the number of mature individuals (Farrugia *et al.* 2016). This study sought to assess the genetic diversity and connectivity of *P. productus* from San Pedro, CA to Guerrero Negro, Baja California Sur, MX. Genetic diversity and connectivity were assessed using the complete mitochondrial control region as well as genomic SNP data produced by RAD-seq. Both markers show evidence of high levels of connectivity from southern California to northern Baja California Sur, indicating admixture across international boundaries. Mitochondrial DNA evidence supports higher levels of population structure while genomic SNP data supports panmixia between localities. This may be indicative of sex-specific movement patterns, with higher levels of male-mediated gene flow between localities. Based on these data, *P. productus* should be managed as a bi-national species with sex-based restrictions as males contribute more to genetic admixture than females.

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**237 Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Lauren Meyer, Madeline Green, Lachlan Fetterplace

*Otlet, Sydney, NSW, Australia*

## **Otlet – an online platform for sourcing biological samples**

Research teams collect >94 million biological samples annually, the majority of which are subsampled for targeted analysis. The remaining sample, often including a number of unused organs, is then able to be repurposed for additional studies by collaborators around the world. However, the absence of a systematic way to source these unused samples results in wasted tissues, organisms and opportunities for research as scientists undertake redundant sampling regimes. As such, ‘Otlet’, a global online database, was set up to overcome the challenges of sourcing scientific research samples from colleagues. The platform allows the users to 1) upload a record of their unused samples, 2) search the database of existing samples from other users and request them directly from the contributor and, 3) post a request for samples onto a searchable community board. The platform facilitates communication between research teams across different locations, taxa and expertise to foster novel collaborations while accelerating scientific output. Otlet’s newly constructed platform is an important tool for biological scientists of all disciplines to efficiently communicate and source research material. Membership is freely available for scientific use by researchers from universities, government agencies, museums, private consulting and NGOs.

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## **235 AES Trophic Ecology I, Alpine A,B,C – The Snowbird Center, Sunday 28 July 2019**

Lauren Meyer<sup>1</sup>, Heidi Pethybridge<sup>2</sup>, Peter Nichols<sup>2</sup>, Crystal Beckmann<sup>3</sup>, Barry Bruce<sup>2</sup>, Charlie Huveneers<sup>1</sup>

<sup>1</sup>Flinders University, Adelaide, South Australia, Australia, <sup>2</sup>CSIRO Oceans and Atmosphere, Hobart, South Australia, Australia, <sup>3</sup>SARDI Aquatic Sciences, Adelaide, South Australia, Australia

## **Café or Buffet? Using fatty acids to reveal the generalist diet and coastal habitat use of Australia’s white sharks**

White sharks (*Carcharodon carcharias*) have been shown to expand their diet and foraging strategies as they grow. As they approach ~ 3.5 m, they move from inshore teleost and chondrichthyan preys to a mixed diet of marine mammals and more pelagic cephalopods and teleosts. However, white shark diet has yet to be investigated in Australia, where ongoing tagging studies have revealed they rarely travel off the continental shelf, unlike in the eastern Pacific where large white sharks frequently migrate off the continental shelf. We assessed diet using fatty acid profiling from 145 individuals ranging from 1.6–5.5 m, collected from Qld, NSW, and SA. Unlike the ontogenetic diet shifts observed in the eastern Pacific and off the coast of South Africa, white sharks in Australia show no size-related differences in diet or increase in pelagic foraging (size class nested within location  $P = 0.202$ ). Furthermore, in South Australia, where white sharks ranged in size from 1.6-5.5 m there was no increase in specific fatty acids indicating marine mammal consumption (22:5w3, 20:5w3 or 16:1w7) or pelagic foraging (22:6w3, 16:0, 18:0) with increasing size. Instead of specialized apex predators, the Australian

white sharks of all sizes are generalists with a wider diet breadth than previously thought. This parallels their coastal habitat use, which affords them a wide variety of coastal prey items including pinnipeds on nearshore islands. Revealing this broad-spectrum, inshore foraging approach highlights where management of coastal prey resources is essential for this population of white sharks.

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**362 ASIH STOYE GENETICS, DEVELOPMENT, & MORPHOLOGY AWARD I,  
Cottonwood A-D – The Snowbird Center, Thursday 25 July 2019**

Kara Million

*Indiana University, Bloomington, IN, USA*

**Characterizing Immunogenetic Diversity in Darters (*Etheostoma*) of Indiana: a Deep-Sequencing Approach**

The vertebrate immune system is equipped with the Major Histocompatibility Complex (MHC), a system of cell surface proteins involved in self-nonsel self recognition and immune defense. One of the major questions concerning the evolution of MHCs is, why are there such high levels of diversity and polymorphism in MHC genes compared to other parts of the vertebrate genome? In my research I am using an assemblage of darters (genus *Etheostoma*) in an Indiana stream to test several competing hypotheses proposed to explain the maintenance of MHC diversity in vertebrates. As a major first step, I used Illumina sequencing technology to generate deep-sequencing data for the MHC class IIb gene in darters. I sought to determine the number of genetic variants present within individual darters, within species, and between five co-occurring species in a single stream. I evaluated allele frequencies and levels of heterozygosity within and between the species. Additionally, I sought to determine whether alleles or functional supertypes are shared between species, an occurrence known as trans-specific polymorphism (TSP). To date I have identified 60 putative alleles in darters and 1 to 6 alleles per individual, with some alleles shared between species. Copy number variation models suggest that darters could have at least five copies of the MHC IIb gene. These results will allow me to use darters and their naturally-occurring parasites in future research as a powerful system to test hypotheses related to host-parasite coevolution, mate choice, and the maintenance of immunogenetic diversity in vertebrates.

## **812 General Ichthyology I, Cottonwood A-D – The Snowbird Center, Saturday 27 July 2019**

Michael Minicozzi, Alice Gibb,

*Northern Arizona University, Flagstaff, Arizona, USA*

### **Changes in body size affect the biomechanics and behavior of teleost fishes**

Many studies have examined how the biomechanical and physiological underpinnings of movement are influenced by body size in tetrapods. Yet, relatively few studies have considered how changes in body proportions (length/area/volume) and established allometric parameters for muscle kinetics dictate what behaviors can be employed and how habitats can be used by teleost fishes. We note that several hallmark teleost behaviors may only be possible for individuals of certain sizes. For example, a very rapid change in buccal volume is required to produce effective suction feeding, but the muscular forces required to produce this behavior may not keep pace with increased buccal volume in large fishes. Similarly, the time to complete the “preparatory” stage of a fast-start (or C-bend) will become greater as fish grow larger, with the result that a large fish will remain in a vulnerable position for an extended period of time. In addition, because fishes live in a microgravity environment, inertial effects of increased body mass are often completely ignored. However, simple predictions based on fundamental scaling parameters yield size-based expectations for key teleost behaviors: either large fishes cannot perform these key behaviors and have eliminated them from their behavioral repertoires, or they have developed physiological or morphological “workarounds” to circumvent the problems inherent to changes in body size. Thus, best practices for fish ecologists, biomechanists, behaviorists, and physiologists are studies that incorporate predictions based on established scaling relationships for morphological/physiological parameters and test the assumptions of geometric similarity (isometric scaling) in teleost fishes.

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## **757 ASIH STOYE GENERAL HERPETOLOGY AWARD II, Primrose A&B – Cliff Lodge, Thursday 25 July 2019**

Stephen Mirkin, Mary Tucker, Dean Williams

*TCU, Fort Worth, Texas, USA*

Predation release of Texas horned lizards living in small towns

Texas horned lizards (*Phrynosoma cornutum*) have a number of ways to avoid predation, including camouflage, sharp cranial horns, flattening of the body, and the ability to squirt blood from the eyes. These characteristics and their relatively low survival in the wild (20-54% annual survival) suggests these lizards are under high predation pressure. These lizards can occur in small south Texas towns where they can reach densities that are much higher (~50 lizards/ha) than in natural areas (~4-10 lizards/ha). We hypothesized that one reason for the high densities may be reduced predation pressure in town. Anecdotal observations over the past 6 years also support a lack of many horned lizard predators in the towns. We used models of Texas horned lizards to test whether predation levels might be lower in two south Texas towns than on a nearby ranch. We constructed Texas horned lizard models from urethane foam, a material that is ideal for preserving marks (bites and pecks) left behind by predators. Models (n = 126) were left in the field for a period of 9 days in each location once in June and again in August 2018, and marks left behind by predators were categorized accordingly. We found significantly less attempted predation events in the towns (n = 1 predation attempt) compared to the ranch (n = 60) and no differences between months. Our results suggest that Texas horned lizards living in towns may be escaping high predation pressure leading to higher than normal lizard densities.

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### **361 ASIH STORER ICHTHYOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Blake Mitchell, Jennifer Main, Ginny Adams, Reid Adams

*University of Central Arkansas, Conway, Arkansas, USA*

### **Variation in habitat use and body condition of *Etheostoma caeruleum* and *Etheostoma fragi* in the Strawberry River, Arkansas**

The Strawberry River is occupied by 19 fishes listed as Species of Greatest Conservation Need, including the endemic *Etheostoma fragi*. We explored potential differences in habitat use and body morphometrics between *E. fragi* and the more widespread *E. caeruleum* to better understand interactions between these two species. Totals of 453 *E. fragi* and 571 *E. caeruleum* were collected during 2017 and 2018 across 30 sites. Compared to historical data (1970-1980s), *E. fragi* was found at three additional sites and in higher abundance overall. Mean relative abundance *E. fragi* to *E. caeruleum* was significantly higher in pools (0.67 +0.08) compared to riffles (0.28 +0.06) and runs (0.20 +0.1) ( $P < 0.001$ ). At 40% of sites where *E. fragi* was detected, they were found at 2X or greater abundance in pools compared to riffles, while *E. caeruleum* showed the opposite pattern. Both species showed similar condition (ANCOVA,  $p > 0.05$ ) within a species across habitat types (riffle, run, pool). Based on our data, future monitoring should include pool and run habitat to increase detection probability of *E. fragi*. Our data suggest *E. fragi* is stable or expanding within the system and interactions with *E. caeruleum* are probably influenced by habitat segregation.

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## **503 Herpetology Lightning Talks, Ballroom 3 – Cliff Lodge, Saturday 27 July 2019**

Corey Mitchell<sup>1</sup>, Todd Esque<sup>2</sup>, Amy Vandergast<sup>3</sup>, Jill Heaton<sup>1</sup>, Kirsten Dutcher<sup>1</sup>, Steve Hromada<sup>1</sup>, Kevin Shoemaker<sup>4</sup>, Kenneth Nussear<sup>1</sup>

<sup>1</sup>University of Nevada, Reno, Department of Geography, Reno, NV, USA, <sup>2</sup>U.S. Geological Survey, Western Ecological Research Center, Henderson, NV, USA, <sup>3</sup>U.S. Geological Survey, Western Ecological Research Center, San Diego, CA, USA, <sup>4</sup>University of Nevada, Reno, Department of Natural Resources and Environmental Science, Reno, NV, USA

### **Integrating Telemetry and Mark-Recapture Methods to Estimate Density for the Mojave Desert Tortoise**

Mark-recapture sampling methods are an important tool that have been used to monitor populations of many species, including the federally protected Mojave desert tortoise (*Gopherus agassizii*). By incorporating spatial location data into conventional mark-recapture models, spatial capture-recapture models have the potential to reduce bias in estimates, and account for common assumption violations such as spatially heterogeneous detection probability and temporary emigration. We conducted mark-recapture surveys for desert tortoises at a 1-km<sup>2</sup> study plot in the Ivanpah Valley southeast of Jean, NV and collected desert tortoise movement data concurrently using radio-telemetry and GPS data loggers. Two closed-population mark-recapture surveys have been conducted at the study plot separated by three years, and quantification of GPS logger movement data over the survey period demonstrates that desert tortoises frequently exhibit temporary emigration outside the study plot, thereby complicating standard mark-recapture approaches for density estimation. We integrated mark-recapture survey data with telemetry data using a modified spatial capture-recapture method. This custom model, fitted in a Bayesian framework, allowed us to generate high-precision estimates of density for a species where detectability and abundance are low, enhancing the efficacy of long-term efforts to monitor population trends and informing recovery efforts. We discuss the implications of this new approach on desert tortoise conservation and management.

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## **197 SSAR SEIBERT PHYSIOLOGY & MORPHOLOGY AWARD, Ballroom 3 – Cliff Lodge, Thursday 25 July 2019**

Haley A. Moniz<sup>1</sup>, Vicki L. Thill<sup>1</sup>, Robert E. del Carlo<sup>1</sup>, Jessica S. Reimche<sup>1</sup>, Edmund D. Brodie Jr.<sup>2</sup>, Normand LeBlanc<sup>1</sup>, Chris R. Feldman<sup>1</sup>

<sup>1</sup>University of Nevada, Reno, Reno, Nevada, USA, <sup>2</sup>Utah State University, Logan, Utah, USA

### **Jack of all trades, or master of one? Tradeoffs in organismal performance of Tetrodotoxin-resistant garter snakes (*Thamnophis*)**

Adaptive evolution of tetrodotoxin (TTX) resistance in some garter snake populations (*Thamnophis*) has enabled a coevolutionary arms race between these predators and their toxic

Pacific newt prey (*Taricha*). Resistance to TTX stems from mutations in the molecular targets of TTX, the outer pore of voltage-gated sodium ion channels that are essential for action potential propagation in excitable cells. Specialization of such a highly conserved trait may have adverse consequences on nerve and muscle function caused by unexpected side effects via pleiotropy or epistasis. In this system, resistance appears to be costly at both cellular and organ levels, reducing sodium channel function and several aspects of muscle mechanics (phasic contraction, time to maximum force, etc.). We explore whether this tradeoff scales up to an ecologically relevant level by measuring various whole-animal parameters that capture short-burst speed, endurance, and behavior. We find little to no tradeoffs in TTX-resistant snakes at the whole animal level. These data suggest that resistant snakes exhibit compensatory mutations or behaviors to balance the cost of mutations. However, tradeoffs at the molecular level may still manifest in other physiological aspects of the animals, such that resistant snakes may be at a disadvantage under certain ecological conditions. Clarifying the nature and extent of these tradeoffs impacts our understanding of the coevolutionary dynamic between *Taricha* and TTX-resistant populations of *Thamnophis*.

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**719 ASIH/HL/SSAR Symposium: Citizen Science in Herpetology: Productive Past and Promising Future, Ballroom 2 – Cliff Lodge, Sunday 28 July 2019**

Dillon Monroe, Robert Espinoza

*California State University, Northridge, CA, USA*

**Comparison of Traditional and Citizen-Science Datasets for Inferring Distribution and Ecological Niche Patterns of Mediterranean House Geckos in Texas**

Citizen science has emerged as a practical, cost effective, and potentially prosperous means of collecting biological data. However, few studies have examined the extent to which decentralizing data collection changes the variance in patterns of spatial sampling. To assess this, we conducted a point-pattern analysis to compare traditional and citizen-science approaches to determining the invasive distribution of Mediterranean House Geckos (*Hemidactylus turcicus*; hereafter MHGs) in Texas. MHGs first arrived in Brownsville, Cameron County, Texas in 1950 and have since established populations in more than half of the state's 254 counties. Traditional data sources were museum and university collections (288 unique locations), and for the citizen-science databases, we used HerpMapper and iNaturalist records ( 1893 unique locations). Quadrant analysis was used to test whether the locations were non-random using variance-to-mean ratio and Poisson-distribution tests. To test whether the locations were clustered or dispersed, we used a nearest neighbor analysis. To examine the ecological niche and probability of suitable habitat, we used an ecological niche modeling approach. We found that citizen-science data are comparable to traditional data sources for regional-scale inferences of species presences or absences. However, we noted differences in the location patterns and ecological niches that could result in shifted patterns when comparing smaller datasets of either collection method. Overall, our results support the idea that citizen scientists can provide researchers with



access to valuable data that would otherwise be challenging to acquire, particularly for urban-adapted, human-commensal species.

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### **693 Poster Session II, Event Center – The Snowbird Center, Saturday 27 July 2019**

Carmen G. Montana-Schalk<sup>1</sup>, David Peterson <sup>2</sup>, Christopher M. Schalk<sup>3</sup>

<sup>1</sup>*Sam Houston State University, Huntsville, Texas, USA*, <sup>2</sup>*Southern Research Station. USFS, Nacogdoches, Texas, USA*, <sup>3</sup>*Stephen F. Austin State University, Nacogdoches, Texas, USA*

#### **Historical and contemporary assessment of urban stream fish assemblages: taxonomic and functional perspectives**

Urbanization is one of the leading threats to freshwater biodiversity, and urban areas continue to expand globally. Here we examined taxonomic and functional diversity, and the functional trait–environment of stream fish assemblages in an urban stream in East Texas: La Nana Creek. First, we compared the taxonomic diversity of fish assemblages using historical (1950, 1990) and contemporary data (2017-2019) using relative species richness and relative abundance. Then, we used contemporary data to examine changes in species richness and functional diversity along a gradient of urbanization, from less urbanized (upstream) to more urbanized (downstream). Traits linked to feeding, locomotion and habitat use were measured in fishes from these sites. Relationships between functional traits and environmental variables were also measured and examined via multivariate ordination analysis. Contemporary surveys found that species richness increased compared to historical surveys. Coinciding with the increase in species richness were the presence of non-native species for the first time. Contemporary surveys conducted along the mainstream of La Nana Creek suggested an increase of species richness along the gradient with sites in middle reaches containing more diverse assemblages. Functional diversity of assemblages also increased with species richness along the gradient, and traits related to swimming, habitat preference and food resource use were associated local variables including substratum type and depth. Our results suggest that contemporary resurveys are an important tool for examining how freshwater taxa are responding to recent environmental change.

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### **517 AES Physiology I, Alpine A,B,C – The Snowbird Center, Sunday 28 July 2019**

Gisele Montano<sup>1</sup>, Karen Steinman<sup>2</sup>, Todd Robeck<sup>1</sup>

<sup>1</sup>*Species Preservation Lab - SeaWorld, Orlando, FL, USA*, <sup>2</sup>*Species Preservation Lab - SeaWorld, San Diego, CA, USA*

#### **Development of a Liquid Storage Method and Effect of Cryoprotectants on Semen Collected From Whitespotted Bamboo Sharks (*Chiloscyllium plagiosum*)**

Two experiments were performed in order to determine an appropriate holding and cryopreservation media for whitespotted bamboo shark (WSBS, *Chiloscyllium plagiosum*) spermatozoa. Semen was collected from 7 males by aspiration from urogenital papilla, using a massage technique with animals held in tonic immobilization with gills underwater. A Computer Assisted Sperm Analysis system was used to assess WSBS sperm motility. The first experiment determined the effects of different osmolalities (200 to 1000 mOsm/kg) and incubation temperatures (4°C and 23°C) over time (6h, 12h and 24h). Membrane integrity and morphology was significantly degraded over time, however, sperm held within HBSS 1000 and HBSS 800 were least affected. Significantly higher TM, VAP and SLOW were observed with HBSS 1000 and HBSS 800. No other sperm motility parameters were affected. The second experiment compared different cryoprotectants (DMSO 10%, DMSO 20%, Ethylene-glycol (EG) 10%, EG 20%, Trehalose (TRE) 10%, TRE 20%) during incubation at 4°C for 2 h. Across all time points, sperm cells incubated in TRE (10 or 20%) had significantly increased membrane integrity compared to all other media and raw. Normal morphology showed an overall significant decline across incubation regardless of media, but TRE provided significantly more protection than other cryoprotectants. Sperm motility was not affected ( $p > 0.05$ ) by time or cryoprotectant. Spermatozoa collected from WSBS are robust and remained without drastic changes when exposed to different media osmolality or cryoprotectants. TRE and DMSO were superior than EG and should be examined in future studies.

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## 767 Ichthyology Reproduction, Development, and Morphology, Cottonwood A-D – The Snowbird Center, Sunday 28 July 2019

Cristiano Moreira<sup>1</sup>, Kevin W. Conway<sup>2</sup>

<sup>1</sup>Museu Nacional/Universidade Federal do Rio de Janeiro - Setor de Ictiologia, Departamento de Vertebrados, Rio de Janeiro, RJ, Brazil, <sup>2</sup>Texas A&M University, College Station, Texas, USA

### Do Freshwater Hatcherfishes (Characiformes; Gasteropelecidae) "hear" with the top of their heads?

Gasteropelecidae (*Carnegiella*, *Gasteropelecus*, and *Thorachocharax*) are among the most unusual fishes within the order Characiformes. Although these fishes are well known for their ability to detect and locate potential prey items on the water surface, the morphological modifications that facilitate this behavior remain unknown. Here, we describe several unique modifications of the surface of the head and laterosensory canals of freshwater hatcherfishes that may be involved in prey detection at the water surface. The top of the head is covered by multiple rows of superficial neuromasts running from just posterior to the upper lip to the supraoccipital. The frontal and parietal have two longitudinal, parallel crests of bone that create two pairs of elongate troughs (one lateral, one medial) on the dorsal surface of the head. Each trough is roofed by a thin layer of skin. The medial trough extends along the entire frontal and a portion of the parietal, connecting to the exterior only through the nasal canal. The shorter lateral trough is located dorsal to the orbit, and connected to the medial by a foramen. Inside each of the bony troughs are large banana-shaped neuromasts that are arranged perpendicular to each other.

This includes two in the median and one in the lateral chamber, as well as one in the foramen between the two. Together these modifications may serve as a “tympanum”, enabling hatchetfishes to better sense prey items at the surface.

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## **CANCELLED**

### **495 AES Genetics/Ecology, Rendezvous A&B – The Snowbird Center, Friday 26 July 2019**

Clark Morgan, Dr. Jim Gelsleichter

*University of North Florida, Jacksonville, Florida, USA*

#### **Distribution and community structure of First Coast shark assemblages**

Nearshore marine environments are known to be highly productive systems with relatively high faunal diversity and abundances, but these systems are particularly vulnerable to negative impacts from anthropogenic disturbances such as pollution and overexploitation. Despite these challenges, many shark species of various life stages utilize coastal shelf habitats, inshore estuaries, and bays. The inshore habitats of Cumberland and Nassau Sounds in northeast Florida have been proposed as potential nursery grounds by earlier work, but this suggestion did not satisfy all of the standard criteria of shark nursery designation. It has recently been stated that the combination of surveys inside and outside suspected nursery habitats, especially those incorporating mark-recapture studies, would provide a very comprehensive test of the nursery criteria. A primary objective of the present study was to initially describe the composition and abundance of shark populations utilizing the nearshore habitats of northeast Florida, while also comparing them to inshore communities, with emphasis on spatial and temporal variations in assemblages. Fishery-independent longline sampling was conducted across the region, and while considerable overlap of species were observed, significant differences in community structure between inshore and nearshore locations were detected providing support of distinct nursery grounds. The identification of factors that influence coastal shark habitat utilization can contribute to the understanding and predicting of how they may respond to environmental changes. This study may serve as an example to inspire future studies assessing nursery habitat use and may be useful for comparisons against other locations.

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### **371 AES CARRIER AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Joshua Moyer<sup>1</sup>, Stephanie Shannon<sup>2</sup>, Duncan Irschick<sup>3</sup>

<sup>1</sup>*Graduate Program in Organismic & Evolutionary Biology, University of Massachusetts Amherst, Amherst, MA, USA,* <sup>2</sup>*Mystic Aquarium, Mystic, CT, USA,* <sup>3</sup>*Department of Biology, University of Massachusetts Amherst, Amherst, MA, USA*

#### **Feeding Kinematics and Behavior of the Sand Tiger Shark, *Carcharias taurus***

Logistical challenges have historically limited analyses of feeding performances in large predatory vertebrates. Enabled by recent technological advances in “action cam” video technology, this study examines the feeding behavior and kinematics of three sub-adult Sand Tiger Sharks, *Carcharias taurus*, on display at Mystic Aquarium (Mystic, Connecticut, USA). We used high-speed video data from 52 bites to identify kinematic variables associated with the expansive and compressive phases of biting in *C. taurus*. Mean bite duration was  $0.14 \pm 0.01$  s, and across the ten fastest bites of each individual, the maximum performance average was  $0.13 \pm 0.01$  s. These values did not vary among individuals. When compared to kinematic bite data from previously studied species, these results indicate that body size is not the only determinant factor of bite duration. We also provide detailed descriptions of feeding behaviors in *C. taurus*, including documentation of tooth loss. Finally, we discuss behavioral and ecological aspects of prey capture in the Sand Tiger Shark and suggest points of consideration to facilitate interspecific comparisons of prey capture performance large, macrophagous elasmobranchs.

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**565 ASIH STOYE GENETICS, DEVELOPMENT & MORPHOLOGY AWARD II,  
Primrose A&B – Cliff Lodge, Friday 26 July 2019**

Kevin P. Mulder<sup>1,2,3</sup>, Nandadevi Cortes-Rodriguez<sup>4</sup>, Evan H Campbell Grant<sup>5</sup>, Adrienne Brand<sup>5</sup>, Robert C. Fleischer<sup>1</sup>

<sup>1</sup>Center for Conservation Genomics, Smithsonian Conservation Biology Institute, National Zoological Park, Washington, DC, USA, <sup>2</sup>CIBIO/InBIO, Research Center in Biodiversity and Genetic Resources, Vairão, Porto, Portugal, <sup>3</sup>Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA, <sup>4</sup>Department of Biology, Ithaca College, Ithaca, NY, USA, <sup>5</sup>United States Geological Survey, Patuxent Wildlife Research Center, SO Conte Anadromous Fish Research Lab, Turners Falls, MA, USA

**North-facing Slopes and Elevation Shape Asymmetric Genetic Structure in the Range-restricted Salamander *Plethodon shenandoah***

Species with narrow environmental tolerances are often distributed within fragmented patches of suitable habitat, and dispersal among these subpopulations can be difficult to directly observe. Genetic data can help quantify gene flow between localities, which is especially important for vulnerable species with a disjunct range. The Shenandoah salamander (*Plethodon shenandoah*) is a federally endangered species known only from three mountaintops in Virginia, USA. To reconstruct the evolutionary history and population connectivity of this species, we generated both mitochondrial and nuclear data using sequence capture from individuals collected across all three mountaintops. Applying population and landscape genetic methods, we found strong population structure that was independent of geographic distance. Both the nuclear markers and mitochondrial genomes indicated a deep split between the most southern population and the genetically similar central and northern populations. Although there was some mitochondrial haplotype-splitting between the central and northern populations, there was admixture in nuclear markers. This is indicative of either a recent split or current male-biased dispersal among mountain isolates. Models of landscape resistance found that dispersal across north-facing slopes

at mid-elevation levels best explain the observed genetic structure among populations. These unexpected results highlight the importance of incorporating landscape features in understanding and predicting the movement and fragmentation of this range-restricted salamander species across space.

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### **33 AES Reproduction & Life History, Alpine A,B,C – The Snowbird Center, Friday 26 July 2019**

Christopher Mull<sup>1</sup>, Sebastián Pardo<sup>2</sup>, Alastair Harry<sup>3</sup>, Luz Saldaña Ruiz<sup>4</sup>, Emiliano Garcia Rodriguez<sup>4</sup>, Brit Finucci<sup>5</sup>, Christopher Bird<sup>6</sup>, Cassandra Rigby<sup>7</sup>, Manuel Dureuil<sup>2</sup>, Nicholas Dulvy<sup>1</sup>, Holly Kindsvater<sup>8</sup>

<sup>1</sup>*Simon Fraser University, Burnaby, BC, Canada*, <sup>2</sup>*Dalhousie University, Halifax, Canada*, <sup>3</sup>*DPIRD, Perth, Australia*, <sup>4</sup>*Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE), Ensenada, Mexico*, <sup>5</sup>*Victoria University, Wellington, New Zealand*, <sup>6</sup>*CEFAS, Norwich, United Kingdom*, <sup>7</sup>*James Cook University, Townsville, Australia*, <sup>8</sup>*Rutgers University, New Brunswick, USA*

### **SharkTraits: a curated, open-access database of shark, ray, and chimaera life history traits**

Accurate and complete information on life history traits is critical for reliably estimating biological reference points and for developing successful management and conservation strategies. Shark and ray scientists have long collected data on fundamental biological information including size, age and growth, and reproduction. However, this information is spread throughout a range of primary and grey literature and can be further obscured by taxonomic revisions, making data difficult to access and subsequently underutilized in addressing broad-scale questions. To address these challenges, we present SharkTraits, an open-access and expertly curated database of shark, ray, and chimaera life history traits. Our database, modeled after the Coral Trait Database initiative, provides species-, population-, and individual-level data from published field studies and technical reports for six trait classes comprising 56 traits across the 1,192 species of sharks, rays, and chimaeras. Additionally, we provide observation-level methodological information to account for potential biases in data collection or model methods that may have changed over time. Through synthesizing this information, we hope to provide a tool for understanding variation in life history strategies between species, interspecific variation both spatially and temporally, and to identify crucial taxonomic or geographical gaps in our understanding. Our goal is for the SharkTraits database to provide an open-access, and community-driven central data repository and clearinghouse that enhances and accelerates shark, ray, and chimaera research, management, and conservation.

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### **78 ASIH/HL/SSAR Symposium: Professional Women in Herpetology: Lessons and Insights, Ballroom 1 – Cliff Lodge, Saturday 27 July 2019**

Martha Munoz

*Virginia Tech, Blacksburg, VA, USA*

### **Stories from the field: On the role of behavior in evolution and being a woman in herpetology**

One of the most ubiquitous patterns in evolution is that biological diversity is distributed unequally. Whereas some traits and lineages diversify rapidly others remain inert for millions of years. But, why is this true? Why are some features in evolutionary overdrive while others appear stuck in the slow lane? I primarily address this question by focusing on one of evolution's most powerful architects: behavior. I discover how behavior generates phenotypic diversity in natural populations and reveal these signatures at both micro- and macroevolutionary scales. My research focuses on two key study systems: *Anolis* lizards and plethodontid salamanders. Although different in many ways, I have discovered that behavior imparts distinct, repeatable signatures on physiological evolution in both groups of organisms. Although I have been conducting herpetological research for more than a decade, my career trajectory has been far from linear. I was always fascinated with nature as a child, but I had no idea that I could ever be a scientist or a herpetologist. And, even when I knew that I wanted to study herpetology, I did not always feel welcome in the community. My journey has involved several challenges, but I have found support from excellent mentorship and my colleagues. Rather than force myself to change for herpetology, I have decided to change herpetology by being a part of it exactly as I am. Because of all the diverse people who identify as herpetologists and who make the community inclusive and welcoming, the future of herpetology is bright.

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### **447 SSAR HUTCHISON EVOLUTION, GENETICS, & SYSTEMATICS AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Matthew Murdoch<sup>1</sup>, Lee Grismer<sup>2</sup>, Todd Jackman<sup>1</sup>, Aaron Bauer<sup>1</sup>

<sup>1</sup>*Villanova University, Villanova, PA, USA*, <sup>2</sup>*La Sierra University, Riverside, CA, USA*

### **Comparative Phylogeography of *Hemidactylus* geckos and insights into biogeographical dispersal barriers in Myanmar**

Myanmar sits at a biogeographic crossroads where the faunas of China, Indochina, India, the Himalayas, and the Malay Peninsula converge. Due to its unique geologic past, the region boasts a large number of potential biogeographic barriers to the dispersal of herpetofauna. One of particular importance is the steep elevational gradient between the semi-arid central Myanmar Basin and the hill ranges of the Shan Plateau and Tenasserim mountains. Previous work has shown that this barrier forms the distributional limit of many taxa, including several gekkonid genera such as *Hemiphyllodactylus*, *Gehyra*, *Cnemaspis*, and several major clades of *Cyrtodactylus*. However, the genus *Hemidactylus* has received little attention in the region while in adjacent areas of South Asia significant diversity has recently been uncovered. We present a

phylogeographic hypothesis for the *Hemidactylus bowringii* clade from either side of the Shan/Tenasserim elevation shift. Our study supports previous hypotheses that this geologic feature acts as a biogeographic barrier, limiting gene flow in gekkonids, and reveals greater diversity within Southeast Asian *Hemidactylus* than previously recognized. This work has implications for understanding the evolutionary history of the genus as well as the broader influences of biogeographic barriers within Myanmar on the shaping of present-day herpetofaunal diversity in Asia.

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**290 Herpetology Ecology & Behavior, Primrose A&B – Cliff Lodge, Saturday 27 July 2019**

Mason Murphy, Michelle Boone

*Miami University, Oxford, OH, USA*

**Over the Field or Through the Woods? An Assessment of Movement and Orientation Behavior in Two Anuran Species**

Dispersal links spatially isolated populations, and is vital for the maintenance of healthy populations by reducing regional extinction and inbreeding effects. An organisms' ability or willingness to disperse may be influenced by both intrinsic factors, such as body condition, and extrinsic factors, such as land cover. Specifically, the habitat matrix can promote either isolation or connectivity based on an individual's behavioral response or their likelihood to successfully traverse the landscape. In this study, we examined the effects of both intrinsic and extrinsic factors on movement and orientation in two anuran species (*Lithobates pipiens* and *Anaxyrus americanus*) by tracking movement of two size classes of metamorphic anurans released at habitat edges between three distinct habitat types: pasture, forest, and corn agriculture. We predicted *A. americanus*, a closed canopy species, would avoid open canopy habitat and northern *L. pipiens*, an open canopy species, would avoid closed canopy habitat. Within species, we predicted size specific differences in movement, with smaller individuals displaying shorter path movements within the chosen habitat. We found *Lithobates pipiens* avoided closed canopy forests in favor of open canopy agriculture and old field habitat, and *A. americanus* preferred closed canopy forest habitat. While body size influenced movement in both species, with larger individuals travelled longer distances, we found no effect of body size influenced orientation behavior. By understanding individual behavioral response to habitat edges, this study highlights the differential influence of environment and behavior on movement, and furthers our understanding of factors affecting dispersal.

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**171 ASIH STOYE ECOLOGY & ETHOLOGY AWARD II, Primrose A&B – Cliff Lodge, Friday 26 July 2019**

Alexander Murray, Luke Frishkoff

University of Texas at Arlington, Arlington, Texas, USA

### **Does arboreality heighten sensitivity to habitat modification in anurans?**

Habitat modification is a leading driver of species loss. However, following habitat modification not all species decline and the ecological mechanism underlying these differences remains uncertain. One intuitive means to explain which species are lost is species' niche to environment matching. If species niche requirements are unavailable or reduced in a modified habitat, this should lead to reduced abundance or local extinction. Species affiliation with vegetative strata may be a critical axis limiting species in modified habitats, due to the extensive simplification of vegetative structure following habitat conversion. Using 34 studies of anuran community composition, we evaluate the role of vertical niche position in defining abundance within primary forest, plantation, and pastures. We test the hypothesis that species that use higher vegetative strata will be most severely reduced following conversion of tropical forest, and that this reduction will be most severe in structurally simple pastures. Our results confirm that vertical niche position is an important predictor of abundance in modified habitats. Yet surprisingly we show that abundance in modified habitats increases with vertical niche position, such that arboreal species are more dominant in modified habitats than terrestrial species. This counterintuitive result could come about because physiological tolerance to desiccation and high temperatures experienced in forest canopies pre-adapt these species to the harsher abiotic conditions in pasture. What limits a species' ability to persist is not always clear. Structural components of a species' vertical niche may be less important than other traits correlated with vertical niche position.

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**322 SSAR HUTCHISON ECOLOGY, NATURAL HISTORY, DISTRIBUTION, & BEHAVIOR AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Lindy Muse<sup>1</sup>, Kenzie Pereira<sup>2</sup>, Sarah Woodley<sup>2</sup>, Clifford Fontenot<sup>1</sup>, Brian Crother<sup>1</sup>, Demetra Kandalepas<sup>1</sup>

<sup>1</sup>*Southeastern Louisiana University, Hammond, LA, USA*, <sup>2</sup>*Duquesne University, Pittsburgh, PA, USA*

### **Chytrid Growth Inhibition in Two Fully Aquatic Salamanders**

Chytrid fungal pathogens, *Batrachochytrium dendrobatidis* (*Bd*) and *B. salamandrivorans* (*Bsal*) are causing amphibian die-offs worldwide. While *Bd* is already found in North America, *Bsal* has not yet been detected among native populations. Although it is known that not all amphibian species are susceptible to chytrid pathogens, the factors underlying differences in susceptibility are poorly understood. Because amphibian skin secretions have been shown to have anti-fungal properties mediated through the action of antimicrobial peptides (AMPs) and have been hypothesized to aid in clearing of chytrid infections, it is possible that skin secretions are important for protecting some amphibian species from disease caused by chytrid pathogens. The objective of this study was to determine whether the skin secretions of the fully aquatic



salamander, *Siren intermedia* (Lesser Siren) inhibit the growth of *Bd* or *Bsal* using *in-vitro* growth inhibition assays. Skin secretions were collected from 10 wild caught *S. intermedia*, skin peptides were extracted, pooled, serially diluted, combined with either *Bd* or *Bsal* zoospores and plated. Optical density was read daily for 14 days. We found that when combined with even low concentrations of *S. intermedia* skin peptides, *Bd* and *Bsal* growth was less than that of *Bd* and *Bsal* groups without skin peptides. These results suggest that the skin secretions of *S. intermedia* contain AMPs which may be protective against chytridiomycosis. In the future, we would like to repeat this experiment using the skin secretions of *Necturus beyeri* (Gulf Coast Waterdog). We predict that results will be similar to those observed with *S. intermedia*.

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### **705 Herpetology Lightning Talks, Ballroom 3 – Cliff Lodge, Saturday 27 July 2019**

Edward Myers<sup>1</sup>, Frank Burbrink<sup>2</sup>

<sup>1</sup>*National Museum of Natural History, Smithsonian Institute, Washington, DC, USA*, <sup>2</sup>*American Museum of Natural History, New York, NY, USA*

#### **The Importance of Biogeographic Barriers, Refugia, and Climatic Gradients in Driving Speciation in Corn Snakes (*Pantherophis guttatus* complex)**

The corn snakes (*Pantherophis guttatus* complex) are a widespread and phenotypically diverse snake species complex. Previous research has suggested that speciation within this group has been driven by both physical biogeographic barriers and adaptation to contrasting habitats. Here we further evaluate these hypotheses by generating population genomic data and implementing phylogeographic model selection coupled with ecological niche models. These analyses suggest that the rivers of southeastern North America, Quaternary refugia, and environmental gradients have contributed to divergence within the *P. guttatus* species complex. Furthermore, process-oriented species delimitation analyses demonstrate that species level diversity may be under-represented in this group.

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