Arturo - Currie
A New Species of Grunt (Lutjaniformes: Haemulidae) from the Puerto Rican Upper Slope

A new species of the haemulid genus *Rhonciscus* Jordan & Evermann, 1896 was found in the upper slope and deep shelf of the northeastern Caribbean island of Puerto Rico. The new species is separated from the other three species of the genus [the western Atlantic *R. crocro* (Cuvier, 1830) and the Eastern Pacific *R. bayanus* (Jordan & Evermann, 1898) and *R. branickii* (Steindachner, 1879)] by having seven scale rows between the dorsal fin and the lateral line; *R. crocro* and *R. branickii* have six or less scale rows above the lateral line, while *R. bayanus* has eight scale rows above the lateral line. It differs clearly from its western Atlantic relative by having 50 lateral-line scales (vs 53-55 in *R. crocro*) and 11 short lower gill rakers (vs 7-9 in *R. crocro*). Habitat is another evident difference between the two western Atlantic species: *R. crocro* inhabits shallow waters, not deeper than 20 m and is frequently found in the mouth of short, rapid rivers; the new Puerto Rican species, on the other hand, inhabits the deep portion of the island shelf and the upper segment of the slope. The new species may be clearly separated from its two Eastern Pacific congeners by having a well serrated preopercle, with 2-3 large spines in the angle and 20-21 relatively small spines in the vertical border; the preopercle is weakly or not serrated in both Eastern Pacific species.

Impacts of Native and Invasive Leaf Litter on Larval Anuran Behavior

Recent studies have demonstrated that Chinese tallow (*Triadica sebifera*) leaf litter can cause changes in behavior in anuran larvae by causing drastic changes in water chemistry. The effects of the leaf litter on water chemistry is attributed to the rapid decomposition of leaves causing a high biological oxygen demand. This reduction in oxygen impacts the behavior of tadpoles, forcing them to increase surfacing frequency to obtain aerial oxygen. It is unclear if the decomposition of native tree species leaf litter will have a similar effect on water chemistry and tadpole behavior. To test this, we compared the sub lethal effects of invasive Chinese tallow leaf litter to seven native tree species leaf litter. We exposed Bronze frog larvae (*Lithobates clamitans*) to three concentrations (0.15g/L, 0.25g/L and 1.0g/L) of Chinese tallow leaf litter and to one concentration (1.0g/L) of seven native tree species leaf litter and measured water
chemistry and tadpole behavior. We found significant differences in water chemistry between the species of leaf litter. Tadpoles exposed to red maple, Chinese tallow and sweetgum treatments had the highest frequency of air-gulping behavior; while tadpoles exposed to loblolly pine and water oak leaf litter made the fewest trips to the water’s surface. While some species of native plants leaf litter had little effect on water chemistry, other species caused drastic changes in dissolved oxygen which impacted tadpole behavior. More work needs to be done to understand the impact native and invasive plants have on water quality and their effects on wildlife.

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

David Adams1, Matthew Gifford2

1Vilonia High School, Vilonia, Arkansas, USA, 2University of Central Arkansas, Conway, Arkansas, USA

**Lizards Modulate Foraging Behavior in Response to Environmental Variation**

Movement is an important determinant of an animal’s fitness because it underlies all tasks necessary to survival, yet the basis on which animals choose varying speeds is still largely unknown. Speeds chosen by animals while preforming tasks, like predator evasion and foraging, are dependent on numerous external and internal factors. Environmental conditions and functional constraints should have influence over movement speeds of animals. Understanding the relationships between these factors and how they contribute to movement would help us better predict the speeds used during survival-dependent tasks. We video recorded Prairie Lizards (Sceloporus consobrinus) in experimental enclosures and analyzed the speeds and attack initiation distances lizards used while foraging. We predicted that, in more cluttered habitats, animals would use slower speeds and initiate prey capture attempts from shorter distances due to reduced visibility. Secondly, we predicted that average attack velocities during successful foraging attempts would be slower than unsuccessful attempts. Further, we predicted that increasing habitat complexity would reduce the difference of speeds between successful and unsuccessful attempts. Overall, attack speeds and distance were dependent on habitat type. Regardless of enclosure type, attack velocity was positively and significantly correlated with the attack distance, indicating that animals modulate attack speed based on distance prey is from them. Successful foraging attempts were significantly slower than unsuccessful ones, and the difference in successful and unsuccessful attempts was dependent on habitat configuration. Finally, this study emphasizes that functional constraints dominate in simple environments and that environmental constraints become more important with increasing habitat complexity.

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

Mia Adreani1, Casey Benkwitt2, Scott Hamilton3, Will White4, Mark Steele5
Effects of size-selective fishing on population dynamics of blackeye gobies

Size-selective removal of individuals from populations, either via natural processes (e.g., predation) or humans (e.g., fishing) can influence the population dynamics of many species. However, it is unclear how selective removal influences fishes that change sex as part of their lifecycle. Therefore, we examined the influence of varying levels of removal intensity (0%, 50%, 80%) and size-selection (small removal, large removal, random removal) on a model species, blackeye gobies. We measured rates of growth, sex change, reproduction, recruitment, and immigration over the course of two experiments in summer 2017. The effect of removal treatments on demographic rates varied throughout the season. In the first experiment, rates of growth and sex change increased when larger individuals were removed from the population. These effects occurred regardless of removal intensity. In the second experiment, rates of growth and sex change only increased when there was both selective removal of large individuals and high removal intensity. Recruitment and immigration was similar among all reefs, regardless of treatment. Applying these results to commercially-important sex-changing fishes may help determine the most effective management strategy for preventing over-harvesting.

Use of Hatchling Orange Bars in Male-Male Interactions of *Crotaphytus collaris*

Collared lizards, *Crotaphytus collaris*, are sexually dimorphic; males use their sexually selected traits to defend territories against rival males and to attract females. Collared lizards are different from other animals in that they are sexually dichromatic as both hatchlings and adults, but the dichromatism is distinct during these stages. Hatchling males develop orange dorsolateral bars (HOB) that are lost as the lizards become sexually mature. Juvenile males are aggressive toward other juvenile males and use HOB in this aggressive context. We conducted behavioral trials that separated the effect of HOB from aggressive behavior. Lizards either had their HOB removed (masked with paint) or enhanced (increased area of bars with spectrally similar paint) and received either a hormone implant that increased dihydrotestosterone (DHT) levels and aggressive behavior, or a blank implant. Treatment lizards were placed in a neutral arena with an unaltered and size-matched stimulus male and behaviors of both lizards were recorded and scored to measure relative aggression. HOB and aggressive behavior were linked in behavioral...
trials and increasing one, either HOB or aggression, negatively altered the outcome of male-male interactions. Lizards with increased aggression via hormone implants were significantly more aggressive in comparison to blank implanted lizards; lizards with only enhanced HOB or enhanced aggression received more aggression from opponents as retaliation for signal discordance. This result means that lizards police and punish those that act outside of the bounds of their signal.

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

Mickey Agha, Yuzo Yanagitsuru, Nann Fangue, A. Justin Nowakowski, Laura Kojima, Joseph Cech, Melissa Riley, Janna Freeman, Dennis Cocherell, Brian Todd

University of California, Davis, Davis, CA, USA

Physiological consequences of rising water salinity for a declining freshwater turtle

Sea level rise, drought, and water diversion can all lead to rapid salinization of freshwater habitats, especially in coastal areas. Increased water salinities can in turn alter the geographic distribution and ecology of freshwater species including turtles. The physiological consequences of salinization for freshwater turtles, however, are poorly known. Here, we compared the osmoregulatory response of two geographically separate populations of the freshwater Western Pond Turtle (*Actinemys marmorata*) — a species declining across its range in western North America — to three constant salinities: 0.4, 10, and 15‰ over two weeks. We found that turtles from an estuarine marsh population regulated their plasma osmolality more efficiently than their conspecifics from a freshwater creek population 45 km away. Plasma osmolalities were consistently lower in estuarine marsh turtles than the freshwater creek turtles over the entire two-week exposure to 10 and 15‰ water. However, individuals from both populations exhibited body mass loss in 15‰ water, with significantly greater loss in estuarine turtles. We suggest the greater capacity to osmoregulate by the estuarine marsh turtles may be explained by their greatly reduced feeding and drinking in elevated salinities that was not exhibited by the freshwater creek population. However, due to rapid mass loss in both populations, physiological and behavioral responses exhibited by estuarine marsh turtles may only be effective adaptations for short-term exposures to elevated salinities, such as those from tides and when traversing saline habitats, and are unlikely to be effective under long-term exposure to elevated salinity as is expected if sea levels rise.

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

Matthew Ajemian¹, Catherine Lamboy², Ali Ibrahim³, Breanna DeGroot¹, Kimbrough Bassos-Hull⁴, Laurent Cherubin¹

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Breaking ground with underwater sound: a novel approach to remotely measure hard prey consumption in durophagous predators

The elusive behaviors of durophagous (shell-crushing) aquatic predators creates challenges to observing predation in situ and thus quantifying their impacts on prey communities. Passive acoustics, or the remote monitoring of underwater sounds with sensitive hydrophones, provides an opportunity to observe shell fracture with sound, which travels over considerable distances in the aquatic environment. Despite these potential advantages in long-distance predation detection, researchers have not utilized this approach in ecological studies. Here, we report on results from an experiment where whitespotted eagle rays (Aetobatus narinari) were fed an assortment of hard-shelled mollusks and shell fracture events were recorded by a hydrophone coupled to a video camera. From April to May 2018, a total of 462 unique recordings were created from four captive rays. Overall, shell fracture events were short-lived (<0.1 sec) with a dominant frequency centered around 2.4 kHz, characteristics that make feasible feature identification and extraction from long-term acoustic recordings. Additionally, a multivariate analysis of variance of fracture frequency characteristics found differences between representative bivalve (hard clam, Mercenaria mercenaria) and gastropod (banded tulip, Cinctura lilium) prey (Pillai’s Trace, $F_{3,137} = 4.627, P < 0.0001$) with significantly lower minimum frequencies for fracturing banded tulips. Further, significant variation in processing behavior was observed between the prey types; hard clams required significantly more processing time ($39.0 \pm 2.8$ sec) than similarly sized banded tulips (mean = $15.5 \pm 1.3$ sec). While additional field testing is required, these findings indicate the potential to remotely quantify foraging in durophagous species via passive acoustics.
that have relatively low levels of genetic diversity with individuals from more genetically diverse populations of this species. Here, we present our analyses of nucleotide sequence variation in the mtDNA ND2 gene for North Carolina populations of *R. capito*. Our results indicate that mtDNA sequence variation within and among the NC populations is relatively small. We have also genotyped individuals from these populations using microsatellite markers in order to assess finer-scale geographic patterns of genetic variation as well as relatedness of individuals sampled from a given site. Overall, this genetic information can be used as a framework for guiding conservation and management decisions for gopher frogs in North Carolina.

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

**Fernando Alda¹, Diego Elias², William Ludt³, Caleb McMahan⁴, Prosanta Chakrabarty²**

¹University of Tennessee at Chattanooga, Chattanooga, LA, USA, ²Louisiana State University, Baton Rouge, LA, USA, ³National Museum of Natural History, Smithsonian Institution, Washington DC, USA, ⁴The Field Museum of Natural History, Chicago, IL, USA

**Compared Performance of Hybrid-Target Capture Methods in Resolving the Phylogeny of Heroine Cichlids: Are All Markers Good for All Nodes?**

Phylogenomic studies are struggling to develop computational protocols scalable to the amount of genomic data generated by massive parallel sequencing technologies. Therefore, we usually rely on the analysis of datasets containing reduced representations of the genome. These datasets can be obtained through hybrid target capture of hundreds to a few thousand orthologous loci (e.g. exon capture, ultraconserved elements, anchored enrichment), with desirable properties such as low paralogy, easy alignment, high consistency across studies, and proven utility at multiple evolutionary timescales. However, there are also differences inherent to the nature of these markers that may potentially affect their performance. Alignment length, polymorphism, or nucleotide substitution rates and models, can result in different amounts of phylogenetic informativeness relative to systematic error, and therefore alter the inference of species trees. The information content of the markers in a study is rarely interrogated. Let alone, comparing different types of markers to decide which one is more suitable to resolve the relationships of interest. Here, we inferred the phylogenetic relationships of Central American heroine cichlids using—novel—ultraconserved elements and—previously published—exon data. We compared topologies and support between species trees inferred using concatenation and coalescent methods, and related estimates of phylogenetic informativeness across the tree for each type of marker with the consistently recovered nodes at each particular period of time. We also evaluated heterogeneity among gene trees of different molecular markers, and draw conclusions on the relative effect of incomplete lineage sorting vs. systematic errors in obtaining accurate species trees.
High Levels of Hidden Phylogenetic Structure Within Central and West African *Trachylepis* Skinks

The genus *Trachylepis* is widespread throughout most of continental Africa and its surrounding islands. However, the majority of phylogenetic studies on this genus have focused on species occurring in eastern and southern Africa. We examined relationships among ten *Trachylepis* taxa that occur in central and west Africa: *T. affinis*, *T. albilabris*, *T. aureogularis*, *T. gonwouoi*, *T. maculilabris*, *T. mekuana*, *T. perrotetii*, *T. polytropis*, *T. polytropis paucisquamis*, and *T. quinquetaeniata*. Five genes (two mitochondrial and three nuclear) were sequenced for 153 individuals, revealing much higher levels of diversity than previously realized and justifying the need for future taxonomic investigations. Because of high levels of morphological conservatism in *Trachylepis*, the taxonomy of each of these species is complex, and previously synonymized names may be available for several lineages. Molecular dating techniques suggest that while the two major clades of *Trachylepis* represented in this study diverged approximately 23 million years ago, the majority of diversification has taken place in the last 17 million years. Further work is needed to fill in sampling gaps and increase genetic coverage for some clades before the full genetic diversity of this group can be realized.

The Song of *Stereolepis*

To investigate sound production of Giant Sea Bass, we captured (under CDFW SCP permit) three, mature Giants (40-50 kg) and placed them into captivity in a 5,000 l tank at the Southern California Marine Institute’s Fish Harbor Laboratory facility in the summer of 2017. One male and two females remained isolated from other fish species and any sounds produced were continuously recorded using underwater hydrophones (Soundtrap 202: Ocean Instruments^NZ^) during the breeding seasons (June-August) of both 2017 and 2018. After analysis of hundreds of 6-min recording sessions, only low frequency “Booms” were recorded. The male Giant Sea Bass SOK-3 (aka Maxie”) presumably produced these sounds. We have now characterized the frequencies and amplitude these “Boom” sounds in detail. In short, these “Booms” and concert bass drums have very similar acoustic profiles ranging from 30 to 90 Hz in max frequencies.
Necropsies of beached specimens have also revealed the sound producing mechanism associated with the swimbladders of male Giant Sea Bass. The characterization of these “booms” should allow us to identify spawning aggregations of Giant Sea Bass throughout their range based solely on sound in the future.

747 Herpetology Conservation and Disease, Ballroom 3 – Cliff Lodge, Saturday 27 July 2019

Matthew Allender¹, Michael Ravesi², Ellen Haynes¹, Emilie Ospina¹, Christopher Petersen³, Christopher Phillips⁴, Robert Lovich⁵

¹Wildlife Epidemiology Laboratory, Department of Veterinary Clinical Medicine, College of Veterinary Medicine, University of Illinois Urbana-Champaign, Urbana, IL, USA, ²Connecticut Department of Energy and Environmental Protection, Wildlife Division, Sessions Woods WMA, Burlington, CT, USA, ³Naval Facilities Engineering Command Atlantic, Norfolk, VA, USA, ⁴Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, Champaign, IL, USA, ⁵Naval Facilities Engineering Command Southwest, San Diego, CA, USA

Ophidiomyces Detection in Free-ranging Snakes on Department of Defense Installations in the United States and Puerto Rico

Ophidiomyces (formerly referred to as snake fungal disease, SFD) is an emergent condition affecting North American snakes. Our goal was to assess the threat that ophidiomycosis poses to snake species on Department of Defense lands and, ultimately, to military training. We provided military natural resource managers with outreach materials, sampling protocols, and a training session. This enabled volunteers to sample for SFD on participating installations, and for us to test samples for Ophidiomyces DNA. Sampling kits were sent to 68 installations and 56 (82%) returned swabs. A total of 657 individuals (34 species in 30 states) were observed and tested for Ophidiomyces. Twenty-three species from 19 states/territories were detected with O. ophiodiicola DNA, including the first reports of the pathogen in snakes in Idaho, Oklahoma, and Puerto Rico. Apparent ophidiomycosis (lesions and O. ophiodiicola DNA present) was observed in 49 individuals, O. ophiodiicola DNA was detected in 64 individuals in the absence of clinical signs, 82 snakes had possible ophidiomycosis (lesions but no detection of O. ophiodiicola DNA), and 462 were qPCR negative and lacked lesions. Multinomial multivariable logistic regression identified adults having a 2.38 higher odds of being diagnosed with ophidiomycosis. Snakes from Georgia, Massachusetts, Pennsylvania, and Virginia all had higher odds of ophidiomycosis, while snakes from Idaho were less likely to be detected with ophidiomycosis. The results of this survey indicate that this pathogen is endemic in parts of the country (eastern US), but also identified new sites that could represent emergence or improved detection of endemic sites.
Evolution of the adaptive immunity – A new perspective given by Chondrichthyan fishes as basal jawed vertebrates

The adaptive immune system is the ability of lymphocytes to identify foreign antigens produced by pathogens. Chondrichthyes (sharks, rays and chimaeras) are the most basal vertebrate lineage possessing the basic features of the innate and adaptive immune systems present in mammals, and thus are key taxa to understand the emergence and evolution of vertebrate adaptive immunity. These species also occupy a variety of habitats and have different lifestyles, thus they are exposed to different pathogens that may rely on different immune mechanisms. We will present preliminary results on the genetic architecture and diversity of the major histocompatibility complex (MHC) in Chondrichthyes. The MHC genes are required for the presentation of antigens to T cells. A new, MHC-linked class I gene was found in all cartilaginous fishes, which appears to be single copy in Elasmobranchs, but multicopy in Holocephalans. This new gene is apparently monomorphic and has a unique tissue distribution. The new molecule binds a unique set of peptides in all Elasmobranchs rather than to species-specific sets of peptides as found for classical class I molecules. Two other lineages of previously reported nonclassical class I genes in cartilaginous fish were also examined, of which one was found across them and is generally multicopy, while the other was only detected in elasmobranchs and has a wide gene-number range. It seems that early in vertebrate history there was already a division of labor among class I genes, most likely presenting antigens of different classes to different subsets of T cells.
Understanding the fate of bycatch is necessary for effective management of marine resources, particularly for species that are overfished or of other conservation concern. The northwest Atlantic population of porbeagle sharks represents one such species, as it is currently listed as Endangered by the International Union for the Conservation of Nature. Of particular concern are juvenile and young of the year porbeagles, which appear to be highly susceptible to interaction with both commercial and recreational fisheries (rod-and-reel, longline) in this region. In order to gain a better understanding of the resiliency of this life history stage to capture, handling, and release, the current study investigated the post-release survival of porbeagle sharks following capture by rod-and-reel and longline fisheries. Pop-off satellite archival tags (PSATs) were affixed to a total of 14 juvenile porbeagle sharks captured in the pelagic longline fishery (n=7) or with rod-and-reel gear (n=7). Individuals were either handled in the water to mimic fishery practices or brought onboard to be freed from gear. Of the 14 sharks captured, 13 survived (93%) with the only mortality occurring in the pelagic longline fishery. That observed mortality occurred immediately (~1 hour) following release. Additionally, several surviving individuals remained in surface waters (<20 m) for several hours to days following capture, after which sharks occupied a broad vertical depth range and made frequent dives to >250 m. The observed depth-holding behavior may indicate juvenile porbeagle sharks exhibit a post-release recovery period following capture and handling.

**CANCELLED**

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

Alyssa Andres¹, Brad Seibel¹, Emily Slesinger², Grace Saba², Jack Morris³, Vincent Saba⁴

¹University of South Florida, Saint Petersburg, FL, USA, ²Rutgers University, New Brunswick, NJ, USA, ³Mote Marine Laboratory, Sarasota, FL, USA, ⁴NOAA, Princeton, NJ, USA

**Metabolic Implications of Rising Temperature and Hypoxia in Three Coastal Shark Species**

Rising ocean temperatures and coastal hypoxia may restrict metabolically available habitat of marine organisms, as studies suggest that the balance between metabolic oxygen demand and environmental supply plays an important role in limiting viable habitat and species fitness. As ectothermic predators, with temperature-dependent metabolism and high metabolic demands, coastal shark species may be susceptible to the effects of increased ocean temperatures and hypoxia. However, the physiological responses of elasmobranch species to these environmental changes have been poorly studied. Hypoxia tolerance and aerobic scope have been indicated as key physiological factors in predicting species distribution, and viable habitat across variable environmental conditions. In this study, hypoxia tolerance and aerobic scope were quantified in three coastal shark species; *Squalus acanthias*, (US Northeast Shelf), *Carcharhinus limbatus*, and *Carcharhinus leucas* (Gulf of Mexico). Aerobic scope (maximum metabolic rate (MMR) – basal metabolic rate (BMR)) and hypoxia tolerance (Pcrit) were determined metabolically, using intermittent respirometry to determine rate of oxygen consumption, a proxy for energy use. To quantify temperature sensitivity of both physiological metrics, experiments were run at 10, 13, 17, 21, and 23° C for *S. acanthias*, and 22, 26, 30, and 34° C for *C. limbatus*.
and *C. leucas*. Results from this study will ultimately provide a physiological basis for predicting species-specific viable habitat in the face of climate shifts. Together with historical shark catch and climatological data, metrics derived in this study will be used to mechanistically model viable habitat across the Gulf of Mexico and US Northeast shelf for each study species.

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**My “alternative” early career research: recovery of species when threats still exist**

In a rapidly changing world, species recovery is difficult to assess. I work on species recovery assessments and persistence of highly cryptic species. I study ways to find individuals, to return species to their historic ranges, and the methods that will allow us to accurately assess their population statuses. As the head of a territorial wildlife division, I am a practitioner, but I remain a conservation biologist and research herpetologist. The #HERper symposium is about visibility and persistence of women in herpetology; I study species that also aren’t always visible. My talk will focus on methods to assess latent progress in species recovery goals, but I will use those examples to explain how I found opportunities to develop professionally as a female herpetologist under male and female mentors, facilitate and execute exciting research projects, and apply for funding opportunities to create a taxonomically, geographically, methodologically, and personally diverse research program: namely, how I created a career trajectory to provide vision and implement scientific research in government.

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**Skeletal Development and Axial Regionalization of Centroscyllium fabricii (Selachii)**

For more than a century, the axial skeleton (vertebral column and ribs) has been recognized to have played an important structural role during vertebrate evolution. The vertebral column consists of serial vertebrae that are cartilaginous, mineralized or ossified, and ligamentous elements around the notochord. Anatomical similarities among vertebral units define vertebral regions or domains (e.g., occipital, cervical, thoracic, lumbar, sacral, precaudal, caudal) along the anteroposterior axis. The presence of five axial regions (i.e., cervical, thoracic, lumbar, sacral,
caudal) was first recognized in tetrapods, and subsequently reported in basal osteichthyan but knowledge on chondrichthyans is needed. We cleared and stained 110 specimens of Black dogfish, Centroscyllium fabricii, measuring from 2.9 to 28.2 cm in total length, to characterize the chondrification and mineralization of their vertebral column. For the first time, the complete development of cartilaginous and mineralized structures of the vertebral column of a shark is described. Qualitative and quantitative morphological differences were found among vertebral segments along the body axis, and during ontogeny, forming five distinct anatomical and developmental regions. Morphological abnormalities (e.g., fusion of hemal arches, addition of neural arch) are found in transitional zones delimiting each region; and primarily between the thoracic and sacral regions. Transitional zones seem to match the overlap areas found for Hox genes expression. The presence of five anatomical and developmental axial regions is most likely a gnathostome novelty than an osteichthyan synapomorphy.

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

Andrea Aparicio Ramirez, Karina Perez, Rory Telemeco

Fresno State, Fresno, California, USA

Temperature Preference and Performance in Crested Geckos (Correlophus ciliatus)

The Crested Gecko (Correlophus ciliatus) lizard was rediscovered in New Caledonia 20 years ago and despite becoming common in the pet trade, there are currently no data on their life history or physiology. Crested Geckos have a very small geographic range at risk of habitat destruction and climate change, both of which will alter their thermal environment. However, the importance of changes to the thermal environment for Crested Geckos is uncertain because, unlike most reptiles, they do not have any special temperature requirements, and are comfortable at room temperature, which is generally colder than what reptiles prefer. We measured thermal behavior (preferred body temperature and voluntary limits) and performance (optimal and maximum temperature for running) of adult and juvenile Crested Geckos to describe thermal tolerances, assess correlations between behavior and performance, and assess differences among life stages. Crested Geckos displayed typical thermal biology for a lizard with no difference among life stages. The optimal temperature for sprint performance (32.2 ± 3.5 °C) was substantially higher than the preferred body temperature (26.2 ± 5 °C) but corresponded to the maximum temperature voluntarily experienced by the lizards (33.0 ± 2.9 °C, all are mean ± s. d.) Our results demonstrate that despite tolerating a broad range of temperatures, Crested Geckos actively thermoregulate and their performance is highest at lower temperatures than for most reptiles. These data allow us to improve captive care of Crested Geckos and begin making predictions for how they could be affected by climate change.
Thermal hardening of *Pristimantis medemi* (Anura: Craugastoridae) from forest around Villavicencio (Meta), Colombia

Forest throughout the Colombian Andes has been transformed by anthropogenic activities, resulting in a dramatic modification of the thermal landscape that threatens regional amphibian diversity. *Pristimantis medemi*, a terrestrial breeding frog, is found abundantly in forest around the city of Villavicencio, in the state of Meta in eastern Colombia. Previous studies have indicated that terrestrial breeders are particularly sensitive to the relatively high temperatures in human-dominated areas compared with cool, thermally-buffered forest. Here, we evaluated the acclimation capacity of *Pristimantis medemi* from low- and high-elevation forest around Villavicencio. We conducted laboratory experiments to determine critical thermal limits ($CT_{max}$ and $CT_{min}$) following capture, and again 24 hours later to assess the extent of thermal hardening, or an increase in critical thermal limits following exposure to extreme temperatures. In our sample of 32 individuals, a marked thermal hardening was observed for some individuals with respect to both $CT_{max}$ and $CT_{min}$. The acclimation response was variable depending on where individuals were obtained along the altitudinal gradient. Individuals from high and low elevations showed little evidence of acclimation, whereas individuals from mid elevations showed highly variable thermal responses, and a high degree of acclimation capacity. Information such as that provided by our study is critical to understanding the implications of change in thermal environments for amphibians, and generating effective strategies for their conservation.
recovered *L. enigmatica* among the “Big Africa” clade of Siluriformes and sister to Claroteidae with the timing of divergence happening after the separation of Africa and South America. Morphological evidence failed to resolve phylogenetic relationships of Lacantuniidae placing it in a polytomy of 22 Siluriformes families. Despite the family being sympatric to Ariidae, Heptapteridae and Ictaluridae, it does not share morphological similarities with those families. We investigated function, form, origin and insertion of 11 cranial muscles for Lacantuniidae, Claroteidae, and Auchenoglanididae. For Lacantuniidae, we applied high-resolution X-ray computed tomography (HRXCT) to visualize, illustrate and describe the structures while for the comparative material we performed direct dissection of specimens. Thus, we could establish homologies within catfishes and established variations in the composition and structure of the muscles. The *adductor mandibulae* and the *levator arcus palatini* exhibit the greatest differentiation among the three families studied. The *protractor hyoidei* exhibit simplification in the number of portions that are present in Lacantuniidae, Claroteidae and Auchenoglanididae when compared with species of Bagridae, Siluridae and Pimelodidae. Configuration of the cranial muscles of Lacantuniidae provide an additional insight to understand the relationship of the family with other Siluriformes and explores a different set of morphological characters to be included in future research.

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

Dahiana Arcila, Sara Cartwright

*Sam Noble Museum, Norman, Oklahoma, USA*

**Ichthyology Collection of the Sam Noble Oklahoma Museum of Natural History**

Museum natural history collections play a central role in documenting and studying organismal diversity. The ichthyology collection of the Sam Noble Oklahoma Museum of Natural History, established in 1924 - 1934, contains nearly two million specimens representing 30 orders, 42 families, and 340 species of freshwater and marine fishes, including 16 paratypes from 7 species. The collection comprises large holdings of fishes from the rivers of the Great Plains in North America, as well as species from the Panamanian and Neotropical regions. The collection is currently expanding its taxonomic emphasis to the Neotropical, Afrotropical, and Indo-Pacific regions.

156 Ichthyology Systematics II, Cottonwood A-D – The Snowbird Center, Sunday 28 July 2019

Dahiana Arcila¹,², Guillermo Ortí³, Lily Hughes⁴, Mark Sabaj⁵, Ricardo Betancur-R.²

¹Sam Noble Oklahoma Museum of Natural History, Norman, OK, USA, ²University of Oklahoma, Norman, OK, USA, ³The George Washington University, Washington, DC, USA,
Phylogenomic incongruence, hypothesis testing, and taxonomic sampling: The monophyly of characiform fishes

Phylogenomic studies using genome-wide datasets are quickly becoming the state of the art for systematics and comparative studies, but in many cases, they result in strongly supported incongruent results. The extent to which this conflict is real depends on different sources of error potentially affecting big datasets (assembly, stochastic, and systematic error). Here, we apply a recently developed methodology (GGI or gene genealogy interrogation) and data curation to new and published datasets with more than 1000 exons, 500 ultraconserved element (UCE) loci, and transcriptomic sequences that support incongruent hypotheses. The contentious non-monophyly of the order Characiformes proposed by two studies is shown to be a spurious outcome induced by sample contamination in the transcriptomic dataset and an ambiguous result due to poor taxonomic sampling in the UCE dataset. By exploring the effects of number of taxa and loci used for analysis, we show that the power of GGI to discriminate among competing hypotheses is diminished by limited taxonomic sampling, but not equally sensitive to gene sampling. Taken together, our results reinforce the notion that merely increasing the number of genetic loci for a few representative taxa is not a robust strategy to advance phylogenetic knowledge of recalcitrant groups. We leverage the expanded exon capture dataset generated here for Characiformes (206 species in 23 out of 24 families) to produce a comprehensive phylogeny and a revised classification of the order.

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

Triana Arguedas Alvarez
El Colegio de la Frontera Sur, Campeche, Campeche, Mexico

An Analysis of Catch Trends of Carcharhinus leucas and Carcharhinus acronotus in the Southern Gulf of Mexico: A Preliminary Review

Most of the Mexican fisheries are classified as artisanal fishing. Due to lack of government oversight, fishing communities have collapsed a wide range of valuable stocks including elasmobranch species. Shark fisheries are multispecific and multigear and historically there is a lack of analysis concerning the catch trends by species. There are official records by species since 2006, however, there is uncertainty regarding the catch by species due to lack of standardized methods of record keeping. Bull sharks (Carcharhinus leucas) and Blacknose sharks (Carcharhinus acronotus) are of high economic value in Mexico but have unclear catch trends. A compilation and comparison of available catch records will be formed, standardized, and analyzed in order to estimate their catch trends in the period 2006-2014.
Environmental preferences of a male Blacktip Shark during seasonal migration

Several shark species undertake large-scale migrations along the southeastern seaboard of the United States, including lemon (*Negaprion brevirostris*), nurse (*Ginglymostoma cirratum*) and blacktip (*Carcharhinus limbatus*) sharks. Blacktip sharks overwinter in southeast Florida from January to March, then migrate to summer birthing and mating grounds in Georgia and the Carolinas between April and May. Nine male blacktip sharks were instrumented with Finmount SPOT 6 satellite transmitters while overwintering in southeast Florida. Eight of the individuals were not subsequently detected but one tagged individual provided 540 real-time positions as it migrated from Palm Beach, Florida to Avon, North Carolina. This shark traveled a total distance of approximately 1250 km in 86 days. Water temperatures inhabited by this individual ranged from 19.8 to 29.1°C (mean= 23.1°C, SD= 1.4). Half of all detections were at a water temperature of 23.0°C, indicating a relatively strong preference for that temperature. For each detection, the corresponding depth at that location was collected from NOAA digital chart data. This individual inhabited depths of 0 to 56.6m (mean= 15.58m, SD= 8.5) along its migratory path with 67% of all detections in water depths of 10-19m. These data reveal a relatively strong preference for a narrow range of water temperatures and depths. An understanding of the limited water temperature range selected by this population allows us to predict how warming of global sea temperatures will alter migrations in the future.

Rapid age estimation of longnose skate (*Raja rhina*) vertebrae using near-infrared spectroscopy

Accurate age data are an important component of assessing and managing fish populations, yet traditional age estimation methods are time consuming and expensive. We explored the use of Fourier transform near-infrared spectroscopy to efficiently derive age estimates from the vertebral centra of a batoid species. The Longnose Skate (*Raja rhina*) is one of the few species of elasmobranch for which traditional age estimation criteria has been validated. We were therefore able to use robust age estimates to build a predictive model between near-infrared spectra and...
skate age. The model fit well with sixty-eight percent of the traditional ages within 1.5 years of those predicted based on their near-infrared spectra. When externally validated with a separate data set, the model was able to predict the traditionally generated age within 1.6 years sixty-eight percent of the time. The results of this pilot study suggest that the use of near-infrared spectroscopy is a promising alternative method for deriving age estimates from longnose skate vertebrae that could reduce cost and improve efficiency.

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

Morgan Arrington1, Beth Matta2, Christopher Gburski2, Thomas Helser2, André Punt1, Timothy Essington1

1The University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA, USA, 2National Oceanic and Atmospheric Administration, Alaska Fisheries Science Center, Seattle, Washington, USA

Exploring the growth of longnose skates (Raja rhina) along the North American West Coast

Longnose skates (Raja rhina) are commonly caught as bycatch in the Pacific groundfish fishery. Bycatch allowances are set according to stock assessments, but a key limitation to the certainty of these assessments is a lack of age data and potential bias in existing estimates. This is a concern because life-history characteristics such as late age at maturity and low fecundity make longnose skates vulnerable to fishing rates. While four separate studies have estimated age and growth parameters for longnose skates, these studies are spatially inconsistent and have conflicting results. It is unknown whether the results indicate regional variability in growth or are an artifact of differences in aging methodology among agencies. To address this question, we estimated the ages of over 1000 longnose skates based on validated age reading criteria. The specimens were captured throughout the extent of their range from the Gulf of Alaska to Baha, California between the years 2011 to 2018. We used the von Bertalanffy growth function to explore spatial variability in growth parameters and Bayesian parameter estimation to quantify uncertainty in parameter estimates. We also standardized age determination protocols across three federal agencies to reduce bias in future age estimates. We will present the results of model selection and the consequences for stock assessment and management.

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

Taylor Ashby, Kristopher Pedersen, Charles Hanifin

Utah State University Uintah Basin, Vernal, Utah, USA
Using Glow Sticks to Catch Tiger Salamanders (*Ambystoma mavortium* (*tigrinum*))

As with many amphibians, the success of field studies of Caudates are frequently limited by the ability to capture or observe target species. Minnow (funnel) traps are effective and commonly used tools for collecting and monitoring of salamander populations. There is some evidence that baiting traps with either scents or light (e.g. glowsticks) increases capture rates in these traps but this approach has not been formally tested in western ambystomatid salamanders. Here we report the results from a study looking at the effect of light baiting on capture rates of paedomorphic *Ambystoma mavortium*. Small and medium minnow traps were laid out in a systematic grid in a small permanent pond located on the USU Uintah Basin campus and baited with either activated (treatment) or un-activated (control) glowsticks. These were left overnight, and traps were checked in the morning. An analysis of count data (total n = 197 salamanders; n =122 in light traps and n = 75 in dark traps) showed that the presence of glowsticks significantly increased capture rates of *Ambystoma mavortium*. Results shown here suggest that baiting minnow traps with light increases capture rates, but ongoing studies also suggest that these effects may be seasonal and context dependent.

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

Fernando Assega, Jose Birindelli

*Universidade Estadual de Londrina, Londrina, Brazil*

Testing the monophyly of *Anostomoides*, with proposal of a new genus of Anostomidae (Characiformes)

Anostomidae is the second most diverse family of Characiformes. However, much is still poorly understood in the taxonomy and phylogeny of the species of the group. *Anostomoides* is one of 15 genera of Anostomidae. According to a recently unpublished taxonomic revision, it encompasses only two valid species. *Anostomoides atrianalis*, the type species, is a more widespread species occurring in the Amazon, Orinoco, and Essequibo drainages, whereas *A. nattereri* (formerly *Leporinus nattereri*) is distributed in the Amazon basin. The phylogenetic relationships of these species are poorly understood. The aim is to study the phylogenetic relationships of these two species among Anostomidae, testing the monophyly of the genus. For that, two independent phylogenetic analyses were performed, one including 123 morphological characters coded for 48 species of Anostomidae representing all but one genera, and another using data of five gene sequences originally sequenced or obtained in GenBank for 26 species of 11 genera representing all major lineages. Our results strongly support the polyphyly of *Anostomoides*, as previously defined. Therefore, a new genus is proposed and illustrated to allocate *A. nattereri*. In addition, the main morphological characters supporting the phylogenetic relationships of the new taxa are discussed.
Maternal Inheritance and Fitness Consequences of a Male-typical Ornament in *Sceloporus undulatus*

Flashy sexual traits are uncommon in females of species with traditional sex roles. Such occurrences are often attributed to inheritance of a trait that is adaptive in males, although in some species females may benefit from displaying colorful signals. We investigated maternal inheritance and fitness consequences of male-typical blue badges across three populations of eastern fence lizards, along with potential hormonal drivers of this trait. We measured size and saturation of badges of mothers and their offspring, and relationships between this trait and concentrations of testosterone and baseline corticosterone. We also assessed potential costs related to honest signaling such as impaired immunocompetence in offspring. There was a positive relationship between saturation of badges of mothers and their female offspring, and a negative relationship with their male offspring. Testosterone was a predictor of badge saturation only in males. Corticosterone levels were negatively associated with badge size, indicating that physiological stress may hinder development of this trait. Badge size was associated positively with immunocompetence. It appears that females inherit their degree of ornamentation maternally, but males may be able to develop high-saturated badges independent of maternal phenotype. Despite the positive relationship between badge saturation and testosterone, typical immune costs of ornamentation and androgens were not detected, but the progeny of more ornamented females may suffer different costs such as reduced attractiveness as mates in both males and females. Still, other benefits have been associated with ornamentation in females (e.g. increased performance), which may allow variability in this trait among females.

Novel Techniques for Understanding Thermal Behavior and Improving Conservation of a Threatened Australian Alpine Lizard

Climate change is predicted to erode biodiversity and worsen global mass extinctions. Alpine biota are especially vulnerable to warming due to their inherent sensitivity to temperature and limited ability to avoid unfavorable conditions as they arise. Here we use Australia’s highest
elevation reptile, the Guthega Skink (*Liopholis guthega*), as a case study to examine the effects of predicted warming in Australia’s alpine zone. Using a novel technique, involving implanted miniature temperature loggers, we tracked the internal body temperature of the skinks for one year. This revealed behavioral information such as daily thermal profiles, as well as overwintering hibernation regimes. This information has greatly informed a captive breeding program resulting in increased overwintering survival and successful breeding. Additionally, these data were inputted into climate models, and utilized to predict activity under differing climate scenarios for 2050 and 2070. A warmer future alpine climate predicts a reduced, albeit more interrupted, hibernation period, resulting in a decrease in overall metabolic rate. While such thermal changes might appear outwardly beneficial to ectotherms restricted to the harsh alpine zone, there may be hidden costs. Here, I discuss the ramifications of extensive climate warming and the subsequent possible outcomes for this species. I consider the benefits of detailed field data collection, for multiple uses such as captive breeding, and informing protocols for alpine conservation programs globally. This work provides informed insight, and an important head start in determining the best management procedures and protocols to ensure minimal species loss due to anthropogenic climate change.

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

Matthew Atkinson, Anna Savage

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

**Impacts of the emergent protistan pathogen Perkinsea on Florida’s amphibian communities**

Amphibians as a group suffer from large-scale population declines across the globe, and disease is a central driving force behind these declines. Most of the current research focuses on two globally distributed pathogens, *Batrachochytrium dendrobatidis* (Bd) and *Ranavirus*. However, another emerging pathogen, the protist Amphibian Perkinsea, causes mass mortality events in several anuran species throughout much of the southeastern US, and has been tied to more of these mortality events than Bd in the continental United States. We sought to better understand the fundamental ecology and the implications of Perkinsea infections in Florida by surveying across the state for this pathogen using a recently developed qPCR assay. We collected tissue samples using monthly standardized dipnetting, visual and minnow trapping surveys from over 1500 individual frogs from 31 different wetlands throughout the state. We found that Perkinsea infections are widespread throughout the state of Florida and infections occur in numerous species of special concern and invasives. Around 30% of individuals infected with Perkinsea were also infected with *Ranavirus*. The prevalence and infection intensity of Perkinsea infections were significantly different based on season, species, family, life stage, and location. Additionally, we found that there is a strong relationship between the prevalence of Perkinsea infections and the average pH within a given wetland. Understanding the influence of this disease in the southeast is critical for successful conservation efforts of anurans. By
understanding the fundamental disease ecology of Perkinsea, we can potentially predict the likelihood of outbreaks in the future.

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

Calder Atta¹,², Luke Tornabene¹,², Hao Yuan³, Chenhong Li³

¹School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA, USA, ²Burke Museum of Natural History and Culture, Seattle, WA, USA, ³Key Laboratory of Exploration and Utilization of Aquatic Genetic Resources, Shanghai Ocean University, Ministry of Education, Shanghai, China

Phylogenomic analysis of pleuronectid flatfishes based on exon-capture data

Flatfishes in the family Pleuronectidae are primarily found in temperate and polar marine habitats in the Northern Hemisphere. Since the family was established, there has been much debate over its internal relationships and position within the broader Pleuronectiformes. Relationships within this group have been inferred using both morphological and genetic techniques, but are inconsistent among published phylogenies. This may be due to using different sets of genetic markers (maximum of 23 in Sanger methods), sample size, taxon representation, incomplete lineage sorting, and in the case of morphological data, uncertainties with outgroups and character polarization. We attempt to reconstruct the pleuronectid phylogeny using the exon-capture method developed by Li et al. (2013) and compare our results to past phylogenies. Exon-capture has not yet been applied to pleuronectids and considers a larger set of genetic characters sampled from more loci (4434 genes) than previous methods. This method also allows us to select genes with high quality sequences, unambiguous alignments, and behave the most clocklike prior to tree reconstruction. Our phylogenetic analysis infers the relationships between 31 of the 61 species, and 20 of the 23 genera within the Pleuronectidae, and will represent the first genome-wide phylogenomic dataset for pleuronectids using next-generation sequencing tools.

787 General Herpetology II, Primrose A&B – Cliff Lodge, Sunday 28 July 2019

Justin Autz¹, Jennifer L. Buchanan¹, Michael S. Mahr¹, Alexis F.L.A. Powell¹, Lynnette Sievert¹, David R. Edds¹, J. Daren Riedle²

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Distribution and seasonal activity patterns of the Mudpuppy in eastern Kansas
While known to be declining in many parts of the Midwest, conservation status of the Mudpuppy (Necturus maculosus) is poorly documented, especially in Kansas where almost nothing is known of its distribution and population sizes. Mudpuppy declines have been attributed to climate change, habitat degradation, invasive species, and pollution. We are conducting trapping surveys to describe the species’ distribution and to assess effects of water chemistry and landscape variables on its occurrence. Target sites in rivers in eastern Kansas include locations of known historical occurrence, low-water dams, sites with fallen logs and woody debris, and locations downstream from riffles. Results from November 2017 through February 2019 suggest that mudpuppies are most active between mid-December and late April and that they do not differentiate between baited and unbaited traps. We are modeling relationships between landscape, water quality, and habitat variables, and presence/absence at three different spatial scales — basin for major river drainages, reach for individual rivers or streams, and site for specific sites less than 500 m in length — to explain patterns of occurrence. We are also trapping mudpuppies at marinas in two large artificial reservoirs to study seasonal activity patterns and bait preference. Thus far, we have caught 15 individuals in rivers at 11 locations, and 122 individuals in the two reservoirs, for capture success rates per trap night of 1.5% and 2.9%, respectively.

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

Troy Baird\textsuperscript{1}, Joshua York\textsuperscript{2}

\textsuperscript{1}University of Central Oklahoma, Edmond, OK, USA, \textsuperscript{2}University of Oklahoma, Norman, OK, USA

Female Collared Lizards Acquire Fitness Benefits by Producing Offspring with Multiple Males

Unraveling the evolutionary mechanisms underlying the origins of females producing offspring with multiple sires remains a challenging problem, because a single male can usually fertilize all eggs produced by individual females. We tested the hypothesis that having multiple males sire individual clutches is adaptive for female eastern collared lizards, Crotaphytus collaris, by examining both the fitness costs and benefits for females of producing offspring with one versus multiple male partners. We found no support for the hypothesis that females produce offspring with multiple sires to access higher quality food resources or refuges. However, hatching success of individual clutches increased with the number of males that inseminated eggs, suggesting that accepting sperm from multiple males may improve hatching success via one or more mechanisms. Females that produced offspring with multiple male partners also gained genetic advantages. Even though offspring mortality from clutches inseminated by one versus multiple males was similar, females producing clutches having multiple sires produced more total offspring that survived to maturity, resulting in a net fitness advantage. Producing offspring sired by multiple males, is therefore, adaptive for female collared lizards because it promotes several fitness benefits. Consequently, mating tactics that are adaptive for females conflict with those of
territorial males that attempt to monopolize mates, but promote success by males employing stealthy mating tactics.

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

Patrick Baker

United States Military Academy, West Point, NY, USA

Seasonal Development of Symbiotic Algae on the Carapace of the Painted Turtle (Chrysemys picta)

For North American turtles, the most conspicuous algal growth is attributed to two species of cladophorales from the genus Arnoldiella (formerly Basicladia). Attached growth of these filamentous algae on the surface of turtle shell has been described as parasitism, commensalism and eventually as a mutualism. Adult Painted Turtles (Chrysemys picta) are regularly colonized by Arnoldiella; however, annual shedding of scutes may retard the formation of diverse epibiont communities found in species that do not shed entire scutes. We examined seasonal changes in algae coverage in a Painted Turtle population in New York. We found a seasonal change in the percentage of individuals in our population with algae on their carapace as well as a change in algae coverage (% of carapace). Algae was typically absent on Painted Turtles in early spring, but increased to a maximum (~90% of individuals) in early summer and declined in autumn as scutes were shed. Similarly, the % coverage on the carapace increased to a maximum (80% in some individuals) by late July and declined in autumn.

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

Kristin Bakkegard

Samford University, Birmingham, AL, USA

A review of the chigger species infecting North American amphibians

Chiggers are the parasitic larval form of mites which infect all terrestrial vertebrates. In amphibians, chiggers burrow into the skin and are potentially harmful by causing mechanical damage or introducing a pathogen. In response to finding Northern Slimy Salamanders (Plethodon glutinosus) in north-central Alabama infected by Hannemania c.f. dunni, I conducted a literature review on amphibians infected with chiggers in North America. There are 302 records in 81 peer-reviewed publications with state-level locality data. Two genera of chigger infect amphibians, Hannemania (amphibian specialist) and Eutrombicula (generalist). Chigger infected amphibians were recorded in 11 Mexican and 20 U.S. states. Of the literature records, only 15% were in herpetology journals, whereas almost 60% of publications were in
parasitology, entomology, or regional natural history journals. Challenges discovered during this review include determining the number of amphibian-infecting chigger species that are valid (9 to 11 *Hannemania* spp. in North America, perhaps 25 total; *Eutrombicula cinnabaris* (alfredrugési) is a species complex). Difficulties are due to unclear taxonomic keys and species descriptions, some types are lost, and synonymy is common in *Hannemania*. The earliest North American record of a chigger-parasitized amphibian is 1921. Since then, the taxonomy and geographic ranges of many host species have also been redefined. Reports of chigger infected amphibians, when practicable, should be published in the herpetological literature to improve awareness and encourage further research into the contribution of chiggers and other multicellular parasites to amphibian decline.

405 SSAR SEIBERT ECOLOGY AWARD II, Ballroom 2 – Cliff Lodge, Thursday 25 July 2019

Neil Balchan, Stephen Mackessy

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

**Physiological venom resistance of Colorado rodents to Desert Massasauga and Prairie Rattlesnake venoms**

The Red Queen hypothesis describes the coevolutionary dynamic between predator and prey where both partners must evolve in tandem to remain competitive. In several cases, rodents have demonstrated resistance to the venoms of their snake predators. For example, the California Ground Squirrel (*Otospermophilus beecheyi*) exhibits high resistance to the venom of the Pacific Rattlesnake (*Crotalus oreganus*). Conversely, cases exist where a prey species apparently lacks physiological resistance to the venom of its predator - the Cape Ground Squirrel (*Xerus inauris*) lacks proteolytic venom resistance to the predatory Puffadder (*Bitis arietans*) and Snouted Cobra (*Naja annulifera*). My research evaluates patterns of venom resistance in a Colorado grassland ecosystem, where the Desert Massasauga (*Sistrurus tergeminus edwardsii*) and Prairie Rattlesnake (*Crotalus viridis*) predate upon a suite of rodent species. Field sites are located in northern (one snake predator) and southern Colorado (two snake predators) to investigate patterns of resistance between and within locations at the geographic level. Median lethal dose assays are used to assess venom resistance of select rodent populations to specific rattlesnake venoms. Serum-based assays determine the protective effect that a rodent’s serum exhibits against specific venom components. Preliminary results indicate a protective effect in the serum of Deer Mice (*Peromyscus maniculatus*) and Meadow Voles (*Microtus pennsylvanicus*) against Prairie Rattlesnake venoms, but not Desert Massasauga venom. Studying patterns of venom resistance in a system with two predator and multiple prey species allows us to understand better the evolution of such defenses and to evaluate whether local adaptation exists.

439 Poster Session II, Event Center – The Snowbird Center, Friday 26 July 2019
Sierra Ball¹, Carrie Jo Bucklin¹, Laurie Mauger²

¹Southern Utah University, Cedar City, UT, USA, ²Duke University, Durham, NC, USA

A Population Survey and Biodiversity Assessment of Reptiles in Southern Utah

Southern Utah fauna is comprised of a wide assortment of organisms from small mammals and lizards to deer and snakes. There are over 600 animal species in Utah with about 200 of them residing solely in the south. The purpose of this study is to conduct a preliminary population survey of reptiles in southern Utah. There are no published, comprehensive surveys of reptile habitat usage in Iron county. In order to gain a broader understanding of the species living in the area, camera traps are being used to observe local reptilian species and estimate the herpetological biodiversity and habitat usage of Three Peaks Recreation Area, Quichapa Lake, and Old Iron Town. Each area is in a different geographical zone providing a rounded view of the animals living around 6,000 feet in elevation. Three Peaks is in the pine/oak belt, Quichapa is surrounded by grassland, and Old Iron Town is in the pinyon/juniper belt. We have set up 4 camera traps in each location. Photos are collected weekly and analyzed for species type present. Walking surveys are also conducted weekly in each location to assess the different varieties of herpetological species present. Preliminary data gathered suggests that Aspidoscelis has two species present; the tigris species has only been observed in the pine/oak belt while the Hyerpythra beldingi has only been observed in the pinyon/juniper belt. This project was started in March 2018 and will conclude in September 2019.

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

Suzana Bandeira¹, Aaron Bauer¹, Luís Ceríaco²

¹Villanova University, Villanova, Pennsylvania, USA, ²Museu de História Natural e de Ciências do Porto, Porto, Porto, Portugal

Integrative taxonomy of Angolan Ichnotropis (Squamata: Lacertidae)

Ichnotropis is one of the most diverse lacertid genera in sub-Saharan Africa, reaching its maximum richness in Angola, where seven species and subspecies are represented. However, it has been poorly investigated, and there is taxonomic uncertainty with virtually all of these taxa. In the I. bivittata complex it is unclear if the subspecies I. b. pallida Laurent, 1964 is specifically distinct from the nontypical form and if I. micropelidota Marx, 1956, known only from its type series is a synonym of one of these taxa. In order to clarify these and other issues related to the Angolan taxa, we conducted morphological and morphometric analyses and incorporated new distribution data. Ichnotropis bivittata and I. b. pallida occur in sympathy in southwestern Angola and, there is significant morphological differentiation between the two, with the former being larger in body size and having more midbody scales. New material of Ichnotropis from Mt. Moco, the type locality of I. micropelidota supports the contention that it is a senior
synonym of *I. b. pallida*. Three mitochondrial markers (COI, ND2 and 12S) and one nuclear marker (RAG1) were also used to corroborate our findings. Using a combination of morphological and molecular approaches reveals that the taxonomy of Angolan *Ichnotropis* is in need of revision, just as has been demonstrated in the lacertid genera *Pedioplanis* and *Heliobolus*.

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**438 AES Ecology, Rendezvous A&B – The Snowbird Center, Friday 26 July 2019**

Charles Bangley¹, Tobey Curtis², Matthew Ogburn¹

¹Smithsonian Environmental Research Center, Edgewater, MD, USA, ²National Marine Fisheries Service, Gloucester, MA, USA

**Seasonal changes in distribution and habitat preferences of Dusky Sharks (*Carcharhinus obscurus*) in the Northwest Atlantic Ocean**

The Dusky Shark (*Carcharhinus obscurus*) is a slow-growing, highly migratory large coastal shark that has experienced significant population declines driven by overfishing in the Northwest Atlantic Ocean. Though landings of Dusky Sharks are prohibited in United States fisheries, bycatch mortality remains an obstacle to rebuilding populations. To delineate and predict potential habitat along the species’ migratory range, tag detections from 23 juvenile Dusky Sharks fitted with Vemco 69-kHz acoustic transmitters during 2016 and 2017 were used as daily presence/absence data at the sites of acoustic receivers that had detected them. Environmental data (depth from global topography data, sea surface temperature, salinity, and chlorophyll a concentration from satellite-based remote sensing data) were extracted at detection locations and used to fit boosted regression tree models of shark presence probability based on environmental conditions. Modeling was conducted independently for each month from October 2017-2018 to identify differences in environmental preferences at different stages of the Dusky Shark migration. Modeling results suggest that environmental preferences and potential exposure to human activities may vary by time of year. This approach may be useful in developing adaptive bycatch mitigation measures and identifying potential overlap between important habitat areas and offshore energy development sites.

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

William Barichivich, Mary Brown, Katie O'Donnell, Susan Walls

USGS, Gainesville, Florida, USA

**Forecasting the Timing of Breeding Events in the Ornate Chorus Frog (*Pseudacris ornata*): Implications for Conservation Status in Florida**
The ability to forecast the timing of breeding is fundamental to designing conservation and management plans for species of concern. Ornate chorus frogs (*Pseudacris ornata*) are declining in peninsular Florida; this species could be vulnerable to environmental stochasticity, especially extremes in precipitation. Automated recording units (ARU’s) have been valuable tools for detecting breeding events in male anurans and call activity has been a useful proxy for estimating site occurrence. In turn, occupancy estimates provide information on the status of populations across spatial scales. Covariables (e.g., temperature and precipitation) can help explain patterns in site occupancy, but it is not clear whether local vs. regional scale covariates (e.g., drought indices) are better predictors of breeding events. Using ARU’s, we collected digital audio recordings at 26 wetlands scattered across 22 km² at St Marks National Wildlife Refuge, FL, from mid-winter to early spring, 2009–2016. We examined the utility of local environmental variables, land cover at different spatial scales, and regional climatic indices in predicting breeding activity. We found that peak calling activity and site occupancy varied annually, suggesting that male calling behavior is likely not related to large-scale trends in climate patterns. Rather, calling may be more influenced by factors acting at the site level. This complicates the use of broader scale climate indices in forecasting breeding events for this species. Our results illustrate that using male calling activity as a proxy for occupancy could help inform decisions regarding the status of this species in Florida.

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**Population Structure and Conservation Genetics of Scalloped Hammerheads (*Sphyrna lewini*) in the U.S. Atlantic and Gulf of Mexico**

Scalloped hammerheads (*Sphyrna lewini*) are large, circumglobally-distributed sharks that use coastal habitats in the U.S. Atlantic and Gulf of Mexico as nurseries. Scalloped hammerheads are listed as globally Endangered by the IUCN and four out of six distinct population segments (DPS) are listed as Threatened or Endangered under the U.S. Endangered Species Act. Protection for the NW Atlantic and Gulf of Mexico DPS was not warranted, however, this did not consider the presence of Carolina hammerheads (*S. gilberti*), a sympatrically distributed cryptic species, and abundance and life history information likely contain data from both species. In this study, next-generation sequencing was used to characterize 5,372 SNP-containing loci in scalloped hammerhead sharks sampled in the U.S. Atlantic Ocean and Gulf of Mexico. Composite multilocus genotypes were obtained from young-of-the-year and small juvenile scalloped hammerheads sampled within nursery areas in South Carolina, Georgia, Atlantic Florida, Gulf Florida and Texas. A discriminant analysis of principal components was conducted to identify
genetic clusters. Single-level and hierarchical analyses of molecular variance were conducted to test for genetic differentiation among geographic samples. Composite multilocus genotypes for 1,326 SNP-containing loci were also obtained for young-of-the-year and small juvenile Carolina hammerhead sharks from nursery areas in South Carolina and Atlantic Florida. The contemporary effective number of breeders was estimated for both species in each nursery to evaluate reproductive potential and identify nurseries that may be of greatest conservation concern.

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

Patrick Barnhart¹, Amy Yackel Adams², Eric Hileman¹, Abbey Feuka³, Scott Goeta⁴, Robert Reed², Shane Siers⁴, Melia Nafus²

¹US Geological Survey, Dededo, Guam, USA, ²US Geological Survey, Fort Collins, Colorado, USA, ³Colorado State University, Fort Collins, Colorado, USA, ⁴USDA APHIS WS National Wildlife Research Center, Hilo, Hawaii, USA

Radio Transmitter Attachment Methods for Thin-Bodied Arboreal Snakes

The Brown Treesnake (Boiga irregularis, BTS) is a thin-bodied, arboreal snake native to Australia and parts of Melanesia. The BTS was accidentally introduced to Guam after WWII, likely via military cargo. BTS are responsible for the extirpation or extinction of most of Guam’s native bird species, and have had significant negative economic impacts. Federal and local agencies are cooperating to develop and implement detection and control tools for BTS to reduce the probability of introduction elsewhere and to improve restoration efforts on Guam. Understanding snake biology, ecology, and movement behavior in a variety of environments allows for more efficient targeting of snakes in rapid response/early detection situations and allows us to find exploitable weaknesses for BTS suppression in order to enable ecosystem restoration. Radiotelemetry, whereby a high frequency transmitter is attached to the study animal, is vital to studying movement and behavior of highly secretive snake species. Although several transmitter attachment methods for snakes are described in the literature, most were developed for thick-bodied, non-arboreal species. Multiple attachment methods that have been successfully used on other species have been problematic for BTS in the dense vegetation and limestone karst prevalent on Guam. We have tried intracoelomic implantation, transmitter ingestion, several variations of external attachment with post-ventral sub-dermal sutures, and several variations of external attachment using tapes and glues. We have encountered several issues with these attachment methods and are looking to share our results and solicit feedback from peers on potentially useful methods.

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CANCELLED

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

Jenna Barrett¹, Luke Tornabene¹, Carole Baldwin², Ross Robertson³
Temperature influence on depth distributions of fishes on Caribbean deep reefs

An increase of manned submersible dives for ocean exploration has revealed that reef fish communities extend down to about 300 m, far beyond previously thought. We conducted fish surveys on more than 100 such dives across five sites within the Caribbean Sea. A collective analysis of these surveys concluded there is a significantly similar community structure over nearly the same faunal breaks; there were a few dissimilarities in community breaks up to about 20 m, but overall, the depth ranges and respective mesophotic and raphiphotic communities were consistent. Thus far, no underlying physical or biological factors have been attributed to these trends. This study tested whether differences in temperature may explain patterns of community structure on deep reefs. We recorded temperature data during several dives off Curacao and Roatan, Honduras, and coupled this with the data from fish surveys. We compared the depth ranges of species that were abundant in both sites to the respective temperature at those depths. We hypothesized that if temperatures were driving community structure, species with different depth distributions at the two sites should still occur at similar temperature ranges. A T-test of about 10,000 observations of 31 species revealed no consistent relationship between temperature and species ranges across the two sites. Further tests using different physical and biological variables (i.e. substrate, habitat availability, light and nutrient availability, or trophic structure) may help refine the relationships that drive deep-reef community structure.

Do Species Traits Predict Genetic Diversity in North American Amphibians?

Intraspecific genetic diversity is a key component of biodiversity and provides the capacity for species to adapt to environmental change. Determining whether species-level traits can predict genetic variation within species is thus an important goal for understanding evolutionary processes and to inform conservation priorities. Over the last several decades, genetic data has been accumulated for thousands of species and archived on GenBank, providing the potential for synthesis and analysis in comparative frameworks to address broad questions. We aimed to identify factors associated with genetic diversity within species, focusing on North American amphibians as a case study. We downloaded occurrence records from the Global Biodiversity Information Facility (GBIF) for the ~300 amphibian species in the U.S. and Canada. Species traits including body size, clutch size, breeding habitat, and larval period were compiled for all species from the AmphibiDB database, AmphibiaWeb, and field guides. Range size, latitude, elevation, and bioclimatic variables were extracted from IUCN range maps, occurrence records,
and the WorldClim database. Using custom scripts, we downloaded georeferenced GenBank sequences associated with GBIF records, aligned them by gene to calculate genetic diversity statistics, and tested predictors of genetic diversity. We found that although sequences for more than 200 species were available on GenBank, fewer than 60 species currently have locality information directly associated with at least three sequences. We are linking locality data from published studies to sequences for future analysis and encourage the research community to accession sequences with localities in future to facilitate broad analyses with implications for conservation.

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

Cameron Barrows

University of California Riverside, Riverside, CA, USA

Surveying Lizards with Citizen Scientists to Detect the Effects of Climate Change in the Deserts of Southern California

Assessing effects of modern climate change on biodiversity is among the most pressing questions for ecologists to address today. While modeled responses of species to a warmer future provide important hypotheses as to potential distributional shifts and perhaps species extinctions, it is critical that such hypotheses are tested. A test of such models might ask whether demographic changes in metrics such as recruitment and sustainability are occurring between lower and higher elevations, and if those shifts are consistent with those modeled predictions. Answering that question requires data spanning climate gradients. Engaging with citizen scientists can provide the necessary boots on the ground to collect these data. While crowd-sourcing approaches yield volumes of occurrence data that then “feed” model building, those opportunistically collected data are not suited for addressing demographic changes. Such data require comprehensive and spatially discrete survey approaches. Nevertheless, citizen scientists can play a critical role accompanying “trained scientists” on surveys. Research shows that data collected by untrained citizen scientists left on their own can be questionable, however, when in the company of a scientist there is no erosion in data quality. In fact, there can be up to a doubling of both the number of observations and the number of species sighted. More eyes equal more observations. There are also attendant benefits; citizen scientists become advocates for good (not fake) science, and there can be the development of an “esprit de corps” that allows for expanding surveys that then answer these pressing questions regarding the fate of biodiversity.

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

Shannon Barry, Toby Daly-Engel
Identifying ecological drivers of nursery habitat use for the bull shark (*Carcharhinus leucas*) in the Indian River Lagoon, Florida

While shallow coastal waters are essential habitats for many aquatic species, they remain the most vulnerable to human-induced perturbation. The bull shark (*Carcharhinus leucas*) is a medium-sized euryhaline species found in tropical and subtropical waters. Female bull sharks exhibit natal philopatry, in which they return to the same site to give birth, followed by long-term juvenile utilization before transitioning to offshore habitats. As adult bull sharks are mobile species, they are more likely to migrate to new habitats in response to environmental shifts, making them a good bioindicator of the health of an ecosystem. The Indian River Lagoon (IRL) in Florida is an important nursery habitat for bull sharks in the eastern Atlantic Ocean, which has undergone successive harmful algal blooms (HABs) since 2011, significantly decreasing sea grass beds, a habitat heavily utilized by juvenile bull sharks. By identifying a range overlap between juvenile bull sharks, historically-abundant sea grass beds, and HABs, we can determine if bloom-induced habitat loss has affected bull shark nursery sites. Comparing bull shark populations in heavily and less impacted sea grass beds will help scientists understand how habitat loss is influencing sharks, or if HAB toxins are altering population dynamics. Bull sharks are an important apex predator and increasing anthropogenic and environmental pressure is likely to increase HABs, which could cause the population to lose a vital nursery site along the Atlantic Coast. Understanding how HABs have impacted the IRL bull shark population, both historically and today, can help improve future management of this species.

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

Henry Bart¹, Ray Schmidt², Joseph Gathua³, Dorothy Nyingi³

¹Tulane University Biodiversity Research Institute, Belle Chasse, Louisiana, USA, ²Randolph-Macon College, Ashland, Virginia, USA, ³National Museums of Kenya, Nairobi, Nairobi, Kenya

A new species of *Neobola* from the Tana River, Kenya (Actinopterygii: Danionidae)

Sampling of streams in the middle reaches of the Tana River Basin in Meru National Park, Kenya, from 2010 to 2012 as part of a NSF-funded International Research Experiences for Students (IRES) project, resulted in the capture of a number of specimens of what were initially thought to be *Neobola fluviatilis* (Whitehead). On closer examination the specimens were determined to represent a distinct species. The new species is readily diagnosable from *N. fluviatilis* by the combination of higher scale counts, higher numbers of pectoral rays, and a smaller anal fin with lower numbers of anal fin rays. The new species was recorded at three sites in Meru National Park, in numbers that suggest this population is healthy and viable. A single, juvenile specimen was earlier reported from the Tana River at Garissa. *Neobola fluviatilis* is only known from the Athi River at Yatta. Sampling at several sites in the Athi River system...
during and after the IRES project, including Nairobi National Park, the Athi River below Nairobi and the Tsavo River, failed to produce specimens, suggesting that the species may be extinct.

Historical presence and prevalence of *Batrachochytrium dendrobatidis* in Mexico

The global emergence of *Batrachochytrium dendrobatidis* (*Bd*) is recognized as one of the principal causes of amphibian declines. Previous historical studies in Mexico found early *Bd* positives dating before the pathogen was first identified, showing evidence of a spread from Southern Mexico to Central America related with several amphibian declines. However, information about the earliest date of presence of *Bd* and how it was spread is unknown. Using large museum collections of amphibian specimens, we conducted a randomly sampled retrospective survey to describe the spread of *Bd* across Mexico. We used a qPCR assay to determine historic *Bd* prevalence in Mexico testing a total of 500 specimens from nine amphibian families and 59 species collected from 1894 to 1985. We found a total 149 individuals positive for *Bd* of 39 amphibian species. We detected *Bd* in Mexico as early as 1894, 78 years earlier than the current oldest estimate in Mexico, which means that Mexican amphibians coexisted with *Bd* for at least since that year. Our results raise new hypotheses about the history of *Bd* in Mexico, possible coevolution between host and pathogen and potential lineage differences between *Bd* strains, and its potential role in historic population declines.

Herpetology in a World at War: Natural History Collections and Global Conflict

For war-torn areas, *ex situ* natural history collections serve as arks for biodiversity data. Examples of herpetological collections from Afghanistan, Libya, and Angola are used to explore how natural history collections can contribute to present and future research and conservation following years of strife. Each country reflects a different stage in its recovery from war, the
state of its collections, and its future prospects. Angolan museum material serves as the basis for a resurgence of evidence-based management decisions and provides a key to resolving difficult taxonomic problems across all of Central Africa. Historical collections from Libya preserve evidence of oasis faunas that reflected ancient paleodrainage systems, but which are now irreparably changed. For Afghanistan, historical collections have identified new challenges to integrative taxonomy that may be addressed if and when improved security conditions prevail. Further, advances in both ancient DNA technology and CT imaging methods provide the prospect of obtaining more data from these largely irreplaceable collections than has ever been possible before.

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

Sarah Bauer¹, Emilie Ospina², Matthew Allender³, John Peterson¹

¹University of Wisconsin-Platteville, Platteville, WI, USA, ²University of Illinois Urbana-Champaign, Urbana, IL, USA, ³University of Illinois Urbana-Champaign, Champaign, IL, USA

Thermal Ecology of Ophidiomyces ophiodiicola, the Cause of Snake Fungal Disease, in Free-Ranging Snakes along a Waterway in Wisconsin

Snake fungal disease is caused by the fungal pathogen, Ophidiomyces ophiodiicola. Infected snakes have been found throughout eastern North America and surveillance has increased significantly over recent years. To our knowledge, no study has investigated O. ophiodiicola’s association with host temperature and environmental temperature in free-ranging snakes. Throughout spring and fall 2018 we monitored O. ophiodiicola intensity on the face and skin abnormalities of DeKay’s Brownsnake (Storeria dekayi), Common Gartersnake (Thamnophis sirtalis), Milksnake (Lampropeltis triangulum), and Common Watersnake (Nerodia sipedon). Host and environmental temperature were also assessed at capture. Artificial cover objects of different thermal properties (wood, corrugated asphalt, corrugated steel) were used to capture snakes. All four snake species contained O. ophidiicola. Brownsnakes were the most common species captured. Fungal intensity was significantly higher at higher Brownsnake body temperature and higher environmental temperatures. Fungal intensity was also significantly higher in spring, compared to fall. These results are consistent with previous lab studies of O. ophidiicola growth temperature assays. Brownsnakes were captured significantly more often under steel boards; however, we found no relationship between cover object type, temperature, and fungal intensity. More studies are needed to determine what environmental factors influence the intensity of O. ophidiicola in free-ranging snakes.

430 ASIH STORER HERPETOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019

Eli Beal, Adam Rosenblatt
American Alligator (*Alligator mississippiensis*) Distribution Across an Urban Landscape

Urbanization is an ever-increasing threat to wildlife and their natural habitats, yet little research has been performed for a wide variety of taxa. Filling this knowledge gap, while effectively educating people about urbanization and its effects on wildlife, will require new research projects that target charismatic species which naturally capture the public’s attention. One such species, the American alligator (*Alligator mississippiensis*), is an apex predator across the southeast U.S. and has surprisingly received minimal attention. Surveys of relative alligator abundance are being conducted in nine tributaries with varying levels of urban influence surrounding the St. Johns River over the span of a year. For each animal sighted, several environmental variables are measured and global positioning system (GPS) coordinates are recorded. These points are being incorporated into a geographic information system (GIS) analysis to determine the direct effect of nearby urban development via land use on alligator spatial distribution. Habitat selection preferences are being determined from measured habitat characteristics such as percent open water and percent anthropogenic structure immediately around each animal sighted, as well as at a random point nearby. Preliminary data from the relative alligator abundance surveys show that there is no correlation between percent developed land and the respective alligator abundance across tributaries. Preliminary habitat selection data shows that average percent emergent vegetation is significantly different between alligator sighting points and random available habitat points. This result shows that alligators prefer and selectively choose habitat with emergent vegetation.

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

Steve Beaupre¹, Rod Wittenberg², Larry Kamees¹

¹University of Arkansas, Fayetteville, AR, USA, ²Haas Hall Academy, Bentonville, AR, USA

Secrets of the Rattlesnake Rattle: An Overlooked Comparative Tool

Aside from its defensive functions, the rattle of rattlesnakes holds information about individual history of growth and body condition. The width of each rattle segment is known to correlate with both body length (SVL) and body weight at the time of segment development. Transitions between successive rattle segments are not always stable (indicating stable size) or positive (indicating growth). Decreases in rattle segment width (suggesting loss of body mass) are common. We investigated the possibility that frequency of negative changes in the rattle could be used as an index of natural food availability and stability. We assessed measurement errors through repeated sampling of 33 rattle segments in a range of sizes (from 0.48cm to 1.8cm) and determined that the 95% CI (+/-2sd) for segment measurements was +/-0.01cm, and independent of segment size. Rattle strings (exclusive of living basal segments and natal buttons) were
analyzed by conversion of adjacent segments to size transitions (differences). Transitions were classified as positive (>0.01cm), stable (between +0.01cm and -0.01cm, inclusive) or negative (<-0.01cm). Rattle segment data were available for four populations: *Crotalus horridus* (AR), *C. horridus* (MO), *C. atrox* (AZ), and *C. lutosus* (NV). Contingency table analysis revealed no sex differences within populations. However, significant differences among populations were detected. Population ordering suggested by segment transition analysis fits our general perceptions of food availability in these populations. Potential applications are many, including rapid assessment of food environment, comparisons among populations and ranking of the food security of populations of special concern.

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

Christine Bedore

*Georgia Southern University, Statesboro, GA, USA*

**Visual ecology of elasmobranch fishes**

Sensory systems represent an interface between animals and their environment. As such, sensory physiology is shaped by a species ecology; sensitivity and resolution of each modality reflect the physical and biological environments in which the sensory system functions. Among elasmobranchs, these parameters are most well-studied in the visual system. Irradiance, spectral composition, temperature, and behavior all impart selective pressures on elasmobranch visual systems. For example, deep sea species possess adaptations for blue-dominated and low-light habitats, such as large eyes and blue-shifted visual pigments. This review will illustrate the breadth of visual adaptations in elasmobranch fishes, highlight the ecological implications of physiological adaptations of elasmobranch visual systems, and identify future avenues of vision research within an ecological and comparative context.

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

Anat Belasen, Tim James

*University of Michigan, Ann Arbor, Michigan, USA*

**Habitat fragmentation reduces genetic diversity and increases susceptibility to *Batrachochytrium dendrobatidis* infections in frogs of the Brazilian Atlantic Forest**

Why are amphibians so susceptible to disease? Besides introductions of recently emerged pathogens such as the fungus *Batrachochytrium dendrobatidis* (Bd), amphibians are subject to
anthropogenic (human-caused) modification of natural habitats. Amphibians are particularly sensitive to the negative consequences of habitat fragmentation, the process by which continuous habitats (such as forests) are divided into small isolated patches. Habitat fragmentation can result in loss of genetic diversity due to intense genetic drift (smaller population sizes) and inbreeding (isolation in habitat patches). We hypothesized that this renders fragmented amphibians more susceptible to infections, as inbred animals are known to exhibit higher disease susceptibility. We evaluated the impacts of intensive habitat fragmentation on frog genetic diversity and susceptibility to Bd in the Brazilian Atlantic Forest. We analyzed neutral genetic diversity and gene flow (a proxy for dispersal) using ddRAD-Seq, and detected Bd infections and quantified loads (intensity) using quantitative PCR (qPCR). We compared forest specialist frogs to “weedy” species that can exploit low-quality habitat to determine the range of effects experienced by diverse tropical amphibian faunas. We found that forest specialists are definitively isolated in fragments, but that counterintuitively, genetic diversity loss in specialists has lagged behind "weedy" frogs. We hypothesize that this may be due to longer generation times in specialists. In addition, Bd prevalence was higher in fragmented areas, and Bd loads were highest in fragmented forest specialists. Our results indicate a significant interaction between habitat fragmentation and infection susceptibility, which represent significant threats to the Brazilian Atlantic Forest biodiversity hotspot.

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

Rayna Bell

National Museum of Natural History, Washington, DC, USA

Behind the scenes of the Smithsonian’s National Museum of Natural History: collections, research, and inspiring the next generation

The Smithsonian’s National Museum of Natural History is responsible for the long-term preservation of over 145 million specimens, documenting the diversity and evolution of the planet, and sharing this knowledge with the general public. In this talk I provide some brief background on the history of the National Museum and the career paths of a few women herpetologists at the NMNH in collections, research, and education. The first woman curator of herpetology at NMNH, Dr. Doris Cochran, spent her entire career at the museum where she focused on the herpetofauna of the West Indies and South America and honed her skills as a very talented scientific illustrator. Almost 90 years later, I became the second woman curator of herpetology at NMNH, and I balance my time between my own research interests, mentoring students and postdocs, and jointly overseeing the use and long-term preservation of the national collection. In collections, Esther Langan (M.S. Wildlife Ecology and Conservation) is central to the day-to-day operations of the Division of Amphibians and Reptiles where she prepares specimens, catalogs new collections, processes loan requests, hosts visitors, and conducts fieldwork. In education, Dr. Devin Reese (Ph.D., Integrative Biology) is the lead digital science writer for the Q?rius website where she writes and gathers media for the museum’s Science How? webcast series, blogs, and webpages.
Biting the Hand That Feeds You: Effects of Parasitism in Northern Watersnakes (*Nerodia sipedon*)

Corticosterone is the primary hormone produced by vertebrates in response to stress. Acute increases in corticosterone are associated with increased survival and reproductive rates whereas chronically elevated corticosterone levels have negative health effects, such as decreased body growth and reproductive output. Stress is analyzed by quantifying corticosterone levels and heterophil:lymphocyte ratios. Chronically elevated corticosterone levels alter white blood cell profiles by lowering the ratio of lymphocytes to heterophils in reptiles and birds. Endo- and ecto-parasitism is highly prevalent in wild populations of vertebrates, however, the physiological effects they exert on their hosts are only now being investigated. In this study, I experimentally investigate the relationship between naturally-occurring helminthic parasites in the digestive system of Northern Watersnakes (*Nerodia sipedon*) and their effect on corticosterone and white blood cell ratios. Subjects were treated with either fenbendazole, an antihelminthic medication, or 0.9% saline. I compared corticosterone levels and white blood cell profiles before and after treatments on day 0, 28, and 56. Fenbendazole treatment effectively removed gastrointestinal parasites, whereas 0.9% saline did not affect parasite presence. Corticosterone was quantified using enzyme-linked immunosorbent assays and white blood cell profiles were analyzed using Wrights-Giemsa stain and viewed at 1000x magnification. The decrease in corticosterone and heterophil:lymphocyte ratios was not statistically significant in both treatment groups. I conclude that gastrointestinal parasites do not cause stress in this population of *N. sipedon*. This is the first study to investigate the effects of gastrointestinal parasites on stress levels in *N. sipedon*.

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

Katherine Bemis¹,², James Tyler³, Dahiana Arcilia⁴

¹Department of Fisheries Science, Virginia Institute of Marine Science, William & Mary, Gloucester Point, Virginia, USA, ²Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA, ³Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA, ⁴Sam Noble Oklahoma Museum of Natural History and Department of Biology, University of
Life history, distribution, and molecular phylogenetics of the Upward-Mouth Spikefish *Atrophacanthus japonicus* (Teleostei: Tetraodontiformes: Triacanthodidae)

Ninety-six juvenile specimens (37–54 mm SL) of the rarely collected Upward-Mouth Spikefish *Atrophacanthus japonicus* (Triacanthodidae) were obtained from the stomachs of three Yellowfin Tuna, *Thunnus albacares*, collected off Guam in the Mariana Islands in the central Pacific Ocean. These specimens extend the range of *A. japonicus* eastward into Oceania. We review the systematic characters of the monotypic genus *Atrophacanthus* and present color photographs of freshly collected specimens. The diet of the juvenile specimens of *A. japonicus* consisted of thecosome pteropods and foraminifers. We present a range map of *A. japonicus* based on all known specimens and show that specimen size is related to whether specimens were collected in the pelagic zone or on the bottom. Our results support that *A. japonicus* has an unusually extended pelagic larval and juvenile period (up to 54 mm SL) compared to all other Triacanthodidae; adult *A. japonicus* are benthic. We also provide a multilocus phylogeny addressing the phylogenetic placement of *Atrophacanthus* based on eight of 11 triacanthodid genera and six genetic markers. Our results reveal that *Atrophacanthus* is the sister group of *Macrorhamphosodes* and provide new insights about the evolutionary history of the family.

Comparative Anatomy and Ontogeny of Ocean Sunfishes (Tetraodontiformes: Tetraodontoidae: Molidae)

We reviewed and summarized 260 years of literature on the comparative anatomy of Ocean Sunfishes (Molidae) to demonstrate what is known about similarities and differences among the three living genera (*Mola*, with three species, and the monotypic *Masturus* and *Ranzania*). We concentrated on descriptions and illustrations for baseline anatomical data to guide our new studies of fresh and preserved adult specimens, ontogenetic series, and fossils. We organized our results using an organ system approach with 11 categories: 1) general body form and external anatomy; 2) skeleton; 3) muscles; 4) integument; 5) brain and sense organs; 6) digestive organs; 7) heart and circulation; 8) respiration; 9) excretory organs; 10) reproductive organs; and 11) endocrine organs. There is limited comparative anatomical information for several organ...
systems, e.g., the respiratory and excretory systems, whereas external anatomy and skeletal elements are relatively well known for the extant genera. Most older reports are for specimens interpreted as *M. mola*; however, for many of these accounts it is unclear whether the specimen(s) studied can be assigned to this relatively commonly collected species rather than to the two other species now recognized of this genus, *M. alexandrini* and *M. tecta*, because few large molid specimens studied prior to 1950 were deposited in permanent collections. We describe our new findings on the general ontogeny, dentition, brain, integument, and gill arch morphology, and present our results in the context of higher relationships of Molidae within Tetraodontoidea.

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

Katherine Bemis¹,², James Tyler³, Edward Stanley⁴, Eric Hilton¹

¹Department of Fisheries Science, Virginia Institute of Marine Science, William & Mary, Gloucester Point, VA, USA, ²Department of Vertebrate Zoology, National Museum of Natural History, Washington, DC, USA, ³Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA, ⁴University of Florida, Florida Museum of Natural History, Gainesville, FL, USA

Dentition of living and fossil Porcupinefishes (Tetraodontiformes: Diodontidae) studied using CT scanning: Implications for systematics of isolated fossil jaws

Porcupinefishes (Tetraodontiformes: Tetraodontoidei: Diodontidae) are familiar Cenozoic fossils commonly encountered by avocational fossil hunters and paleontologists. Whole skeletons are rare and almost all fossil diodontids are known only from isolated jaws and their unique hypermineralized triturating (=grinding/crushing) plates, which were used to feed on hard-shelled prey. There are seven genera of diodontids known only as fossils that are currently considered valid; other fossils have been referred to the extant genera *Diodon* and *Chilomycterus*. However, most fossil taxa that are represented only by triturating plates are referred to as Diodontidae incertae sedis because few diagnostic generic characters for the jaws and teeth are known. For example, within fossil diodontids, genus-level distinctions are often based on differences in the number of triturating plates, but this character is strongly correlated with body size. We used CT-scans to collect data on jaws and triturating plates from all extant species (17 species in 7 genera) and 10 fossil specimens to evaluate individual, ontogenetic, and generic variation in jaws and triturating teeth. We describe species-level characters, and provide recommendations for the use and limitations of dental characters in diodontid systematics and taxonomy for fossil specimens. We also demonstrate the importance of micro-CT scanning for interpreting morphology and integrating the study of fossil and extant specimens.
Teeth and tooth replacement in the Bluefish, *Pomatomus saltatrix* (Acanthopterygii: Pomatomidae)

The oral teeth of the Bluefish (*Pomatomus saltatrix*) undergo regular replacement that can be characterized by four stages: Absent, Incoming, Functional, and Eroding. In previous work, aspects of these four replacement stages have been described using techniques of osteology, histology, SEM, and biomechanical testing. In recent years, tooth replacement in Bluefish has been used as a model for comparisons to dentitions and tooth replacement patterns of several other teleosts, including the Atlantic Wolffish, *Anarhichas lupus* and the Atlantic Cutlassfish, *Trichiurus lepturus* and other Scombriformes. New high-resolution CT datasets of tooth replacement of Bluefish allow further exploration into the sites of origin of new tooth germs in the oral epithelium and the paths by which these germs enter dentigerous bones. Combined with previously unpublished histological evidence, these findings confirm that: 1) new tooth germs form in the epithelium covering the dentigerous bones; 2) That these tooth germs subsequently migrate into the bone; and 3) that there is no evidence of a persistent dental lamina associated with the formation of new germs. These results are discussed in the general context of tooth replacement phenomena in teleosts. Supported by the Tontogany Creek Fund.
a significant declining trend in both mean and median FL (p < 0.005) for the blacknose shark (*Carcharhinus acronotus*) and a significant decline in median FL (p < 0.05) for the Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) and finetooth shark (*Carcharhinus isodon*). We also found that 4 species examined (*C. acronotus, Carcharhinus plumbeus, Mustelus canis, R. terraenovae*) showed significant declines (p < 0.03) in indices of maximum FL. Significant declines in size indices ranged between 49 and 541 mm (6–35%), with the greatest decline reported for the sandbar shark (*C. plumbeus*) L₉₀%. This suggests that some NC coastal shark species, particularly small coastal sharks, exhibit shifts towards smaller sizes, potentially as a result of selection pressure caused by fishing. These results are discussed in the context of varying life-history characteristics and resiliency to fishing pressure across these species.

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

**Maxwell Bernt, James Albert**

*University of Louisiana at Lafayette, Lafayette, Louisiana, USA*

**Assessing the Amazonian Radiation of Ghost Knifefishes (Gymnotiformes: Apterontidae)**

The Apterontidae is the most species-rich and morphologically-disparate family of electric knifefishes (Gymnotiformes), with roughly 100 species in 15 genera. Apterontids are found throughout the humid Neotropics from Panama to northern Argentina, but are most diverse and abundant in the deep channels (> 5 m) of large rivers in the Amazon Basin. The presence of diverse, sympatric assemblages in deep channels in conjunction with highly-disparate cranial morphologies suggest an *in situ* Amazonian radiation. We use a species-dense, dated phylogeny and biogeographic model testing to estimate ancestral ranges and ultimately infer the effects of geologic history on apteronotid evolution. Our results suggest apteronotids arose in the late Eocene to early Oligocene, with most diversification occurring during or after the Miocene. Ancestral area estimation places the origin of the family in the Western Amazon. Most clades are largely limited to the Amazon and Orinoco basins, with only relatively recent colonizations to other basins. One notable exception is the genus *Apterontus*, which is the only clade to exhibit early vicariance or dispersal into the La Plata, Magdalena, and Maracaibo basins. Using ancestral state estimation of habitat preference, we find that *Apterontus* made a single early transition from the deep channel habitat to *terra firme* streams. We suggest that the eurytopic habitat tolerance of *Apterontus* to survive outside of deep river channels facilitated its spread and diversification across the continent. For most apteronotid taxa, diversification appears to be inextricably linked to the late Miocene formation of the modern Amazon River system.

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**132 Ichthyology Systematics II, Cottonwood A-D – The Snowbird Center, Sunday 28 July 2019**
Ricardo Betancur-R.¹, Carmen Pedraza-Marron²

¹University of Oklahoma, Norman, OK, USA, ²University of Puerto Rico, San Juan, PR, USA

Genomics to the rescue when mitochondrial DNA and morphology conflict on the species delimitation of red snappers

Species delimitation is a major quest in biology and is essential for adequate management of the organismal diversity. A challenging example comprises the fish species of red snappers in the Western Atlantic. Red snappers have been traditionally recognized as two separate species based on morphology: Lutjanus campechanus (northern red snapper) and L. purpureus (southern red snappers). Recent genetic studies using mitochondrial markers, however, failed to delineate these nominal species, leading to the current lumping of the northern and southern populations into a single species (L. campechanus). This decision carries broad implications for conservation and management as red snappers have been commercially over-exploited across the Western Atlantic and are currently listed as vulnerable. To address this conflict, we examine genome-wide data collected throughout the range of the two species. Population genomics, phylogenetic and coalescent analyses favor the existence of two independent evolutionary lineages, a result that confirms the morphology-based delimitation scenario in agreement with conventional taxonomy albeit in conflict with mitochondrial DNA. Despite finding evidence of introgression in geographically neighboring populations in northern South America, our genomic analyses strongly support isolation and differentiation of these species, suggesting that the northern and southern red snappers should be treated as distinct taxonomic entities.

Catherine Bevier¹, Vaughn Holmes², Michael Kinnison², Phillip deMaynadier³

¹Colby College, Waterville, ME, USA, ²University of Maine, Orono, ME, USA, ³Maine Inland Fisheries and Wildlife, Bangor, ME, USA

Assessing Distribution and Abundance of the Introduced Mudpuppy (Necturus maculosus) in Maine Using Trapping and eDNA Efforts

The Common Mudpuppy (Necturus maculosus) was introduced to central Maine in 1939. Subsequent reports of mudpuppy captures in other lakes have been documented, but no efforts to assess distribution, population sizes, or impacts on aquatic ecosystem sustainability exist. Mudpuppies may feed on certain invertebrate species of state conservation concern, or they may be significant competitors with native fish. Our team has developed protocols to assess the current distribution of the mudpuppy in Maine. The combination of being fully aquatic and potentially rare in new colonization sites presents challenges for traditional survey methodologies, so this project pairs trapping efforts with environmental DNA (eDNA) sampling methods. Environmental DNA sampling detects DNA that organisms naturally shed in the aquatic environment, and is therefore sensitive to detecting an organism even when not immediately present. Both trapping and eDNA approaches have confirmed that the mudpuppy
has spread widely from their initial introduction site, including up to potentially 14 waterbodies across three major watersheds. Our initial data indicate that eDNA sampling has detected the presence of mudpuppies in more waterbodies than trapping methods, suggesting that eDNA monitoring may be a more sensitive tool for monitoring this elusive invader. Morphological data and analyses of gut contents reveal subtle differences across populations. In general, mudpuppies are primarily eating common macroinvertebrates and may not pose a threat to native species. We are currently refining eDNA sampling approaches and conducting follow-up surveys to confirm mudpuppy distribution and assess whether eDNA can also provide insight into mudpuppy relative abundance.

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

Daniella Biffi

Texas Christian University, Fort Worth, TX, USA, ecOceânica, Lima, Peru

Developing a Sustainable Seafood Initiative: Testing Message Framing on Intentions to Avoid Shark Meat in Peru

Peru has one of the major shark fisheries in the world. Moreover, shark meat consumption is popular and the main commercially exploited species are considered threatened by the IUCN. Recent studies have found high mislabeling rates and high concentrations of methylmercury in shark meat. Current sustainable seafood initiatives recommend consuming species above minimum landing sizes and disregard factors such as mercury content and mislabeling. The purpose of this study is to explore the effectiveness of different framing messages in changing intentions towards shark meat consumption. Specifically: To what extent do intrinsic and extrinsic messages differ in terms of deterring the intention to eat shark meat and promoting the consumption of “popular” (i.e., forage) fish, in the presence or absence of a risk perception message? The three message frames are: intrinsic (sharks have mercury), extrinsic (sharks are threatened), and efficacy frame (sharks are mislabeled). The experiment has a factorial design of 2 X 2 X 2 (present vs. absent for each message). Participants, surveyed through an online questionnaire, will be assigned to one of eight experimental conditions. Participants will then complete a survey regarding their intentions and attitudes towards shark meat and popular fish. We expect that participants in the intrinsic condition will have higher intentions of not consuming shark meat than participants in the extrinsic condition. Preliminary results will be presented at the meeting. This study has the potential to help stakeholders determine the optimal approach for promoting sustainable seafood that is also healthy for consumers.

581 ASIH STOYE CONSERVATION AWARD, Cottonwood A-D – The Snowbird Center, Friday 26 July 2019
Mislabeled and Mercury Content in Seafood in Peru

Peru is experiencing a “gastronomic boom” that is increasing the demand for seafood. Several market-based initiatives have been created in order to inform consumers about sustainable choices. We chose two of these initiatives and investigated two implicit assumptions: seafood is not mislabeled and the recommended species contain low levels of methylmercury and are therefore healthy for consumers. Between May and July 2017, we collected 449 seafood samples, representing a minimum of 64 different species, from markets and restaurants in Lima and Tumbes, Peru. A sub-sample of 270 samples were analyzed for mercury. We extracted DNA from all samples and sequenced them at the mitochondrial cytochrome oxidase I (COI) gene. The species identified were grouped into seven categories (sharks, rays, billfish, white meat, dark meat, commercially desirable species, and other). There was an overall mislabeling rate of 32.7%. Mercury content was compared to US-EPA (300 ng/g) and Peruvian guidelines (1,000 ng/g). Seventy-five samples (28%), had mercury values above the US-EPA recommendations and 13 samples had values above the Peruvian recommendation. Our results indicate that mislabeling is a common practice. Mercury concentrations below Peruvian guidelines may erroneously indicate that consumption of some predatory species is healthy for consumers. Market-based initiatives seek to change behaviors, however, mislabeling hampers the objectives of these initiatives, and some recommendations are even unsafe for consumers considering our results. Consumers’ health should be considered as part of the efforts to ensure seafood sustainability.

Ecological lifestyles and the scaling of shark gill surface area

Fish gill surface area varies across species and with respect to ecological lifestyles. The majority of previous studies only qualitatively describe gill surface area in relation to ecology and focus primarily on teleosts. Here, we quantitatively examined the relationship of gill surface area with respect to specific ecological lifestyle traits in elasmobranchs, which offer an independent evaluation of observed patterns in teleosts. As gill surface area increases ontogenetically with body mass, examination of how gill surface area varies with ecological lifestyle traits must be assessed in the context of its allometry (scaling). Thus, we examined how the relationship of gill
surface area and body mass across 11 shark species from the literature and one species for which we made new measurements, the Gray Smoothhound Mustelus californicus, varied with three ecological lifestyle traits: activity level, habitat, and maximum body size. Relative gill surface at 5,000g ranged from 4,724.98 to 35,694.39 cm² and varied across species and the ecological lifestyle traits examined. Specifically, larger-bodied, active, oceanic species had greater relative gill surface area than smaller-bodied, less active, coastal species. In contrast, the rate at which gill surface area scaled with body mass (slope) was generally consistent across species (0.85 ± 0.02) and did not differ statistically with activity level, habitat, or maximum body size. Our results suggest that ecology may influence relative gill surface area, rather than the rate at which gill surface area scales with body mass.

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

Jose Birindelli¹, Mark Sabaj²

¹Universidade Estadual de Londrina, Londrina, Brazil, ²Academy of Natural Sciences, Philadelphia, PA, USA

Fossil Doradidae (Siluriformes) revisited

The fossil material of Doradidae (Siluriformes) is revisited. New identifications are provided for some fossil specimens, and new interpretations for morphological features are provided based on insights from additional fossil and extant specimens. Fossil specimens are compared to a comprehensive collection of dry skeletons representing most extant species of Doradidae. Fossil specimens are photographed using multifocus software and illustrated using line drawings. In addition, 3D-scanning is used to illustrate key fossil specimens. The highlight results include a description of a new genus and species based on three more or less complete crania and a partial pectoral girdle from the Urumaco Formation, Upper Member, Late Miocene, Tío Gregorio, northwestern Venezuela (11°14’43.0”N 70°18’19.1”W). The new genus and species is diagnosed based on the size and shape of the anterior nuchal plate, epioccipital, frontals and mesethmoid, and also by the number of pectoral-fin spine serrae. The new species is considered closely related to Centrodoras, Lithodoras and Megalodoras. New interpretations on morphological features present in fossil and extant species confirm that these taxa form a monophyletic group, corroborating the more recent studies based on molecular data. The new species was found in the mouth of the Proto-Amazon, a habitat that was most likely similar to that of the extant Lithodoras dorsalis.

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

Joseph J. Bizzarro¹,², Oliver N. Shipley³, Simon C. Brown⁴, Aaron B. Carlisle⁵, Jose Leonardo Castillo-Geniz⁶, David A. Ebert⁷
Regional variability in ecological function of eastern North Pacific skates

Increased scientific attention, improved techniques, and emerging technologies have resulted in considerable recent advancements in our understanding of skate ecology. The simplistic view of skates as generalist predators on unconsolidated substrates has been replaced with a more nuanced understanding of the complexities and variability of skate ecological interactions. In this study, we estimated and compared both elements of the ecological niche among skates and skate assemblages (Gulf of Alaska, California, Gulf of California) using a synthesis of analytical approaches (i.e., stomach contents, spatial survey data, seafloor video data, stable isotopes). Although skates in the Alaskan assemblage were significantly larger than those from the southern regions, they fed at lower trophic levels. Regional differences in generalized diet composition were significant for Big Skate (*Beringraja binoculata*; Alaska, California), Longnose Skate (*B. rhina*; Alaska, California), and California Skate (*B. inornata*; California, Gulf of California). Spatial segregation was pronounced within skate assemblages, and spatial associations differed regionally between species. Size-based differences in diet were evident; however, when comparably sized skates overlapped spatially they also showed a high degree of dietary overlap. Our findings indicate that the ecological roles of skates vary substantially among eastern North Pacific ecosystems. There seems to be more plasticity evident on trophic (vs. spatial) niche axes for skates, which may reduce resource competition among sympatric species. It is becoming apparent that niche space is much greater than historically perceived for skates, and that the large number of extant skate species reflects a great diversity of ecological functions within this group.

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

Cory Blackwelder, Aaron Geheber

*The University of Central Missouri, Warrensburg, MO, USA*

**Trophic Morphology of *Mayaheros urophthalmus* as a Function of Diet in Native and Non-native Populations**

Cichlids (Family: Cichlidae) are the focus of numerous ecological and evolutionary studies; however, few studies have focused on comparisons of trophic-related morphology across populations. *Mayaheros urophthalmus* is a widely distributed species of Cichlid found in the southern-most areas of North America (Southern Mexico), Central America, and has become established in Florida. Whether *M. urophthalmus* morphological features (jaw shape, head shape, and intestinal length) differ across populations, and whether these features are related to diet has
not been tested. Our overall goal was to understand relationships between diet and morphology within and among populations of *M. urophthalmus*. Morphological and dietary relationships were examined using individuals from sites in the Usumacinta and Grijalva drainages in Guatemala and Mexico, the Belize River drainage in Belize, and in invasive populations from South Florida. Geometric morphometric techniques were employed to determine variation in jaw shape, head shape, and body shape among populations. Diets were quantified by examining stomach contents and through measuring intestinal lengths. Findings suggest general morphological differences among drainages based on head size and mouth position. Specifically, Florida individuals varied greatly in head shape and mouth position, and some Florida individuals possessed superior mouths not found in native populations. These results suggest that novel environments (in Florida) may play some influential role in altering *M. urophthalmus* feeding strategies. Potential processes through which novel morphological variation may have been acquired (e.g., natural selection and or phenotypic plasticity), and ways in which morphological features relate to diet will be presented and discussed.

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544 Herpetology Morphology and Systematics, Ballroom 1 – Cliff Lodge, Friday 26 July 2019

Allison Bogisich, Jennifer Dever

*University of San Francisco, San Francisco, California, USA*

**Frogs Hiding in Plain Sight: Phylogenetic Systematics of Myanmar’s *Occidozyga* Species Complex**

Species estimates for anuran genera have been found increasingly inaccurate given the high level of undetected cryptic speciation. In Myanmar specifically, with its unique north-south alignment of mountain ranges and valleys, genetic isolation is frequent and thus it is part of the Indo-Burma biodiversity hotspot. For this study, the taxonomic identity of the *Occidozyga* complex across Myanmar was investigated. To gain insight into the little-known evolutionary status of *Occidozyga*, an integrated phylogenetic approach was used combining molecular, morphological and phylogeographic data to better assess its taxonomy. Our results indicate the presence of six new putative species within *Occidozyga*. We combined two mitochondrial (16S, CO1) and one nuclear gene (Rhodopsin) to produce sequences isolated from forty-seven preserved specimens from the California Academy of Science (CAS). Spatial data from collection localities for specimens was integrated into phylogeographic analyses. Additionally, morphological data was analyzed for morphometrics and principal component analysis (PCA) from 257 specimens at the CAS and National Museum of Natural History (NMNH). Significant molecular differentiation was observed, further bolstered by subsequent phylogeographic analysis. From our results, it is apparent that within Myanmar, *Occidozyga*’s evolutionary pattern is chiefly based on topography. PCA analysis indicates slight species-specific clustering, which could aide field classifications. From these findings, we advocate for adequate protection of each of these distinct evolutionary lineages. The on-going deforestation and migration-humanitarian crises in Myanmar are impacting not only its human inhabitants but its numerous newly identified-yet already threatened-species.
221 SSAR HUTCHISON CONSERVATION & MANAGEMENT AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019

Amy Bogolin¹, Abdullah Rahman¹, Richard Kline¹, Carl Franklin², Saydur Rahman¹, Drew Davis¹

¹University of Texas Rio Grande Valley, Brownsville, Texas, USA, ²University of Texas at Arlington, Arlington, Texas, USA

Comparing Novel and Traditional Sampling Methodologies to Assess the Population Status of the Rio Grande Cooter, Pseudemys gorzugi

Traditional sampling methodologies used to survey for turtle species are often time consuming, labor intensive, and invasive, resulting in limited data and high costs. The emerging technologies of drone surveys and environmental DNA (eDNA) analysis offer potential solutions to the shortfalls of traditional sampling by providing a minimally invasive and more efficient approach for wildlife detection. Little research has been conducted on the Rio Grande Cooter, Pseudemys gorzugi, but data suggests that populations are declining due to habitat destruction, pollution, and collection for the pet trade, and its conservation status is currently undergoing review. We used a DJI Matrice 600 pro drone with a digital camera attachment to conduct aerial surveys along the Rio Grande river and its tributaries for visual detection of P. gorzugi. High resolution color photographs were analyzed to differentiate between sympatric turtle species and the number of turtles detected was quantified. Collection of eDNA samples also occurred at these sites and was analyzed through a PCR amplification procedure to determine if P. gorzugi DNA was present. Additionally, traditional survey methods (e.g. visual surveys, snorkel surveys, and baited hoop-net trapping) were conducted, and comparisons were made between number of detections to determining sampling efficacy. Initial results have confirmed that eDNA methods are able to detect P. gorzugi DNA and the detection and quantification through drone surveys has been successful. Research will continue through 2019 to allow for a more robust analysis and comparison between different sampling methodologies from a larger number of sites.

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

Lea' R. Bonewell¹, Amy A. Yackel Adams¹, Bryan G. Falk², Adam J. Knox³, Emma B. Hanslowe⁴, Mark A. Hayes⁵, Thomas R. Stanley¹, Robert N. Reed¹

¹US Geological Survey, Fort Collins, CO, USA, ²National Park Service, Homestead, FL, USA, ³Maui Invasive Species Committee, Maui, HI, USA, ⁴Colorado State University, Fort Collins, CO, USA, ⁵Normandeau Associates, Inc., Gainesville, FL, USA
An introduced population of southern watersnakes, *Nerodia fasciata*, in the Lower Colorado River, Arizona

Eradication of incipient populations of introduced herpetofauna is usually only possible when detected before they spread and impact native species. Southern watersnakes (*Nerodia fasciata*) are native to the southeastern United States but are now established at several sites in California. We investigated the presence of a suspected introduced population at Mittry Lake, north of Yuma, Arizona. During this 50-day detection effort, we captured 20 watersnakes using 159 minnow traps in aquatic habitats. We also documented two incidental watersnake sightings and three roadkills. Trapped watersnakes measured 269-798 mm SVL and weighed 16-697 g, including three females with follicles or embryos. We captured snakes along the entire length of Mittry Lake. Our results indicate the existence of an established population of introduced watersnakes over a large area. Native snake species that were trapped or observed included 61 checkered garter snakes (*Thamnophis marcianus*) and seven California kingsnakes (*Lampropeltis getula californiae*). We could not assess direct effects of introduced watersnakes on other species but extensive habitat restoration of the Colorado River in this area is creating habitat for listed species that could be adversely affected. Additionally, breeding populations of this watersnake pose dispersal risks to new areas and could serve as the source of additional introductions into the region.

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

John Bosak, Diego Huerta, Jonathan Gould, Alexus Cazares, Matt Goode

*University of Arizona, Tucson, AZ, USA*

The Effect of Moon Illumination and Other Environmental Variables on Nightly Snake Abundance

Moon phase changes in a cyclic, repeated pattern from new moon to full moon, allowing animals to adapt to the environmental condition due to selective pressures from increased visibility leading to predation. While conducting surveys of snake species in a developing, residential area, we observed fluctuations in snake abundance, sometimes dramatically, from night to night. Numerous studies have shown the influences of temperature and humidity on snake activity, but few have focused on effects of light availability on nocturnally active snake species. Even though sight is not the only method of prey detection for most snake species, light availability has been shown to affect the activity of many of their preferred prey species (e.g. rodents), as well as other nocturnal predators (e.g. owls). Changes in behavior of prey species relative to moon phase may stimulate snakes to change their hunting strategies to increase efficiency. Snake species may also rely on lower light availability to increase their rate of survival. In the Sonoran Desert, snake activity increases dramatically during the summer monsoon, which brings increased cloud cover that may negate possible effects of moon illumination. We used moon illumination data in conjunction with temperature, humidity, and cloud cover to examine snake relative abundance over multiple years.
Wood turtle (*Glyptemys insculpta*) nest protection fails to overcome spatial and temporal influences on nest success in northern Wisconsin

Across their distributional range, wood turtles (*Glyptemys insculpta*) are threatened by increasing nest predation and declining nesting habitat availability. In an effort to promote nest success, conservationists have protected wood turtle nests and restored habitat; however, the effectiveness of these methods has rarely been quantified. To understand the drivers of nest success, we located 120 wood turtle nests in northern Wisconsin on the Tomahawk, Namekagon, and Wisconsin rivers from 2014-2018. We protected a subset of nests (*n* = 57) and moved a subset of nests (*n* = 36) to restored nesting areas. We conducted 3 separate analyses on wood turtle nesting using the logistic exposure method to investigate the influence of abiotic and habitat factors on (i) nest success, (ii) nest predation, and (iii) nest success excluding predation as a form of nest failure. Our analysis of nest success revealed that site, year and nest habitat restoration were important predictor variables. Our analysis of predation indicated that predation risk was greater for younger nests and unprotected nests, while nest success (excluding predation) was largely driven by year. Although protection was effective in reducing predation and restoration was marginally effective in increasing success, neither protection nor restoration could overcome the large spatial and temporal influences that ultimately drive nest success.

Traveling the Atlantic Seaboard: Blacktip Shark Coastal Hot Spots

The commonality that all migratory species share is some motivational factor that drives their movement. Sharks follow narrow ranges of environmental parameters when migrating over large distances. Blacktip sharks, *Carcharhinus limbatus*, migrate south from their summer mating grounds in Georgia and the Carolinas when water temperatures drop below 21°C. They overwinter off the coast of southeastern Florida in dense aggregations when sea surface temperatures are below 25°C. Upon the vernal equinox, they head north again to Georgia and the...
Carolinas. Only rare strays are reported to travel north of Cape Hatteras, NC, a boundary that was described over seventy years ago. Since that time, sea surface temperatures have increased 0.85°C. However, some areas like the Gulf of Maine are warming at a disproportionate rate. Many marine species have shifted their distribution poleward as oceans have warmed globally. This research assesses whether the migratory pattern of the blacktip shark has shifted in response to warming oceans. Fifty-one male blacktip sharks were tracked using acoustic telemetry. Hot spot analysis suggests poleward shifts have occurred in the migratory pattern of this population. If poleward migratory shifts continue, the seasonal influx of blacktip sharks into higher latitudes may cause trophic cascades that affect ecologically and economically important species. The blacktip shark may have already reached its maximum latitude if the Gulf of Maine is too warm to accommodate the thermal preference of these migrators. This may lead to greater densities of blacktip sharks in New York waters.

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

Brandon Bowers¹, Danielle Walkup¹, Toby Hibbitts¹,², Paul Crump³, Wade Ryberg¹

¹Texas A&M Natural Resources Institute, College Station, Texas, USA, ²Texas A&M University Biodiversity Research and Teaching Collections, College Station, Texas, USA, ³Texas Parks and Wildlife Department, Austin, Texas, USA

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

Little is known about the Western Chicken Turtle (WCT) in Texas. Past research suggests it is potentially rare in the state with a patchy distribution, and its habitat is under threat from increasing urbanization. For these reasons, U.S. Fish and Wildlife Service (FWS) issued a 90-day finding declaring that listing may be warranted, and requested information on current and future threats to WCT populations and habitat throughout its range. To address this request, we designed a GPS telemetry study to characterize movements, home range, activity patterns and habitat selection of WCT in a Texas population under threat from urbanization. Data from these four behavioral traits will be used to differentiate between aquatic movements among wetland habitats and terrestrial movements during nesting and estivation. Understanding factors that influence movement patterns and habitat selection in both aquatic and terrestrial environments is central to managing or conserving this subspecies, especially given potential threats posed by anthropogenic activities. For example, small home range movements among wetland patches during the activity season may be less likely to be influenced by anthropogenic landscape features causing direct mortality (e.g., roads) when compared with terrestrial movements for nesting or estivation. Here, we present preliminary results on these four behavioral traits from our first, on-going field season at Katy Prairie Conservancy. Collectively, these data will 1) inform the development of standardized survey protocols for the subspecies, 2) allow quantitative estimates of current habitat, and 3) identify conservation priorities and assist regional conservation planning for the subspecies.
The influence of mesoscale eddies on pelagic predators

Mesoscale features, like eddies, make up the internal weather of the ocean, exciting vertical fluxes and transporting pelagic communities thousands of kilometers. These ubiquitous features cover ~30% of the open ocean. Yet, while satellite technology now allows us to view these features in near real time, their influence on pelagic predators remains largely unknown. Using movement data collected by >300 tagged sharks of 5 different species combined with a constellation of earth-observing satellites and data-assimilating ocean forecast models, we collocated shark positions to eddies tracked in maps of sea-level anomaly and performed an eddy-centric analysis to quantify how sharks interact with mesoscale eddies in the Atlantic Ocean. In particular, we compared eddy use by endo- and ectothermic sharks across a range of oceanographic regimes with varying eddy energy. For a subset of tagged individuals, high-resolution dive data facilitated the comparison of vertical behavior among oceanographic habitats. Our results challenge the existing paradigm that anticyclonic eddies are generally unproductive, ocean "deserts" and suggest that they may facilitate connectivity between the epipelagic and the ocean twilight zone. This study also provides valuable new insight into open ocean habitat use by pelagic predators and the structural role of mesoscale oceanography in pelagic ecosystems that should be incorporated into dynamic ocean management approaches. Furthermore, our results shed new light on the ecosystem value of mesopelagic prey, suggesting additional considerations are necessary before biomass extraction from the ocean’s twilight zone as these activities could interrupt a key link between planktonic production and top predators.

Chemoreceptive Terrestrial Orientation and Natural History of the Invasive Walking Catfish (*Clarias batrachus*)

Walking Catfish (*Clarias batrachus*) are an invasive species in Florida, renowned for their air-breathing and terrestrial locomotor capabilities. However, it is unknown how they orient in a terrestrial environment. Furthermore, while anecdotal life history information is widespread for this species in its nonnative range, little of this information exists in the literature. The goals of this study were to identify sensory modalities that Walking Catfish use to orient on land, and to
describe the natural history of this species in its nonnative range. Fish (n = 100) were collected from around Ruskin, FL, and housed in a greenhouse, where experiments took place. Individual catfish were placed in the center of a terrestrial arena and were exposed to four treatments: dionized water- and alanine solution-wetted benchliner in direct contact with the fish, and pools of filtered and pond water out of direct view or contact. Additionally, 87 people from Florida wildlife-related Facebook groups who have personal observations of Walking Catfish on land were interviewed for information regarding their terrestrial natural history. This data was combined with observations from 38 YouTube videos of Walking Catfish in Florida. Walking catfish exhibited significantly positive chemotaxis toward alanine and pond water, suggesting chemoreception is important to their terrestrial orientation. Walking Catfish appear to emerge most frequently during or just after heavy summer rains, particularly from storm drains in urban areas, where they may feed on terrestrial invertebrates. By better understanding the full life history of Walking Catfish, we can improve management of this invasive species.

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

Noah Bressman¹, Joseph Love², Tyler King¹, Caroline Horne¹, Miriam Ashley-Ross¹

¹Wake Forest University, Winston Salem, NC, USA, ²Maryland Department of Natural Resources, Annapolis, MD, USA

Emersion and Functional Terrestrial Locomotion by the Invasive Northern Snakehead, Channa argus

Many fish are known to exhibit terrestrial behaviors, but most of these fishes are very small and/or elongate. Northern Snakehead (Channa argus) are large, air-breathing piscivores that are anecdotally known for terrestrial behaviors. Our goals were to describe the terrestrial locomotion of Northern Snakehead over a wide size range (3.5-70 cm), compare their performance on multiple substrates, and identify environmental factors that encourage emersion. Fish were collected by electrofishing in Potomac River tributaries in Maryland, USA, and were filmed moving on four different substrates: benchliner, grass, artificial turf, and a rubber boat deck. Videos were digitized in MATLAB to describe their kinematics and measure their performance. Electromyography was used to correlate kinematics with muscle activity patterns. We also exposed individuals to a variety of environmental conditions, such hypoxia, to determine conditions that promote emersion from the water. Northern Snakehead used a unique form of axial-appendage-based terrestrial locomotion involving cyclic oscillations of the axial body, paired with near-simultaneous movements of both pectoral fins. Overall, Northern Snakehead perform better on more complex, three-dimensional substrates than on smoother substrates. In the emersion experiments, individuals emerged when exposed to extreme yet plausible environmental conditions, including low pH, high dissolved CO₂, and high salinity. As an invasive species to the United States, it is important to consider their natural history when making management decisions. Because Northern Snakehead can breathe air, locomote
effectively on land, and emerge from the water, their ability to spread overland should be factored into the management of this invasive species.

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

Robert Bretzing, Elizabeth Hunt, David Portnoy

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

**Comparative Analysis of Elasmobranch Field Identification Using CO1**

Elasmobranchs, including sharks, skates, rays, and sawfish, are of conservation concern and increases in citizen scientist effort have aided in additional data collection. Angler identification of sharks relies on the use of morphological characters, but misidentification may still be problematic. An annual catch-and-release tournament conducted in Texas aims to promote the conservation of sharks by involving anglers in data collection and tagging of coastal shark species. Hosted by Texas Shark Rodeo, data sheets, spaghetti tags, and fin clip kits are provided to angler teams to help gather data. Since 2015, the Marine Genomics Lab at Texas A&M University - Corpus Christi has been receiving tissue samples from this tournament. The intent of this project is to quantify the rate of correct identification by anglers in the field by sequencing a portion of the Cytochrome Oxidase I gene for ~1000 field identified sharks. By quantifying species for which identification is problematic, we hope to improve information provided to anglers on best practices for species identification.

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

Casey Brewster, Steve Beaupre

*University of Arkansas, Fayetteville, Arkansas, USA*

**The Effect of Body Posture on Available Habitat and Activity-time in a Lizard: Implications for Thermal Ecology Studies**

Ectothermic animals contend with variable environmental temperature through behavioral thermoregulation, including selection of activity-times and microhabitat spaces with suitable operative temperatures. Thus, an important component to understanding the influence of temperature on animals is through the assessment of thermal constraints on time and space usage. Thermal ecologists have recognized that postural adjustments are an important part of behavioral thermoregulation. However, the impact of postural adjustments on available space and time has received little attention. We hypothesized that postural adjustments would significantly affect the thermal availability of space and time for surface activity. To test our hypothesis, we used data collected over a four-year study of the thermal ecology of Eastern
Collared Lizards (*Crotaphytus collaris*) in Arkansas. We used a novel approach to model three distinct postures used by *C. collaris*, and to assess the impact of posture on available space and time. For our study species and habitat, posture had a significant impact on several indices of available space and time including: a) a 13% increase in length of the reproductive activity season, b) a 35% increase in the frequency distribution of habitat within active body temperature range and c) a 42% increase in average thermal quality index. We conclude that posture can significantly impact space and time available for surface activity in species that employ it for thermoregulation. Thus, a clearer understanding of the thermal constraints on time-space usage in ectotherms requires consideration of the impact of posture on the spatiotemporal distribution of thermally suitable microhabitats.

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

Lauran Brewster¹, Matthew Ajemian¹, Breanna DeGroot¹, Michael McCallister¹, James Locascio², Laurent Chérubin¹

¹Florida Atlantic University's Harbor Branch Oceanographic Institute, Fort Pierce, FL, USA, ²Mote Marine Laboratory, Sarasota, FL, USA

**Advancing Understanding of Goliath Grouper Behavioral Ecology**

The Atlantic goliath grouper (*Epinephelus itajara*) is a large (max 360 kg, 250 cm) tropical and subtropical marine fish found on rocky reefs and wrecks at depths of up to 100 m. Their predictable spawning aggregations and life history traits have made them highly susceptible to overfishing which led to their status as “critically endangered” on the International Union for Conservation of Nature (IUCN) Red List. After decades of conservation efforts and signs of recovery, the IUCN status was changed to “vulnerable” in 2018. Despite this, there are few behavioral studies of free-ranging goliath grouper. Goliath grouper produce low frequency, high intensity sounds (i.e., “booms”) associated with courtship/spawning and antagonistic behavior, which may be distinguished according to boom duration and frequency. Here we present a custom-built, multi-sensor tag developed with the aim of elucidating the behavioral ecology of wild goliath grouper. We incorporated a hydrophone for monitoring acoustic responses, accelerometer/magnetometer/gyroscope for measuring kinematic movement, a SPOT tag and VHF transmitter for facilitating tag retrieval, and a video camera for ground-truthing behavioral data obtained from animals at liberty. We also present preliminary results from our captive experiments, including the response of these animals to different stimuli they may encounter in the wild.

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

Karyl Brewster-Geisz (presenter: Guy DuBeck)
Update on Atlantic Shark Management in the United States

The Highly Migratory Species Management Division of the National Marine Fisheries Service (NOAA Fisheries) is responsible for the management of the U.S. federal shark fisheries in the Atlantic Ocean, including the Gulf of Mexico and Caribbean Sea. Federal management of sharks began in 1993. At that time, management was relatively simple, and included establishing three management groups for 39 species of sharks and requiring fishermen and dealers to follow certain regulations such as permitting and reporting. Since then, our knowledge about sharks in general has improved dramatically. As a result, the regulations continue to become more and more complex and detailed, including species-specific regulations, restricted gears, and various regions and seasons. A number of recent regulations have gone into effect that aim to minimize mortality to the extent practicable, including recreational regulations that requires all shark anglers to not only recognize certain species of sharks but also the gender of the shark. The additional changes that are underway will continue to need strong scientific research and support.

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

Michael Britton, Maureen Donnelly

*Florida International University, Miami, Florida, USA*

**Metabolic ecology of over 100 species of amphibians across a 5,000 meter elevational gradient in the Peruvian Andes**

Metabolic ecology considers biological processes, their rates and requirements, and how they change and interact in different contexts. It is a basis for understanding the energetic demands of organisms and how these processes are affected by environment and evolution. We sampled amphibians across an elevational gradient from 200–5,200 m asl in the Manu Biosphere Reserve in southeastern Peru. We used an infrared gas analyzer to measure changes in CO₂ in a closed system containing unmoving amphibians and to then calculate resting metabolic rates. We examined thermal sensitivity and diurnal variation of metabolic rate by taking measurements at night and during the day (low and high ambient temperatures). We measured 113 species of amphibians in 14 families, including anurans, salamanders, and caecilians, across the 5,000 m gradient. We analyzed resting metabolic rates at the species level, across elevational ranges and among populations, to examine variation within species. Additionally, we used phylogenetic analyses to examine the extent to which metabolic characteristics are constrained by evolutionary history and to compare various models of evolution. There exists substantial variation of resting metabolic rate within both individual species as well as at higher taxonomic levels. This variation may reflect either plasticity or genetic, heritable differences, and merits further study. These characteristics, their variation, and the potential for adaptation may be predictive for how
amphibians, and which areas and species, will be vulnerable to energetic impacts from climate change.

140 ASIH STORER HERPETOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019

Michael Britton, Maureen Donnelly

*Florida International University, Miami, Florida, USA*

**Circadian rhythm of resting metabolic rate in tropical amphibians**

Circadian rhythms result in predictable daily variations in biological traits such as physiology and behavior. Understanding these rhythms is important across biological scales, from microbiological processes to organismal and community ecology. Amphibians are a diverse group of organisms with a large variety of ecological roles and strategies, and this diversity extends to daily cycles. In the present study, we measured the resting metabolic rates of amphibians to examine how energetic requirements vary across the daily cycle and among species. Amphibians were captured in the field and kept for 24 hours prior to the first measurement. Measurements were taken every 3 hours across a 27 hour period, the final measurement allowing comparison with the first to examine consistency and the effects of measurement stress. Three to five individuals for each of eleven species of amphibians (ten anurans and one salamander) were measured from 6 families including both diurnal and nocturnal species. These species show variation in both the timing and amplitude of the circadian rhythms of resting metabolic rate. These results, in accordance with many studies, suggest that circadian rhythm could have large effects on the measurements in physiological studies. Biologists should be careful to explicitly account for time of day within studies to make sure their measurements reflect both the processes they are interested in as well as the time periods for which they are important.

657 General Herpetology II, Primrose A&B – Cliff Lodge, Sunday 28 July 2019

Colin W. Brocka, John L. Koprowski

*The University of Arizona, Tucson, Arizona, USA*

**Terrestrial Ecology of the Endangered Sonoran Tiger Salamander (Ambystoma mavortium stebbinsi)**

Knowledge of ecological and behavioral processes are essential for the conservation of species at risk of extinction. Connectivity between habitat patches is necessary to maintain genetic diversity and population stability, especially for pond-breeding amphibians. The Sonoran tiger salamander (STS; *Ambystoma mavortium stebbinsi*) is a federally endangered subspecies found
only in the San Rafael Valley of southeastern Arizona and northern Sonora, Mexico. The STS was listed as endangered in 1997 due to highly restricted distribution, dependence on human-constructed environments, invasive species, genetic swamping by non-native salamanders, and disease. Stock ponds created by ranchers have replaced natural springs and are now primary breeding sites for STS. Some STS larvae metamorphose into terrestrial adults, but the majority undergo facultative paedomorphosis and remain aquatic. This rare terrestrial life stage is the only means of responding to pond drying or die-offs and thus is critical to the maintenance of metapopulation dynamics. However, the ecology of the terrestrial life stage is virtually unknown. We radio-tracked 78 individuals to assess STS terrestrial movement patterns, habitat preferences, and life history traits at three sites in the San Rafael Valley. We found that STS travel greater distances from their breeding pond than most eastern *Ambystoma* species and occupy small activity zones on the terrestrial landscape. Additionally, high mortality upon initial movements out of the breeding tank suggests that connectivity between sub-populations of STS may be low. Spatial ecology is important for wildlife managers to develop effective management strategies to conserve the STS and other isolated species.

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

Robert Brodman

*Buena Vista University, Storm Lake, Iowa, USA*

**Interactive effects of temperature and roundup on salamanders: Are things going to keep getting worse?**

Herbicides and climate change have been implicated as causes of amphibian declines. However little is known about the interactive effects of herbicides and temperature on the amphibians. We studied the effects of temperature and herbicide application on Spotted Salamander (*Ambystoma maculatum*) eggs and larvae with a 2 x 2 factorial experimental design with temperature and exposure to herbicide as factors. We collected salamander eggs and exposed half to Roundup at 2ppm reared them in the lab for five weeks in three temperature groups (16C, 18C, and 20C). Temperature and herbicide treatment had significant interactive effects on survival, growth and development. Compared to control groups at the same temperature the Roundup treated groups had significantly reduced survival at 18C and 20C, reduced growth at 20C, reduced developmental rates at 20C and 18C, and higher rates of fluctuating symmetry at 20C and 18C. There no difference between Roundup treated eggs and larvae at 16C. This suggests that herbicides would have a greater negative impact on amphibian populations in a +2C or +4C future.

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

George Brooks¹, Dylan Childs², Thomas Gorman¹,³, Carola Haas¹

¹San Diego State University, La Jolla, CA, USA
²Utah State University, Logan, UT, USA
³Arizona State University, Tempe, AZ, USA
Assessing Population Viability and the Efficacy of Future Management Scenarios for an Endangered Amphibian

Population viability analyses (PVAs) represent a key component of many recovery plans for threatened and endangered species. Demography links the processes that affect individuals to population-level patterns, and hence projections constructed from demographic data are the most common tools for PVAs. Integral projection models (IPMs) allow vital rates to be governed by continuous traits, such as body size or weight. Here we evaluate the demographic influences on population growth of Reticulated Flatwoods Salamanders, *Ambystoma bishopi*, and predict the efficacy of future management actions for this endangered species. Flatwoods salamanders breed in ephemeral wetlands in the Southeastern US. The ephemeral nature of breeding sites can result in complete recruitment failure in years when wetlands dry before metamorphosis occurs. As a result, this species exhibits marked temporal variability in vital rates that must be accounted for in projection models. We constructed a stochastic IPM from eight years of mark-recapture data, and parameterized models using a Bayesian framework. Flatwoods salamanders exhibited relatively low survival rates compared to congeners and a high probability of recruitment failure, which resulted in a low predicted probability of population persistence. Sensitivity analyses revealed large-bodied, adult females, exerted the greatest influence on population growth, and thus managers should prioritize conservation efforts that target this life stage. Additional management should seek to dampen temporal variability in larval survival, something that could be achieved through captive rearing efforts and by restoration of pond hydroperiods.

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

**Jill Brooks**1,2, Kaitlyn Isaacson2, Hannah Medd2, Gretchen Arndt2,3, Deborah Azevedo2, Dan Tabatabai4, Steven Cooke1, Steven Kessel5

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

Depth Use of Great Hammerhead Sharks (*Sphyrna mokarran*) Released from a Shore-based Recreational Angling Fishery in Florida, USA

Recreational anglers with various levels of experience and gear types target great hammerhead sharks (*Sphyrna mokarran*) as a trophy catch-and-release species in Florida. Great hammerheads are vulnerable to mortality in commercial fisheries and yet little is known about the impacts of the recreational fishery. Commercial quotas account for post-release mortalities from both the
commercial and recreational sector; however, this information does not yet exist from the shore-based fishery. Here we present the results of our pilot study using High Rate archival depth recording X-tags (Microwave Telemetry Inc™) to determine survival. Without delaying the anglers' release of the shark, we deployed 4 satellite tags on great hammerheads caught between November 2018 and February 2019 by volunteer shore-based anglers. The high rate tags have a predetermined deployment duration of 30 days, transmit time-series depth and temperature data at a rate of 1-6 minutes and a constant pressure release after 2 days. Potential factors influencing survival, i.e. gear types, fight time, handling time and surf conditions were recorded. The depth data and constant-pressure release mechanism indicate the survival of 3 of the sharks angled using best-practices and one post-release mortality event angled with less-experienced anglers and harsher surf conditions. Although preliminary, communications with the angling community and these data have already guided best-handling practices and our methodology for further tagging efforts. These include having at least 3 experienced anglers, a tail rope for safe maneuverability and release of the shark, and long-handled cutters readily available and capable of rapidly cutting hook or cable.

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

Nancy J. Brown-Peterson, Andrea J. Leontiou

University of Southern Mississippi, Ocean Springs, MS, USA

Female Red Snapper Reproductive Parameters on Artificial Reefs: Differences among Structure Types?

Red Snapper (Lutjanus campechanus) are a reef-associated species commonly found around artificial structures in the northern Gulf of Mexico (nGOM). We hypothesized female reproductive parameters would differ based on the complexity of artificial structure regardless of depth. Red Snapper were collected from April through September 2016-2018 in nGOM Mississippi waters using vertical lines at three depth strata (shallow, <20m, mid, 21-49m, deep, 50-100m) from varying artificial structure types (low, <1.3m; mid, 1.4-5m; high, 5.1-12.3m; rigs-to-reefs, 13-67m; platforms, complete water column). We used increasing structure height as a proxy for increasing structural complexity, although all structures were not present at all depths. While SL and GSI differed among depths when structures were combined (p<0.002), there was no significant difference in either parameter among structures within a depth. The percentage of immature females did not differ by depth or structure type. The distribution of reproductive phases was different among structures at mid depth (p=0.001), with reproductively inactive females most common at mid (43%) and high (60%) structures, while actively spawning (32%) and spawning capable (31%) females were most common at low and platform structures, respectively. Spawning interval was significantly shorter (p<0.01) at platform (1.6 days) compared to rigs-to-reefs (15 days) structures in deep water, and at low (1 day) compared to mid (4 days) and platform (4.8 days) structures in shallow water. There was no difference in relative
batch fecundity by depth or structure type. Overall, variation in reproductive parameters among structure types exists within depth strata but shows no definitive patterns.

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

Jacob Brumley¹,², Philip Lienesch¹

¹Western Kentucky University, Bowling Green, Kentucky, USA, ²Austin Peay State University, Clarksville, Tennessee, USA

Use of Dead Mussels by Madtom Catfishes in the Green River

The Green River in Kentucky has high fish and macroinvertebrate diversity. As both fish and macroinvertebrates have evolved together in this system, symbiotic relationships have developed between species. One type of relationship that has been observed is between madtom catfish (Noturus spp.) and mussels in the Green River, where madtoms use dead mussel shells as cover when not actively foraging. In the fall of 2016 and 2017, surveys were conducted to determine if madtom catfish use dead mussel shells more than rocks of similar size as cover. We predicted that madtoms would select mussel shells as cover more frequently than rocks due to the natural concavity of mussel shells, which would not require excavation prior to use; rocks typically require removal of underlying substrates to create a cavity prior to use as cover. Three 12-meter by 12-meter plots were sampled at four separate sites along the Green River, once per year, by snorkeling in an upstream direction and searching for madtoms in dead mussel shells and under the rock substrate. Equal effort was used searching for madtoms under rocks and in mussel shells. Significantly more madtoms were found under mussel shells than under rocks of similar size. These results support our prediction and demonstrate the importance of mussel shells as cover sites for madtom catfishes. The decline of mussel populations, and resulting decline in available mussel shells in rivers and streams, may have negative effects on madtom populations in the future.

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

Jennifer Buchanan, Alexis Powell, Lynnette Sievert

Emporia State University, Emporia, Kansas, USA

Diet of the Mudpuppy (Necturus maculosus) in Lentic versus Lotic Habitats

The Mudpuppy (Necturus m. maculosus, N. m. louisianensis) is an elusive and poorly understood permanently aquatic salamander in the eastern United States. Little has been published on its natural history in Kansas, and baseline data are needed to assess its status and to inform
conservation efforts. Our goal is to examine the trophic role and community interactions of the Mudpuppy through examination of its diet. We predict that dietary differences exist between sexes resulting from their different roles in reproduction. We also predict dietary differences between lake and river populations due to differences in available prey. We have caught Mudpuppies in the Marais des Cygnes, Neosho, Cottonwood, and Verdigris rivers and at Melvern and Pomona lakes in Kansas. We have obtained the stomach contents of each individual with a non-lethal flushing protocol. Stomach contents are preserved in 70% ethyl alcohol for identification to the lowest identifiable taxonomic group. We have recovered fish (Teleostei), frogs (Rana sp., Acris Blanchard), crayfish (Procambarus sp.), shrimp (Palaemonidae), caddisfly larvae (Trichoptera), mayfly nymphs (Ephemeroptera), Dobsonfly larvae (Corydalus cornutus), midge larvae (Chironomidae), water fleas (Cladocera), and Zebra Mussels (Dreissena polymorpha). Knowledge of diet variation will provide valuable insight into the subspecies’ natural history and provide data for state conservation efforts.

CANCELLED

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

Matthew D. Buehler¹, Robert N. Fisher², Jonathan Q. Richmond², Ikuo G. Tigulu³, Rafe M. Brown⁴, Scott L. Travers⁴

¹Villanova University, Villanova, PA, USA, ²United States Geological Survey, San Diego, CA, USA, ³Ecologiacl Solutions Solomon Islands, Gizo, Western Province, Solomon Islands, ⁴University of Kansas, Lawrence, KS, USA

Biogeography and Systematics of Melanesian Elapids

The Solomon Islands are an important biogeographic zone for understanding the evolution and biogeography of Australasian squamates. In particular, the archipelago is important for understanding the dispersal and evolution of elapid snakes, because three monotypic endemic genera occur there (Loveridgegaps, Parapistocalamus, and Salomonelaps). Previous work done on hydrophiine elapids have lacked complete sampling of Solomon Island species. We present a time-calibrated phylogenetic hypothesis for the group that contains all species from the Solomon Islands, as well as Ogmodon vitianus, a Fijian endemic genus. Our study supports previous hypotheses about the sister relationship of the Solomon Islands elapids to all other hydrophiine snakes excluding Laticauda, and reveals greater diversity within the group than is currently recognized. Further, we have estimated the historical biogeography of the group to gain insights into the timing and patterns of colonization events for elapids in the region. This work has implications for understanding early hydrophiine evolution and the role that the Solomon Island Arc played in the colonization of Australia by elapids.

357 SSAR RABB UNDERGRADUATE AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019
Evidence for Ecogeographic Divergence Linked to Dorsal Coloration in the Eastern Hognose Snake

The Eastern Hognose Snake (*Heterodon platirhinos*) is a wide-ranging colubrid that is highly variable in dorsal scale coloration (a fixed trait); however, the ecological implications of this phenotypic diversity are unclear. Here, we test the hypothesis that dorsal color variants exhibit ecogeographic divergence, using geo-referenced photographs of adult snakes taken throughout the species’ range retrieved from citizen science databases. First, we visually assigned each photographed snake into one of four color phases based on dorsal scale coloration: yellow, red-orange, black, or brown. We then used MaxEnt to model geographic patterns of color phase occupancy relative to concomitant variation in four bioclimatic variables drawn from the WorldClim database. Black phase *H. platirhinos* were most common in wetter and more-seasonal coastal plain habitats, brown phase snakes primarily occurred in less-seasonal mixed-wood and central plains areas west of the Appalachians, and red-orange snakes frequented wetter, forested areas of the Appalachians and northeastern US. We then used pairwise comparisons of bioclimatic niche space to explicitly test for niche divergence among the color phases. These analyses supported our MaxEnt findings, whereby black, brown, and red-orange phase *H. platirhinos* differed significantly in bioclimatic niche occupancy. In contrast, yellow phase snakes overlapped with red-orange and brown phase snakes in both geographic and bioclimatic niche space. Aside from this overlap, our findings collectively support that black, brown, and red-orange phase *H. platirhinos* diverge in ecogeographic associations. Overall, this link between dorsal coloration and environmental conditions may partly underlie the ecological success of this unique colubrid.


The African jewelfish, *Hemichromis letourneuxi*, is a cichlid fish, native to northern Africa, and commonly traded as an aquarium fish worldwide. It was first described in the waterways of Florida in the early 1960s, and it is currently flourishing and spreading throughout the State. This species is highly predatory and there is evidence that local native fishes do not do as well in its presence as they would otherwise. In order to provide baseline information about the African jewelfish in Florida, we are using genetic techniques to characterize the connectivity and relative
isolation of regional populations. We developed multiple nuclear sequence markers from non-coding regions of the African jewelfish genome in order to characterize the phylogeography of this species in Florida. Using a multi-locus analysis, we are creating a phylogeographic tree of African jewelfish populations. The tree serves as a hypothesis depicting the history of the introduction(s) of this species to Florida. This evolutionary tree has allowed us to hypothesize the number and location(s) of introduction to the State. In addition, the tree offers insight into how populations in some locations may have arisen from populations elsewhere in Florida. Using this information, we hope to assist managers to develop strategies that might help limit the spread of this destructive species.

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

Russell Burke¹, Alexandra Kanonik²

¹Hofstra University, Hempstead, NY, USA, ²American Littoral Society, Highlands, NJ, USA

The Special Relationship Between Citizen Science and Turtle Ecological Research

Among all the species that biologists study, turtles have a special position with the public because turtles are charismatic, they are often conspicuous, and are often found near people. Therefore, turtles are appealing, accessible and usually non-threatening. As a result, more potential citizen scientists contact us to assist with our research on the ecology and conservation of diamondback terrapins (Malaclemys terrapin) in Gateway National Recreation Area in New York City, than we can manage productively. We have learned it is vital to identify citizen scientists that are more likely to be helpful and to determine which tasks are appropriate for citizen scientists. The general applicant pool often has very different ideas about what kind of work is important than do scientists, and a considerable amount of our time is spent explaining why we do what we do. For example, most non-scientists want us to protect hatchlings and head-start and kill, while we are generally more concerned with protecting habitat for adults. These differences in goals and experience has led to a careful separation of tasks that we allow citizen scientists to perform and others they are not allowed to perform. Some advantages of working with citizen scientists are increased funding opportunities, high levels of enthusiasm each year, and the development of a new focus on environmental education as a specific goal. Scientists starting long term turtle ecology projects should consider involving citizen scientists from the earliest stages of their projects.

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

Echelle Burns¹, Jeff Armstrong², Danny Tang², Ken Sakamoto², Christopher Lowe¹
Differences in the Short-Term Movement Patterns and Habitat Association of Flatfishes (Order Pleuronectiformes) Near the Orange County Sanitation District Outfall

The Orange County Sanitation District (OCSD) in Southern California regularly samples demersal fish species (e.g., Parophrys vetulus, Pleuronichthys verticalis) near their outfall to assess whether the discharge of secondary-treated wastewater adversely affects the health of local fish populations. In recent years, local abundances of species regularly sampled for monitoring have decreased, resulting in the need to identify other potential species to monitor (e.g., Citharichthys sordidus). In addition, contaminant tissue loads from individuals sampled at the outfall indicate intraspecific differences in exposure to sediment-bound contaminants, suggesting a need to understand how these species use the habitat surrounding the outfall. A large acoustic receiver array (Vemco VPS) was used to track the movements of 55 pleuronectiform fishes near the OCSD outfall for one year. The outfall site was divided into three zones: non-diffuser region of the outfall, diffuser region of the outfall, and surrounding sandy habitats. Results suggest that while individuals show a low mean residency (0.087±0.083 SD) to the outfall site, the ecotone created by the outfall may differentially influence the short-term behavior (e.g. rate of movement, ROM) of monitored species. For example, C. sordidus (n=22) showed significantly higher ROMs (p<0.01) in sandy regions, while P. verticalis (n=13) showed significantly higher ROMs (p<0.01) in the diffuser region. Furthermore, species that show a short-term association to the non-diffuser region of the outfall may be less likely to be exposed to sediment-bound contaminants when compared to species that spend more time in more contaminated, sandy areas upcoast of the outfall.

Migratory lineages rapidly evolve large body sizes in ray-finned fishes

Migratory animals respond to environmental heterogeneity by predictably moving long distances at various stages in their lifetime. Migration has evolved repeatedly in animals, and a wide array of adaptations in morphology and physiology are found across the tree of life that increase migration efficiency. Life history theory predicts that migratory species should evolve a larger body size than non-migratory species and some empirical studies have shown this pattern. A recent study analyzed the evolution of body size between diadromous and non-diadromous clupeiforms, finding that clupeiforms evolved larger body sizes when adapting to a diadromous lifestyle. It remains unknown whether different fish clades adapt to migration similarly. We hypothesize that migratory ray-finned fishes rapidly converged on a larger body size optima than
non-migratory species, which would indicate that an increased body size is a key adaptation for all migratory fishes. We use an adaptive landscape framework to explore body size evolution for over 3000 migratory and non-migratory species of ray-finned fishes. By fitting models of macroevolution, we show that migratory species are evolving towards an optimal body size that is three times larger than non-migratory species, regardless of the habitat type, migration strategy, or phylogenetic placement. Furthermore, we find that migratory lineages are evolving towards their optimal body size six times more rapidly than non-migratory lineages, indicating body size is a key adaption for migratory fishes. Our results show, for the first time, that the largest vertebrate radiation on the planet exhibited strong evolutionary determinism when adapting to a migratory lifestyle.

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

Angela Burrow, John Maerz

University of Georgia, Athens, GA, USA

The Contribution of Wetland Succession to Declines of Threatened Amphibians in the Longleaf Pine Ecosystem

Historically, habitat conversion for agriculture and development was the primary threat to geographically isolated longleaf pine wetlands, but today remnant isolated wetlands are often overgrown and hydrologically altered due to fire exclusion or incompatible, cool season fire regimes. In the absence of warm season fires when wetlands are dry, shrubs and trees succeed herbaceous plants, which alters wetland productivity via effects on light and detritus quality. In turn, wetland productivity determines larval amphibian performance including survival and size at metamorphosis, which are large determinants of amphibian population growth. Therefore, the objectives of our work are to quantify the effects of hardwood encroachment on the growth, development, and survival of gopher frog (Lithobates capito) and ornate chorus frog (Pseudacris ornata) tadpoles. Tadpoles were reared in outdoor aquatic mesocosms containing either leaf litter of an encroaching hardwood or a grass/sedge with and without a shading treatment. Results for P. ornata suggest that survival was minimally affected by light and litter treatments with the exception of sweetgum. Larval periods were significantly increased in shade while mass decreased with shading and hardwood litters. Results for L. capito suggest that survival tends to decrease in shade and hardwood litters. Larval periods were significantly increased in hardwood litter and shading while mass decreased with shading. Our results suggest that successional changes within geographically isolated longleaf pine wetlands due to fire exclusion may negatively impact P. ornata and L. capito populations through reduced survival, prolonged development and reduced mass.

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Stags of the Sea? Comparisons of Territoriality and Cranial Weapon Morphology in the Fish Subfamily Oligocottinae (Pisces; Cottoidea)

Many vertebrate groups have weaponized their skulls, with mammalian horns attracting the lion’s share of attention from evolutionary biologists. Though some cranial weaponry aids defense, intraspecific combat appears to drive the evolution of these structures in most terrestrial cases, such as in Cervidae or Bovidae. Equally impressive weaponry adorns aquatic vertebrates, such as the sculpins in superfamily Cottoidea. The skulls of these diverse fishes bear antler-like preopercular spines of remarkable variation, and the males of many species defend nesting sites during the breeding season. Does the intensity of territoriality predict the extent of skull weaponization? We tested for differences in spine shape and sexual dimorphism among guarding and non-guarding species in the sculpin subfamily Oligocottinae by quantifying spine shape with 3D geometric morphometric techniques applied to reconstructions from micro-CT scans of males and females of each species. Multivariate analysis of variance (MANOVA) tested for sexual dimorphism of spine shape and compared the degree of dimorphism for guarding vs. non-guarding species. In addition, we compared the mean shape of spines of guarding vs. non-guarding species using phylogenetic MANOVA. Nest-guarding species show greater sexual dimorphism in spine shape, with males possessing more robust spines that project further from the head of the fish. This suggests that males in nest-guarding species use their preopercular spines for additional or different purposes than do conspecific females. We conclude that, as in many terrestrial vertebrates, the need to establish and defend territories promotes the evolution and augmentation of cranial weapons beneath the waves.

Phylogeography and Taxonomy of Angolan Agamas

The *Agama agama* species group harbors great diversity in West Africa, however taxa in this group from southwest Africa have largely gone unstudied. The Namib Rock Agama, *A. planiceps*, extends over 1000 km throughout Angola and into Namibia along the Great Escarpment. In addition to the Angolan subspecies, *A. p. schacki*, several other taxa in central and northern Angola have been associated with the *Agama agama* clade, including *A.
*mucosoensis* and *A. congica*. A phylogeographic analysis was carried out to clarify this group’s relationships and geographic boundaries in this region. Maximum likelihood, Bayesian, and multilocus coalescent methods were used to estimate phylogenetic trees with divergence dates between major lineages, while population statistics were generated to assess gene flow between populations/lineages. The results reveal hidden diversity within Angolan *A. planiceps*, including several distinct evolutionary lineages that are candidates for new species. These findings provide additional evidence that the Great Escarpment has generated high diversity and endemism in Angolan herpetofauna.

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

Nathan Byer¹, Brendan Reid², M. Z. Peery¹

¹UW-Madison Department of Forest and Wildlife Ecology, Madison, WI, USA, ²W. K. Kellogg Biological Station, Michigan State University, Hickory Corners, MI, USA

**Impacts of life-history and pace-of-life on nesting behavior in an armored ectotherm**

The concept of Pace-of-Life Syndromes (POLS) predicts that physiological and behavioral traits co-evolve. Although this theory represents an attractive theoretical framework for exploring how life-history traits impact behavior and physiology, empirical support has been mixed for this theory, and more work is required to determine how well animals in the field conform to predictions based on POLS. We investigated factors that affect adult risk exposure and nest success during nesting excursions for the Blanding’s turtle, a long-lived ectotherm. We used radio telemetry to track gravid animals to nesting areas while measuring temperature and predation risk across the study site, and monitored nest success to connect behavior to current reproductive success. Turtles responded more strongly to thermal gradients than predation risk when moving to nest sites, consistent with their armored morphology and ectothermic physiology, and generally selected relatively warm microclimates during these excursions. Nests placed further from wetland edges were more successful, but were often in areas with high predator activity, indicating that successful nesting areas may be riskier to adults. Accordingly, turtles did not appear to select for nest sites far from wetlands in areas likely to produce successful nests, instead placing nest sites in areas where potential predator encounters were less likely. Consistent with POLS theory, our study suggests that long-lived organisms engage in behavioral strategies that prioritize their own survival at the expense of current reproduction.

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**149 SSAR HUTCHISON CONSERVATION & MANAGEMENT AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019**

Nathan Byer¹, Brendan Reid², M. Z. Peery¹
Landscape genetic and metapopulation modelling tools reveal complex effects of climate and land use change on a long-lived vertebrate

Climate change has had widespread impacts on global biodiversity, and is expected to result in worldwide species extinctions and declines by the end of the 21st century. Although many species may be able to track shifting climate space, human landscape alterations may interact with climate change impacts to reduce functional connectivity and increase extinction risk. Although many attempts have been made to assess species responses to climate or human-caused landscape change, most of these efforts fail to account for demographic characteristics and functional connectivity when predicting future species distributions. Using genetic and demographic data collected in Wisconsin for the Blanding's Turtle (Emydoidea blandingii), we constructed a spatially-explicit metapopulation model that accounts for both climate change impacts on habitat suitability and landscape change impacts on dispersal and connectivity. We used this model to assess future metapopulation viability and patch occupancy under climate and land-use change scenarios. This model predicted declines in abundance and number of patches occupied under all climate change scenarios. When land-use change was incorporated into models, the number of occupied patches by end of century was substantially reduced relative to climate-only models, but no such reductions were seen for end-of-century abundances, suggesting synergies between climate and land-use change. Furthermore, this model predicts that populations in eastern and northwestern Wisconsin may be most likely to persist under most climate and land-use change scenarios. We suggest that predictions from this and similar models can be used to prioritize conservation efforts and confront uncertainty in an era of increasing environmental change.

Cryptic diversity of a widespread global pathogen reveals new targets for amphibian conservation

Biodiversity loss at the global scale is one of the major outcomes of human-mediated ecosystem disturbances. One way that humans have triggered wildlife declines is through the transportation of disease-causing agents to remote areas of the world. Amphibians have been hit particularly hard by disease due in large part to the pathogenic chyrid fungus (Batrachochytrium dendrobatidis, Bd). Two decades of research on this pathogen have revealed important insights into the biology and distribution of Bd, however there are still many outstanding questions in this
system. While we know that there are multiple divergent lineages of Bd, we know little about how these lineages are distributed in understudied parts of the world and where lineages may be coming into secondary contact. Here, we implement a novel genotyping method to a global set of Bd samples. This method is optimized to amplify and sequence degraded DNA from swab samples. We describe a new lineage of Bd, which we call BdASIA3, that appears to be widespread in southeast Asia, and often cooccurs with the global panzootic lineage (BdGPL). Additionally, we shed light on the global distribution of BdGPL and highlight the expanding range of another lineage, BdCAPE. Finally, we identify future monitoring targets – areas of the world where Bd lineages are coming into contact and where we know very little about Bd lineage diversity. Monitoring need not use expensive or difficult field techniques but can instead opportunistically use archived samples to further explore the history – and predict the future – of this devastating pathogen.

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

Camila Caceres1, Oceane Beaufort2, Lauren Ali3, Aljoscha Wothke4, Jeremy Kiszka1, Michael Heithaus1

1FIU, North Miami, FL, USA, 2Reguar, Fort l’Olive, Guadeloupe, 3UWI, St. Augustine, Trinidad and Tobago, 4ERIC Tobago, Charlotteville, Trinidad and Tobago

Characterizing Catches in Artisanal Elasmobranch Fisheries in the Lesser Antilles

Elasmobranch populations are experiencing dramatic declines in many regions around the world. Although 95% of fishers are artisanal, little is known about the magnitude of elasmobranch catches and consumption in artisanal fisheries at the global scale. We used a rapid assessment framework to study elasmobranch occurrence, fisheries and use in coastal artisanal fisheries in Guadeloupe, Martinique, and Tobago, combining observational data and fisher’s knowledge. We conducted in-person structured interview surveys (n=405) between June 2015 and June 2017 at the main fishing towns/docks across the three islands. We compared elasmobranch species diversity and relative abundance within the waters targeted by fishers using baited remote underwater video (BRUV) surveys (n=50/reef). Protection status varied across the nine surveyed reefs. Fishers reported using handlines, fish traps or pots, drumlines and longlines the most often. They identified thirteen shark taxa and four ray taxa as part of their captures, including, in order of proportion of fishers reporting them, Sphyrnidae spp., Ginglymostoma cirratum, Galeocerdo cuvier, Hypanus americana, Aetobatus narinari, and Myliobatis goodei. From BRUVs, only six shark species and three stingray species were detected: Sphyrnidae spp., Ginglymostoma cirratum, Galeocerdo cuvier, Rhizoprionodon spp., Carcharhinus perezi, Carcharhinus limbatis, Dasyatis americana, Himantura schmardae and Aetobatus narinari. There was no significant difference in elasmobranch presence between the protected and unprotected sites (GLM: z = .415; P > 0.05). Our project revealed that artisanal fishers continue to exploit coral reef resources inside the MPA, retain almost all animals caught, and perceive less elasmobranchs than when they started fishing.
Historical Changes in Patterns of Shark Presence along Florida’s Central Gulf Coast

Mote Marine Laboratory’s Center for Shark Research has conducted seasonal surveys for adult and older juvenile large coastal shark species to determine patterns of abundance and movement off Florida’s central Gulf of Mexico coast. The primary objectives of this study were to (1) describe seasonal patterns of shark presence over the last two decades, and (2) compare this information to historical data (1955-1963) published by Clark and von Schmidt (1965) to determine if seasonal presence and patterns have changed over time. Drumlines and longlines were the gear types used to sample coastal shark species and effort was expressed as hook-hours for CPUE analysis. From 2001-2017, more than 3000 drumlines and 100 longlines were set within 10 miles from shore. On drumlines, blacktip sharks (*Carcharhinus limbatus*) and bull sharks (*C. leucas*) were the most abundant species in all seasons except winter, in which sandbar sharks (*C. plumbeus*) were most abundant. However on longlines, blacktip sharks (*C. limbatus*), spinner sharks (*C. brevipinna*), and nurse sharks (*Ginglymostoma cirratum*) were the most abundant overall but with seasonal variability. When compared to Clark and von Schmidt’s data from five decades previously, four species were not observed in modern surveys, including dusky sharks (*C. obscurus*), Florida smoothhounds (*Mustelus norrisi*), finetooth sharks (*C. isodon*) and sand tigers (*Carcharias taurus*). Overall, fewer shark species were caught in modern surveys as compared to historical records, potentially indicating depletions and/or range shifts in species once commonly found in the eastern Gulf of Mexico.
Twenty-six percent of migratory cartilaginous fish are threatened globally by rapidly expanding anthropogenic pressures. Within the Western Atlantic Ocean, tiger (*Galeocerdo cuvier*), great hammerhead (*Sphyrna mokarran*), and bull sharks (*Carcharhinus leucas*) are bycatch species in U.S. commercial fisheries. Identifying the movement patterns of these species and understanding their behavioral drivers can help support the development of management plans to reduce unintentional shark-fishery interactions. We analyzed the movement patterns of these animals using tracking data from 96 sharks equipped with SPOT satellite tags in the Western Atlantic Ocean and Gulf of Mexico. Our analysis included Big Data methods to characterize the displacements, occupancy, predictability, and tortuosity patterns of each species. Results show interspecific variations in the movement patterns of these animals and provide insights to how varying resource conditions in different habitats may affect their movements. Understanding the behavioral drivers of shark movement patterns will help improve our ability to predict and understand where shark-fishery interactions are likely to occur and will aid in the development of effective conservation management plans for these and other migratory marine species.

744 Herpetology Biogeography I, Ballroom 3 – Cliff Lodge, Friday 26 July 2019

Kaitlyn S. Campbell, Andy Baltensperger, Jacob Kerby

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**Random Frogs: A Machine Learning Approach to Predicting Amphibian Distributions in the Upper Missouri River Basin**

Climate change and anthropogenic stressors, such as urbanization and changes in land use, have contributed to rapid declines in biodiversity worldwide. Although many taxonomic groups have recently experienced human-caused biodiversity loss, amphibian population declines have been particularly severe. Amphibians play an important role in the ecosystem by serving as early indicators for declining water quality and overall ecosystem health, yet little is known about amphibian distributions, hotspots, or the factors that influence these patterns in the Upper Missouri River Basin. Ecological niche models are commonly used to increase our understanding of the biotic and abiotic factors driving species' distributions, and to deepen our understanding of threats to species conservation across broad landscapes. We used the machine-learning algorithm, RandomForest, to predict the distributions of 12 amphibian species throughout the Upper Missouri River Basin using publicly-available occurrence data in combination with 40 environmental and climatic variables. Models accurately predicted the occurrence of species across the study region and may serve as baseline assessments of the current state of amphibian diversity in the region. Here we discuss spatial patterns in species distributions and biodiversity trends, as well as the behavior of important environmental predictors and their relative influence in species models. As an example, we found that Blanchard’s cricket frogs (*Acris blanchardi*) were strongly associated with summer and winter temperatures, summer precipitation, elevation, and distance to oil extraction activities. The following distribution models provide a framework for future conservation and policy work for surviving amphibian species in a harsh, agriculturally dominated landscape.
A New *Siren*? The Value of Alternative Hypotheses in Taxonomy, with Examples

Researchers who name new taxa, whether species or higher taxa, often do not consider alternative hypotheses. So not surprisingly, taxonomy is often considered to be a merely "descriptive" rather than hypothesis-driven science. Some degree of support, such as posterior probability, for the best hypothesis (e.g., phylogram, coalescent tree), combined with a subjective threshold of phenotypic or genetic divergence, is often considered sufficient to justify naming a new taxon, without considering alternatives. But is the "best" hypothesis really better than other hypotheses, and if not, what should we do? I will present examples, including the recent naming of a new species of *Siren*, to show the usefulness of alternative hypotheses in taxonomy.

Environmental Factors Impacting Alternative Life-history Pathways in a Facultative Paedomorphic Salamander (*Notophthalmus viridescens*)

The Central newt (*Notophthalmus viridescens*) has a complex life-history with the potential to express alternate life-history pathways: typical dimorphic and facultative paedomorphic life-histories. This intraspecific heterochrony has the potential to have broad implications from evolutionary biology to community ecology. It has been demonstrated that environmental factors, (e.g. density and larval growth rate) can affect the life-history pathway expressed by the Central Newt. However, a few things are still not fully understood about facultative paedomorphosis of the Central Newt: (1) environmental factors that contribute to the expression of alternate life histories (e.g. food abundances, growth, temperature, density); (2) potential sex-specific bias to the expression of alternate life-history pathways. Using density experiments and food and temperature experiments I will test the hypothesis that certain environmental factors (food abundances, growth rate, temperature, and density) can impact the rates of paedomorphosis and that paedomorphosis in the Central Newt has a sex bias.
Development and applications of DNA forensics to global shark conservation and law enforcement

Tracking elasmobranch catches and trade on a species-specific basis has proven challenging, in part due to difficulties in identifying products such as processed and unprocessed fins, meat, and liver oil. This has hindered efforts to implement regulations aimed at promoting sustainable use of commercially important species and protection of imperiled species. Here, we describe the development and application of a novel multiplex PCR mini-barcode assay to detect elasmobranch species in processed products, its application in Asian shark fin retail markets surveys, and a field-based, fast, and cost effective multiplex real-time PCR protocol capable of detecting nine of the twelve sharks listed under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) in a single reaction. Three CITES Appendix II listed sharks were consistently the second, fourth and fifth most common species (out of >80) in processed fin trimmings ($N = 11,500$) collected randomly from the Hong Kong retail fin market from February 2014 to December 2017, suggesting that listed species are often imported without CITES documentation. Hence, our real-time PCR approach facilitates detection of illicit trade at the port-of-entry, with positive results providing probable cause to detain shipments for more robust forensic analysis. We provide evidence of its application in real law enforcement scenarios in Hong Kong. The molecular approaches described here can aid law enforcement officers in major shark trade hubs around the world meet their CITES requirements and can also serve as a model for other monitoring applications for sharks and rays.
Amphibians play important roles in many ecosystems, so the global decline of many anuran species is of growing concern. The proliferation of pollution, especially insecticides, in the environment is thought to be a threat to many threatened or endangered species. Increasingly there is an effort to promote the use of alternative “natural” or “organic” compounds to replace the use of traditional pesticides. Tadpoles were exposed to the carbamate insecticide, carbaryl in a controlled laboratory setting. Effects on growth, development, and behavior were compared to control tadpoles and to tadpoles exposed to a “natural” pesticide alternative, lemongrass oil. Bullfrog (\textit{Lithobates catesbeianus}) tadpoles exposed to carbaryl exhibited decreased average movement, decreased startle response, and decreased growth compared to control tadpoles or tadpoles exposed to lemongrass oil. However, African clawed frog (\textit{Xenopus laevis}) tadpoles exposed to either carbaryl or lemongrass oil developed faster than tadpoles in the control group. Interestingly, \textit{X. laevis} tadpoles also experienced behavioral effects when exposed to either carbaryl or lemongrass oil compared to control tadpoles. The results illustrate that “natural” pesticides may not necessarily be less harmful alternatives, and that effects might vary significantly among species.

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\textbf{New Insights into the Trophic Ecology of the Cookiecutter Shark (\textit{Isistius brasiliensis}) from eDNA, Stable Isotope, and Fatty Acid Analysis}

The Cookiecutter Shark is a small, enigmatic shark that inhabits epi- and mesopelagic habitats of subtropical and tropical waters around the world. It is a vertically migrating ectoparasite that ambushes larger prey and uses its unusual jaw morphology to remove plugs of tissue from larger species. However, due to the difficulty of studying the Cookiecutter Shark, much about their biology and ecology remains unknown or poorly understood. We collected tissue samples from Cookiecutter Sharks and a variety of epi- and mesopelagic species from Hawaii and used stable isotope (SIA) and fatty acid analysis (FAA) to investigate the trophic ecology of this species in the Central Pacific. Environmental DNA (eDNA) was also used to investigate stomach contents of Cookiecutter Sharks and help inform our analysis and interpretation of the SIA and FAA data. We found that these sharks primarily feed on mesopelagic or vertically migrating species, feeding relatively little on epipelagic prey. Furthermore, mesopelagic micronekton species were important prey throughout ontogeny and we found evidence of an ontogenetic shift in habitat. Integrating these multiple chemical tracer approaches provides a unique and powerful way to study the ecology of these and other little known and difficult to study predators.
Phylogeography of the Proserpine Shiner *Cyprinella proserpina* (Girard, 1856)

West Texas is home to many endemic species that are facing threats due to habitat loss stemming from habitat degradation, development, introduced species, aridification and ground-water usage. This includes several minnows and shiners in the family Cyprinidae, one of the largest and most diverse families of fishes in North America. The Proserpine Shiner, *Cyprinella proserpina* (Girard, 1856) is a moderately sized minnow dependent upon spring fed habitats, a resource currently at risk in West Texas. It is distributed within a restricted range, only occurring in Texas in Las Moras, Pinto and San Felipe creeks and the Pecos and the Devil’s rivers. However, in Las Moras and Pinto creek, *C. proserpina* may be extirpated and replaced by the Red Shiner, *C. lutrensis*, a species more tolerant of poor water quality. Currently, the Proserpine shiner is listed as vulnerable by the IUCN and considered critically imperiled in Mexico and threatened in Texas. Despite this, information is lacking on the status of *C. proserpina* and therefore no conservation plans are in place. In order to further our knowledge on the status of this species, we conduct a phylogeographic study of *C. proserpina* throughout its range using the mitochondrial marker cytochrome c oxidase subunit 1 (COI) collected from tissues sampled from available museum specimens housed at the Biodiversity Research and Teaching Collections at Texas A&M University. We construct a haplotype network in order to assess haplotype diversity and use phylogenetic analyses to infer phylogeographic relationships and determine population structure and connectedness across the range.

Evidence for the onset of recovery of smalltooth sawfish from relative abundance data analyzed within a Bayesian hierarchical model

Monitoring the abundance of rare species over a broad area is a difficult task because of the low probability of finding individuals in random samples, whereas nonrandom sampling may lead to statistical problems. An important component of monitoring the recovery of endangered species
is establishing long-term baseline trends in abundance. Prior to their listing, very little information was available on abundance or habitat use of smalltooth sawfish, *Pristis pectinata*. Initially data from public encounters, primarily recreational fisherman, were used to design an abundance survey for smalltooth sawfish. Fixed areas (areas sampled multiple times over many years) were established based on high encounters of sawfish and previous captures. Some surveys also include random samples taken within subregions while in the field based on an unbalanced design by depth and proximity to shore. These data, along with data from a recreational creel census and a commercial observer program, were analyzed within a generalized linear mixed model to include environmental and sampling design covariates. Standardized indices of abundance were then analyzed using a Bayesian hierarchical framework to estimate a single time series of relative abundance. Estimates of process error show the indices performed reasonably well for smalltooth sawfish abundance and indices process standard deviation estimates were similar. Overall, the combined index demonstrates an increasing trend, suggesting some initial recovery from past exploitation.

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667 SSAR HUTCHISON CONSERVATION & MANAGEMENT AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019

Taylor Carlson, Elisa Cabrera-Guzmán, Stanley Fox

*Oklahoma State University, Stillwater, OK, USA*

**First Documentation of Breeding Aggregations of the Ringed Salamander, *Ambystoma annulatum*, in Oklahoma, USA**

The Ringed Salamander, *Ambystoma annulatum*, is a cryptic ambystomatid species from the Ozark Highlands and Ouachita Mountains of Arkansas, Missouri, and Oklahoma in the United States. Breeding aggregations have been scientifically documented in Arkansas and Missouri, but not in Oklahoma. Individuals emerge *en masse* from underground burrows to breed in upland, ephemeral, fishless ponds during heavy, extended fall rains. From September to December, 2018, we performed nocturnal field surveys searching for *A. annulatum* at several sites along the Ozark Plateau in Oklahoma. We observed migration of hundreds of adult salamanders to ponds, documented courtship with waterproof digital cameras, marked individuals with elastomer tags, and photographed them to begin mark-recapture studies. We found a heavily male biased sex ratio: 460 of the 683 individuals captured were males. We implemented photographic techniques to determine the efficacy of individual identification using pattern variation of the dorsal bands and other distinctive markings. We hope to use these photographic techniques as a less invasive way to identify individuals in the future, as current techniques involve invasive dye injection. This ongoing study has already provided new scientific information and we hope to continue to obtain more data on this understudied species of salamander to aid in its conservation in Oklahoma.
Max Carnes-Mason, Steven Beaupre

University of Arkansas, Fayetteville, AR, USA

Timber Rattlesnake Habitat Restoration: Persistent effects of habitat management efforts in the Ozarks after 10 years

We investigated the lasting impacts of a management plan designed to benefit wildlife, including a population of Timber Rattlesnakes in the Ozark Highlands in Madison, Co., AR. Controlled burns and selective logging were used to thin the canopy, increase ground level productivity, and increase the abundance of the snakes' primary prey item. We used measurements of overstory and understory densities, light availability, and the abundance of mice in the genus Peromyscus across time to look at the lasting impacts of management. Different treatment plots were used to investigate the impact of each management action separately (Burn or Cut) and in combination (Burn and Cut) relative to control plots. Measurements were compared between pre-treatment, post-treatment, and 10 years post-treatment time points. We found that a 10 year lapse in management resulted in a complete return to pre-treatment values in overstory density across all treatments. We saw a decline below pre-treatment values in understory density. Analysis of light availability at the forest floor revealed a persistent effect of treatment after 10 years ($X^2 = 50.36, df = 12, p < 0.001$). Mean small mammal abundance (individuals per ha) increased from pre-treatment (2005: 19.2 ± 11.9) to post-treatment (2009: 68.9 ± 30.5), but returned to pre-treatment values (2017: 8.14 ± 2.22) after 10 years without management. We conclude that 10 years between management events is too infrequent to affect the desired changes within the system. More frequent management would be beneficial to ground-foraging wildlife, including the snake population.

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Home Range and Resource Utilization by Urban Copperheads, Agkistrodon contortrix

Urbanization and fragmentation associated with anthropogenic environments leads to changes in movement patterns and spatial use in a wide variety of taxa. Limited mobility organisms, such as snakes, may be constrained to native habitats within cities. This radio telemetry study examines the spatial ecology and resource selection of the southern copperhead (A. c. contortrix) within Overton Park, a heavily used area bordered by roads in Memphis, Tennessee. Adult copperheads were implanted with radio transmitters and tracked periodically to collect spatial and habitat information. Geographic data were analyzed using different spatial models to determine home
range estimates and movement parameters. Utilization distributions were used to estimate probability of use and related to habitat covariates to create a global resource selection function. Home ranges and core areas in the Overton population are smaller than previously reported for this species and compared to a site 40 km north, Meeman Biological Station. Consequently, average daily movement is also less than rural copperheads. Contrary to previous studies, no differences in spatial patterns between the sexes were noted. Home range size was also not correlated with body condition indices. Important habitat characteristics for Overton snakes included overhead canopy and number and size of nearby logs after controlling for sex and day of year. Urban copperheads may adapt to fragmentation by decreasing overall movement and home range size. In areas where snake populations currently exist, complex habitat structures that provide cover should be maintained to provide appropriate shelter and basking sites.

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

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Small and Separate: Population Genetics of Urban Copperheads, Agkistrodon contortrix

As global human populations increase, urban areas grow in size and continuous natural habitat decreases. Fragmentation leads to decreased habitat size and increased isolation of conspecifics. Consequently, organisms have fewer opportunities to mate with non-related individuals, leading to inbreeding, lower levels of genetic heterozygosity, and decreased effective population size. Organisms with limited mobility, such as snakes, may be constrained to natural areas and be particularly vulnerable to the genetic costs of isolation. This study examines the population genetics of the southern copperhead (A. c. contortrix) within Overton Park, a heavily used old-growth forest within the heart of Memphis, and Meeman Biological Field Station, a rural area in Shelby County, Tennessee. Blood samples were collected from captured adult snakes. Microsatellite loci were used to determine private alleles, allelic richness, genetic diversity (heterozygosity, Hₑ), inbreeding coefficient, and to evaluate population structure using Fₛₜ. Mass and snout-to-vent length were measured for all snakes captured during the study. Individuals belonging to the rural Meeman population had more total and private alleles, higher allelic richness, and greater genetic diversity compared to conspecifics in the urban population. Neither population had significant indices for inbreeding. Significant population structure was identified between the two populations. Morphologically, Overton snakes tend to be smaller than Meeman snakes. Decreased genetic diversity could have negative fitness consequences for the Overton population. Further work should be done in regards to potential management actions, particularly for reptile species that may be of conservation concern and located within areas of increasing urbanization.
Marlies Carter\textsuperscript{1}, Rebecca Penn\textsuperscript{2}, Jonathan Bynum\textsuperscript{2}, Madison Daniels\textsuperscript{2}, Christopher Beachy\textsuperscript{2}

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**Geographic variation in the larval life history of the Southern Two-lined Salamander, *Eurycea cirrigera* (Caudata, Plethodontidae) in Louisiana and Mississippi**

The family Plethodontidae has more diversity in life cycle than the other eight families of salamanders combined. There are three basic variations of life cycle: metamorphic, paedomorphic and direct-developing. Those plethodontid species that are biphasic differ from most amphibians in that larval growth is very slow and the larval period is long (9-60 months). There are few studies of species that occupy the coastal plain of the southeastern United States. We collected monthly samples of larval *Eurycea cirrigera* from two localities in Washington Parish, Louisiana (Bogue Chitto State Park, Stubbs Creek) and Wilkinson County, Mississippi (Clark Creek) for a full year cycle to estimate larval density, larval growth rate, timing of oviposition, timing of hatching and timing of metamorphosis. At each locality hatching takes place in early summer months and metamorphosis occurs in late summer. We estimate the larval period to be 24 months at Clark Creek and 36 months at BCSP and Stubbs Creek.

Nicholas Caruso, Carola Haas

Virginia Tech, Blacksburg, VA, USA

**Hydrological characteristics of Ephemeral Wetlands on Eglin Air Force Base: Implications for the Persistence of the Flatwoods Salamander**

Ephemeral wetlands are critical habitat for a diverse array of species, including pond breeding amphibians. Unfortunately changes in climate may threaten these habitats by altering hydrologic regimes. In the Florida panhandle, the reticulated flatwoods salamander (*Ambystoma bishopi*), which is currently listed as vulnerable by the IUCN, has an unusual breeding behavior in which animals migrate to breeding ponds in the fall or winter and lay their eggs in dry wetland basins. Eggs hatch if winter rains fill ponds before embryos desiccate, freeze, or starve, and larvae require 11 - 18 weeks of inundation to complete metamorphosis. Changes in either the timing or length of pond hydroperiod can be detrimental to these already vulnerable populations. We have instrumented 45 wetlands on Eglin Air Force Base since 2012 using barometric pressure loggers to monitor the depth of water, both below and above ground, in 15 minute intervals to assess the variation in hydrologic regimes of both occupied and unoccupied wetlands across the landscape. We characterized each wetland by determining hydroperiod, recession rate, specific yield, and evapotranspiration during the surveyed breeding seasons. Additionally, we developed a statistical
model to examine how climate affects pond hydroperiod. We found a large variation in wetland characteristics across the landscape and that precipitation and drought conditions were major drivers of pond hydroperiod. These results provide the framework for understanding the role of wetland hydrological characteristics in the outcome of flatwoods salamander breeding and predicting the sustainability of this species under future climate change.

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

Madeline Cashion¹, Tim Cashion²

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A Global Synthesis of Chondrichthyan Fisheries Catches

Overfishing is the greatest threat to fishes of the class Chondrichthyes (sharks, rays, and chimaeras), of which a quarter of species are likely threatened. Effective fisheries management has been identified as a key tool for mitigating their population declines, but incomplete information on chondrichthyan exploitation limits implementation. The Sea Around Us database contains reconstructed fisheries catches, including discards and landings, from all sectors (large and small-scale) and countries from 1950-2014. Recently, the Sea Around Us assigned gear types to these catches, presenting a new opportunity for understanding marine fisheries. We synthesized the chondrichthyan portion of these data to describe the associated gear types, fishing sectors, and catch types (landed vs. discarded). We found that industrial fisheries accounted for 65% of global chondrichthyan catches while small-scale fisheries accounted for 35%. Within industrial gears, bottom trawls and longlines equally contributed to the catch of sharks accounting for 25 and 22%, respectively. Alternatively, ray and chimaera catches were dominated by bottom trawls (42 and 60%, respectively). The majority of chondrichthyan catches were landed (69%), but a substantial portion was discarded (31%). In recent years, catches from bottom trawls have declined, while longline and small-scale catches have increased. Interestingly, despite the spatial expansion of fisheries, nearly all chondrichthyan catches (at least 90%) consistently occurred within countries’ national waters. Our study highlights priorities and potentially overlooked aspects of chondrichthyan conservation, including the importance of bottom trawl gears for rays and the high levels of catches in national jurisdictions, even for these sometimes highly migratory species.

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

Mollie Cashner, Rebecca Johansen, Erin Schwarzbach

APSU, Clarksville, TN, USA
Phylogeographic patterns of contemporary populations of *Chrosomus cumberlandensis* (Blackside Dace), a federally threatened minnow

*Chrosomus cumberlandensis* is a federally threatened minnow with a limited range in the upper Cumberland River system in southeastern Kentucky and a small portion of north-central Tennessee. Its restricted range has been heavily impacted by various anthropogenic activities including mining and logging which have coincided with considerable declines in abundance. Despite declines, new range records for *C. cumberlandensis* are not rare. Newly established populations in the Kentucky River system and the Clinch and Powell River systems in Virginia have been documented and are likely the result of human-mediated introductions. The native range of *C. cumberlandensis* crosses a large instream-barrier (Cumberland Falls), and populations below the falls are potentially isolated. In this study we use the mtDNA cytb gene from multiple individuals in populations throughout the range (native and introduced) to: (1) assess whether Cumberland Falls is a barrier to fish movement; (2) identify putative source populations for established populations; and (3) compare historic gene flow to contemporary distribution patterns. We recovered three clades of cytb haplotypes, two of which encompass the entire range, suggesting widespread historic gene flow. However, there are a number of populations (specifically those below Cumberland Falls) with relatively reduced haplotype diversity, indicating contemporary isolation. Furthermore, the Kentucky River population is one of the most genetically diverse populations, both in haplotype number and diversity suggesting it is most likely an introduced population.

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

Rebecca Castro, Amanda K. Pinion, Kevin W. Conway

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

The lateral line canal bearing scales of the Ghost Shiner *Notropis buchanani* (Teleostei: Cyprinidae)

The Ghost Shiner *Notropis buchanani* is a small, semi-transparent North American minnow native to the Mississippi River basin and the Gulf slope drainages of the US and Mexico, from the Rio Grande to the Calcasieu River. The scales bearing the lateral line canal in *N. buchanani* are heterogeneous and vary in height along the length of the body. The first 9-11 scales are approximately twice as tall as scales located towards the posterior of the body and are often referred to as “elevated” in the literature. In addition to differences in size, the elevated lateral line scales also exhibit a greater number of primary and secondary radii than the smaller, more posteriorly located scales. One or two vertical rows of superficial neuromasts are located on the surface of each lateral line canal bearing scale. The number of superficial neuromasts that contribute to these vertical rows varies along the length of the body, ranging from 18-22 on the surface of elevated scales to 2-5 on the surface of the smaller scales located towards the posterior of the body. The aforementioned differences in scale size, shape, and microanatomy along the
length of the lateral line canal scale row are documented using a combination of light microscopy, SEM and CT. We predict that the elevated anterior scales that are well provisioned with superficial neuromasts may serve a different function from those scales located more posteriorly on the body.

247 Amphibian Disease, Ballroom 3 – Cliff Lodge, Sunday 28 July 2019

Alessandro Catenazzi

Florida International University, Miami, FL, USA

Status of Frog Communities Ravaged by Fungal Disease 15 Years after the Epizootic

The fungal disease chytridiomycosis is associated with catastrophic loss of amphibian biodiversity worldwide, and with the collapse of anuran communities in the Amazonian Andes. I have been surveying anuran communities near Manu National Park, Peru since 1996. This large national park protects one of the richest amphibian faunas along an elevational gradient from the Amazonian lowlands to the Andean peaks. Epizootics of chytridiomycosis have reached this region around 2002–2004, and were followed by the disappearance of nearly 20 species of frogs, with most vanishing species occurring at middle elevations in the cloud forest where chytrid prevalence is highest. A large proportion of vanishing species are stream-breeding species, including species in the genera *Atelopus* and *Telmatobius* known to be especially vulnerable to chytridiomycosis. I have employed two standard methods, 10x10 m leaf litter plots and visual encounter surveys, to monitor frog species richness and abundance during the wet seasons of 1999, 2008–2009, and 2018. Since 2012, I complemented this dataset with visual encounter surveys during the dry season. Despite increasing search effort, most vanishing species continue to be absent from surveys. Whereas species richness of terrestrial-breeding species has decreased little during the epizootic and is now recovering, species accumulation curves for visual encounter surveys suggest stream-breeding communities have not recovered. My findings highlight the catastrophic effect of fungal disease on one of the most diverse anuran faunas, and suggest limited population recovery for most species.

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

Itzue Caviedes-Solis, Adam Leache

University of Washington, Seattle, Washington, USA

Intertwined evolution of swimming, morphology and microhabitat in tree frogs from the subfamily Hylineae
Multidisciplinary studies including phylogenetic inference, functional morphology and phylogenetic comparative methods are imperative to understand how closely related species evolved. By combining those three approaches we aim to disentangle the evolution of morphological traits and their influence on swimming behavior and performance, both within multiple microhabitats for Neotropical tree frogs. The subfamily Hylinae includes 163 species; they have three main locomotion modes with a direct impact on species fitness: they jump, swim and climb. Convergences in morphotype and locomotion are primarily driven by microhabitat, but in some cases morphology is the result of long-term phylogenetic constraints. Swimming is a critical behavior during life history for predator avoidance, reproduction, and early developmental stages. However, it is still poorly understood how swimming evolved in closely related species with multiple locomotion modes. I included 225 individuals from 16 localities in Mexico, corresponding to 31 species and 14 genera. Our data set includes linear velocity, forelimb and hind limb behavior, and we categorized aquatic and arboreal microhabitats. I estimated the correlations among the evolution of traits along the phylogeny by using the threshold model. I found that Hylinae species use the two types of swimming reported for frogs, alternating gait (considered the primitive condition in frogs) and simultaneously gait (the derived mode). In addition there is a high rate of inter- and intra- specific variation in swimming behavior and performance. Therefore, our results have important implications for the study of tree frog evolution and habitat selection.

618 Reptile Conservation, Ballroom 2 – Cliff Lodge, Saturday 27 July 2019

Alexus Cazares, Matt Goode, Diego Huerta, John Bosak, Jonathan Gould

University of Arizona, Tucson, Arizona, USA

Effects of Urbanization on Gila Monsters in Arizona

Urban development can have negative impacts on wildlife, as it often leads to habitat destruction and a loss of biodiversity. This study focuses on the effects of urbanization on a Gila Monster (Heloderma suspectum) population at Stone Canyon, a residential golf community located at the base of the Tortolita Mountains in Oro Valley, Arizona. During the spring and summer months, we conducted nightly surveys of the road and golf cart paths. We collected environmental (e.g., temperature, relative humidity) and location data (UTM coordinates) for each Gila Monster captured. After each survey, lizards were taken into the lab for processing. This included collecting body measurements (e.g., snout-vent length, mass), determining age and sex, and implanting passive integrated transponder (PIT) tags. We quantified the time spent and distance covered during our surveys, which allowed us to calculate the number of lizards encountered per unit effort. We compare results from 2017-2018 with our long-term (2002-2014) data set to understand how ongoing development affects Gila Monster abundance, distribution, age structure, and sex ratios. It is important to understand how urban development affects Gila Monsters and other herpetofauna because we can use this information to minimize impacts on wildlife in urban settings.
A Dwarf Among Giants: Biogeography and Phylogenetic Position of the Elusive Angolan Adder, *Bitis heraldica* (Bocage, 1889)

The Angolan Adder, *Bitis heraldica* (Bocage, 1889), endemic to the Angolan central plateau is one of the most poorly known and rarely observed species of African snakes. The phylogenetic placement of *B. heraldica* within the four subgenera of the genus *Bitis* (*Bitis*, *Macrocerastes*, *Calechidna*, *Keniabitis*) remains highly problematic. The few recent taxonomic and phylogenetic revisions dealing with African viperids and the genus *Bitis* have faced a complete lack of molecular data on it, and all recent authors followed the morphology-based opinion that considered *B. heraldica* as member of the subgenus *Calechidna*, due to its diminutive size and similar morphology. During a survey to Huambo Province, central Angola, we collected the first specimens of this species in the last 65 years, allowing us to test its phylogenetic affinities. We generated sequence data for the species from two mitochondrial (16S, ND2) and one nuclear (PRLR) marker. To place *B. heraldica* in a phylogenetic context, Bayesian and maximum likelihood analyses were run. Additional data were downloaded from GenBank for individuals from all species of *Bitis*, with the exception of *B. harenna* for which no genetic data are available. Contrary to what was expected, our results unambiguously place *B. heraldica* among other members of the subgenus *Macrocerastes*, constituted by the largest members of the genus. The placement of *B. heraldica* within *Macrocerastes* raises interesting questions about body-size evolution in viperids, as well as contributes to a better understanding of the biogeographic patterns of Southwestern Africa, and especially to the increasingly known faunal-turnover in Angola.

Neurodevelopmental Effects of Corticosterone in Northern Leopard Frog (*Lithobates pipiens*) Tadpoles, a Common Vertebrate Model
Low levels of chlorpyrifos, an organophosphorus pesticide, are found in many different habitats. These low levels of pesticide, although considered safe by the government, shape neurodevelopment of Northern Leopard Frogs (*Lithobates pipiens*), a common vertebrate model, resulting in tadpoles with altered brain morphology and increased corticosterone, a stress hormone. We hypothesized that the increased corticosterone contributed to the pesticide-induced changes in neurodevelopment. To test this, we exposed tadpoles to corticosterone or vehicle for one week and measured tadpole corticosterone, brain morphology, brain mass, and behavior. As expected, corticosterone levels were higher in the corticosterone-treated tadpoles. Also, relative diencephalon width was larger in corticosterone-treated animals, although there were no behavioral or other differences. Ongoing studies are examining the role of apoptosis in the effect on diencephalon width. In summary, our results support our hypothesis that corticosterone contributes to the effects of chlorpyrifos on the developing vertebrate brain.

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

Chris L. Chabot¹, Matthew P. Salomon², Corinne N. Paterson Holder³, Larry G. Allen¹

¹California State University, Northridge, Northridge, CA, USA, ²John Wayne Cancer Institute at Providence Saint John’s Health Center, Santa Monica, CA, USA, ³Cooperative Institute for Marine and Atmospheric Studies, Rosenstiel School for Marine and Atmospheric Science, University of Miami, Miami, FL, USA

Phylogeography of the spotted sand bass, *Paralabrax maculatofasciatus* (Serranidae), within the northeastern Pacific

The spotted sand bass, *Paralabrax maculatofasciatus* (Serranidae), is an important fisheries species endemic to the northeastern Pacific Ocean from San Francisco Bay, CA to Mazatlán, Mexico. With continued fisheries pressure and the risk of regionally depleted stocks, determining the existence of isolated populations is critical for the management and conservation of the species. Several biogeographic and phylogeographic barriers have been observed within the distribution of *P. maculatofasciatus* including Point Conception, the Los Angeles Region, Punta Eugenia, the Peninsula of Baja California, the Sonoran Gap, and the Central American Gap. To determine the impact of these barriers on the genetic connectivity of *P. maculatofasciatus* within the northeastern Pacific, tissue samples were collected from throughout the species’ range and genetically investigated using mitochondrial control region sequence data and nuclear microsatellites. Results from these markers indicate regional breaks in genetic connectivity that split *P. maculatofasciatus* into a minimum of five and a maximum of six populations. Based on these findings, discrete populations of *P. maculatofasciatus* can be described as follows: California (Santa Catalina Island, CA—San Diego Bay, CA), northern Pacific Baja California (Guerrero Negro, BCS), southern Pacific Baja California (Magdalena Bay, BCS), southwestern Gulf of California (La Paz, BCS), and the northwestern Gulf of California (Bahía de los Angeles, BC—San Felipe, BC).
Lizards of a Different Stripe: Phylogeography of the *Pedioplanis undata* Species Complex (Squamata: Lacertidae)

The African Sand Lizards (genus *Pedioplanis*), with 13 currently recognized species, are the most species-rich clade of lacertid lizards in southern Africa. Most species are arid-adapted specialists, occupying semi- to highly xeric habitats including the coastal fynbos of South Africa, Nama and succulent Karoo, grassland savannah, and the hard-packed gravel plains and deserts of Namibia. The *P. undata* species complex, whose members are autochthonous to Namibia, have proven particularly taxonomically challenging. All are similar in size (SVL 40–56 mm) and overall body form, but exhibit differences in dorsal patterning and coloration, arrangement of scales in the lower eyelid, and geographic distribution. We herein present a thorough phylogeographic assessment of the *P. undata* species complex in order to resolve interspecific relationships among described species, investigate the status of previously recognized unnamed lineages, and elucidate the geography of species diversification within the complex. To do this we compiled a multi-locus dataset to reconstruct the phylogeny of the genus *Pedioplanis* as a whole and greatly increased sampling of each member of the *P. undata* species complex throughout their ranges, but particularly in Namibia. Our phylogenetic results suggest that species diversity within the *P. undata* complex is greater than previously thought, and that traditional morphological characters used for diagnosing species within the group are inadequate. Furthermore, the results of the phylogenetic analyses are supported by morphology and on this basis we describe two new *Pedioplanis* species using a novel suite of diagnostic characters.

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Exploring immune gene expression and microbiome variation in natural populations of pathogen-tolerant and pathogen-susceptible amphibians

The fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) is responsible for a lethal, emerging infectious disease in amphibians and threatens their populations throughout the world. Certain amphibian populations within species show varying resistance or susceptibility to *Bd*, yet we
understand little about the basis for this natural variation. Extensive work studying *Bd* outbreaks in Arizona has yielded information about a group of field sites inhabited by frog populations with characterized *Bd* disease histories and resistance levels. Here, we used RNA sequencing (RNA-Seq) to characterize gene expression in southern Leopard frogs (*Rana yavapaiensis*) from these locations. From sequenced skin and spleen samples, we found a group of differentially expressed amphibian genes across locations and sampling seasons that were enriched for immune functions, endopeptidase activity, and transcriptional regulation. We were also interested in how microbial species might affect these gene expression patterns. On the microbiome level, especially in amphibian skin, commensal bacteria and fungi likely interact with *Bd* to affect its pathogenicity and subsequent host immune response. Accordingly, we used a recently described RNA read-filtering protocol to look at the quantity and diversity of microbial contaminants in our skin samples. We identified reads from protists, fungi, and bacteria in our data set and tested if microbe contamination levels and variety affected gene expression patterns. This is the first study to utilize amphibian population demographic information in conjunction with microbial community data to explain gene expression in the wild in the face of *Bd*.

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

Benjamin Chubak, Mark Steele

*California State University, Northridge, Northridge, CA, USA*

**Evaluating the Importance of Reef-Based Resources for Reproduction in a Temperate Reef Fish**

California sheephead are among the most ecologically important fish on temperate reefs in California and Mexico, yet little is known about their reproductive ecology. Environmental factors can affect reproductive success in fish populations in a variety of ways, including by affecting diet. The goal of this study was to determine if any differences in reproduction among populations of California sheephead (*Semicossyphus pulcher*) were related to differences in diets among them. We measured the prey availability, diet composition, and batch fecundity of California sheephead on three large reefs within the Southern California Bight. Reproductive output, diet, and prey availability all differed between years, implying that variation in prey availability affected diet, which affected reproductive output. Understanding how changes to kelp forest habitat impact reproductive output can aid in future management efforts of economically and ecologically important species of fish.

26 HL GRADUATE RESEARCH AWARD, Ballroom 1 – Cliff Lodge, Thursday 25 July 2019
The magnitude of roadkill in Taiwan: Patterns and consequences from the citizen science Taiwan Roadkill Observation Network

As large roadkill databases become more developed, inferences from roadkill data can better inform landscape-scale studies with broad conservation aims. The Taiwan Roadkill Observation Network (TaiRON) is one of the largest roadkill observation systems in the world (>60,000 observations), and we conducted the first analysis of patterns and trends from this database. We elucidated taxonomic, seasonal, and temporal trends in wildlife-vehicle collisions in Taiwan, as well as patterns of protected species roadkill. Notably, the study revealed that snake roadkill was the largest proportion of all roadkill (35%) and 26% of those observations were of protected species. Additionally, the database comprised 111 families, 198 genera, and 496 identified species. The top 23 species of the total 491 species ranked by roadkill abundance made up 50% of the roadkill observations, and 14 of the top 20 roadkill species were of herpetofauna. Additionally, 19% percent of the total observations were of protected species. The staggering magnitude and extent of roadkill observations indicates a clear impact of roads on Taiwan’s vertebrate fauna, especially herpetofauna. The patterns of roadkill demonstrate that certain taxa (i.e. snakes) are disproportionately killed on roads, and that a small number of species account for most of the roadkill. Additionally, certain seasons account for higher frequency of roadkills, particularly for ectothermic taxa. These are important insights, as this means that there are groups and species that are being highly and disproportionately affected by roads.
if there were any significant differences between the nests and random sites. We found that overall, nest sites only differed from random sites in the percent of overhead cover from the South (p=0.006). This follows the general pattern in similar studies of northern hemisphere turtles in the consistent importance of southern exposure.

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

Christopher Clark

Harvey Mudd College, Claremont, CA, USA

Modeling and Tracking Fish Aggregations

This research concerns the development of methods for stochastic modeling and then tracking of an animal aggregation. Two new aggregation models based on provably stable Markov Process Matrices are shown as viable models for representing aggregations. As well, a state estimation architecture based on Particle Filters is presented that can estimate the time-varying model parameters, i.e. the 2D planar size, location, orientation, and number of individuals, in real-time. To validate the approach, a historical data set is used consisting of 100+ shark trajectories from a leopard shark aggregation observed in the La Jolla, CA coast area. Finally, a prototype multi-quadcopter system for tracking such aggregations is previewed.

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

Jaden Clark¹, Chris Clark²

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Modeling the Flight Dynamics of Draco volans

The ability to glide, climb, and run effectively is unique in the animal kingdom. Draco volans, a species of flying lizard native to southeast Asia, attaches the leading edge of its patagial membrane, which functions as a wing, to its forelimbs, hence forming a “composite wing”. This allows full terrestrial running ability as well as long distance gliding. However, it is currently unknown how Draco lizards are able to maneuver effectively during flight. Prior studies have hypothesized that this “composite wing” gives Draco its ability to navigate mid-flight and maintain body position while gliding long distances. We theorize that the tail, which accounts for approximately 60% of the lizards’ length, also plays a pivotal role in glide maneuverability. We first modeled the Draco’s flight dynamics as a function of gravitational, lift, and drag forces. Initial modeling leveraged the known mass and planar surface area of the Draco volans to estimate lift and drag coefficients. We developed a simplified, three-dimensional simulation for
Draco flight, calculating longitudinal and lateral position and pitch angle of the lizard with respect to a cartesian coordinate frame. Our model suggests Draco may need to use its tail to adjust its center of gravity in real time in order to maintain a desired angle of attack and control glide distance. This simulation will be further developed in the future using physical models to more accurately measure lizard flight, in order to determine the effect of the tail on how Draco is able to maneuver mid-glide.

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

Meaghan Clark¹, Ralph Saporito², Andres Vega³, Jeanne Robertson¹

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Tasting the rainbow: geographic variation in palatability and color pattern in red-eyed treefrogs

Bright color patterns with high contrast are linked to toxicity in many organisms, including many diurnal amphibians. The function of bright coloration in nocturnal frogs, however, has received relatively little attention. The red-eyed treefrog (Agalychnis callidryas) has brightly colored flanks and legs as well as noxious host-defense polypeptides (HDPs) in their skin. HDP composition varies among different color-pattern morphs in Costa Rica, suggesting that color could function as a warning to predators that an attack would be unprofitable. We test the palatability of HDPs among divergent color-pattern morphs to determine if (1) variation in HDP composition is associated with variation in palatability and (2) if variation in palatability is correlated with color pattern. We are using fruit flies as a proxy for predator taste preferences in two-choice trials that allow for the quantification of palatability. Differences in palatability could indicate that ecological selection acts on color pattern and drives evolutionary diversification.

624 ASIH STORER HERPETOLOGY AWARD, Poster Session I, Event Center – The Snowbird Center, Friday 26 July 2019

Natalie Claunch¹, Ignacio Moore², Heather Waye³, Laura Schoenle⁴, Samantha Oakey⁵, Cynthia Downs⁴, Lynn Martin⁵, Christina Romagosa¹, Robert Reed⁶

¹University of Florida, Gainesville, FL, USA, ²Virginia Tech, Blacksburg, VA, USA, ³University of Minnesota Morris, Morris, MN, USA, ⁴Hamilton College, Clinton, NY, USA, ⁵University of South Florida, Tampa, FL, USA, ⁶United States Geological Survey, Invasive Species Branch, Fort Collins, CO, USA

Stress in the infamous island invader, Boiga irregularis
The insular population of introduced brown tree snakes (*Boiga irregularis*) on Guam have largely depleted the native vertebrate fauna, yet continue to exist at relatively high densities. Under such conditions of stress, secretion of the glucocorticoid hormones may be altered, which can subsequently affect fitness. This well-studied population of snakes provides an avenue for long-term evaluation of glucocorticoid responses, and an opportunity to examine functional aspects of changes in CORT, such as innate immunity. In April 2016, we captured 37 brown tree snakes and collected baseline blood samples. Snakes were placed in cloth bags for one hour to induce an acute stress response and resampled. All blood was immediately centrifuged, serum separated, and flash-frozen in liquid nitrogen vapor phase, then transferred to a freezer at -80°C on return to the mainland. Bacterial killing ability was assessed within 1 month of collection by assessing percent killing ability of plasma incubated with *E. coli* compared to growth of *E. coli* in a positive control via spectrophotometry, similar to French et al. 2012. CORT concentration was assessed via enzyme immunoassay with a commercially available kit. We evaluate the hypothesis that glucocorticoid hormone levels are altered in the long-term in populations with depleted resources and overpopulation by comparing our data to that collected 15 and 25 years prior. Additionally, we examine the functional response of the complement pathway of the innate immune system via bacterial killing ability of plasma as it relates to baseline and acutely-stressed CORT levels.

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

Natalie Claunch¹, Laura Schoenle², Samantha Oakey³, Cynthia Downs², Lynn Martin³, Robert Reed⁴, Christina Romagosa¹

¹University of Florida, Gainesville, FL, USA, ²Hamilton College, Clinton, NY, USA, ³University of South Florida, Tampa, FL, USA, ⁴United States Geological Survey, Invasive Species Branch, Fort Collins, CO, USA

**Stress, Immunity, and Invasion: A Case Study of Multiple Populations of Two Lizards in their Introduced Range**

The Enemy Release Hypothesis posits that species introduced to a new range are at an advantage because they are removed from their native predators, competitors, and pathogens. In the new range, however, continual exposure to new pathogens may induce a near-constant state of inflammation that could prevent individuals from dispersing or reproducing. Species that are introduced to a new range and capable of partially suppressing the inflammatory response may prevent unnecessary reactions to innocuous substances or non-pathogenic bacteria. If the benefits to immune suppression outweigh the costs, and if reproduction can occur before species succumb to an infectious agent, suppressed inflammatory responses may be crucial to the establishment success of a non-native species. If heritable, anti-inflammatory phenotypes may reflect an early-stage invasion, as longer-established populations build an antibody repertoire for the new environment. This mechanism may be informative for determining multiple establishments of species via jump dispersal. We use two species of lizard with multiple geographically-discrete populations in Florida (four *Agama picticauda* and seven *Leiocephalus carinatus* populations) to
evaluate the hypothesis that more recently-established populations will suppress inflammatory responses. To explore potential indicators of invasion history, we examine both circulating corticosterone levels as a mediator of anti-inflammatory phenotypes and bacterial killing ability of plasma as a proxy for inflammatory response. We found differential inflammatory capacity among populations as they relate to estimated and published establishment dates.

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

Alyssa Clevenstine, Christopher Lowe

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

**Aggregation patterns and site fidelity of the protected giant sea bass (*Stereolepis gigas*) at Catalina Island, California**

The giant sea bass (*Stereolepis gigas*) is a large (> 2 m, 200 kg) reef-associated predator that was over-fished during the 20th century due to the predictability of summer spawning aggregations. After protections were enacted during the 1980s and 1990s, there have been signs of population recovery, including the return of summer aggregations; however, temporal and spatial data on aggregations and fidelity to aggregation sites are limited. Passive acoustic telemetry was used to quantify residency and site fidelity of giant sea bass to aggregation sites at Catalina Island, CA. In total, 32 individuals were tracked for 498 days over two successive spawning seasons in 2017-2018 and visual surveys were conducted monthly to estimate aggregation size. Fish aggregated at different locations during different times of day in the summer, suggesting courtship and spawning site preferences. Overall residency across sites was significantly different (Kruskal-Wallis, p < 0.01), but sites had different degrees of residency in spawning (p < 0.01) and non-spawning months (p < 0.05). At least 10 (31%) giant sea bass remained at the island year-round and 11 (34%) exhibited annual spawning site fidelity. Four individuals (12%) were documented leaving the island during late fall/early winter 2017 and returning in spring/early summer 2018, indicating partial migration and year-round fidelity to specific sites at Catalina Island. Information from this study can be used in future management decisions concerning sustainable fishing and diving activities in areas frequented by giant sea bass.

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

Anthony Cobos1,2, Robert Espinoza2, L. Lee Grismer3, Evan Quah4, Shahrul Anuar4

1*University of California, Riverside, Riverside, CA, USA*, 2*California State University, Northridge, Northridge, CA, USA*, 3*La Sierra University, Riverside, CA, USA*, 4*Universiti Sians Malaysia, Penang, Malaysia*
An Introduction to Gollum’s Rule with an Assessment of Convergent Evolution for Cave-dwelling Malaysian Bent-toed Geckos

Convergent evolution is a widely studied evolutionary phenomenon that encompasses a plethora of biological systems, however one traditionally overlooked system is the cave environment. Cave life is often associated with novel adaptations for coping with the unique challenges of a subterranean existence. Accordingly, cave-adapted species are expected to converge on a common suite of adaptive differences—introduced here as Gollum’s rule—relative to their forest-dwelling relatives. Here we tested for adaptive differences in morphology, performance, and physiology of cave-dwelling banded Bent-toed Geckos within the Cyrtodactylus pulchellus complex relative to their close relatives living on granite boulders outside the caves in the surrounding forests—as these different metrics may be relevant in transitioning into the cave environment. We found strong evidence for convergence among cave-dwelling Cyrtodactylus that were not sister species. Conventional statistics and comparative analyses accounting for the phylogenetic relationships among these taxa generally agreed that, relative to forest-dwelling species, cave-dwelling cave species had shorter digits, small palmar and plantar surface areas, higher cling scores to cave substrata, and lower rates of resting metabolism. These data provide evidence that geckos occupying the caves undergo consistent changes in traits that are likely adaptive for life in caves thus supporting Gollum’s rule.

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

Todd D. Cook1, Gerard R. Case2, Bradley Van Ess1, Morgan Shields1, Bonney Weathers3

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A Paleoeocological and Paleobiogeographical Examination of Late Eocene Selachians from the Southern Region of the United States Atlantic Coastal Plain

Selachian (shark and ray) teeth are common vertebrate remains in Eocene marine deposits. In addition to serving as an important biostratigraphic tool, fossilized teeth may provide important insights into regional paleoecology and reveal paleobiogeographical distributions of extinct taxa. The Eocene was a time of varying climatic conditions that heavily influenced the marine biome. The end of this epoch was characterized by considerable global cooling. Although late Eocene selachian assemblages have been well investigated in Europe and northern Africa, only a few studies have documented late Eocene selachian diversity along the Atlantic coastal plain of the U.S. during this important time in Earth’s history. Herein, we reviewed the selachian diversity previously reported from late Eocene deposits from this region, updated the taxonomy, and presented additional taxa. Accordingly, species from 21 genera, 12 families, and seven orders can now be reported as having inhabited the waters of the southern region of the Atlantic coastal plain. The faunal composition reveals a wide-ranging trophic structure that included both large pelagic macrophagous and small nektobenthic durophagous species. A comparison with
contemporaneous selachian assemblages throughout the planet revealed a large number of late Eocene species appear to have been endemic to North America.

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

Pearce Cooper1,2, Shannon O'Leary3, David Portnoy3, T. Reid Nelson1,2, Sean Powers1,2

1The University of South Alabama, Mobile, AL, USA, 2Dauphin Island Sea Lab, Dauphin Island, AL, USA, 3Texas A and M University Corpus Christi, Corpus Christi, TX, USA

An Assessment of Associations between Patterns of Salinity Exposure and Genomic Diversity in a Euryhaline Fish

There is significant environmental heterogeneity in the coastal waters of the northern Gulf of Mexico that affect population connectivity and species distributions. A gradient occurs in the north-central Gulf as a result of a shift from high discharge, freshwater-dominated estuaries to low discharge, high salinity estuaries. A population genomic study of sheepshead, *Archosargus probatocephalus*, indicates a significant restriction in gene flow and a divergence in loci under directional selection proximal to this shift. With no known contemporary physical barriers, divergent adaptation has been proposed to contribute to the maintenance of this genetic break. For sheepshead, there is an admixture zone between eastern and western genetic groups in the Apalachicola estuary. Sheepshead spawn in nearshore coastal waters and use estuarine and low salinity habitats as nursery and sub-adult habitat. Environmental selection may be acting upon individuals during these vulnerable periods. The degree of selection, the life history stage in which it is acting upon, and the ability of the fish to control the environmental conditions they experience are all in question. To begin to evaluate these questions, we obtained fin clips and otoliths from adult sheepshead collected from the Apalachicola estuary, as well as nearshore, and offshore spawning aggregations. All individuals were genotyped at 5601 SNP-containing loci and otolith chemical transects measuring Sr/Ca and Ba/Ca were used to infer salinity exposure during the first two years of life. We discuss the degree of correlation between these datasets, and the implications and caveats to our findings.

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

Samuel Cornelius, Sunny Scobell, Daniel Gold

*St. Edwards University, Austin, TX, USA*

Molecular Characterization of Parasites of the Gulf pipefish, *Syngnathus scovelli*

Syngnathids (seahorses, sea dragons, and pipefish) are commonly kept in aquariums and are growing in importance as they become a model organism for sexual selection studies. As the
quantity of syngnathids in captivity has increased, husbandry continues to pose a problem. Despite much advancement in knowledge of care required for syngnathids in recent years, mass die-offs remain common. Parasites are a known cause of morbidity and mortality in captive populations. However, there is much to be learned about the species of parasites infecting syngnathids, their virulence, and routes of transmission between hosts. For husbandry to improve, it is vital that these parasites are better understood. We aim to molecularly characterize parasites found in the Gulf pipefish, *Syngnathus scovelli*. During the investigation of the sudden deaths of several test subjects, white foreign bodies were found embedded in connective tissues surrounding the liver, heart, and lateral fat deposits of the body cavities in both males and females, as well as in the brood pouches of males. The severity and loci of infection varied between subjects, however, all subjects were infected. Foreign bodies were isolated and lysed to isolate DNA samples, which were then amplified via PCR using pan-eukaryotic 18S rDNA primers and sequenced. Organisms sampled from the brood pouches of males were positively identified as the fluke *Gyrodactylus sp.*. Further identification and characterization of the parasites in the internal organs and cavities will contribute to the knowledge of aquaculture and improve quality of care for syngnathids in captivity.

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

Brittany Cornell¹, Chelsea Thorn¹, Bethany Walker¹, James Willet¹, Aaron M. Bauer², Juan Diego Daza¹

¹Sam Houston State University, Huntsville, TX, USA, ²Villanova University, Radnor Township, PA, USA

**Variation on the Atlas- Axis Complex in Gekkota**

We scored characters of the atlas-axis complex for members of Gekkota, with the intention to find diagnostic features. The atlas is responsible for holding the weight of the skull. The axis is responsible for supporting movement of the first vertebra and skull, and in geckos, the dens interacts also with the braincase. Atlas and axis elements are important for defining the range of skull motion. CT scans of the atlas- axis complex of multiple species were analyzed. Eighteen characters were assembled and scored using visual observation. Through this comparison, we found some traits that are consistent with some groups and might be informative. In general, pygopodoideans have an atlas with a poorly defined posterolateral process, while in gekkonoideans this process is more defined. Pygopodoideans tend to have a fused atlas intercentrum, while in gekkonoideans it is sutured. The number of intercentrum processes of the axis fluctuates from 0 to 4 among geckos, and only *Pseudogonatodes* and *Chatogekko* having the highest number. The dens length vs width was sub equal for the vast majority of geckos, but *Aprasia* has a dens more than 2 times longer than the width. Variations in the atlas- axis complex may be influenced by different ecological niches, and further analysis could be done to determine this relationship more precisely.
Does Body Temperature Predict Surface Activity and Microhabitat Use in Heliothermic Lizards?

The financial and time investment of radio-tracking and monitoring the location and behavior of species of interest, including the federally endangered Blunt-nosed Leopard Lizard (*Gambelia sila*), can be extremely high for researchers and agencies. We tested how well field-active body temperature predicts lizard surface activity and microhabitat use (temperature-based activity estimation, TBAE) to evaluate the extent to which this method could be used to optimize the efficiency of radio-telemetry, and to conduct a more fine-scale analysis of lizard thermoregulatory behavior than can be provided by temperature-sensitive radio-telemetry alone. TBAE has proved effective in predicting the surface activity of Gila monsters, but it has never been evaluated in a smaller heliothermic (sun basking) lizard. We radio-tracked 30 leopard lizards twice daily for the entirety of their 2.5-month active season in 2018, recording data including the microhabitats occupied by the lizards. In addition, we collected over 90,000 field active body temperatures using an automated telemetry data collection system that logged lizard body temperature throughout the day. By validating the data against daily observations using radio-telemetry, we will analyze the extent to which lizard body temperature accurately indicates if the lizard is above or below ground, and which microhabitat it occupies (on the surface in the sun, on the surface in the shade of a shrub, or below ground in a burrow). TBAE may allow researchers to reduce radio-telemetry effort and/or dramatically increase the amount and quality of data obtained via daily radio-telemetry.

Whole mitogenome relaxed hybridization target sequence capture from environmental DNA samples

Environmental DNA (eDNA) is DNA that is released into the environment by organisms, through decomposition, shedding or secretion, and extracted from an environmental sample (e.g. seawater, soil). Sampling eDNA is becoming popular in lieu of directly sampling target
organisms and is being used for diverse applications ranging from detection of rare, ephemeral, invasive or cryptic species/life stages to biodiversity surveys. Most eDNA-based studies adopt a metabarcoding approach. The amplicon-based nature of this approach, however, can be biased or lack diagnostic power when universal priming sites are not available or when the target fragment does not discriminate among closely related groups. Lack of comprehensive reference material, in terms of both taxon and marker representation, is also problematic. Target sequence hybridization capture approaches have been proposed as potential alternatives that address these restrictions. Multiple gene regions may be targeted simultaneously, increasing the amount of diagnostic information available for taxonomic assignment or use as reference material. Issues associated with primer bias are reduced by targeting gene regions using probe tiling and retrieving sequence by hybridization, rather than amplification. As proof of concept, we developed a relaxed hybridization target gene capture approach for surveying elasmobranch biodiversity on coral reefs based on eDNA extracted from seawater. We have collected a database of ~1200 whole mitogenome sequences spanning the diversity of Chondrichthyes. These sequences were used for probe design and also form the basis of our reference database. We compare our results to those obtained using a metabarcoding approach and comment on benefits and limitations.

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

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Using genetic and morphological data to delineate the species boundaries for two freshwater sculpins, Cottus perplexus and Cottus gulosus

Sculpins of the Pacific Northwest (genus Cottus) are a diverse group of bottom-dwelling fishes that occupy nearly all freshwater drainages. They are typically the dominant vertebrate group in their range and occupy several ecological roles within freshwater food webs, including predator-prey interactions between juvenile and adult salmonids. They also have the potential to serve as indicators of stream health due to their acute sensitivity to increased chemical and warm water environments. However, many co-occurring species share similar morphological and meristic characteristics and confidence in their identification is lacking. This potentially leads to misidentification in field studies and important data gaps in our understanding of these fishes and their ecology. Two species with overlapping distributions and unresolved boundaries are the Reticulate Sculpin, Cottus perplexus, and Riffle Sculpin, Cottus gulosus. The delineation between these species has been disputed for over a century, but previous studies have focused on morphological characteristics. To resolve these taxonomic discrepancies and to capture population-level differences, we are proposing a comprehensive multi-locus phylogenetic inference along with morphometric analysis of the same voucher specimens.
716 Ichthyology Conservation, Cottonwood A-D – The Snowbird Center, Saturday 27 July 2019

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Development of SNPs for molecular monitoring of the endangered razorback sucker (Xyrauchen texanus)

The razorback sucker (Xyrauchen texanus) is a federally listed endangered species that currently relies on human intervention for survival. This conservation program focuses on the protection of naturally born larvae that are predated so heavily as to prevent recruitment; therefore, larvae are captured and raised in aquaria and backwaters and repatriated to their natural habitat when sufficiently large enough to improve their chances of avoiding predation. After repatriation recaptured individuals are tracked for movement and growth rate, however the reproductive success of individuals remains unknown. We developed molecular markers that can be used for estimations of population genetic parameters and for parentage analysis to quantify reproductive success of individuals, especially in protected backwaters. DNA samples of more than 2000 wild and repatriated adults as well as over 10,000 naturally borne larvae have been collected since 1997. We selected 168 individuals and used RADseq to identify thousands of loci across the genome of X. texanus. Over 7000 loci passed quality control filters based on read-ratio deviation, Fis, number of single nucleotide polymorphs (SNPs), short tandem repeats, and number of ambiguous base pairs. Sequencing primers were designed for 300 randomly chosen loci and these were used to generate a GT-seq panel. Parentage assignment was inferred and compared to original microsatellite data to validate the usage of GT-seq in future monitoring of X. texanus. This genomic data can help to provide important parameters for managing lake and backwater populations.

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

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Total Mercury and Molecular Responses in North Atlantic White Sharks (Carcharodon carcharias) and Tiger Sharks (Galeocerdo cuvier)

The feeding ecology and related life-history characteristics of white and tiger sharks make these species susceptible to bioaccumulation of contaminants and associated negative health effects. We measured total mercury (THg) in muscle tissue from white (n=9) and tiger sharks (n=3) from Nova Scotia, Canada and the Southeastern US collected during 2018 and 2019 OCEARCH expeditions. White shark THg body burdens averaged 14.0 mg/kg d.w. (3.12 mg/kg w.w) and
ranged from 4.30 to 25.3 mg/kg d.w. THg in tiger sharks averaged 4.96 mg/kg d.w. (0.76 mg/kg w.w.) and ranged from 3.96 to 6.42 mg/kg d.w. There was a positive correlation between precaudal length (223-324 cm white sharks; 246-274 cm tiger sharks) and THg concentration for both species suggesting larger individuals bioaccumulate THg over time. The highest THg values observed were for male white sharks collected near Nova Scotia. Our prior investigation of the molecular responses associated with dietary exposure of little skates (Leucoraja erinacea) to Hg and persistent organic pollutants (POPs), suggests that expression of the CYP1A gene in muscle tissue is correlated with THg and POP body burdens. We plan to measure CYP1A expression in white and tiger shark muscle tissue to verify if correlations between these measurements are also observed in wild-caught, naturally exposed sharks. We plan to compare our results to health metrics such as oxidative stress and inflammatory response from ongoing studies of these individual sharks.

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

Hayley Crowell, Emily Taylor

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Thermoregulatory Accuracy and the Effects of Rising Temperatures on Pacific Rattlesnakes (Crotalus oreganus)

Reptiles have become focal organisms for studying the direct effects of changing climates due to their reliance on environmental temperatures for physiological functions. In this study, we compared thermal and behavioral data collected during 2010-2017 from four distinct populations of Crotalus oreganus to examine how climate change will impact closely related populations inhabiting distinctly different climates. Using operative temperature models, surgically implanted temperature data loggers, and radiotelemetry, we collected data on the thermal microhabitats available as well as field active body temperatures for 85 individual snakes. Along with lab-derived preferred body temperature range, we determined the thermal accuracy of each snake population. Snakes from hot, inland populations thermoregulated most accurately, despite inhabiting more thermally constrained environments. We then used a climate change model at a 1°C and a 2°C increase to predict changes in habitat thermal quality and theoretical changes in snake standard metabolic rates. In both coastal and inland areas, the thermal quality of the environment is predicted to increase with increasing ambient temperatures. Additionally, a theoretical increase in body temperature of 1 and 2 °C would have a minute impact on the overall energetic needs of snakes, still allowing them to meet baseline energetic requirements with only one large meal a year. Small increases in ambient temperature will most likely have little impact on rattlesnake thermal ecology, as our findings suggest that these animals are fairly precise thermoregulators, maintaining relatively constant body temperatures regardless of the thermal quality of their surroundings.
Look How Far We've Come!

Aristotle (384-322 BCE) wrote that women are immature, imperfect, intellectually inferior, and deficient; their place is the home, controlled by their husbands. His writings commanded respect at least until the end of the Middle Ages. Thus, it's no wonder that women were long considered intellectually inferior to men. The Age of Reason/Age of Enlightenment, from the late 17th through the 18th century, emphasized reasoning, the scientific method, and experimentation to understand the world, but science was still the domain of men. Jean Jacques Rousseau (1712-1778), who strongly influenced intellectual thought during the 18th century, perpetuated the belief that women should be subservient to men, and that their primary roles were as wife and mother. He wrote that "participation in science required a certain strength that women simply lack." By the 19th century, women demanded the right to become educated and be accepted as scientists. Many early women scientists assisted their husbands or other men, without pay or position, just to participate in science. Now women are commonly hired as professors, curators, lab directors, and in other positions once reserved for men. We have had to prove ourselves and fight for tenure and pay equality, but we have proven that women are on an intellectual par with men and that we are brilliant scientists. It has been a long road, and we still face challenges, but look how far we've come!

Wet Rock Crevices Impact Egg Deposition and Survival in Green Salamanders, Aneides aeneus

Green salamanders, Aneides aeneus, occur in rock crevices that are humid but not wet. This is true for deposition and brooding of eggs. Females usually do not deposit eggs in crevices with standing water. Eggs are usually attached to the crevice ceiling in a horizontal plane with a space below the egg clutch. The brooding female often has her head in this space. Also, the space may allow water accumulation without damaging eggs. Females may move into and out of contact with eggs to minimize water uptake. In two crevices that produced hatchlings over ten years, young were not produced in summers of 2004 and 2005. Periods of extended rainfall led to wet crevices and thus failed egg clutches, or eggs were not deposited although gravid females were observed. Extensive rainfall during egg deposition in July 2011 resulted in some breeding.
crevices with standing water. In one crevice that had been monitored for several years, a female deposited eggs 10 cm away from the regular crevice to the ceiling of a larger more exposed crevice visible from outside the rockface. Due to the large space below the eggs, the female was unable to brood them. She was located to the left of the eggs with head oriented toward them and snapped at introduced probes. The clutch failed and the eggs had disappeared by Aug 10, 2011. Adaptations of *A. aeneus* to this microhabitat resulted in return of brooding females and eggs to these crevices in 2014 and 2015.

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

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**Annotation of MHC loci in two parthenogenetic lizard complexes**

The major histocompatibility complex (MHC) plays an essential role in vertebrate adaptive immune systems by encoding cell surface proteins necessary for antigen binding and presentation. As some of the most polymorphic genes known, strong associations have been seen between levels of MHC diversity and susceptibility or resistance to pathogens. In this study, we annotate MHC genes using draft genomes of two different parthenogenetic lizards (*Lepidodactylus* and *Aspidoscelis*). These parthenogenetic species arise via hybridization events between two sexual species, and the resulting static variation could have potential consequences on the function of immune genes at the population level. The results from this study will provide a resource to investigate the variation at immune genes within parthenogenetic populations in comparison with their sexual relatives.