



JOINT MEETING OF ICHTHYOLOGISTS AND HERPETOLOGISTS

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SNOWBIRD, UT - SNOWBIRD SKI AND SUMMER RESORT



ABSTRACTS

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

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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.

102 Ichthyology Ecology, Alpine A,B,C – The Snowbird Center, Saturday 27 July 2019

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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

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

Ophidiomycosis (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.

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

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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.

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

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Preliminary Investigation of the Resiliency of Juvenile Porbeagle Sharks to Capture and Handling Techniques

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.

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

Nicole Angeli

Government of the Virgin Islands, Division of Fish and Wildlife, St. Croix, VI, Virgin-Islands, U.S.

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.

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

Margot Angibaud, Richard Cloutier

University of Quebec in Rimouski, Rimouski, Québec, Canada

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 osteichthyans 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

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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 \pm 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.

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

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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.

436 Ichthyology Life History/NIA, Alpine A,B,C – The Snowbird Center, Saturday 27 July 2019

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Anatomical Variation of Mandibular and Hyoid Musculature of Chiapas Catfishes (Lacantunidae, Siluriformes)

In this study, we present results from an exhaustive examination of the mandibular and hyoid musculature of *Lacantunia enigmatica* (Chiapas Catfish). The Chiapas Catfish was first described in 2005 as the only species in Lacantuniidae based on five autapomorphies. Phylogenetical placement of Lacantuniidae is controversial given that molecular evidence

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 Arcila^{1,2}, Guillermo Ortí³, Lily Hughes⁴, Mark Sabaj⁵, Ricardo Betancur-R.²

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⁴The George Washington University, Norman, OK, USA, ⁵The Academy of Natural Sciences of Drexel University, Philadelphia, PA, 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.

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

Gretchen Arndt, Beth Bowers , Stephen Kajiura

Florida Atlantic University, Boca Raton, FL, USA

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.

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

Morgan Arrington¹, Thomas Helser², Irina Benson², Beth Matta², Christopher Gburski², Timothy Essington¹

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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

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²*National 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.

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.

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

Braulio Assis¹, Julian Avery², Catherine Tylan², Ryan Earley³, Tracy Langkilde²

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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.

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

Zak S. Atkins¹, Nick Clemann^{2,3}, Amy M. Edwards¹, Michael R. Kearney⁴, Kylie A. Robert¹

¹*La Trobe University, Melbourne, Victoria, Australia*, ²*Arthur Rylah Institute for Environmental Research, Melbourne, Vic, Australia*, ³*Museums Victoria, Melbourne, Vic, Australia*, ⁴*The University of Melbourne, Melbourne, VIC, Australia*

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 Atta^{1,2}, Luke Tornabene^{1,2}, Hao Yuan³, Chenhong Li³

¹*School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA, USA*, ²*Burke Museum of Natural History and Culture, Seattle, WA, USA*, ³*Key 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

¹*Department of Biological Sciences, Emporia State University, Emporia, KS, USA*, ²*Kansas Department of Wildlife, Parks and Tourism, Pratt, KS, USA*

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 Baird¹, Joshua York²

¹University of Central Oklahoma, Edmond, OK, USA, ²University 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 *Basycladia*). 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* (*alfreddugési*) 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

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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 *Hyperythra 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

¹*Villanova University, Villanova, Pennsylvania, USA*, ²*Museu de História Natural e de Ciências do 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 nominotypical 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 sympatry 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*.

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.

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.

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

Amanda Barker¹, Doug Adams², Christine Bedore³, Bryan Frazier⁴, Jim Gelsleichter⁵, David Portnoy¹

¹Texas A&M University- Corpus Christi, Corpus Christi, TX, USA, ²Florida Fish and Wildlife Conservation Commission, Melbourne, FL, USA, ³Georgia Southern University, Statesboro, GA, USA, ⁴South Carolina Department of Natural Resources, Charleston, SC, USA, ⁵University of North Florida, Jacksonville, FL, USA

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.

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.

CANCELLED

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

Jenna Barrett¹, Luke Tornabene¹, Carole Baldwin², Ross Robertson³

¹University of Washington, Seattle, WA, USA, ²National Museum of Natural History, Washington, DC, USA, ³Smithsonian Tropical Research Institute, Balboa, Panama

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 20m, but overall, the depth ranges and respective mesophotic and rariphotic 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.

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

Lisa Barrow, Emanuel Fonseca, Coleen Thompson, Bryan Carstens

Ohio State University, Columbus, OH, USA

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 AmphibiO 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

Florida Institute of Technology, Melbourne, Florida, USA

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.

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, 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.

CANCELLED

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

M. Delia Basanta^{1,2}, Erica Bree Rosenblum³, Gabriela Parra-Olea¹

¹*Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City, Mexico City, Mexico*, ²*Posgrado en Ciencias Biológicas, Unidad de Posgrado UNAM, Mexico City, Mexico City, Mexico*, ³*Department of Environmental Science, Policy, and Management, University of California, Berkeley, California, USA*

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.

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

Aaron Bauer

Villanova University, Villanova, PA, USA

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. ophiodiicola*. 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. ophiodiicola* 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. ophiodiicola* 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

University of North Florida, Jacksonville, Florida, USA

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

¹*University of Arkansas, Fayetteville, AR, USA*, ²*Haas 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 ($>0.01\text{cm}$), stable (between $+0.01\text{cm}$ and -0.01cm , inclusive) or negative ($<-0.01\text{cm}$). 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.

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.

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.

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.

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

John Bellah, Lynnette Sievert

Emporia State University, Emporia, KS, USA

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 Bemis^{1,2}, James Tyler³, Dahiana Arcilia⁴

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Oklahoma, Norman, OK, USA

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 foraminiferans. 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.

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

Katherine Bemis^{1,2}, James Tyler³, Eric Hilton¹, William Bemis^{4,5}

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Comparative Anatomy and Ontogeny of Ocean Sunfishes (Tetraodontiformes: Tetraodontoidea: 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.

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

Katherine Bemis^{1,2}, James Tyler³, Edward Stanley⁴, Eric Hilton¹

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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.

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

William Bemis

Cornell University, Ithaca, NY, USA

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.

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

Martin Benavides¹, Joel Fodrie¹, Stephen Fegley¹, Giada Bargione²

¹*UNC Institute of Marine Sciences, Morehead City, NC, USA*, ²*Università Politecnica delle Marche, Ancona, Italy*

Maximum size changes within North Carolina coastal shark populations over decadal timescales

Exploitation of harvested populations have been observed to cause shifts in size structure, either towards smaller sizes, presumably via genetic selective mechanisms, or towards larger sizes via density-dependent compensatory growth. We examine population size structure of 12 coastal shark species caught during a 45+ year survey conducted by the UNC Institute of Marine Sciences to document any patterns of size changes among these species over the past several decades. Mean Fork Length (FL), median FL and an index of maximum FL (L_{90%}) for each species were plotted separately as functions of time (year), with changes in length frequencies and effort (CPUE) also examined for a more robust assessment of population state. We detected

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*) $L_{90\%}$. 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.

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 apterontid evolution. Our results suggest apterontids 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 apterontid taxa, diversification appears to be inextricably linked to the late Miocene formation of the modern Amazon River system.

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.

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

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, ecOceánica, 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

Daniella Biffi^{1,2}, Andrea López-Mobilia³, Shaleyla Kelez², Dean A. Williams¹, Matthew M. Chumchal¹, Molly Weinburgh¹

¹Texas Christian University, Fort Worth, TX, USA, ²ecOceánica, Lima, Peru, ³Sustainable Fishery Trade, Lima, Peru

Mislabeling 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* gene (COI). 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.

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

Jennifer Bigman¹, Sebastián Pardo^{1,2}, Tanya Prinzing¹, Nicholas Wegner³, Nicholas Dulvy¹

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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. Bizzarro^{1,2}, Oliver N. Shipley³, Simon C. Brown⁴, Aaron B. Carlisle⁵, Jose Leonardo Castillo-Geniz⁶, David A. Ebert⁷

¹University of Santa Cruz, Santa Cruz, CA, USA, ²National Marine Fisheries Service-Fisheries Ecology Division, Santa Cruz, CA, USA, ³State University of New York, Stony Brook, Stony Brook, NY, USA, ⁴Maryland Department of Natural Resources, Annapolis, MD, USA, ⁵University of Delaware, Newark, DE, USA, ⁶Instituto Nacional de Pesca y Acuicultura Mexico, Ensenada, MX, USA, ⁷Moss Landing Marine Laboratories, Moss Landing, CA, USA

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* 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.

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.

CANCELLED

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.

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

John Bosak, Diego Huerta, Jonathan Gould, Alexis 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.

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

Tiffany Bougie¹, Nathan Byer¹, Carly Lapin², M. Zach Peery¹, James Woodford², Jonathan Pauli¹

¹University of Wisconsin - Madison, Madison, Wisconsin, USA, ²Wisconsin Department of Natural Resources, Rhinelander, Wisconsin, USA

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.

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

Beth Bowers, Stephen Kajiura

Florida Atlantic University, Boca Raton, FL, USA

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 Hibbitts^{1,2}, 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.

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

Camrin Braun¹, Simon Thorrold², Peter Gaube¹

¹*Applied Physics Laboratory - University of Washington, Seattle, WA, USA*, ²*Woods Hole Oceanographic Institution, Woods Hole, MA, USA*

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.

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

Noah Bressman¹, Jeffrey Hill², Miriam Ashley-Ross¹

¹*Wake Forest University, Winston Salem, NC, USA*, ²*University of Florida, Ruskin, FL, USA*

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.

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.

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.

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.

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

Karyl Brewster-Geisz (presenter: Guy DuBeck)

NOAA Fisheries, Silver Spring, Maryland, USA

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.

CANCELLED

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.

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.

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

George Brooks¹, Dylan Childs², Thomas Gorman^{1,3}, Carola Haas¹

¹Virginia Tech, Blacksburg, VA, USA, ²University of Sheffield, Sheffield, United Kingdom, ³Washington State Department of Natural Resources, Castle Rock, WA, 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 Arndt^{2,3}, 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 Brumley^{1,2}, Philip Lienesch¹

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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 blanchardi*), 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, ³Ecological 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 (*Loveridgelaps*, *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

Michael Buontempo, Matthew Lattanzio

Christopher Newport University, Newport News, VA, USA

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.

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

Elizabeth Burke, Natalia Belfiore

University of Tampa, Tampa, FL, USA

Genetic Characterization of Introduced Populations of the African Jewelfish, *Hemichromis letourneuxi*, to the Waterways of Florida

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

¹*Hofstra University, Hempstead, NY, USA*, ²*American 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

¹CSULB, Long Beach, CA, USA, ²OCSB, Fountain Valley, CA, USA

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 (OCSB) 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 OCSB 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.

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

Michael Burns^{1,2}, Devin Bloom¹

¹Western Michigan University, Kalamazoo, Michigan, USA, ²Cornell University Museum of Vertebrates, Cornell Lab of Ornithology, Cornell University, Ithaca, New York, USA

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 adaptation 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.

**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.

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

Thaddaeus Buser¹, Adam Summers², Brian Sidlauskas¹

¹Oregon State University, Corvallis, OR, USA, ²University of Washington - Friday Harbor Laboratories, Friday Harbor, WA, USA

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.

185 Herpetology Biogeography II, Ballroom 3 – Cliff Lodge, Friday 26 July 2019

Brett Butler^{1,2}, Aaron Bauer¹, Todd Jackman¹

¹Villanova University, Villanova, Pennsylvania, USA, ²Universidad Nacional Autónoma de México, Mexico City, Mexico City, Mexico

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.

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

Nathan Byer¹, Brendan Reid², M. Z. Peery¹

¹*UW-Madison Department of Forest and Wildlife Ecology, Madison, WI, USA*, ²*W. 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.

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

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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.

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

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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 chytrid 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

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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 perezii*, *Carcharhinus limbatus*, *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.

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

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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. Drumlins 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.

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

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Big Data Methods Reveal Behavioral Drivers of Shark Movement Patterns

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.

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

David Cannatella

University of Texas, Austin, Texas, USA, National Science Foundation, Alexandria, Virginia, USA

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.

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

Christopher Cannon, Christopher Beachy

Southeastern Louisiana University, Hammond, Louisiana, USA

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.

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

Diego Cardenosa^{1,2}, Andrew Fields¹, Elizabeth Babcock³, Stan Shea⁴, Huarong Zhang⁵, Kevin Feldheim⁶, Jessica Quinlan⁷, Debra Abercrombie⁸, Gunter Fischer⁵, Demian Chapman⁷

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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.

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

Gerardo Carfagno

Manhattan College, Riverdale, NY, USA

Behavioral and Developmental Effects of Alternative Pesticides on Two Tadpole Species

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 (*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 (*Xenopus laevis*) tadpoles exposed to either carbaryl or lemongrass oil developed faster than tadpoles in the control group. Interestingly, *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.

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

Aaron Carlisle¹, Sora Kim², Lauren Meyer³, Jesse Port⁴, Stephen Scherrer⁵, John O'Sullivan⁶

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New Insights into the Trophic Ecology of the Cookiecutter Shark (*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.

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

Audrey Carlos, Amanda K. Pinion, Kevin W. Conway

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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.

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

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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.

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.

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

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.

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

Malle Carrasco-Harris¹, Youngsang Kwon¹, Dale Bowman¹, Judith Cole¹, Steve Reichling²

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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

Malle Carrasco-Harris¹, Jennifer Mandel¹, Carol Siniscalchi¹, Judith Cole¹, Steve Reichling²

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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, H_E), inbreeding coefficient, and to evaluate population structure using F_{ST} . 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.

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

Marlies Carter¹, Rebecca Penn², Jonathan Bynum², Madison Daniels², Christopher Beachy²

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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.

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

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.

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 burchanani* (Teleostei: Cyprinidae)

The Ghost Shiner *Notropis burchanani* 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. burchanani* 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 Hyalinae

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 Hyalinae 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 Hyalinae 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.

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

Luis Ceriaco^{1,2}, Krystal Tolley³, Mariana Marques^{4,2}, Matthew Heinicke⁵, David Blackburn⁶, Aaron Bauer⁷

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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. harena* 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.

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

Elizabeth Cha¹, Sara McClelland², Sarah Woodley²

¹University of California, Berkeley, Berkeley, CA, USA, ²Duquesne University, Pittsburgh, PA, USA

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).

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

Jackie Childers¹, Aaron Bauer², Todd Jackman²

¹*Museum of Vertebrate Zoology, UC Berkeley, Narberth, CA, USA*, ²*Villanova University, Villanova, PA, USA*

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.

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

Nicholas Christodoulides, Anna Savage

University of Central Florida, Orlando, FL, USA

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

Kristina Chyn¹, Te-En Lin², Yu-Kai Chen², Chih-Yun Chen², Lee Fitzgerald¹

¹Texas A&M University, College Station, Texas, USA, ²Taiwan Endemic Species Research Institute, Jiji, Nantou, Taiwan

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.

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

Rebecca Cjaza¹, Amanda Scholz², Miranda Figueras², Russell Burke²

¹The Ohio State University, Columbus, Ohio, USA, ²Hofstra University, Hempstead, New York, USA

Nest Site Selection and Microhabitat Choice in Diamondback Terrapins (*Malaclemys terrapin*)

Nest site choice and nest construction have the potential to play significant roles in the reproductive fitness of organisms. Nest site choice can affect offspring size, offspring sex, offspring locomotor performance, and offspring survivorship. During June and July in 2004 and 2005 we observed diamondback terrapins (*Malaclemys terrapin*) nesting at the Jamaica Bay National Wildlife Refuge in Queens, New York. We collected data on the microhabitat measuring percent ground cover and overhead cover, using a densiometer, of 144 and 138 nests in 2004 and 2005, respectively. This same data was collected for 3 random sites associated with each of the natural nests. We did a conditional logistic regression in SPSS in order to determine

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 a 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

¹*Claremont High School, Claremont, CA, USA*, ²*Harvey Mudd College, Claremont, CA, USA*

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

¹California State University, Northridge, Northridge, CA, USA, ²John Carroll University, University Heights, OH, USA, ³AMBICOR, Tibás, Costa Rica

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 indices 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.

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 Clevestine, 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 Cobos^{1,2}, Robert Espinoza², L. Lee Grismer³, Evan Quah⁴, Shahrul Anuar⁴

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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

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A Paleoecological 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

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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

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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.*, a known ectoparasite. 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

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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.

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

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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.

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

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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, F_{is} , 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

Lisa Crawford¹, Nicholas Fisher¹, Cheng-Shiuan Lee¹, Douglas Adams², Maeva Giraudo³, Anne McElroy¹

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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

California Polytechnic State University, San Luis Obispo, CA, USA

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.

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

Martha Crump

Utah State University, Logan, UT, USA

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!

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

Paul Cupp

Eastern Kentucky University, Richmond, KY, USA

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.

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

Kathleen Currie, Matthew Fujita

University of Texas at Arlington, Arlington, TX, USA

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.

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

Joseph Nacy, Joseph Pechmann

Western Carolina University, Cullowhee, North Carolina, USA

Artificial Burrows Mitigate the Effects of Fire-Suppression on the Growth of Juvenile Dusky Gopher Frogs.

The dusky gopher frog occupies longleaf pine savannas periodically frequented by fire, where grasses and natural burrows are abundant. Gopher frogs avoid fire-suppressed habitat, where the understory is comprised of shrubs and there are fewer burrows. It is assumed that fire-suppression creates a suboptimal environment for the frog, but there are few data to support this. We examined growth rates of juvenile dusky gopher frogs in these two habitats and how burrow density affected these rates, using artificial burrows. We marked and released newly metamorphosed frogs into outdoor enclosures in a longleaf pine forest assigned to one of four treatments: frequently-burned, frequently-burned with artificial burrows, fire-suppressed, and fire-suppressed with artificial burrows. We recaptured frogs and recorded their mass and snout-vent length from June 2, 2018 through January 3, 2019. Frogs in frequently-burned enclosures containing artificial burrows had the greatest growth rates. Frogs in fire-suppressed enclosures without artificial burrows had the lowest growth rates. Frogs in the frequently-burned enclosures without artificial burrows and frogs in fire-suppressed enclosures with artificial burrows had strikingly similar growth rates. This demonstrates that increasing burrow density could mitigate the effects of fire-suppression. Survival also increased in frequent-fire enclosures containing artificial burrows. The results of this research suggest that both controlled burns and artificial burrows can increase growth and survival in these frogs. We recorded warmer temperatures in frequently-burned enclosures than in fire-suppressed, which may explain the higher growth rates in the former. Incorporating artificial burrows into management strategies will facilitate the recovery of this endangered species.

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

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Estimating Detection Probability for Burmese Pythons with Few Detections and Zero Recapture Events

Detection has been a long-standing challenge to monitoring populations of cryptic herpetofauna, which often have detection probabilities that are closer to zero than one. Burmese Pythons (*Python bivittatus* [=*Python molurus bivittatus*]), a relatively recent invader in the Greater Everglades Ecosystem of Florida, are cryptic snakes that have long periods of inactivity.

Additional management actions, such as removal of every python encountered, create challenges for estimating population size and quantifying effects of management using traditional statistical approaches. We used Bayesian analysis of data collected from 59 visual surveys and radiotelemetry to estimate detection probability for Burmese Pythons. Detection probability estimates can be used to improve interpretation of encounter and removal data and whether they are having positive effects on management goals. We found that detection probability ranged from 0.0001 – 0.0146 depending on statistical method used and how survey effort was calculated. Detection probabilities for Burmese Pythons are therefore likely < 0.05, but factors such as the number of searchers or time of day may improve detection probability. Traditional capture-recapture or visual surveys are, however, unlikely to yield accurate information on Burmese Python population size or trends across time without cost-prohibitive effort. Consequently, novel method development to monitor or measure Burmese Python populations, including techniques better equipped to handle very low detection, is critically needed for informative and reliable inferences about population size or the management effects of python removal.

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

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Underrepresented Animals, Underrepresented People: how the needs of amphibians and reptiles shed light on ways to empower people

Natural resource management decisions and policies historically have omitted amphibians and reptiles. Therefore, herpetofauna remain underrepresented in conservation and management communities. This lack of attention is among the contributing reasons to their population declines worldwide. To benefit herpetofauna, more actions and policies must include amphibians and reptiles and also address their needs. Such actions and decisions will allow these animals not only to survive, but will foster conditions that allow them to thrive. Herein lies a metaphor: our study animals illuminate the path forward to creating inclusion in herpetology. When our actions and decisions intentionally consider and address the needs of underrepresented groups, we equip these colleagues with reasons to remain in herpetology, and we create conditions that allow them to thrive, the first step in empowering minoritized groups. Throughout history, individuals within underrepresented groups contributed to our understanding and advancement of herpetology, but they were not always welcomed. In some instances, the actions and words of individuals in the majority and in roles of power created exclusive spaces that not only left people out, but left them behind. During the 2018 JMIH, a flurry of actions and discussions led to changes in policy and increased efforts in inclusivity among the three societies. The events also empowered underrepresented people to share how prior experiences had discouraged them from these sorts

of meetings, or worse, from pursuing herpetology. We will share insights on being included (and excluded), and the stories of those who are not here to speak for themselves.

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

Ann-Elizabeth Nash, Stephen Mackessy

University of Northern Colorado, Greeley, CO, USA

Social Structure of the Spiny-Tailed Iguana, *Ctenosaura similis*

Social structures of reptile groups are poorly known, yet cohorts may influence mate choice, foraging, nesting sites, predator avoidance, and disease transmission. To address this dearth of information, I examined personality, network position, and genetic relatedness of a group of free-ranging Spiny-Tailed Iguanas (*Ctenosaura similis*). These social (but non-cooperative) animals form stable aggregations (>5 years), developing relationships through repeated, non-random interactions. During four field seasons, ~28 lizards wore physical proximity tags, recording associations when lizards were ≤ 2 meters apart. Networks were analyzed for individual and group measures. To evaluate personality, lizards were assayed via flight initiation distance, arena tests, and observed agnostic encounters with conspecifics. There is strong support for existence of distinct personalities and a boldness/aggression behavioral syndrome. Social network positions, however, fluctuate by season. Female associations remain constant during but differ between seasons, perhaps indicating less need to remain near a preferred mate. Network analysis demonstrates high group density, yet animal disappearances were not rapidly filled, possibly weakening group cohesion. Targeted individual removal may therefore deteriorate the social structure, and this offers the possibility of control where *C. similis* is invasive. This is the first large-scale study to look at personality and social network structure in an egg-laying, Neotropical lizard that exhibits facultative group formation. Results to date demonstrate a level of complexity hypothesized as an important step in the evolution of more multifaceted sociality. As an IUCN “species of least concern,” this proxy may reveal social structure characteristics needed to support self-perpetuating populations of endangered iguanas.

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

Lisa Natanson¹, Bethany Deacy²

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Age Underestimation Using Vertebral Band Pairs in the Sandbar Shark, *Carcharhinus plumbeus*, in the Western North Atlantic Ocean

Age underestimation of many shark species has been shown using age validation techniques such as bomb radiocarbon, oxytetracycline (OTC) injection, and tag-recapture data. Validation studies indicate that band pair deposition in vertebral centra may not be directly related to time, especially in older individuals of a species. Vertebrae from tagged, OTC-injected, and recaptured sandbar sharks, *Carcharhinus plumbeus*, were examined to determine if band pair deposition past the OTC mark matched the time at liberty. In 6 of the 8 OTC injected sharks at liberty >1 year, band pair count past the OTC mark underestimated time at liberty by 24-58%. Additionally, tag-recapture growth models were applied to updated recapture data for sandbar sharks and compared with growth rates described by vertebral band pair count, bomb radiocarbon, and OTC injection. The growth rates derived from the updated recapture data were slower than those described by previous vertebral band pair growth curves but similar to those predicted by bomb radiocarbon and OTC injection. It is likely that vertebral band pairs may be coincidental to time in small individuals due to faster growth, however, as growth slows in older individuals, band pairs no longer coincide with time. Together these results indicate that age underestimation based on vertebral band pairs is occurring and that modeling tag-recapture data may be a more accurate method for age determination in elasmobranchs given that band pair deposition in vertebral centra do not coincide with time throughout life.

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

Laurel Nave-Powers, Kyle Piller

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Testing global niche convergence of cypriniform fishes (Suborder Cyprinoidei): A geometric morphometric approach

Niches of animals can be inferred from the shape of their bodies. By quantifying body shape, the niches of individual species can be compared and niche-packing patterns of communities can be examined. Cyprinoidei (Cypriniformes) is a suborder of freshwater fishes that are widely distributed and ecologically variable. By comparing body shape data for communities of cyprinoid fishes across their range, we can investigate patterns of niche use and assess whether the same general patterns of niche packing are recovered throughout their distribution. We hypothesize that the same general niche patterns will be recovered across the globe regardless of species richness (niche conservatism), however, the disparity of niches (spread in morphospace) will vary based on species richness. This hypothesis will be tested by comparing body shapes of representative stream-dwelling cyprinoids across the globe. At present, we have gathered body shape data from cyprinoid fish communities from three regions (North America, Africa, and Asia) and analyzed the data using standard geometric morphometric data analyses. It is expected that we will find clear replicated patterns of body shapes and niche position across the globe regardless of the number of co-occurring species, although the degree of disparity among and within groups may be reduced as species diversity increases.

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

Heather Neldner¹, Michael Westphal², Ignacio Moore³, Kathleen Ivey¹, Emily Taylor¹

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Blunt-Nosed Bling: Are Radio Collars a Stressor to Blunt-nosed Leopard Lizards (*Gambelia sila*)?

The federally endangered blunt-nosed leopard lizard (*Gambelia sila*) inhabits the rapidly disappearing San Joaquin Desert of California. A variety of techniques are employed to better understand the remaining populations of blunt-nosed leopard lizards, including the deployment of radio collars around the lizards' necks. However, the extent to which the collars impact the lizards is unknown. Sub-lethal effects of radio collars may be detected by examining hormonal evidence of stress. Corticosterone (CORT) is a glucocorticoid hormone and mediator of stress, and high plasma CORT levels may suggest an animal is under some form of physiological stress. At the end of a three-month radiotelemetry project, we collected blood samples from twenty-five radio-collared and six uncollared blunt-nosed leopard lizards. Preliminary results suggest baseline CORT did not differ between radio-collared and uncollared lizards, indicating that wearing radio-collars may not be a chronic stressor to the lizards. To measure stress reactivity - the rise in CORT from baseline following an acute stressor - lizards were placed inside breathable cotton bags for one hour, after which an additional blood sample was collected. We found that stress reactivity also did not differ between groups, indicating that radio-telemetry did not alter the acute stress response. Examining these endocrine profiles provides much-needed data suggesting that radio-telemetry may not be stressful to blunt-nosed leopard lizards, suggesting that our field methods for tracking sensitive species do not negatively impact them.

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

Lindsey Nelson¹, Christian Jones², Jan McDowell¹

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An Interdisciplinary Investigation of the Population Structure of Clearnose Skates, *Rostroraja eglanteria*, Using Genetics and Morphology

Clearnose skates, *Rostroraja eglanteria* (Bosc 1800) inhabit the United States coastal waters of the western Atlantic Ocean, from Massachusetts to Florida and in the eastern Gulf of Mexico. They are often incidentally caught in bottom trawl fisheries, discarded at sea, and poorly

recorded. Unlike their more charismatic relatives, they have been afforded little attention by fisheries managers and conservation groups. Before any policies can be implemented or improved, more life history research is needed. In particular, understanding population structure can aid in characterizing *R. eglanteria* population gene flow, segregation, migration, local adaptation, and phenotypic variation, delimiting stocks, and more accurately manage harvest. For the purposes of our research, *R. eglanteria* natural range has been subdivided into three study regions; the east coast of the U.S. north of Cape Hatteras, the east coast of the U.S. between Hatteras and the Florida Peninsula, and the Gulf of Mexico. We tested whether clearnose skates consist of a single panmictic population using an interdisciplinary combination of genetic and morphological methods. Fine scale genetic analysis was examined for evidence of differentiation within and between study regions. Additionally, 71 morphometric and meristic characters were collected from whole skates and also examined for differences between study regions. Results from each method were compared for concordance or discordance, and together, can provide biologically meaningful insights.

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

Dalton Neuharth, Michael Forstner, Sarah Fritts

Texas State University, San Marcos, TX, USA

Response of a Lizard Assemblage to a Catastrophic Wildfire

As wildfire frequency and severity increase, it has become more important to understand responses of resident faunal communities to these events. Overall, reptiles have shown variable responses to wildfire. Total abundance and diversity tend to respond neutrally, while individual species may have negative responses. However, some species may even respond positively to wildfire. Much of the research conducted on wildfire impact on reptiles have assessed short-term impacts, often approximately two years following the event. This brief time period may not detect potential lagged responses, which have been shown to occur in long-term projects. The Lost Pines ecoregion represents the westernmost, and disjunct, population of Loblolly pine (*Pinus taeda*) in central Texas. It experienced a catastrophic wildfire in 2011, resulting in major habitat restructuring. Lizard community composition and individual species responses were quantified during the spring months following this wildfire. These datasets were compared to determine whether the lizard community in the Lost Pines ecosystem exhibited a lagged response following the wildfire of 2011. Additionally, burned forest was salvage logged and responses to this were also measured.

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

Emily Neuman, Matthew Julius

You are what you eat: Impact of food quality on fatty acid in fish

Fish have been a source of food consumption for millenia, and their nutritional quality is an important aspect for human health. Lipid quality in fish is related to the dietary intake of fish. Variations in the primary production community, where lipid sequestered by fish originate, have varied in response to anthropogenic environmental alterations. These alterations potentially impact lipid composition in fish and subsequently modify their nutritional quality as food source for humans. Over a 20-day period, *Pomoxis nigromaculatus* were fed with pellets produced by two different algal species. These were *Cyclotella meneghiniana* (a diatom rich in omega 3 and 7 fatty acids), and *Haematococcus pluvialis* (a green algae rich in carbohydrates). This was done to test the hypothesis that fish fed a lipid rich diet should have a higher nutritional value than fish fed with a carbohydrate rich diet. At the end of the 20-day period several metrics were quantified and compared statistically, most notably, total lipids (soxhlet extracted) and lipid class composition (GS/MS quantified). These results demonstrate how variation in the primary production community impact the food quality of grazing fish. Anthropogenic alterations via nutrient enrichment of aquatic systems is known to cause a shift from golden (diatom) algae to green algae. These results have management ramifications for environmental managers that are not current considering this impacts when making management decisions.

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

Alisa Newton¹, Michael Hyatt¹, Malatos Joseph¹, Steven Ksepka², Stephan Bullard²

¹Wildlife Conservation Society, New York Aquarium, Brooklyn, NY, USA, ²Southeastern Cooperative Fish Parasite and Disease Laboratory, Auburn University, Auburn, AL, USA

Scuticociliate (*Miamiensis* sp.) Associated Meningoencephalitis in Wild Northwest Atlantic Smooth Dogfish (*Mustelus canis*)

A mortality event in free ranging smooth dogfish (*Mustelus canis*) affected Coney Island and Brighton Beaches in Brooklyn, NY, USA between 15 August and 4 September 2018. Four live-stranded sharks were recovered from the beach. They were minimally responsive, disoriented, and could not right themselves when inverted. All died or were euthanized within 48 hours despite medical care. Four additional dead sharks were recovered from the beach. Eight animals received a gross necropsy, histopathology and ancillary testing. At necropsy gross lesions were confined to the brain. The olfactory lobe and bulbs were malacic, the leptomeninges demonstrated increased opacity and pinpoint hemorrhages. The cerebral spinal fluid (CSF) was discolored pink to red. Impression cytology of the brain was positive for large numbers of ciliates morphologically consistent with a species of Scuticociliatida (Ciliophora). Direct wet-mount cytology of the CSF was similarly positive for live scuticociliates. Histopathology confirmed necrotizing meningoencephalitis due to a scuticociliate protozoan infection in all animals. PCR and sequencing resulted in a 584 base pair fragment of the small subunit

ribosomal RNA gene (18s rDNA) that was identical (100% similarity) to that of an isolate (GenBank no. KC285109.1) of *Miamiensis avidus* (senior subjective synonym of *Philasterides dicentrarchi*) collected from meningoencephalitic, aquarium-kept zebra sharks (*Stegastoma fasciatum*). Findings resemble the 2017 mortalities of leopard sharks (*Triakis semifasciata*; San Francisco Bay, CA, USA) that had intense brain infections of *P. dicentrarchi* (as *M. avidus*). This local mortality event highlights the need for complete necropsy evaluation in wild shark stranding events.

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

Alisa Newton¹, Nicole Stacy², Michael Hyatt¹, Carolyn Cray³, Chris Fischer⁴

¹Wildlife Conservation Society, New York Aquarium, Brooklyn, NY, USA, ²University of Florida, College of Veterinary Medicine, Gainesville, FL, USA, ³University of Miami, Miller School of Medicine, Miami, FL, USA, ⁴OCEARCH, Park City, UT, USA

Preliminary Animal Health Assessment Findings for Northwest Atlantic White Sharks (*Carcharodon carcharias*)

Health assessments with the goal of developing blood analyte reference intervals in wild elasmobranch populations are essential to understanding individual animal, in situ population, and ecosystem health in the face of current and future environmental disturbance and anthropogenic stressors. Our objectives are to perform health assessments of white sharks across three life stages through physical exam, baseline hematology (hematocrit, total solids, complete blood count, differential), 17 plasma chemistry analytes, protein electrophoresis (fractions 1-5), acute phase proteins (C-reactive protein [CRP], serum amyloid A, haptoglobin), secondary stress response (acid-base, blood gas and metabolites at the beginning and end of handling events), and to explore relationships between these analytes and biologic data (morphometrics, life-history stage, season, and region). To date, we have evaluated 37 animals: 20 YOY (9 male, 11 female), 10 subadult (4 male, 6 female) and 6 adult (5 male, 1 female). Of note, median CRP in subadults and adults sampled in the Southeast/winter were significantly higher compared to those sampled in the Northeast/fall, suggesting regional and/or seasonal biological or environmental stressors to the population. Blood gas and chemistry analysis detected metabolic compensation (decreasing bicarbonate) and adequate ventilation (decreasing pCO₂ increasing pO₂) during handling. Blood lactate was similar or lower than published data in white sharks and other lamnids. Satellite tag movements indicate high survivorship. These data provide comprehensive blood analyte reference intervals factoring in intrinsic and extrinsic factors and contribute to understanding effects of captures and stressors on the Northwest Atlantic white shark population.

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

Kyle Newton

Washington University, St Louis, MO, USA

The Electro- and Magnetosensory Biology of Chondrichthyan Fishes

The Ampullae of Lorenzini (AoL) are the electrosensory organs of Chondrichthyans that were first described morphologically by Stenonis and Lorenzini in the late 1800s, and have been hypothesized to act as mechanical, thermal, or salinity sensors. The electroreceptive function of the AoL was established in the 1960s by Murray, Dijkgraaf, and Kalmijn, and mediates behaviors such as foraging and prey capture, conspecific detection and communication, predator avoidance, and possibly navigation. The electroreceptor cells within the AoL evolved from the sensory hair cells of the lateral line to passively detect the weak, low frequency bioelectric fields generated by the processes of osmoregulation and ventilation in other organisms. Recent studies have determined the behavioral thresholds of several marine chondrichthyans in both marine and freshwater habitats, how the morphological distribution of ampullary pores correlates with phylogeny and habitat, and how the molecular structure of electroreceptor ion channels mediates different behavioral phenotypes. Additionally, studies have shown that chondrichthyans can detect changes in various parameters of the geomagnetic field which they could use as cues to determine their geographic location and compass heading during migrations. Future directions in electro- and magnetosensory research include: understanding the cellular and molecular mechanisms that underlie physiological tuning and the expression of behavioral phenotypes; how electromagnetic “noise” from anthropogenic activities impacts sensory function and behavior; determining the mechanism of magnetic stimulus detection; and whether geomagnetic field cues are used by migrating chondrichthyans to navigate through unknown locations.

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

Stuart V. Nielsen^{1,2,3}, Anna Farmer⁴, Kevin Enge⁴, David C. Blackburn^{1,2}

¹*Florida Museum of Natural History, Gainesville, FL, USA*, ²*University of Florida, Gainesville, FL, USA*, ³*Marquette University, Milwaukee, WI, USA*, ⁴*Florida Fish and Wildlife Conservation Commission, Gainesville, FL, USA*

Integrative Taxonomy of the Near Threatened Gopher Frog (*Rana capito*)

The gopher frog (*Lithobates capito*) is distributed across the Southeastern US, but recent genetic studies have suggested that gopher frogs in peninsular Florida may be genetically distinct from those in the rest of the range of the species. In order to provide a solid foundation for future conservation and management, we gathered additional data to provide an integrative taxonomic decision regarding the taxonomy of this species/species complex. We aim to determine if any regional, ‘species-level’ differences exist by examining i) adult external and osteological

morphology (using linear morphometrics of fluid preserved specimens and geometric morphometrics of ct scanned individuals, respectively), ii) gross larval morphology, while also comparing iii) recordings of male mating calls and iv) photographs of dorsal color pattern, from individuals spanning the species' range. Our results were mixed; when the 'populations' were restricted to just Florida ('panhandle' vs. 'peninsular'), we found subtle but significant differences between populations. However, when expanded to the entire distribution, those differences disappeared. We here present our interpretation of these results and provide alternative paths forward in order to best conserve this declining, near threatened taxon.

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

Stuart V. Nielsen^{1,2,3}, Mark-Oliver Rödel⁴, Michael Barej⁴, David C. Blackburn^{1,2}

¹Florida Museum of Natural History, Gainesville, FL, USA, ²University of Florida, Gainesville, FL, USA, ³Marquette University, Milwaukee, WI, USA, ⁴Museum für Naturkunde, Berlin, Germany

It Isn't Easy Being Slippery...or Giant! Systematics and Biogeography of African Slippery Frogs (*Conraua*)

The African slippery frogs contain the largest extant species of frog, *Conraua goliath*, which can grow to 1ft. in length and weigh more than 7lbs. The six described species are disjunctly distributed across equatorial Africa, with isolated species from West Africa, the Gulf of Guinea, and even the Horn of Africa. They tend to occupy fast moving streams, are a commercially important foodstuff, and—for the most part—are threatened (four of the six species are classified as Vulnerable, Endangered, or Critically Endangered), yet their taxonomy and biogeography is poorly studied. Using a well-sampled multi-locus dataset, we provide the first estimate of phylogenetic relationships for this genus and comment on their biogeographic patterns. Although we recover some within-taxon geographic substructure, samples for each species are well circumscribed based on contemporary taxonomy—with the exception of *C. derooi* (which renders *C. alleni* paraphyletic), albeit with limited genetic divergence between the major clades.

24 Herpetology Biogeography II, Ballroom 3 – Cliff Lodge, Friday 26 July 2019

Lotanna Micah Nneji^{1,2}, Adeniyi Charles Adeola^{1,2}, Jie-Qiong Jin¹, Adiaha A. A. Ugwumba³, Min-Sheng Peng^{1,2}, Robert W. Murphy^{1,4}, Jing Che¹

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Phylogeography of Red Headed Rock agama (*Agama agama*) from Nigeria

Nigeria is an Afrotropical region with considerable ecological heterogeneity and levels of biotic endemism. Among its vertebrate fauna, reptiles have broad distributions, thus, they constitute a compelling system for assessing the impact of ecological variation and geographic isolation on species diversification. The red headed rock agama, *Agama agama*, lives in a wide range of habitats and, thus, it may show genetic structuring and diversification, thus, we tested the hypothesis that ecology affects its genetic structure and population divergence. Bayesian inference phylogenetic analysis of a mitochondrial DNA (mtDNA) gene recovered four well-supported matriline with strong evidence of genetic structuring consistent with eco-geographic regions. Genetic differences among populations based on the mtDNA also correlated with geographic distance. The ecological niche model for the matriline had a good fit and robust performance. Population divergence along the environmental axes was associated with climatic conditions, and temperature ranked highest among all environmental variables for forest specialists, while precipitation ranked highest for the forest/derived savanna, and savanna specialists. Our results cannot reject the hypothesis that niche conservatism promotes geographic isolation of the western populations of Nigerian *A. agama*. Thus, ecological gradients and geographic isolation impact the genetic structure and population divergence of the lizards. This species might be facing threats due to recent habitat fragmentation, especially in western Nigeria. Conservation actions appear necessary.

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

Ai Nonaka¹, Jeff Milisen², Bruce Mundy³, G. David Johnson¹

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Blackwater Diving: An Exciting Window into the Planktonic Arena and Its Potential to Enhance the Quality of Larval Fish Collections

”Blackwater diving”, in pelagic habitats at night, has roots in both scientific and recreational diving. The first documented scientific pelagic dives were conducted in France in 1962 for the purpose of collecting delicate organisms by hand. By 1990, photographs by Christopher Newbert in his 1982 book “Within a Rainbow Sea” had inspired a recreational following for nighttime pelagic diving. Today, blackwater diving has spread to Florida, Palau, Philippines, Indonesia, South Africa, Japan, and French Polynesia. The images and videos from this activity provide an exciting window into the planktonic arena and the way larval fishes appear and swim within it. For the first time we are able to see the often elaborate appendages and other specializations of these larvae as they appear in situ, prior to extensive net fixation damage. However, blackwater diving remains an almost exclusively recreational pursuit, particularly popular among underwater photographers, who have little interest in (or object to) collecting specimens for scientific study. Nonetheless, a logical next step is careful hand collection of specimens for scientific study. Growing numbers of recreational divers around the world have access to an otherwise expensive-to-research habitat. Here we present in-situ and post-fixation photos of larval fishes that were hand collected and fixed in 95% ethanol while blackwater diving out of Kona, Hawaii, with DNA barcode identifications congruent with morphology where possible. With the right motivation, blackwater diving could augment research in the pelagic ocean and significantly enhance natural history collections and our knowledge of the larvae of marine fishes.

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

Andrew Nosal^{1,2}, Daniel Cartamil², Chi Lam³, Lyall Bellquist⁴, Noah Ben-Aderet², Conner White⁵, Ryan Logan⁵, Ryan Freedman⁶, Christopher Lowe⁵, Brice Semmens², Philip Hastings²

¹*University of San Diego, San Diego, CA, USA*, ²*Scripps Institution of Oceanography, La Jolla, CA, USA*, ³*Large Pelagics Research Center, Gloucester, MA, USA*, ⁴*The Nature Conservancy, San Diego, CA, USA*, ⁵*California State University - Long Beach, Long Beach, CA, USA*, ⁶*Channel Islands National Marine Sanctuary, Santa Barbara, CA, USA*

Triennial Philopatry in the Eastern North Pacific Soupfin Shark (*Galeorhinus galeus*)

The movement ecology of the Soupfin Shark (*Galeorhinus galeus*) was investigated off California, USA using a combination of conventional, acoustic, and satellite tagging. Thirty-three sharks (all mature females) were captured in shallow water (< 5 m) off La Jolla, California in June – November of 2013 – 2017. Each shark was surgically implanted with a Vemco V16 coded pinger and tagged with a spaghetti identification tag. Acoustic receivers off La Jolla detected these sharks sporadically over periods averaging 81 days (range: 1 – 214 days) post-tagging. After leaving La Jolla in autumn, sharks did not return until spring, approximately 3 years post-tagging. This has been observed in three independent cohorts of Soupfin Sharks tagged in La Jolla: sharks tagged in 2013 returned in 2016, sharks tagged in 2014 returned in 2017, and sharks tagged in 2015 returned in 2018. Acoustic detections downloaded in summer 2019 will reveal whether sharks tagged in 2016 returned in 2019 and, perhaps more interestingly, whether sharks tagged in 2013, which returned in 2016, will return again in 2019. Triennial migrations are unusual among animals and often indicate a triennial reproductive cycle. The Soupfin Shark reproductive cycle has been determined to be annual, biennial, and triennial, depending on the population; in California, the cycle was thought to be annual. In light of these new findings, we reconsider the possibility of Soupfin Sharks in the Eastern North Pacific having a triennial reproductive cycle.

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

Clay Noss, Bree Rosenblum

University of California - Berkeley, Berkeley, CA, USA

Trophic Cascades in the Desert? An Exclosure Experiment in White Sands

Trophic cascades are permutations across at least two links in a food chain, and are frequently invoked when there are shifts in the primary trophic level (plants) caused by changes at least two trophic levels above plants. There is currently a serious lack of data from many systems, including deserts, on trophic cascades. We manipulated lizards in a desert dune community in White Sands National Monument and measured the effect on lower trophic levels. Six experimental arrays, each consisting of 3 10 by 10 meter treatments (full exclosure, partial, and control), were built in June 2017. We collected data on lower trophic levels at the beginning of the study and periodically over the next two years. Response variables include web building spider densities, arthropod biomass and community composition (pitfall and sticky traps), plant cover, plant community composition, plant growth and reproductive output, and herbivory (leaf damage). Pitfall trap data indicates no difference in abundance or biomass between treatments for Collembola, Coleoptera, Formicidae or Araneae between June 2017 and March 2018. In our web building spider surveys, we found significantly higher densities in lizard exclosure plots in June 2018 (one way ANOVA; $p = 0.0023$) and no difference in August 2018 ($p = 0.454$). Quantitative results for plants, herbivory and sticky traps are forthcoming, but qualitatively no

major effects of lizard exclusion have been observed. Early conclusions are that that lizard removal has effects lower trophic levels in a desert community, but their strength and magnitude is dependent on season.

802 Amphibian Conservation, Ballroom 2 – Cliff Lodge, Saturday 27 July 2019

Justin Nowakowski¹, Luke Frishkoff², Michelle Thompson³, Tatiana Smith¹, Brian Todd¹

¹*University of California, Davis, Davis, CA, USA*, ²*University of Texas, Arlington, Arlington, TX, USA*, ³*Field Museum, Chicago, IL, USA*

Phylogenetic homogenization of amphibian assemblages in human-altered habitats across the globe

Widespread conversion of natural habitats to human land use creates evolutionarily novel environments and causes declines of native species. Stemming biodiversity loss requires an understanding of why some species persist while others decline in these novel habitats. We analyzed survey data of amphibian species from around the globe to determine whether closely related species respond similarly to habitat conversion. We find that species that persist in converted habitats tend to come from the same clades within the amphibian tree of life and that by favoring these widely distributed clades, habitat conversion leads to nonrandom extirpations and loss of evolutionary history. Our results show that the identity of winners and losers during the Anthropocene can be tightly linked to their evolutionary history.

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

Rob Nowicki^{1,2}, Diana Churchill³

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An Estimate of Amino Acid Trophic Enrichment Factors for Stable Isotope Analysis in Sharks and Rays

Understanding the trophic dynamics of consumers is critical to understanding their ecological roles. Compound Specific Stable Isotope Analysis of Amino Acids (CS-SIA) allows researchers to estimate trophic position of consumers without collecting contemporary baseline food samples. This provides benefits over traditional Stable Isotope Analysis, particularly for widely ranging consumers like sharks and rays. However, using CS-SIA requires knowing the Trophic Enrichment Factor (TEF): the amount that Nitrogen isotopes in amino acids enrich between food and consumer. To date, few TEFs exist for elasmobranchs. We partnered with Mystic

Aquarium in Stonington, CT to gather blood, muscle, and diet samples from captive held elasmobranchs to estimate Trophic Enrichment Factors for these species. Therein, we sought to provide TEF estimates across multiple species and tissue types, compare these to previously published TEFs, evaluate ideal amino acid pairings for TEF estimation, and determine whether TEFs differ significantly between tissues or species or if a single value could be generalized to elasmobranchs. We found that TEFs generated for Cownose rays are lower than TEFs found in non-elasmobranchs, but are similar to those published previously for sharks (TEF_{glu-phe} range of 2.3-3.4%). In contrast, TEFs between blood and muscle tissue suggest different tissues likely need distinct TEF values. Finally, we found that the amino acid Valine may be a good substitute or complement to Glutamic Acid when performing CS-SIA analysis. We suggest that TEFs may be able to be applied generally across elasmobranch taxa, but that each tissue type may require its own TEF.

379 Ichthyology Conservation, Cottonwood A-D – The Snowbird Center, Saturday 27 July 2019

David AJS O'Connor¹, Avery Scherer², Kristine N Moody³, Peter B McIntyre⁴, Michael J Blum³, J Derek Hogan¹

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Effects of aquatic invasive species removal on populations of a native Hawaiian freshwater goby *Awaous stamineus* (Gobioidei: Oxudercidae)

Species invasions have resulted in the imperilment and loss of native species and alteration of ecological processes on islands across the Pacific. Aquatic invasive species (AIS) are consistently identified as a primary threat to aquatic biodiversity in oceanic island streams, but little work has been done to evaluate the feasibility or outcomes of removal or mitigation. Herein we examined how AIS removal from streams on O'ahu (Hawai'i, USA) influence the demography of *Awaous stamineus*, one of five amphidromous gobies native to the archipelago. We tracked *A. stamineus* populations in a dozen watersheds through mark-recapture for a year prior and a year following AIS removal from an experimental 100 m reach, with comparisons drawn to proximate reference reaches. Among other measures, we assessed juvenile recruitment, population size, and adult movement patterns relative to AIS removal as well as abiotic in-stream conditions and climate variability. We found significant correlations between AIS species densities and *A. stamineus* population size, recruitment, and movement. Additionally, we found that stream flow influenced *A. stamineus* demography. Our findings also indicate that AIS removal can be a highly effective tool for the mitigation of AIS impacts, though maintenance removals will be required to sustain long-term benefits to improve the management and conservation of native Hawaiian migratory fishes.

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

Katherine O'Donnell

US Geological Survey, Gainesville, FL, USA

Phenology of Adult Breeding and Juvenile Emigration of Flatwoods Salamanders

For many amphibians, temperature and rainfall are key drivers of life history events like breeding and metamorphosis, and changes in these variables could shift amphibian phenology over time. A better understanding of the phenology of adult breeding and juvenile emigration in relation to these climatic variables would help inform the timing of habitat management and restoration for imperiled species. In 2017, I conducted a mark-recapture study to examine the breeding phenology of federally-threatened frosted flatwoods salamanders (*Ambystoma cingulatum*). I used funnel traps along drift fences to monitor salamander movements at three known breeding wetlands at St. Marks National Wildlife Refuge (Florida), marked and measured all salamanders. In fall 2017, I captured >100 unique adult *A. cingulatum* (97 new, 36 recaptures). There were three peaks of breeding activity, all coinciding with cold fronts moving through the region. In spring 2018, I captured >160 emerging metamorphs and found that hydroperiod variation explained phenological differences among ponds. In fall 2018, trapping effort was lower because storm surge from Hurricane Michael damaged drift fences. Still, I captured 36 adults (25 new, 11 recaptures), but captures were more evenly spread across the season. These results illustrate how the number of migrating adult and juvenile flatwoods salamanders is highly dependent on weather events. Understanding the role of climatic variables in amphibian migration is beneficial to informing both management (e.g., prescribed burning) and conservation (e.g., demographic studies) actions for this imperiled species.

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

Shannon O'Leary¹, Christopher Hollenbeck², Robert Vega³, John Gold¹, David Portnoy¹

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Disentangling Demographic, Spatial, and Environmentally-driven Signals in Genomic Data Sets: An Assessment of Southern Flounder, *Paralichthys lethostigma*

Identifying patterns of connectivity and population structure is an essential step towards effective management of marine fishes. The recent shift toward genome-wide data sets allows for a better understanding of how the complex interplay of genetic drift, migration, selection, and past demographic events shape contemporary patterns of genetic diversity. Here, 4,122 SNP-containing loci were used to determine patterns of connectivity of southern flounder, *Paralichthys lethostigma*, across its range and to assess the relationships between components of genomic

variation and environmental variables that vary among estuarine habitat in the northern Gulf of Mexico. Gulf and Atlantic samples were significantly diverged with Atlantic samples exhibiting significantly lower within-sample genetic diversity. While hierarchical AMOVA indicated significant heterogeneity among the sampled estuaries within the Gulf and Atlantic, pairwise comparisons were not significant. Comparison of the distribution of Tajima's D estimated at genome-wide scale differed significantly from the expectations of equilibrium, exhibiting a pattern consistent with historical population expansion. Landscape genomics analyses indicated that while differences in genetic diversity are related to spatial proximity, they are more strongly influenced by environmental characteristics of individual estuaries. These results suggest that not only the availability of specific habitats but also the diversity of habitat types should be a focus of management strategies, which for southern flounder include stock enhancement using hatchery-reared young-of-the-year.

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

Ken Ogborn¹, Mauricio Hoyos², Elena Tamburin³, Felipe Galvan³, Michelle Weisel⁴, Sue Houghton⁵, Hayes Baxley⁵, Nicolette Murphy¹, Toby S. Daly-Engel¹

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Genetic relatedness and connectivity in great white sharks (*Carcharodon carcharias*) from the Pacific Coast of Baja, Mexico

Understanding how and where reproduction occurs is crucial for devising effective management strategies for at-risk species. Yet relatively little is known about the reproductive strategies of great white sharks (*Carcharodon carcharias*), one of the largest aquatic predators on earth. Like most sharks, they are known to have long gestation periods and produce few pups at a time, though parameters may vary by population. Despite the fact that natal philopatry by white sharks has been shown in the Pacific and elsewhere, little is known about how they utilize specific nursery habitats. We collected tissue samples from two sites inhabited by white sharks on the Pacific Coast of Baja, Mexico, an offshore site where the community consists largely of mature individuals (Guadalupe Island, N = 35) and a coastal site located in a known nursery area (El Vizcaíno Biosphere Reserve, N = 21). We used 750 bp of the mitochondrial control region as well as nine species-specific microsatellite loci to investigate relatedness and connectivity. In Guadalupe, we identified two individuals with a parent-offspring relationship, and several individuals that were a part of a single multi-sired litter. In the nursery at Vizcaíno, we identified members of at least two multiply-sired families, including two half-siblings from different cohorts, confirming natal philopatry. Using genetics to identify critical reproductive habitat for specific populations of great white sharks will increase our chances of conserving these areas for the shark species that depend on them.

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

Kentaro Okuyama, Takeshi Sasaki

Tokyo University of Agriculture, Atsugi-city, Kanagawa, Japan

Morphological Characteristics of the Vomeronasal Organ and its Associated Structures in the Japanese Grass Lizard, *Takydromus tachydromoides*

Squamates possess a functionally well-developed vomeronasal organ (VNO) and heavily depend on it for olfaction. Previous studies have shown that the function of VNO is associated with the nasolacrimal duct and the choanal groove and anatomically supported by the capsule structure, cupola jacobsoni, which consists of several skeletal and cartilaginous components. Although the morphological diversity of these structures have been elucidated, their evolutionary history is not well understood because of the lack of information about the developmental process of these structures. In this study, we investigated adult morphological characteristics and embryogenesis of the VNO and associated structures in the Japanese grass lizard (*Takydromus tachydromoides*, Lacertidae) using light microscopy, aiming to provide basic information and contribute to the understanding of squamate evolution. The morphological characteristics of adult *T. tachydromoides* were similar to other lacertid species in terms of the components of cupola jacobsoni and the presence of the lachrymo-choanal gutter (LCG) structure, which is a completely fused structure between the choanal groove and the nasolacrimal duct and an extended component of the latter. On the other hand, interestingly, the LCG in *T. tachydromoides* is detached from the vomeronasal duct throughout its pathway, a characteristic different from other squamates in which the nasolacrimal duct opens into the vomeronasal duct. We confirmed the separation of the LCG from vomeronasal duct during embryogenesis in stage 35 embryo. In addition, we suggest the possibility of existence of another one lacertid species that has the LCG separated from the VND as observed in *T. tachydromoides*.

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

Charles W. Olaya-Nieto, William A. Pérez-Doria, Angel L. Martínez-González, Fredys F. Segura-Guevara

Fishery Biology Research Laboratory-FBRL, Department of Aquatic Sciences, University of Cordoba, Lórica, Cordoba, Colombia

Multiannual length–weight relationship of Mojarra amarilla *Caquetaia kraussii* in the Ciénaga de Ayapel, Colombia

The multiannual length–weight relationship of Mojarra amarilla *Caquetaia kraussii* in the Ciénaga de Ayapel, Colombia, among 2006 and 2010 years was estimated. The sample size was 2559 individuals, length ranged between 14.0 and 30.0 cm TL, total weight between 48.0 and 598.0 g and the mean length in the catch was 20.9 cm TL. 97.8% of individuals were caught below the minimum length of catch established for the species in the San Jorge River Basin. The length–weight relationship for both sexes was $TW = 0.012 (\pm 0.06) TL^{3.12 (\pm 0.05)}$, $r = 0.95$, $n = 2559$, with positive allometric growth coefficient, ranging between 2.76 (2006 year) and 3.23 (2009 year), with statistically significant differences. The condition factor ranged from 0.010 (2008 and 2009 years) to 0.035 (2006 year), with statistically significant differences. Given the information analyzed, it appears that the body proportions of the yellow Mojarra have changed during the study period, suggesting that the species is being overfished and subject to environmental and anthropogenic pressures that are affecting their growth in size and weight as well as their welfare in the Ciénaga de Ayapel.

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

Charles W. Olaya-Nieto¹, William A. Pérez-Doria¹, Juan M. Villalba-Quintero¹, Ángel L. Martínez-González¹, Fredys F. Segura-Guevara¹, Glenys Tordecilla-Petro²

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Multi-year length-weight relationship of Bocachico *Prochilodus magdalenae* in the San Jorge River Basin, Colombia

To estimate the multi-year length-weight relationship of Bocachico *Prochilodus magdalenae* in the San Jorge River Basin, Colombia, 5556 specimens were collected between 2006 and 2010 years. The length-weight relationship and condition factor were estimated with the equation $TW = a TL^b$ and $K = TW/TL^b$, respectively. The size ranged between 21.9-57.8 cm TL, the total weight between 125.0-3458.0 grams, and the mean length in the catch estimated was 31.4 cm TL; and 3312 females, 2237 males and 7 undifferentiated were found. Length-weight relationship estimated for both sexes was $TW = 0.003 (\pm 0.03) TL^{3.42 (\pm 0.02)}$, $r = 0.97$, $n = 5556$, equation representing the sample studied as no significant statistical differences were found between LWR for females and males. The multi-year growth coefficient was positive allometric and ranged between 3.06 (2006 year) and 3.19 (2010 year) with statistically significant differences; while the condition factor ranged from 0.009 (2006 year) and 0.003 (2010 year), without statistically significant differences. Direct correlation between the condition factor and the hydrological cycle of San Jorge River in low and rising waters was found. The information analyzed suggests that the welfare of the species is maintained over time.

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

Charles W. Olaya-Nieto¹, Fredys F. Segura-Guevara¹, William A. Pérez-Doria¹, Glenys Tordecilla-Petro²

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Reproductive biology of Pacora *Plagioscion magdalenae* in the San Jorge River Basin, Colombia

To study the reproductive biology of Pacora *Plagioscion magdalenae* (Steindachner, 1878) in the San Jorge River Basin, Colombia, 371 Individuals with total length (TL) ranged between 20.5-67.0 cm and total weight (TW) ranged between 74.0-3764.0 grams were collected. The gonads were placed in Gilson solution, the Vazzoler scale was applicated and sexual proportion, maturity index, spawning season, length at first maturity, ovocytes's diameter and fecundity were estimated. It was found 271 females y 100 males, with sexual proportion female: male 2.7:1, differently than expected, with sexual dimorphism to size, because females reach larger sizes than males. The maturity indices show that spawning season extends during the year, observing the largest spawnings in September, November, January, May and July. Length at first maturity was estimated in 36.1 cm TL for combined sexes, the oocytes's diameter was 438 μ m and the average fecundity was 134012 oocytes. The results obtained suggest that Pacora is a fish with partial spawning, with prolonged spawning season throughout the year and independent of hydrological cycle of San Jorge River, small ovocytes and high fecundity.

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

Charles W. Olaya-Nieto¹, Fredys F. Segura-Guevara¹, Glenys Tordecilla-Petro², William A. Pérez-Doria¹

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Multiannual length–weight relationship of Pacora *Plagioscion magdalenae* in the San Jorge River Basin, Colombia

The multiannual length–weight relationship of Pacora *Plagioscion magdalenae* (Steindachner, 1878) in the San Jorge River Basin, Colombia, between 2006 and 2010 years, was estimated. The sample size was 824 individuals, length and total weight ranged between 20.0-67.0 cm TL and 58.0-3764.0 grams, respectively, and the mean length in the catch was 34.7 cm TL. It was found that 67.2% of the individuals are caught below the minimum length of catch established for the species in the San Jorge River Basin, which suggests a problem of overfishing the growth on the species. The length–weight relationship for both sexes was $TW = 0.002 (\pm 0.05) TL^{3.41 (\pm 0.03)}$, $r = 0.99$, $n = 824$, with positive allometric growth coefficient, ranging

between 3.24 (2008 year) and 3.44 (2006 year), without statistically significant differences, and the condition factor ranged among 0.002 (2006, 2007, 2009, 2010 years) and 0.004 (2008 year), without statistically significant differences. As in the five years studied, no significant statistical differences were found between the growth coefficients nor in the condition factors estimated, it is inferred that Pacora has maintained its growth rate despite the fishing pressure exerted on the species in the San Jorge River Basin.

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

Emily Olson

Sea Life Minnesota Aquarium, Bloomington, Minnesota, USA

Documentation of a Sand Tiger Shark (*Lamniformes: Carcharias taurus*) Captive Breeding Event

The sand tiger shark (*Carcharias taurus*) is distributed in warm waters along the coasts of North America, South America, Africa, Asia, and Australia. Their physical appearance is often described as menacing due to their large stocky bodies, pointed rostrum, and rows of protruding dentition. Their ominous appearance and docile nature makes them an excellent addition to zoos and aquariums. There have only been three documented live births of *C. taurus* in captivity. Overall sand tiger sharks have a low rate of reproduction among cartilaginous fishes and typically only produce two pups every two years. In the fall of 2018, staff members of Sea Life Minnesota Aquarium (SLMN) suspected the possible pregnancy of a female sand tiger. The SLMN Aquarium currently houses nine adult *C. taurus*, including four females. In this presentation I document the procedure for transferring, holding, and examining the pregnant sand tiger shark. This includes the procedure of performing an ultrasound of both uterine chambers to examine the presence of eggs and/or developing embryos. Captive breeding is an important role that Zoos and Aquariums play in the conservation of animals, and this study highlights the occurrence of a rare captive breeding event in a lamniform shark.

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

Guillermo Ortí

George Washington University, Washington, DC, USA

FishLife Exons Advance Phylogenomic Studies of Fishes

Our knowledge of the Tree of Life of fishes has undergone a dramatic transformation in the last ten years. Increased phylogenetic resolution has led to identification of new clades among poorly

resolved groups of fishes but many groups remain to be sampled more densely while others still have poor or contested resolution. Much of this progress has been spawned by the development and implementation of methods to sequence a handful of exons for phylogenetic analysis for hundreds of species. A quantitative leap in the size of molecular datasets came about with the development of target enrichment and next-generation sequencing methodologies, a technology that has promoted other types of useful molecular markers such as UCEs. Based on thorough inspection of 144 genomes and 159 transcriptomes of fishes, the NSF-funded FishLife project has identified a set of 1105 orthologous exons and optimized exon-capture protocols to effectively sequence them across the diversity of species in the fish Tree of Life. These exons have phylogenetic information to resolve divergences among ancient lineages, recent speciation events, and even population structure (e.g., phylogeography). In this presentation, I will give a summary of the progress made to acquire sequences, the taxonomic groups under study, the members of the team involved, and of optimized protocols for acquiring and assembling the data. The growing FishLife database, holding large numbers of species sequenced to date (4000, plus 1200 in process), constitutes a valuable resource for future studies aiming to refine our knowledge of the evolutionary history of fishes.

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

Guillermo Ortí¹, John Sullivan², John Lundberg³, Nathan Lujan⁴, Keylie Gibson¹, Lily Hughes¹, Ricardo Betancur-R⁵, Dahiana Arcila⁵

¹*George Washington University, Washington, DC, USA*, ²*Cornell University, Ithaca, NY, USA*, ³*Academy of Natural Sciences of Drexel University, Philadelphia, PA, USA*, ⁴*American Museum of Natural History, New York, NY, USA*, ⁵*University of Oklahoma, Norman, OK, USA*

“Big Bang” Theory of Siluroid Global Diversification Revisited with Phylogenomic Data

Catfishes (Order Siluriformes) are a diverse group with more than 3000 living and fossil species distributed worldwide. They are found in freshwater habitats or along the coast of every continent. Phylogenetic relationships among major lineages of catfishes have been difficult to establish on the basis of morphological evidence alone but molecular data, both mitochondrial and nuclear DNA, have provided informative characters to advance our understanding of their phylogeny. Higher-level relationships among catfishes based on *rag1* and *rag2* sequence data were published over ten years ago, suggesting a South American origin of catfishes. That phylogeny placed Loricarioidei as the sister-group to all other catfishes, which were themselves split into two groups: the family Diplomystidae and a strongly supported and cosmopolitan Siluroidei clade. Resolution among 12 large, strongly supported groups of siluroids, however, could not be established, suggesting rapid diversification (Big Bang) in a short period of time. We here present new phylogenetic results based on analysis of 1051 exons for 123 catfish species plus outgroups. Our results support previous hypotheses based on limited data but further resolve the Neotropical family Cetopsidae as the sister group to all other Siluroidei within which a superclade consisting of the remaining Neotropical siluroids is sister to a clade comprising all living extra-Neotropical catfishes. These results provide new insights into the diversification and worldwide distribution of catfishes by lending support to the hypothesis that a single common

ancestor for all living, extra-Neotropical catfishes dispersed from South America to colonize the World around 100 million years ago.

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

Austin Osmanski¹, Katherine Brittain², Elizabeth Jones², Cao Rui², Jaime Gongora², Alexander Suh³, Ray David¹

¹Texas Tech University, Lubbock, TX, USA, ²Sydney School of Veterinary Sciences, Sydney, NSW, Australia, ³Department of Ecology and Genetics Uppsala University, Uppsala, Sweden

Ancient Hybridization Detection within *Crocodylus*

Interspecific hybridization can have lasting effects on genome architecture and the evolutionary trajectory of a species. The charismatic genus *Crocodylus* contains the most species, boasts the largest distribution, and utilizes more ecologically diverse habitats than any other extant group of Crocodylian. Previous work has recognized multiple cases of hybridization events between *Crocodylus* species with relatively deep diverges (~10mya), an uncommon observation among vertebrates. Here, we investigate ancient hybridization among members of *Crocodylus* by assessing the phylogenetic discordance and SNP variation across their genomes. Light-to-medium coverage Illumina data was used to construct 18 reference-guided assemblies of crocodylians. ABBA-BABA comparisons and D-statistics were calculated for each 100kb sliding-window along the assemblies. We also present the most robust dated phylogeny of *Crocodylus*. Evidence of phylogenetic discordance was abundant in our analyses with possible indications of ancient hybridization events.

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

Dustin Owen, David Ensminger, Michael Sheriff, Tracy Langkilde

The Pennsylvania State University, University Park, PA, USA

Effects of Maternal Stress on Lizards from High- and Low-Stress Sites

Maternal stress hormones, glucocorticoids, can induce transgenerational phenotypic plasticity. While many studies have examined how maternal stress influences traits of offspring, few have compared these effects across populations with different histories of stress exposure. We tested effects of experimentally elevating corticosterone (CORT) of gravid female eastern fence lizards (*Sceloporus undulatus*) from high-stress sites (those invaded by predatory fire ants, *Solenopsis invicta*) versus low-stress (fire ant free) sites. We report effects of CORT-treatment on

reproductive output and success, physiology, morphology, and behavior of mothers and their offspring, and how these differ based on evolutionary exposure to invasive fire ants and associated stress. Such population-differences in maternal CORT could match offspring to typical stressors within the local environment, increasing their fitness. Future work should examine this possibility.

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

Juan Pacheco, Christopher K Beachy

Southeastern Louisiana University, Hammond, Louisiana, USA

Effects of oral probiotic administration in *Ambystoma mexicanum* as a response to a skin incision before and after metamorphosis.

Amphibian populations all over the world are experiencing a decline, due to many environmental factors such as pollution and diseases; a lot of effort has been made to conserve species that may be endangered because of such factors and, many approaches have been taken to solve this problem. Diseases such as Chytridiomycosis, red leg disease and ranavirus are specially playing a role in the decline of amphibians. This investigation aims to test the effect of the administration of oral probiotics, obtained from commercial sources, in improving their response to a skin incision. The results of the study could provide an alternative choice for the prevention of the decline of amphibians threatened by skin diseases.

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

Lawrence Page¹, Zachary Randall¹, Prosanta Chakrabarty², Pamela Hart², Callie Crawford³, Brooke Flammang³

¹Florida Museum of Natural History, Gainesville, Florida, USA, ²LSU Museum of Natural Sciences, Baton Rouge, Louisiana, USA, ³New Jersey Institute of Technology, Newark, New Jersey, USA

Evolution of Walking in Balitorid Loaches as a Model for Vertebrate Invasion of Land

A clear example of a “Rule of Life” is evolutionary convergence, the occurrence of the same or extremely similar phenotypic innovations in independent lineages. The recent discovery of a blind, cave-inhabiting balitorid loach, *Cryptotora thamicola*, that walks and climbs waterfalls with a salamander-like gait and has evolved a robust pelvic girdle (a kind of “hip”) offers an opportunity to study, in living fishes, a pivotal event in evolutionary history. That event, the vertebrate invasion of land, hinged on the evolution of fins to limbs that enabled the first

vertebrates to walk on land. The fossil record of this transition is scarce, and extant fishes were thought to lack the morphological features necessary for studying the origin of quadrupedal walking. Research on the morphology, biomechanics, and walking performance in balitorids is being conducted in an evolutionary framework through phylogenomic analysis and mathematic and robotic modeling. This information will improve our understanding of the mechanism underlying walking in balitorids and possibly shed light on a major event in the history of life: how fishes were able to transition to a terrestrial lifestyle.

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

Robert Page¹, Claire Conarroe², Diana Quintanilla¹, Joshua Solis¹, Andriea Palomo¹, David Marsh²

¹Texas A&M University-San Antonio, San Antonio, TX, USA, ²Washington & Lee University, Lexington, VA, USA

Genetic Variation in *Plethodon hubrichti* and *Plethodon cinereus* from In and Around a Contact Zone

The Peaks of Otter Salamander (*Plethodon hubrichti*) has a geographic range that is restricted to approximately 19 km of ridgeline in the mountains of west-central Virginia. Consequently, *P. hubrichti* is potentially vulnerable to a variety of threats, including reduced recruitment or genetic swamping due to hybridization with closely related species. The range of the Eastern Red-backed Salamander (*P. cinereus*) encompasses much of the Eastern US and Canada and surrounds the range of *P. hubrichti*. Using samples collected from reference populations and sites within a contact zone between these species, we examined eight microsatellite loci and cytochrome B haplotypes. In general, nuclear and mitochondrial markers sorted with morphology, suggesting little or no hybridization between lineages. However, microsatellite-based measures of diversity were substantially higher in *P. hubrichti* relative to *P. cinereus*. Clustering suggested little to no admixture between *P. cinereus* and *P. hubrichti* but did reveal genetic subdivision within both species. Although sampling was conducted in contiguous habitat over similar spatial scales, the magnitude of differentiation was greater in *P. hubrichti* than it was in *P. cinereus*. These results are consistent with the idea that *P. hubrichti* has evolved in this region *in situ* for longer than *P. cinereus* and that *P. cinereus* is a more recent invader. We discuss how these results relate to additional analyses we anticipate conducting and ongoing field experiments assessing dispersal ability in *P. hubrichti* and *P. cinereus*.

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

Wendy Palen

Simon Fraser University, Burnaby, BC, Canada, Liber Ero Fellowship Program, Vancouver, BC, Canada, Evidence for Democracy, Ottawa, ON, Canada

Enough already; changing the power dynamic that holds back our scientific societies

July 2018 saw the relatively small and insulated community of herpetologists thrust into the national spotlight when an award lecture featured inappropriate and unprofessional content. The incident sparked an outpouring of heartbreaking personal stories, collectively revealing how scientific societies and their annual meetings have for decades created an atmosphere that ranged from mildly discouraging to directly abusive for many young women and people of color. Rather than creating a welcoming and inclusive environment, negative experiences with male senior scientists led many women to leave the field or avoid this sub-discipline. Typically those with power and influence in our field reflect only a narrow subset of our diversity, such that the leadership of our societies is often among the most resistant to change. While past damage cannot be undone, this episode has been a catalyst for dialogue and created an opportunity for change. There is growing recognition that there are persistent social, economic, and cultural barriers to participation in science, and without direct acknowledgment and effort to create a more inclusive community, we will continue to fail at accurately reflecting the diversity of people interested in the field. I will share my personal experiences with the challenges of being a #HERper and why I believe the patterns of discrimination and disempowerment persist. I will highlight opportunities I've had to work towards changing our field by supporting young scientists in connecting directly with conservation and policy practitioners, and in seeking leadership positions in order to radically change our community from within.

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

Kristin Palmrose¹, Lindsay French², George Burgess², Jim Gelsleichter¹

¹University of North Florida, Jacksonville, FL, USA, ²University of Florida, Gainesville, FL, USA

Preliminary observations on reproduction of the spinner shark, *Carcharhinus brevipinna*

The spinner shark, *Carcharhinus brevipinna*, is a large coastal shark species that is common on the southeast coast of the U.S. and commonly caught in commercial and recreational fisheries. Little research has been conducted on the life history of *C. brevipinna*, presenting challenges for fishery management. The present report describes preliminary data on maturity and reproductive seasonality of *C. brevipinna* based on archived gonad and reproductive tract samples obtained from 48 female (119–219 cm TL) and 17 (149–258 cm TL) male *C. brevipinna* from the University of Florida's Shark Fishery Observer Program, 2003–2005. Based on increases in maximum follicle diameter (MFD) and oviducal gland width, female *C. brevipinna* appeared to begin sexual maturation at ~160 cm TL, reaching full maturity at >190 cm TL. Based on width of the testis (TW) and epididymis, male *C. brevipinna* appeared to mature at >187 cm TL. MFD and TW peaked in early spring to summer in mature-sized females and males, respectively,

suggesting early summer is the period of ovulation and fertilization. Follicle growth only occurred in some mature-sized females, suggesting a biennial cycle. In addition to data on archived samples, the present study also reports on early efforts to validate the use of chemiluminescent assays for the gonadal steroid hormones testosterone and estradiol in plasma male and female *C. brevipinna*, respectively, for an expanded study on reproduction in this species, using newly obtained samples from northwest Atlantic and Gulf waters.

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

Deb Pandey¹, Pranish Bhattarai², Ram Piya²

¹*Department of Veterinary Microbiology and Parasitology, Agriculture and Forestry University, Rampur, Chitwan, Province no. 3, Nepal,* ²*Department of Zoology, Birendra Multiple Campus, Tribhuvan University, Bharatpur, Province no 3, Nepal*

Food Spectrum of Common Krait (*Bungarus caeruleus*): An Implication for Snakebite Prevention and Snake Conservation

Bungarus caeruleus cause thousands of fatalities annually in Asia. Here, we aim to examine stomach contents of preserved kraits to determine their most favored prey animals that might attract them to residences where they bite sleeping people even under mosquito net. We examined freshly killed *B. caeruleus* and those preserved in collections maintained in hospitals and museums during July 2016 to October 2018 to identify contents of their stomachs and intestines. Among 61 examined *B. caeruleus*, three kraits consumed frogs, one consumed toad, three consumed snakes, one consumed a bird, and five consumed rodents. This is the first comprehensive study of food spectrum of *B. caeruleus* for Nepal and the third study worldwide. Unlike previous findings, we found it mainly feeding on non-snake prey animals. Most snakes having empty stomachs and a few specimens with freshly eaten prey animals indicated its entry into dwellings in search of prey animals due to food stimuli. Findings of partly digested rodents, frogs, snakes, and an avian prey (which are commonly found in houses in the lowlands of Nepal) further support food stimuli to be an important factor driving *B. caeruleus* to residential areas where they often cause envenomation (n = 42, 69%). Our findings can be extrapolated to understand feeding ecology of *B. caeruleus* distributed in residential areas and to formulate effective prevention strategies against their bites. Implementing effective and practicable prevention strategies lessens the fear of snakes. This consequently minimizes unnecessary killing of snakes, which in turn contributes to biodiversity conservation.

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

Yannis Papastamatiou

Florida International University, North Miami, FL, USA

A picture is worth a thousand words: shark-borne camera tags and their use to study ecology, physiology and behavior

Animal-borne video tags provide insight into an animal's habitat use, foraging and social behaviors. Despite first being used with sharks 20 years ago, their overall application to the field studies of sharks have been limited. However, technological advancements have reduced the size of tags, extended recording duration, and allowed video footage to be integrated with other sensors (e.g. acceleration, speed, depth). Improvement in recovery methods now enable tags to be deployed on sharks for multiple days or even weeks. I will review how camera tag technology has changed and how they have provided insight into shark foraging behavior, physiological ecology, and group behaviors. I will discuss how the scene is set for the use of camera tags in hypothesis-driven studies to test ideas from competition and optimal foraging theory, group dynamics, bioenergetics, biomechanics and more. Technological advancements are continuously being made and going into the future we will be able to answer an even wider range of questions.

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

Melanie Paquin¹, Morgan Busby², Ashlee Overdick², Ann Matarese²

¹National Marine Fisheries Service, Seattle, WA, USA, ²National Marine Fisheries Service, Seattle, WA, USA

Larvae from the Deep: Three Grenadier Species Revealed from Unidentified Larvae

Grenadiers (Macrouridae) are ecologically important in the demersal fish assemblages of the outer continental shelf, slope, and abyssal plain of the North Pacific Ocean basin and have a worldwide distribution. These deepwater benthic and benthopelagic fishes are most commonly collected at depths of 200–2000 m, with some found below 6,000 m and new species are regularly described. Around Alaska there are no directed commercial fisheries for grenadiers nevertheless some are retained as by-catch in Sablefish (*Anoplopoma fimbria*) and Greenland Halibut (*Reinhardtius hippoglossoides*) fisheries in the Bering Sea. In order to gain a better understanding of the geographic distribution patterns and diversity of grenadiers in their early life stages, we identify and describe early larvae of three macrourid species: Pacific Grenadier (*Coryphaenoides acrolepis*), Popeye Grenadier (*C. cinereus*), and Giant Grenadier (*C. pectoralis*), based on physical characteristics and genetic data. Larvae were collected during annual ichthyoplankton surveys of pelagic larvae conducted from 1971 – 2014 by the Alaska Fisheries Science Center (AFSC) in Alaskan waters. Genetic analysis of 12 specimens of *Coryphaenoides* spp. larvae provided accurate species identifications so that morphological and pigment character differences could help distinguish species from among archived larval specimens (195 samples). *Coryphaenoides pectoralis* is the most commonly encountered grenadier species in AFSC trawl survey efforts in the large marine ecosystems of Alaska and the

North Pacific Fisheries Management Council has indicated that collection of early life history information on grenadiers, such as *C. pectoralis*, is a research priority.

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

Anjana Parandhaman¹, Marjorie Matocq¹, Doug Boyle¹, Scott Bassett¹, Amy Vandergast², Todd Esque³, Jill Heaton¹, Kenneth Nussear¹

¹University of Nevada, Reno, NV, USA, ²United States Geological Survey, San Diego, CA, USA, ³United States Geological Survey, Las Vegas, CA, USA

Using Existing Genetic and Climate Data to Direct Sampling Efforts for the Desert Tortoise, *Gopherus agassizii*, across the Mojave Desert

Understanding the range of habitat suitability for a species requires sampling of habitat types throughout the entire species distribution. However, many species are sampled using methods that are spatially biased, which affects the accuracy of current and future habitat distribution projections. The Mojave Desert Tortoise (*Gopherus agassizii*) is a federally listed species found in the Mojave Desert of the United States. Its listing under the Endangered Species Act required the designation of critical habitat units, therefore, field surveys for Desert Tortoises have primarily focused on collection of data in these areas. These data do not reflect the extent of habitat heterogeneity across the entire range of Desert Tortoise distribution, let alone any phenotypic or genetic interactions with climate and other environmental variables. We use available genetic data and its underlying spatial data to determine areas that are genetically undersampled for the tortoise. We achieve this by creating maps of diversity and divergence and identifying hot spots represented by relatively few samples. Further, we determine potentially occupied climate space that may influence our understanding of genotype-environment interactions. We then build ensemble models, incorporating genetic, climate, and spatial data, to identify areas that require sampling in future survey efforts. Our approach in Desert Tortoises will maximize efficiency of future sampling, help us gain better understanding of the range of habitat suitability in this system, better integrate past and future data in model building, and provide a multifaceted view of how tortoises use the spectrum of landscapes across the Mojave Desert.

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

M. Rockwell Parker¹, Christopher R. Friesen², Robert T. Mason³

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Patterns of emergence from a hibernaculum and a possible explanation for known sex differences

Red-sided garter snakes overwinter in sizable aggregations (>10,000 individuals) in the Interlake Region of Manitoba, Canada. The aggregations have an equal sex ratio, though during spring emergence the ratio becomes temporarily and significantly skewed toward males as they linger at the den for longer durations than do females. During one breeding season, we collected N=100 males every nine days for 36 days and obtained mass and snout-to-vent length (SVL) for each animal. Different body condition indices revealed different patterns across the breeding season: residual analysis suggested male body condition was highest in the middle of the breeding season while the ratio index (mass/SVL) suggested condition was highest at the beginning. There are arguments for both, though the latter is more intuitive given that garter snakes are aphagic during the spring breeding season. We also conducted an experiment during artificial hibernation (0:24 L:D; 4°C) in an environmental chamber where males and females were given equal access to dry substrate or full body immersion in water. Females chose to be submerged in water whereas males spent time in both substrate and water. Males often emerge first from hibernacula in the Manitoba populations of this species, and it may be that sexually dimorphic overwintering behavior facilitates the demographic differences observed. In 2011, Gregory hypothesized that there were sex-specific hibernation strategies in *Thamnophis sirtalis*, and our artificial hibernation experiment supports this idea with behavioral data.

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

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The Diverse Ways that Citizen Scientists have Contributed to Herpetological Research

The definition of citizen science—“projects in which volunteers partner with scientists to answer real-world questions”—should sound very familiar to most herpetologists because there is such a rich history of collaboration between professional and amateur herpetologists. While non-professionals have made important contributions to herpetology, in recent decades the increasing use of digital cameras, smartphone apps, GPS technology, social media, and the internet have fueled the rapid development and growth of citizen science projects that specifically invite participation by non-professionals, leading to important conservation and research products. We will discuss numerous aspects of citizen science in herpetology, from historical projects to contemporary projects that are providing new methods for conservation, biodiversity, ecology, evolution, and behavior research. We review the use of citizen science for herpetological research, highlight future opportunities for community partnerships to enhance herpetological

research, and encourage herpetologists to make use of the benefits offered by partnering with members of the public.

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

Gregory Pauly, Richard Smart, Lila Higgins, Lina Goggins-Rendon

Natural History Museum of Los Angeles County, Los Angeles, CA, USA

Studying the Rare: Strategies for Crowdsourcing Observations of Introduced Species and Rarely Observed Natural History Events

Numerous biological phenomena are so infrequently observed by a researcher that standard methods of data collection will not yield datasets amenable to statistical analyses and/or inferring broad patterns and processes. Crowdsourcing data collection, especially by taking advantage of the growing use of digital cameras, smartphone apps, GPS technology, social media, the internet, and existing citizen science platforms can allow researchers to generate large datasets of rarely observed phenomena. Here, we evaluate strategies that have successfully generated large natural history datasets over short periods of time through crowdsourced data collection. In the first study, we rapidly accumulated a large dataset of species occurrence records (over 140 observations) for the nonnative Brahminy Blindsnake (*Indotyphlops braminus*) in Southern California, a species for which there were only a few known localities prior to these efforts. In the second study, we accumulated over 250 observations of mating behavior in the Southern Alligator Lizard (*Elgaria multicarinata*) in less than five years, even though there were only three previous such observations reported in the scientific literature. Strategies for generating observations included promoting research efforts in nature blogs, advertising research efforts on a popular natural history website, promoting citizen science data collection, harvesting records from existing citizen science platforms (e.g. iNaturalist and H.E.R.P.), and harvesting records from social media platforms including Instagram and Facebook. We compare the success of these various approaches and provide recommendations for other researchers who desire to generate large datasets of rare phenomena.

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

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Use of Artificial Cover Objects in Studying Snakes: "One Size Fits All" May Not be the Best Approach

Field studies of snakes (Serpentes) present numerous challenges. Many species possess behaviors and natural histories that make field collection and identification difficult. There are a number of methods that have been developed to improve capture rates and collection of snakes including the placement and monitoring of artificial cover objects. This approach can improve capture rates of rare species or those with activity patterns that reduce capture rates. Several studies have shown that differences in the construction of cover objects can affect both capture rates as well as the composition of species captured. High-desert environments in the Great Basin are marked by extreme temperature variation (both seasonal and daily). These extreme temperatures likely have an impact on the thermal microenvironments associated with cover objects but there is little data associated with the efficacy and performance of different types of cover objects in the Great Basin. Here we report differences in capture data associated with different artificial cover objects. We placed and monitored (weekly) artificial cover made of three different materials: roofing tin, plastic, and plywood. Only four snakes were collected under the roofing tin while both wood and plastic had much higher numbers of snakes ($n = 25$ and $n = 32$ respectively) suggesting that the thermal properties of these cover objects had significant effects on use by snakes. Our results demonstrate dramatic differences in the effectiveness associated with these materials and suggest that a “one size fits all” model does not apply to artificial cover objects.

259 AES GRUBER AWARD I, Rendezvous A&B – The Snowbird Center, Thursday 25 July 2019

Emily Peele, Kara Yopak

University of North Carolina Wilmington, Wilmington, NC, USA

In Hot Water: The Effects of Increased Temperature on Brain Development in the Epaulette Shark (*Hemiscyllium ocellatum*)

Over the last century, sea surface temperatures have increased over 0.5°C and are predicted to rise $1\text{-}4^{\circ}\text{C}$ by 2100. As the brain of cartilaginous fishes grows continually throughout their lives, the nervous system may be highly plastic with respect to these environment changes. Brain growth has been linked with numerous life history traits, such as life span, reproduction, prey capture, and predator avoidance. Therefore, changes in brain size and/or brain organization can have functional implications on the fitness of these species in response to increased ocean temperatures. Effects of increased rearing temperature on brain development were studied in the epaulette shark (*Hemiscyllium ocellatum*). Egg cases were collected from a breeding stock of *H. ocellatum* from the Boston Aquarium and placed into either ambient or 4° above ambient seawater conditions. After hatching, neonates were placed in the same treatment condition for 2 months. To understand how brain size and organization may be affected after exposure to increased temperatures, relative brain size and the relative size of major brain regions were compared between the two treatment groups. Though this species regularly experiences changes in temperature foraging in intertidal pools, preliminary results indicate differences in relative brain size between treatment groups, and differences in brain organization are particularly

localized to the telencephalon, an area associated with higher cognitive functions. Understanding the effects of increased temperature on neural phenotype aids in determining the consequences of environmental perturbations in this species and may indicate how they will fare in response to changing ocean conditions.

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

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¹*Department of Biology, Stephen F Austin State University, Nacogdoches, Texas, USA,* ²*Ash Meadows Fish Conservation Facility, USFWS, Amargosa Valley, Nevada, USA*

Opsin Diversity in Anurans

Many ecological, behavioral, and conservation-based questions can be addressed by understanding animal sensory systems and their underlying molecular mechanisms. Among vertebrate groups, anurans are historically understudied with regards to their visual systems and how they function. Their reliance on visual cues, specialization for dim-light vision, and complex visual system metamorphosis may make anurans susceptible to changes in light environment, such as increasing levels of artificial light at night. Photoreceptors, the cells that specialize in light reception, have visual pigments consisting of an opsin protein and a chromophore. Changes in amino acid sequences of opsins can affect an organism's spectral sensitivity, often as a result of environmental light conditions. We evaluated opsin diversity in eastern Texas anurans representing a range of taxa with different life histories. Consequently, our study species likely possess visual systems adapted to meet different ecological needs. We used standard molecular techniques (RNA extraction, cDNA synthesis, PCR, and DNA sequencing) to identify and sequence genes used in anuran color vision. We obtained partial sequences for rhodopsin (Rh1) and three cone opsins (LWS, SWS1, and SWS2A) expressed in anuran retinas. Results show that opsin gene sequences vary among species at amino acid sites associated with changes in spectral sensitivity in other species. This suggests that differences among species may result from selective pressures associated with ecology and that light environment may drive changes to anuran visual systems. This work provides a framework to further our understanding of anuran visual systems and their function in anuran visual ecology.

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

Brooke Perrera

Southeastern Louisiana University, Hammond, Louisiana, USA

Movement patterns, thermoregulatory behavior, and population demographics of

***Sternotherus odoratus* (Eastern Musk Turtles) in an urban environment in southeastern Louisiana**

Today, most habitat fragmentation is not related to change occurring on a geologic time scale; instead, fragmentation results from direct anthropogenic modifications to the landscape. Besides modification, urban expansion has resulted in a decline of natural habitat for native biota. Turtle populations across North America have decreased at an alarming rate, with a major cause being habitat destruction. Urbanization impacts on herpetofauna is limited and inference on whether urban environments provide suitable habitat for turtle populations is novel. The objective of this study is to describe movement patterns, thermoregulatory behavior, and population demographics of *Sternotherus odoratus* within a fragmented urban environment. Ten individuals will be collected in a man-made canal in Kenner, Louisiana and fitted with radio transmitters and iButton temperature loggers. Telemetry locations will be obtained from spring to winter 2019. Opportunistic captures of additional musk turtles will be reserved for mark-recapture to understand population demographics. Trapping will take place from June to August 2019. Preliminary surveys have indicated a dense population and a female-biased population. Data collected over the next few months will be presented and discussed.

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

Cassidy Peterson¹, Dean Courtney², Robert Latour¹

¹Virginia Institute of Marine Science, William & Mary, Gloucester Point, VA, USA, ²Southeast Fisheries Science Center, Panama City, FL, USA

Clarifying Abundance Trends of Coastal Sharks for Assessment

Fishery-independent trends in relative abundance generated from scientific surveys are one of the most important inputs to a stock assessment, as they theoretically represent an unbiased estimate of the underlying pattern of a stock. However, for spatially wide-ranging species with complex life histories and migratory patterns, like sharks, comprehensive population-wide surveys are unrealistic. Further, sharks with particularly slow-growing life history strategies require longer observed time series of relative abundance to capture the dynamics of the stock. As a result, we rely on several independent and spatially fragmented survey programs to estimate the patterns of abundance of sharks. Despite sampling the same population, these trends frequently conflict, obscuring our understanding of the stock and hindering interpretation and assessment performance. Using simulation analyses, we explore the ways in which a statistical technique, dynamic factor analysis (DFA), can be used to reconcile conflicting indices of abundance and simplify inputs to an assessment model using two representative coastal sharks, the large coastal sandbar shark (*Carcharhinus plumbeus*), and the small coastal Atlantic sharpnose shark (*Rhizoprionodon terraenovae*). We compare stock assessment results from using conflicting indices as inputs versus the simplified DFA trend, and consider the potential for use of DFA in future stock assessments. The results of this study have the potential to impact operational assessment protocols for coastal sharks within the United States.

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

Cheston Peterson^{1,2}, Dean Grubbs²

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Preliminary analysis of effects of prey and predator distribution on movement and habitat use of two intermediate marine fish predators

Preliminary data from a study exploring the effects of prey and predator distribution on intermediate predator movement and habitat use in Apalachicola Bay and St. George Sound, Florida, will be presented. Focal species include bonnethead sharks (*Sphyrna tiburo*) and gafftopsail catfish (*Bagre marinus*) as intermediate predator species, blue crabs (*Callinectes sapidus*) as a primary prey species, and bull sharks (*Carcharhinus leucas*) as primary predator species. Densities of the fish species and blue crabs are being estimated using fishery-independent gillnet and longline surveys and trawl and seine surveys, in collaboration with the Florida Fish and Wildlife Conservation Commission, respectively. Passive and active acoustic telemetry are being used to track movement and habitat use of the fish species throughout the system. Initial results include catch-per-unit-effort of focal and related species, relationships of bonnethead and gafftopsail catfish movement and blue crab distribution and density, and occurrence and associations of bonnethead and bull sharks at and among acoustic receivers targeting specific habitats and inlets into the bay.

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

John Peterson¹, Caleb Cizauskas¹, Sarah Bauer¹, Emilie Ospina², Matthew Allender²

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Thermal ecology of *Ophidiomyces ophiodiicola*, the cause of snake fungal disease, in free-ranging snakes in prairie and riparian habitat.

Snake fungal disease, caused by *Ophidiomyces ophiodiicola*, has received increased monitoring in recent years because of its potential impact on snake populations. Recent studies have documented *O. ophiodiicola* ecology in the laboratory, but more studies are needed to address the ecology of *O. ophiodiicola* on snakes in varying environmental conditions in the field. We investigated the thermal ecology of *O. ophiodiicola* on the heads and skin abnormalities of free-ranging Prairie Ring-necked Snake (*Diadophis punctatus edwardsii*), DeKay's Brownsnake (*Storeria dekayi*), Common Gartersnake (*Thamnophis sirtalis*), Milksnake (*Lampropeltis triangulum*), Common Watersnake (*Nerodia sipedon*), and Western Wormsnake (*Carphophis*

vermis) in upland prairie and lowland riparian habitat in southwest Wisconsin. At capture, host temperature and environmental temperature were assessed. Snakes were captured by using artificial cover objects made of materials with different thermal properties (e.g. wood, corrugated asphalt, and corrugated steel). All species had *O. ophiodiicola* on their skin. Infection intensities and temperatures at capture were significantly higher in lowland riparian habitat compared to upland prairies. In upland prairies, infected Brownsnakes and Milksnakes were captured at significantly lower temperatures than uninfected snakes. However, in riparian habitat, infected Brownsnakes were captured at significantly higher temperatures and individuals with higher infection intensities were captured at significantly higher temperatures. More studies should address how environmental variables like temperature influence the presence and intensity of *O. ophiodiicola* on host snakes. These studies can help us identify locations and species that may be more susceptible to this pathogen.

72 Ichthyology Ecology, Alpine A,B,C – The Snowbird Center, Saturday 27 July 2019

Mark Peterson, Michael Andres

University of Southern Mississippi, Ocean Springs, Mississippi, USA

Tale of Two Tributaries: Examples of Urbanization Impacts on Fishes and Benthic Resources

Coastal estuaries and associated watersheds are being urbanized at various scales throughout the world at the expense of the ecosystem services these habitat types provide, spatial and temporal use patterns, and continued habitat sustainability. Habitat is the template on which population and community dynamics occur, and tidal river linkages among lotic-estuarine habitat types and nekton production are being altered directly and indirectly by development, sometimes in subtle ways. We have been interested over the last few decades in the urbanization of our coastal rivers and estuaries, and, in particular, the Pascagoula River, which is the last near-pristine tidal river $\geq 350 \text{ m}^3 \text{ sec}^{-1}$ in the contiguous lower 48 states. The Pascagoula River is $\sim 130 \text{ km}$ long, drains $\sim 23,000 \text{ km}^2$, and splits $\sim 24 \text{ km}$ upstream into two distributaries. The West distributary is relatively pristine whereas the East distributary has a port at its terminus and a dredged and deepened channel extending upriver $\sim 8.3 \text{ km}$ to the Escatawpa River. We provide selected examples of how changes in the channel morphology due to dredging and deepening of the East distributary has potentially influenced the system relative to estuarine-dependent nekton and benthic prey resource richness patterns as well as usage patterns of the federally-threatened Gulf sturgeon. Some changes are quite drastic whereas others are subtler, but all influence the diversity and use of the Pascagoula River system, including potential trade-offs between what constitutes critical habitat for different Gulf Sturgeon size classes.

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

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Phylogenomics, Electric Organ Discharge, and Cranial Evolution in Mormyridae (Osteoglossomorpha)

Mormyridae, the most species-rich family of bony tongue fishes in the superorder Osteoglossomorpha has more than 260 valid species, exhibiting a diverse array of craniofacial morphologies and electric organ discharges (EODs). This diversity includes flat faces, tube-snouts, and a “schnauzenorgan” (an elongate, moveable chin appendage covered with electroreceptors). Species of the genus *Campylomormyrus* display combinations of schnauzenorgans and tube-snouts. Mormyrid electric organs (EO) may be characterized by one of several distinct electrocyte morphologies—with either penetrating or nonpenetrating electrocyte stalks on the anterior or posterior sides of the electrocytes—that generate EODs differing in duration and number of positive- and negative-going phases. To investigate the evolution of these traits in mormyrids, we constructed and analyzed a phylogenomic dataset targeting 1105 FishLife exons for more than 160 species of Osteoglossomorpha. Our results support previous phylogenetic hypotheses and the monophyly for the six major lineages in this group (Hiodontiformes, Pantodontidae, Osteoglossidae, Notopteridae, Gymnarchidae, and Mormyridae). However, within mormyrids there are at least two non-monophyletic genera (*Hippopotamyrus* and *Marcusenius*), characterized by the presence of either a flat face or a schnauzenorgan, respectively, suggesting that these traits are evolutionarily plastic. Ancestral trait reconstructions for EODs and cranial traits were mapped onto the phylogeny using comparative methods. These results advance our understanding of the evolutionary diversification of osteoglossomorphs and, in particular, the pattern of variation of phenotypic traits in mormyrids.

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

Jackson Phillips, Kurt Schwenk

University of Connecticut, Storrs, CT, USA

Surface-feeding and Air-Breathing in Tadpoles: What They Might Tell Us About the Evolution of Lungs

Anuran tadpoles may provide insight into the evolution of lungs. Tadpoles ventilate the gills with an ancestral two-stroke buccal pump in which water is drawn into the mouth with suction, then forced past the gills and out the spiracle with pharyngeal compression, creating one-way flow. Five of six species of tadpoles we studied (three families) used a similar two-stroke pump during surface feeding and air-breathing. During surface feeding, suction pulls the surface of the water into the pharynx, forming a ‘bubble’, along with entrained food particles and a stream of water.

The food particles are transferred to the water and the bubble is released. The water is then expelled through the spiracle, trapping food in the gill basket. This behavior is repeated in an oscillatory manner at up to 30 Hz, but with considerable interspecies variation. Some small tadpoles use nearly identical kinematics for air-breathing. They suck air into the pharynx and close the mouth, forming a bubble. Pharyngeal compression then forces air from the bubble into the lungs. The apparent co-option of the two-stroke water-breathing pump to drive both oscillatory surface-feeding and air-breathing in tadpoles reveals a potential evolutionary sequence for the evolution of lungs in early aquatic vertebrates: gill ventilation with water; surface-feeding that draws air into the pharynx; increased vascularization of the pharyngeal epithelium for gas exchange; increased pharyngeal surface area for gas exchange via vascularized out-pocketings; evolution of lungs from pharyngeal out-pocketings.

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

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Using Environmental DNA to Examine Habitat Use of Bull Sharks (*Carcharhinus leucas*) in the Mobile-Tensaw River Delta, Alabama

Human activities in coastal areas are accelerating changes in ecosystem structure and function at an unprecedented pace, resulting in habitat loss, modifications to hydrology, and declines of predatory species. Understanding how these changes cascade across systems requires an understanding of how mobile species link adjacent habitats. As upper trophic level predators, Bull Sharks (*Carcharhinus leucas*) play a crucial role in ecosystem health through their ability to influence prey abundance and behavior, maintain biodiversity, and buffer against invasive species. Telemetry studies in Mobile Bay, Alabama suggest that *C. leucas* extensively use the northern portions of the bay, an estuarine-freshwater interface known as the Mobile-Tensaw Delta, although the extent to which they use the freshwater rivers is unknown. Environmental DNA (eDNA) provides a cost-effective, sensitive method to conduct targeted species surveys for aquatic taxa. To survey for *C. leucas* across the Mobile-Tensaw Delta, we collected 5 L water samples at each of 21 sites in the summer and winter of 2018: 8 sites along 167 kms of the Mobile/Tombigbee River, 9 sites along 113 km of the Tensaw/Alabama River, and 4 sites across Mobile Bay. Water samples were vacuum-filtered, DNA extractions were performed on the particulate, and DNA extracts were analyzed with Droplet Digital Polymerase Chain Reaction (ddPCR), using species-specific primers to amplify a small DNA fragment in only *C. leucas*. Understanding the extent to which this species links these otherwise disparate habitats is critical for conserving ecosystem balance and function, as well as adequately managing a species that uses multiple habitats.

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

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Returning the Louisiana Pine Snake to Restored Habitat

Ongoing surveys suggest that populations of the Louisiana Pinesnake (*Pituophis ruthveni*) are limited to a few small blocks of degraded and highly fragmented habitat. Research indicates that the species requires frequently burned sites with a well-developed herbaceous understory capable of supporting populations of its primary prey, Baird's Pocket Gopher (*Geomys breviceps*). Recent changes in management practices on U. S. Forest Service lands have resulted in restoration of substantial blocks of suitable habitat, which are now available for reintroduction. A captive population has been established from wild-caught snakes from Bienville Parish, LA. The reintroduction site is located on the Catahoula District of the Kisatchie National Forest. Ninety-eight individuals have been released to date. The current protocol is to release all snakes the April after hatching, as head-starts. Currently, automated pit tag readers and trapping are the primary monitoring techniques. To date, 26 snakes have been detected the year following release, or later. Five of those snakes have been detected 4 years following release. Monitoring results suggest that growth and health of released snakes are adequate, and survival is encouraging. However, despite the presence of sexually mature snakes, reproduction has not been documented. Production of neonates and release of young will be repeated annually until a viable population is established or it is concluded that further releases are not likely to result in establishment of a population.

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

Todd Pierson

University of Tennessee, Knoxville, TN, USA

Divergent Reproductive Phenologies in Male *Eurycea* with Alternative Reproductive Tactics

Plethodontid salamanders provide compelling models for studying the evolution of reproductive behaviors, including courtship, mate choice, and parental care. Within populations of three putative species in the two-lined salamander (*Eurycea bislineata*) species complex, two alternative male reproductive tactics coexist. Searching males have mental glands, premaxillary teeth that pierce the upper lip, and elongate cirri—traits well-suited for locating and courting females. Guarding males (also known as "Morph A" males) lack all of these features and instead have hypertrophied jaw musculature—a trait well-suited for agonistic behavior. These morphological differences are accompanied by behavioral differences, where only

guarding males exhibit mate-guarding behavior. In this study, I used terrestrial and aquatic surveys at Highlands Biological Station to show that during the breeding season, searching and guarding male *Eurycea* cf. *wilderiae* are strongly spatially segregated, indicating that these alternative reproductive tactics have divergent reproductive phenologies.

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

Todd Pierson¹, Richard Secrist², Tiffany Beachy², Jason Love³, Benjamin Fitzpatrick¹

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Monitoring Salamanders in the Great Smoky Mountains: Nearly 20 Years of Citizen Science and the Recent Application of Environmental DNA

Scientists tasked with the inventory and monitoring of wildlife frequently face challenges posed by organisms that are difficult to detect or to identify. Aquatic and semiaquatic salamanders of the family Plethodontidae often fall into both of these categories. Models that account for imperfect detection can provide a useful framework for overcoming some of these challenges, but in order to generate robust estimates of occupancy and detection probabilities, they often require repeat surveys. This may be problematic for scientists with distant study sites or short field seasons, but it is a task well-suited for local citizen scientist collaborators. Here, we describe results from nearly 20 years of continuous, monthly leaf litter-bag surveys conducted by citizen scientists at the Great Smoky Mountains Institute at Tremont. We also describe results from one year of monthly environmental DNA metabarcoding surveys in the same location, and we compare these two methods to highlight the strengths and challenges of using citizen science to inventory and monitor populations of plethodontid salamanders in headwater streams.

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

Amanda Pinion¹, Ralf Britz², Rafael Martínez-García³, Dustin Siegel⁴, Kevin Conway¹

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The larval attachment organ of *Atractosteus tropicus*

Larval attachment organs (LAO) are unicellular or multicellular organs that allow larvae to adhere to the substrate prior to absorption of the yolk sac and free swimming. The small size and ephemeral nature of LAO makes them difficult to study. Nevertheless, LAO have been documented in many groups of fishes, including multiple groups of teleosts as well as non-teleost actinopterygians such as bichirs, bowfin and gars. Previous accounts of the conspicuous LAO of gar describe the gross external morphology as a “sucker disk” located at the anteriormost portion of the larva with the entire organ surrounded by a thickened margin containing many smaller circular organs. As of yet, there is no information on the surface structure or histology of the LAO of gar. Based on a developmental series of *Atractosteus tropicus*, we document the gross morphology and histology of its LAO using a combination of scanning electron microscopy, transmission electron microscopy and light microscopy. We show that the LAO of *Atractosteus* is a compound super-organ, containing many smaller multicellular organs, each comprised of attachment and support cells. At hatching, the weakly bi-lobed super-organ is well-developed and occupies almost the entire anteroventral surface of the head. By 2 days post-hatch (DPH), it is restricted to the anteriormost portion of the rostrum and has become significantly smaller in proportion to the body of the larva. The smaller individual organs become progressively more disorganized and begin to regress at 4 DPH. By 6 DPH the super-organ and its individual organ components are resorbed.

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

Amanda Pinion¹, Daemin Kim², Kevin Conway¹

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Morphological investigation of the Sand Shiner *Notropis stramineus* (Teleostei: Cyprinidae)

In recent years, investigations of widespread North American freshwater fishes have revealed significant levels of cryptic diversity, especially in minnows and shiners of the family Cyprinidae. The Sand Shiner *Notropis stramineus* (Cope, 1865) is a medium-sized North American minnow with an expansive distribution east of the Continental Divide. Though *N. stramineus* is currently regarded as a single species, previous taxonomic authorities recognized two subspecies (*N. s. stramineus* and *N. s. missuriensis*), which are still recognized as valid by some authors. This two subspecies classification is based largely on minor differences in scale-row counts between individuals inhabiting tributaries to the Great Lakes, upper Mississippi and Texas gulf coast river systems (*N. s. stramineus*) and those inhabiting the Missouri and Arkansas River systems (*N. s. missuriensis*). Analysis of an unpublished, multi-locus genetic data set has revealed the presence of multiple genetically distinct lineages geographically incompatible with the aforementioned subspecies designations. These results instead suggest that *N. stramineus* may represent a super-species-complex, comprising multiple (4+) similar looking, yet genetically distinct species, the majority of which have yet to be formally recognized and diagnosed with

phenotypic characters. To uncover morphological traits that may be useful for distinguishing between putative members of this super-species-complex, we have assembled and analyzed datasets running the gamut of the phenotype, from quantitative meristic and geometric morphometric landmark-derived characters to qualitative characters of pigmentation and tuberculation. We investigate whether consistent phenotypic variation exists across the range of *N. stramineus sensu lato* and whether patterns of phenotypic variation are congruent with geography and genetic lineage membership.

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

Helen Plylar, Alan Savitzky

Utah State University, Logan, Utah, USA

Assessing the Relationship Between Eye and Pit Organ Size in Pythonid Snakes

Snakes in three clades (Boidae, Pythonidae, and Crotalinae) possess infrared-receptive pit organs within or between facial or labial scales. Information from the pit organs is transmitted to the brain by branches of the trigeminal nerve and ultimately projects to the optic tectum, the same region of the brain that receives information from the visual system. Thus, many hypothesize that IR-sensing snakes are not only capable of advanced thermal detection, but actually “see” in a combination of light and heat. This overlap of visual and thermal information allows these snakes to form a spatial map of the thermal environment, which has implications for defensive and predatory targeting, as well as thermoregulation via habitat site selection. Behavioral studies of pitvipers and pythons consistently demonstrate that these two sensory modalities complement each other but are also capable of functioning independently. Crotaline snakes exhibit an inverse relationship between eye size and pit size, which (considering the complementary nature of these systems) may indicate that selection for one sensory system could relax selection pressures on the other. To assess this relationship in pythonids, I measured eye size and pit organ size for several species representing different ecologies across the pythonid lineage. Results suggest a similar relationship exists between eye and pit size in pythonids, though more complete taxon sampling is needed.

191 Amphibian Conservation, Ballroom 2 – Cliff Lodge, Saturday 27 July 2019

Sinlan Poo

Memphis Zoo, Memphis, TN, USA

Conservation through Cryopreservation: Behavioral and Morphological Fitness of Captive-Bred Tadpoles

As one of the most endangered taxa, amphibians are threatened by a number of stressors, such as deforestation, habitat degradation, disease, and global climate change. In response to these threats, captive breeding programs have been established in many zoos and institutions to prevent extinctions by providing a safe harbor for at-risk species and a source for captive-release programs. A key issue that determines the success of these programs, however, is the fitness of individuals bred using assisted reproductive technology (ex. *in vitro* fertilization, gamete cryopreservation). In other words, are the behavior, growth, and development of offspring bred through assisted reproductive technology comparable with offspring of adults that bred naturally? To fill this significant gap in scientific knowledge and conservation practice, we examined differences in tadpole behavior, tadpole morphology, and size at metamorphosis between Fowler's toad (*Anaxyrus fowleri*) offspring produced via *in vitro* fertilization using cryopreserved sperm (experimental tadpoles) and offspring produced by amplexic adults (control tadpoles). Preliminary results indicate experimental tadpoles were smaller, exhibited less predator avoidance behavior, and metamorphosed at a small size compared to control tadpoles. This pioneering study provides insights into the comparative behavioral and morphological fitness of offspring produced in captivity, and consequently, the long-term viability of such methods when used in reintroduction programs and *in situ* species conservation.

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

Sinlan Poo, Kristin Hinkson

Memphis Zoo, Memphis, TN, USA

Applying Cryopreservation to Anuran Conservation

Novel conservation methods have become increasingly important in protecting our remaining biodiversity in the face of unprecedented rates of species declines. One method of maintaining genetic and species diversity is through germplasm cryopreservation. However, our knowledge of cryopreservation relies heavily on studies in domestic or aquaculture species. Moreover, most studies are narrowly focused on a single species. Consequently, the broader application of these methods to wildlife conservation is often unknown or assumed. Here, we examine the response of four anuran species from two families (*Anaxyrus fowleri*, *Anaxyrus baxteri*, *Lithobates pipiens*, and *Lithobates sevosus*) to three sperm cryopreservation treatments (5%, 10%, and 15% DMFA with 10% trehalose). Within each family, we selected a congeneric species pair with one common species and one endangered species. We found that endangered species had significantly lower initial sperm quality, though recovery rate of sperm after cryopreservation was not significantly different between common and endangered species. Overall, responses to the three treatments were consistent across species, with 5% DMFA with 10% trehalose producing the highest recovery rates in all four species. Our results demonstrate that standardized methods developed for anurans can be applied more widely across families and can be transferred from model species to species of conservation concern. These findings form a basis for further exploration into cryopreservation as an effective tool for wildlife conservation in amphibians.

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

Daniel Portik, John Wiens

University of Arizona, Tucson, AZ, USA

SuperCRUNCH: A Toolkit for Creating and Manipulating Supermatrices and Other Large Phylogenetic Datasets

Phylogenies with extensive taxon sampling have become indispensable for many types of ecological and evolutionary studies. Many large-scale trees are based on a “supermatrix” approach, which involves amalgamating thousands of published sequences for a group. Constructing up-to-date supermatrices can be challenging, especially as new sequences may become available within the group almost constantly. However, few tools exist for assembling large-scale, high-quality supermatrices (and other large datasets) for phylogenetic analysis. We developed SuperCRUNCH, a Python toolkit for assembling large phylogenetic datasets from GenBank nucleotide data and/or local sequences. SuperCRUNCH searches for specified sets of taxa and loci to create species-level or population-level datasets. It offers many transparent options for orthology detection, sequence selection, alignment, and file manipulation required for generating large-scale phylogenetic datasets. By offering the option to select representative sequences for taxa or retain all filtered sequences, SuperCRUNCH can be used to generate interspecific supermatrix datasets (one sequence per taxon per locus) or population-level datasets (multiple sequences per taxon per locus). It can also be used to assemble phylogenomic datasets with thousands of loci. We demonstrate the utility of SuperCRUNCH by 1) generating a de novo supermatrix for Iguania from GenBank sequence data, and 2) assembling a squamate UCE supermatrix from published UCE and whole genome data. We compare the performance of SuperCRUNCH to other available methods and briefly present the phylogenetic results of each supermatrix.

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

Andrew Powers, Tim Karels

CSU Northridge, Northridge, CA, USA

Habitat Fragmentation and its Indirect Effects on Squamate Species Richness in Southern California

Los Angeles is one of the largest urban areas in the world. This rapid urban sprawl has created many scattered habitat fragments, which can have negative consequences on wildlife diversity and dispersal. Studies of habitat fragmentation have focused primarily on mammals and birds, but less commonly on snakes and lizards. Previous studies have shown that in areas of high

fragmentation and urbanization, lizard species diversity becomes lower than natural unfragmented areas. However, not much is known about how the varying abiotic and biotic characteristics of a given fragment may influence this trend. I will explore the relationship between squamate diversity and habitat fragmentation in Thousand Oaks, California. I will capture snakes and lizards, identify to species, and record mass, length, and sex in order to quantify species diversity and population composition within 25 habitat fragments varying in size and age. I expect to find differences in species composition between patches based on its unique biotic and abiotic characteristics such as patch age and size. I expect less species diversity in smaller patches and that squamate size will decrease as patch size decreases. In addition to this, I hypothesize more recently fragmented patches will have higher diversity than older fragmented patches, as older and smaller patches show a greater influence of edge effects. My study will be the first to examine the indirect effects of habitat fragmentation on squamate diversity in Southern California and will help to better understand the challenges local wildlife face due to urbanization.

542 Herpetology Biogeography II, Ballroom 3 – Cliff Lodge, Friday 26 July 2019

Ivan Prates¹, Kevin de Queiroz¹, Miguel Rodrigues², Rayna Bell¹

¹*Smithsonian National Museum of Natural History, Washington, DC, USA*, ²*Universidade de Sao Paulo, Sao Paulo, SP, Brazil*

Evolutionary consequences of sexual signal diversity in South American anoles

A central question in evolutionary biology is how traits that are involved in species recognition contribute to reproductive isolation and speciation. In *Anolis* lizards, species recognition is mediated by the dewlap, a diverse sexual signal. Despite the potential role of dewlap phenotypes in population divergence, we have a limited understanding of the factors that promote dewlap variation, how this variation affects diversification, and its implications for species delimitation. We investigate the evolutionary consequences of sexual signal diversity in *Anolis fuscoauratus*, a widely distributed South American species complex that shows remarkable spatial variation in dewlap coloration. We generated restriction site-associated DNA markers (RADseq) from 170 specimens spanning this taxon's distribution in both Amazonian lowlands and the coastal Brazilian Atlantic Forest to perform population genetic, phylogenetic, and historical demographic inference. Analyses of population structure suggest low levels of genetic diversity across the range, pointing to rapid and recent geographic expansion. Patterns of genetic structure suggest that dewlap phenotypes do not constitute barriers to gene flow, challenging the presumed role of the dewlap in mate recognition and speciation in anoles. Phylogenetic patterns suggest that similar dewlaps have originated multiple times in distinct geographic regions, potentially as a result of local selection regimes associated with the light environment and vegetation structure. Our results have implications for our understanding of sexual signal diversity in anoles and of cryptic diversity in a broadly distributed South American lizard group.

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

Bree Putman, Riley Williams, Greg Pauly

Natural History Museum of Los Angeles County, Los Angeles, CA, USA

Urban to rural gradients in predation and parasitism studied using community science-generated photographs of the Southern Alligator Lizard

Community science (also known as citizen science) is a powerful tool that can generate large datasets across large geographic scales and in relatively short time periods. These data have been harnessed by researchers to evaluate changes in phenology and species distributions, and we expand on the uses of these data to examine fitness-relevant traits in association with urbanization. We used photographs of Southern Alligator Lizards (*Elgaria multicarinata*) submitted to the community science platform iNaturalist to test the hypotheses that predation risk increases with urbanization and parasitism decreases with urbanization. We quantified predation risk by measuring tail loss rates, and we quantified parasitism by counting tick loads on lizards within the photographs. We found that tail loss rates increased along a rural to urban gradient, but declined in highly urban areas (e.g., commercial districts). This pattern is likely associated with increased abundance of human-subsidized predator populations, including domestic cats, in residential neighborhoods. Conversely, ectoparasite loads decreased with urbanization likely due to a loss of intermediate hosts (small mammals) and anti-tick medications used on domesticated animals. In all, we show that photographic vouchers available on community science platforms can provide large datasets at minimal cost relative to traditional data collection techniques. Further, community science-datasets cover a wide geographic extent, far larger than those that could be generated via standard field surveys.

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

Howard Rainey¹, Todd Pierson², Jennifer Deitloff¹

¹*Lock Haven University, Lock Haven, PA, USA*, ²*University of Tennessee - Knoxville, Knoxville, TN, USA*

Distinguishing morphological differences in the head shape of *Eurycea* cf. *wilderiae* (Blue Ridge Two-Lined Salamander)

Morphology can be correlated with behaviors that impact a male's ability to obtain reproductive success when facing competition for mates. In addition, sexual selection can influence differences in morphological traits between males and females leading to sexual dimorphism. *Eurycea* salamanders display morphological differences in head shape among males as well as between the sexes. Males of *Eurycea* cf. *wilderiae* exhibit two different suites of correlated morphological traits corresponding with alternative reproductive tactics often described as

“searching” and “guarding”. Searching males possess cirri that extend down from the nasolabial grooves, mental glands, and they lack enlarged jaw musculature. Guarding males have enlarged jaw musculature, and they lack cirri and mental glands. We investigated the left-lateral and ventral head morphology of *E. cf. wilderae* using geometric morphometrics. We tested the hypothesis that three forms—searching males, guarding males, and females—would be different in overall head shape. We also tested the hypothesis that head morphology of each form would differ among eight populations. We found that, in the left-lateral view, searching males differed from guarding males and females, but guarding males did not differ from females. In addition, head shape was significantly different among all forms in the ventral view. We found no significant differences among the different populations. Our results provide quantitative evidence of the morphological differences among discrete alternative reproductive tactics in *Eurycea*. Future studies should focus on whether morphological and behavioral variation correspond with variation in reproductive fitness.

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

Muhammad Rais, Sumbul Gill, Muhammad Saeed, Ayesha Akram, Waseem Ahmad

Department of Wildlife Management, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi, Rawalpindi, Pakistan

Description of Taxonomic and Morphological Characteristics of the Tadpole of Murree Hills Frog (*Nanorana vicina*, [Stoliczka 1872])

We described external morphology, morphometry and oral disc structures of the tadpole of Murree Hills Frog (*Nanorana vicina*) for the first time. The species is endemic to Pakistan, India and Nepal, and bears exceptional conservation value. The tadpoles were extotrophic, lotic, benthic, medium sized (43.9-59.94 mm), oval in dorsal view and dorsoventrally flattened in lateral view, nares closer to the eyes than snout, spiracle sinistral, vent tube dextral, tail more than 1.5 the body length with a round tip, anteroventral oral disc, not emarginated, marginal papillae continuous on posterior labium and lateral margins of anterior labium with a wide medial gap, sub-marginal papillae single rowed at the posterior labium and few scattered at the lateral sides of the anterior labium. The keratodont formula was 5(3)/3(1). Scanning electron microscopy revealed that each denticle (stage 36) had 10-13 points, directed inward towards the beak and was club shaped, and the serrations on beak were 11 per 0.5 mm. The tadpoles were categorized as type four larvae of mountain-stream type.

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

Muhammad Rais, Sidra Ikram, Sumbul Gill, Waseem Ahmad, Muhammad Saeed, Ayesha Akram, Imtiaz Ahmed Khan

Department of Wildlife Management, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi,

Rawalpindi, Pakistan

Morphological and Ecological Correlates of Anuran Tadpoles in Scrub and Subtropical Pine Forest, Pakistan

We recorded eight anuran species from scrub and sub-tropical pine forest (District Rawalpindi and Islamabad Capital Territory, Pakistan). These include Asian Indus Valley Toad (*Duttaphrynus stomaticus*) and Asian Common Toad (*Duttaphrynus melanostictus*), Ant Frog (*Microhyla ornata*), Hazara Torrent Frog (*Allopaa hazarensis*), Skittering Frog (*Euphlyctis cyanophlyctis*), Syhadra Frog (*Fejervarya syhadrensis*), Murree Hills Frog (*Nanorana vicina*) and Bull Frog (*Hoplobatrachus tigerinus*). Our results showed that the forest type featuring scrub vegetation, low elevation and warmer climate (air temperature > 27 °C, water temperature > 28 °C) had more species richness, (six of the eight recorded species) while the sub-tropical pine forest showing relatively low air (<16 °C) and water temperature (<13 °C) and higher elevation had a relatively higher anuran endemism (Murree Hills Frog and Hazara Torrent Frog). The anuran species such as Indus Valley Toad are abundant toad species and recorded as invasive while Common Skittering Frog as abundant. Increase in temperature could possibly impact populations of endemic anuran species of pine forest and may encourage spread of invasive species. It seems difficult to conclude if species such as Burrowing Frog and Balloon Frog are threatened or rare in the study area. We, however, suggest detailed studies on these species.

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

Zachary Randall¹, Kevin Love¹, Edward Stanley², Mark Sabaj², Lawrence Page¹, David Blackburn¹

¹Florida Museum of Natural History, Gainesville, FL, USA, ²Academy of Natural Sciences of Drexel University, Philadelphia, PA, USA

oVert: Lessons Learned for High-Throughput Scanning across the Fishes Tree of Life

As part of the oVert (openVertebrate) Thematic Collections Network, > 1,500 scans of fishes have been produced at the University of Florida, representing > 170 families and 620 genera across the fishes tree of life. This presentation will discuss lessons learned at UF for high-throughput scanning of fish taxa during the first year of the grant. Topics will include our process for creating a type species list for fishes and identifying specimens of type species across collaborating institutions. It will also cover workflows for specimen selection and comparisons of different staging methods for scanning a variety of specimen shapes and sizes. Insights to workflows for data management and for making the data accessible through the online 3D repository Morphosource will also be discussed.

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

Deran Reddy

University of the Witwatersrand, Johannesburg, Gauteng, South Africa

A Fluorescence Microscopy study of the Lung of the Nile crocodile

The lung of the Nile crocodile is an extremely heterogenous structure. This is due to the varying degrees of internal subdivision of the lung by various components that comprise it. As a result, the sizes and shape of the airways in the various regions of the lung differ. The distribution of these structures themselves are quite heterogenous in nature. Whilst dense irregular connective tissue is the core of the organ, large amounts of cartilage and smooth muscle has been documented apart from others. The aim of this study was to analyze their location and document their distribution throughout the lung. Tissue samples were taken from the cranial, middle and caudal regions of the dorsal and ventral halves of the lung. They were stained using immunofluorescence methods to highlight the distribution of cartilage and smooth muscle in the aforementioned regions. Light microscopy stains were also used to observe the architecture of all the regions. The cranial regions of the lung were the most subdivided from all the sampled regions. A low propensity of smooth muscle and cartilage was observed in this region but the blood gas barrier was well defined. This level of subdivision decreased in a cranio – caudal direction but the amount of smooth muscle and cartilage observed, increased in this direction. In the middle regions of the lung, cartilage rings were pronounced and well developed with smooth muscle surrounding it. The caudal regions contained copious amounts of irregularly distributed smooth muscle with large cartilage reinforced airways.

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

Amber Reichert¹, Joseph Bizzarro², David Ebert³

¹Moss Landing Marine Laboratories, Monterey, CA, USA, ²National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, Santa Cruz, CA, USA, ³Moss Landing Marine Laboratories, Moss Landing, CA, USA

Habitat characteristics of catshark oviposition sites and potential nursery grounds off central California

Catsharks (Scyliorhinidae) are the most speciose family of extant sharks; however, there is a paucity of information known about their life histories. Three deepsea scyliorhinids occur in the waters off central California; brown (*Apristurus brunneus*), longnose (*Apristurus kampae*), and filetail (*Parmaturus xaniurus*) catsharks. It is necessary to determine essential fish habitat of these scyliorhinid species and their nursery grounds for improved fisheries management as free-living catsharks and catshark egg cases are often incidentally caught as bycatch in commercial

fisheries. Therefore, the purpose of this study is to determine and compare spatial and habitat associations of these catsharks' oviposition locations. Subsequently we can infer locations of nurseries where certain habitat types are used consistently and where egg cases occur in high densities. Archived video of the seafloor collected primarily in Monterey Bay by the Monterey Bay Aquarium Research Institute (MBARI) and the National Marine Fisheries Service, Southwest Fisheries Science Center's Fishery Ecology Division (NMFS-SWFSC-FED) were used to collect spatial and habitat information and to identify eggcases to species. Video from MBARI and SWFSC showed eggcases were commonly observed at depths between 101-524 m. Video footage has revealed that *A. brunneus* and *P. xaniurus* preferentially deposit their eggs within the Monterey Submarine Canyon specifically by wrapping egg case tendrils on sessile invertebrates, rocky outcrops, or derelict fishing gear. *Apristurus kampa* eggs do not have tendrils and have not yet been observed. Preliminary results indicate that sponges are used preferentially as oviposition sites for both *A. brunneus* and *P. xaniurus*.

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

Kelsey Reider, Maureen Donnelly

Florida International University, Miami, FL, USA

Occupancy patterns of Andean frogs in the shadow of melting glaciers

In the tropical high Andes significant changes in temperature, glacier cover, and species distributions have occurred in recent decades. Two frog species, *Pleurodema marmoratum* and *Telmatobius marmoratus*, have colonized new aquatic habitat formed by glacial recession near the upper edge of the biosphere. To understand the effects of ongoing climate change on high-elevation amphibian populations we conducted surveys in 13 recently deglaciated sites in the Cordillera Vilcanota, southeastern Peru. We used occupancy models to examine patterns of upslope migration into habitat created by rapid deglaciation. Our focal species have been asymmetrically successful at colonizing habitat created by recent deglaciation. While *P. marmoratum* were observed in 70% of sites, indicating that the species is undergoing rapid, widespread upward range expansion in response to climate change, *T. marmoratus* were not observed at any new sites. Inside the recently deglaciated zone, high occupancy probability for *P. marmoratum* was linked to co-occurring high-elevation wetland vegetation in our top model: $\rho(\text{search effort})\psi(\text{site+wetland vegetation})$. Our study underscores the importance of these high-elevation wetlands. In addition to providing crucial habitat for some of the world's highest-elevation amphibians, Andean wetlands provide important ecosystem services such as carbon sequestration, water storage, and dry-season pasture sites used by high-elevation herding communities.

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

Eric Reyier¹, Stephanie Watwood², Bonnie Ahr¹, Joseph Iafrate², Douglas Scheidt¹

¹Kennedy Space Center Ecological Program, Kennedy Space Center, Florida, USA, ²Naval Undersea Warfare Center Environmental Branch, Newport, Rhode Island, USA

As Not Seen on Shark Week: Multi-Year Movements of Blacknose, Finetooth, and Sharpnose Sharks in the US South Atlantic

Despite their numerical abundance and economic value, the behavior of many small coastal sharks in the US South Atlantic has been only coarsely described. Here we present movement summaries for blacknose (*Carcharhinus acronotus*), finetooth (*C. isodon*), and Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) as they travelled through a regional-scale acoustic telemetry network, offering direct comparisons of habitat utilization, site fidelity, and the extent and timing of coastal migrations. From 2013-2016, 165 total sharks were implanted with acoustic transmitters at Cape Canaveral, Florida, and tracked up to four years. While blacknose sharks were common off east Florida year-round, finetooth sharks were most abundant winter through early spring and sharpnose sharks summer through fall. Blacknose sharks also moved more slowly (mean 0.8 km/hr) and had the broadest depth preferences, while finetooth sharks were strongly shore-associated and sharpnose preferred proportionally deeper waters. All species exhibited low site fidelity when at Cape Canaveral, remaining at the same site for <1 hour on average, even when associated with deeper hard-bottom habitats. Most finetooth and many blacknose undertook spring migrations as far as Virginia and North Carolina, respectively, before returning to east Florida each winter. Sharpnose also made regular northward movements that were not as obviously seasonally-driven. Multiple individuals of all species, particularly females, returned briefly south to Cape Canaveral in mid-summer, illustrating that coastal migrations in these species are more akin to seasonal expansions of their geographic ranges as opposed to a synchronized shift of the entire population along the coast.

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

Calvin Rezac, Ginny Adams, Reid Adams, Matthew H. Connolly

University of Central Arkansas, Conway, Arkansas, USA

A 40 Year Outlook on the Impacts of Landuse and Fluvial Geomorphology on Fish Assemblages in the Spring River, Arkansas

The Spring River, located in the Ozark Highlands of northern Arkansas, is a spring fed system supported by the 7th largest spring in the United States (Mammoth Spring). The consistent flow makes the Spring River one of the most dependable and important recreational rivers in Arkansas. The river also features a high diversity of aquatic life, including 127 documented fish species making it one of the most diverse in North America. Since the early 20th century clearing of the Ozark forests has stressed the region's water resources. Legacy effects of deforestation combined with increasing residential and agricultural development since the 1970's may be

factors leading to channel instability and streambed gravel aggradations. These factors along with a lack of data concerning Species of Greatest Conservation Need and baseline stream habitat parameters, prompted a need for further study within the basin. We collected fish to compare historical fish surveys (1978-1980) to contemporary fish assemblages (2018). We also performed geomorphic stream surveys and analyzed land-use change using ArcGIS. In 2018 we collected 6,863 individuals representing 43 species across 10 sites compared to 5,561 individuals and 43 species collected historically. Nonmetric multidimensional scaling (NMDS) was used to compare assemblage composition between time periods. Stability and persistence were calculated, and nine of the ten site assemblages were considered to be highly persistent (>0.6). Preliminary findings suggest species composition of the historical surveys remain similar to current surveys. Future fish and geomorphic surveys will help to improve understanding of the entire drainage.

CANCELLED

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

Dustin Rhoads¹, Kristen Larson²

¹Texas Christian University, Fort Worth, TX, USA, ²Arizona State University, Phoenix, AZ, USA

A Quantitative Color-Pattern Test of the 'Stone Mimicry Hypothesis' in Roundtailed Horned Lizards (*Phrynosoma modestum*) Utilizing Digital *in situ* Photography

Quantifying color-matching among organisms and their environments has been a challenge for ecologists due to the qualitative nature of the variable and a lack of affordable technology for such assessments. Many longstanding hypotheses regarding color-pattern mimicry and crypsis remain untested due to these constraints. Here, we test a previously proposed hypothesis that Roundtailed Horned Lizards *Phrynosoma modestum* masquerade as stones throughout their range using a newly available and affordable technology for measuring color-matching with *in situ* digital photos. We compare and test for differential color-pattern matching between Roundtailed Horned Lizards and four components of their immediate environmental surroundings, separately and namely: (1) nearby stones, (2) soil, (3) woody sticks and stems, and (4) herbaceous foliage and flora. Results aim to address this stone masquerade hypothesis while providing further implications for the use of this technology in fields such as evolution and conservation biology.

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

Dustin Rhoads, Dean Williams

TCU, Fort Worth, TX, USA

Background Color-Matching in the Texas Horned Lizard (*Phrynosoma cornutum*)

Most of the literature on the basic ecology of Texas Horned Lizards cites "cryptic color pattern" as the first line of defense against predation in this taxon, and yet the degree to which horned lizards actually color-match their backgrounds has never been quantified. As a state-protected species in Texas that is in decline, several zoos and state wildlife agencies are releasing captive-bred hatchlings and translocated adults to parts of their former range; however, the new populations are not self-sustaining, with the majority of releases lost to predation. Background color-matching has not been quantified for these reintroduction efforts but may be important to take into account when moving lizards into a new habitat where predation may be higher if they are not closely color-matched to the local soils. We quantify background color-matching in this taxon across its known range in the United States and in Mexico from *in situ* photos taken, as found, in the wild. I also present background color-matching variation and trends both within and between phenotypically and genetically diverse populations and ask whether lizards more closely match their local soil colors than soils from other areas. Finally, I suggest a method for zoos and wildlife agencies to score coloration in their captive populations of lizards, thus possibly enabling these institutions to objectively take into account color-matching *a priori* as an applied conservation strategy to potentially increase the survival of reintroduced Texas Horned Lizards.

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

Molly Richard, Chris Gienger

Austin Peay State University, Clarksville, TN, USA

Repeatability of Standard Metabolic Rate in Eastern Box Turtles, *Terrapene carolina carolina*

Selective pressures can influence the survivorship of individuals in a population. For this to occur, the trait being selected for must be expressed consistently over time to allow natural selection to act upon among-individual variation. Measuring the among-individual variation in Standard Metabolic Rates (SMR) of ectotherms is key to understanding the potential for environmental pressures to influence the metabolic phenotype, thus giving insights to the relationship between environmental variation and trait evolution. We measured metabolism of Eastern box turtles captured over the course of several months and over several years. We then estimated the potential for natural selection to act via analysis of phenotypic trait repeatability. Eastern box turtles were measured after entering a post-absorptive metabolic state and were placed in a temperature stable respirometry chamber for a 48-hour period to sample oxygen consumption. Metabolic phenotypes were determined by collecting repeated measurements from the same individuals over time. This information will aid in assessing potential for natural selection to act on energy expenditure and energy allocation decisions of free-ranging box turtles.

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

Shannon A. Richard¹, Eric A. Tillman², Sanjiv Jayamohan¹, John S. Humphrey², Paige E. Carrington¹, Michael L. Avery², M. Rockwell Parker¹

¹James Madison University, Harrisonburg, VA, USA, ²National Wildlife Research Center - U.S. Department of Agriculture, Gainesville, FL, USA

Mate searching behaviors in invasive Argentine black and white tegus

Squamate reptiles (snakes and lizards) rely on chemical cues from conspecifics to search the environment for potential mates, and how such cues are being used by invasive species to facilitate reproduction is a key question that can inform management practices. Argentine black and white tegus are a major invasive reptile species in South Florida, and much information exists on the reproductive ecology of this species in its native range that has aided intervention efforts. However, the chemical ecology of tegus is less clear. By testing both male and female tegus in a Y-maze apparatus, we have been assessing whether either sex follows chemical trails left by conspecifics and how behaviors differ between the sexes and across seasons. Our previous results indicated that males do not preferentially follow female scent trails, but males do show increased rates of chemosensory sampling to female trails. Seasonally, male behaviors were more distinct in the spring (breeding season) than in the fall. We are now testing female trailing behavior in response to various conspecific scent trails and will present those findings. We predict that females should follow male but not female scent trails in the maze and that females will display distinct behaviors at higher frequencies in response to male scent. Collectively, sex-specific targeting via chemical trail application could enhance trapping efforts if we do see strong, sexually dimorphic trailing behavior in these experiments.

502 Herpetology Biogeography II, Ballroom 3 – Cliff Lodge, Friday 26 July 2019

Jonathan Richmond¹, Hidetoshi Ota², L. Lee Grismer³, Robert Fisher¹

¹U.S. Geological Survey, San Diego, CA, USA, ²University of the Ryukyus, Nishihara, Okinawa, Japan, ³La Sierra University, Riverside, CA, USA

Ecological specialization influences historical biogeography and diversification of seafaring scincid lizards (genus *Emoia*)

The narrow niche widths of ecological specialists are predicted to restrict range size, dispersal ability, and elevate the risk of extinction. We explore evidence that challenges this theory in the *Emoia atracostata* complex, an insular radiation of skinks consisting of endemic and widespread species with generalist and specialist ecologies. Our aim was to explore whether tolerance to high-saline habitats may have spurred the group's expansion across the west Pacific and Indo-

Australasia regions, and ultimately drove allopatric speciation as an artifact of the process. We used phylogeographic diffusion models to test whether diversification is consistent with an expanding wave front propagating from a center of origin and focused on reconstructing the historical biogeography of the most specialized group member, *E. atracostata*, to gauge its contribution to the group's overall phyletic diversity through space and time. We show evidence of multi-directional, incremental spread out of western Micronesia and examples of large over-water distances separating nearest relatives. Co-occurring endemics reflect secondary contact and *in situ* speciation within island groups. Dispersal and diversification patterns suggest that *E. atracostata* acted as an evolutionary propagule that generated most of the existing phyletic diversity in the *atracostata* group, and is itself comprised of lineages that represent completed or incipient allopatric speciation. We provide evidence that specialization in the *atracostata* group is not the driver of speciation, but rather a precondition for successful dispersal and colonization of similar saline habitat on remote islands, and that the type of specialization has evolved in a manner that perpetuates its maintenance.

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

Mitchell Rider, Neil Hammerschlag

*University of Miami - Rosenstiel School of Marine and Atmospheric Science, Miami, Florida,
USA*

**Determining Spatial Range and Philopatry of Acoustically Tagged South Florida Bull
Sharks (*Carcharhinus leucas*) Using Data from Cooperative Telemetry Networks**

Understanding the movement ecology of marine species is important for conservation management. Tracking the movements of highly mobile marine predators can be challenging since they exhibit wide-ranging, long distance movements, often across multiple jurisdictions. Employing passive acoustic telemetry, this study exploits data sharing from cooperative acoustic telemetry networks to assess the spatial range, philopatry and connectivity patterns of bull sharks (*Carcharhinus leucas*) along the Gulf of Mexico and across the US Atlantic coast that were originally tagged in South Florida. A total of 14 individuals were caught within Biscayne Bay, Florida, and affixed with internal acoustic tags. Their spatial range varied per individual and spanned the United States coastline from Alabama to Maryland. However, most individuals spent the majority of their time in the Florida Keys, displaying strong philopatric behavior to this area. A seasonal trend was evident, as individuals moved northward from the Florida Keys in the summer and returned in the winter. Possible reasons for these movement patterns could be attributed to prey populations and seasonal temperatures. This study demonstrates the value of using cooperative acoustic telemetry networks for tracking the movements of highly mobile marine species.

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

Nelson Rios

Yale University, New Haven, CT, USA

A Blockchain Inspired Model for Natural History Collections Data

Technological innovations over the past two decades have given rise to the online availability of more than nine-million specimen and species-lot records from ichthyological and herpetological collections around the world through large-scale biodiversity data-aggregator networks. In the present landscape of biodiversity informatics, collections data, which are typically managed locally, are shared online as read-only, point-in-time snapshots in the form of Darwin Core Archives. To maintain currency, data providers are responsible for periodically publishing revised archives, which must then be retrieved, post-processed and indexed by data aggregators such as iDigBio, GBiF, VertNet, FishNet2 and others. In practice, for many data providers, this model of data publication results in lengthy delays prior to the dissemination of new information. Furthermore, no universal paradigm exists to support third-party access, transformation, modification, and supplementation of specimen data records while maintaining accountability, consistency and integrity over time. This talk will: 1) explore a conceptual framework for the next generation of natural history collections data networks that leverages recent advances in cryptographic ledgers and smart contracts to overcome many of the shortcomings of contemporary approaches and 2) review relevant use cases.

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

Leslie Rissler¹, Katherine Hale², Nicholas Caruso³, Nina Joffe⁴

¹National Science Foundation, Alexandria, VA, USA, ²National Center for Science and Engineering Statistics, Alexandria, VA, USA, ³Virginia Tech, Blacksburg, VA, USA, ⁴New Mexico State University, Las Cruces, NM, USA

Why Aren't More Women Submitting Grants?

A healthy and globally competitive society is one with strong science emanating from all members of our community, yet women remain underrepresented in all science and engineering (S&E) fields. This presentation will discuss new data on the relative numbers of men and women by field of science and career stage through time (2001-2016) with an emphasis on understanding submission and funding success patterns to the National Science Foundation (NSF) – the major U.S. funding institution supporting all basic S&E fields in academia. We find that in all NSF directorates women are as likely to receive funding as men; however, fewer women submit proposals than could, given their numbers in the professorial pool, especially in

fields with more women like biology. We provide data that sheds light on why this happens, and how behavior differs depending on field of study. Additional insight on where to find public data on the STEM workforce and the U.S. S&E enterprise will be highlighted, as well as NSF initiatives and programs that promote diversity, especially with respect to gender balance in science.

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

Kim Ritchie¹, Diego Gil-Agudelo², Daniel Conrad¹, Elliott Mark¹, Alex Jonguitud¹, Chris Fischer³

¹University of South Carolina at Beaufort, Beaufort, SC, USA, ²Texas A&M University at Galveston, Galveston, TX, USA, ³OCEARCH, Park City, UT, USA

Antibiotic-Producing Bacterial Symbionts of the White Shark, *Carcharodon carcharias*

Epidermal surfaces provide diverse innate immune functions, including facilitating colonization of mutualistic microorganisms. We have previously shown that epidermal surfaces of skates and rays harbor antibiotic-producing bacteria that may contribute to innate immunity and wound healing (Ritchie et al., 2017). For this study, we surveyed bacterial associates from five white sharks (*Carcharodon carcharias*) to investigate the role that bacteria may play in host health. Over 32 genera of cultured bacteria were identified associated with one adult male and one subadult female white shark sampled, tagged and released off the coast of Hilton Head, South Carolina, in February 2017. Our surveys indicate that up to 20% of bacterial isolates from these two individuals produced antibacterial activity against a range of test strains, including both marine and human pathogens. In contrast, no antibiotic-producing bacteria were isolated from three young-of-the-year (YOY) white sharks sampled off the coast of Montauk, New York, in August 2017. Work continues to characterize these, and recently acquired, bacterial associates of *C. carcharias* to identify beneficial interactions in shark innate immunity. Our growing library of antibiotic-producing elasmobranch bacteria also provides novel candidates for future drug discovery research.

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

Danielle Rivera¹, Miguel T Rodrigues², Matthew K Fujita¹

¹University of Texas at Arlington, Arlington, TX, USA, ²Universidade de São Paulo, São Paulo, SP, Brazil

Patterns of Genetic Diversity in Widespread South American *Rhinella* Toad Populations

Toads are known to exhibit complex genetic patterns, including introgression and hybridization, across populations. Species from the genus *Rhinella* in Central and South America provide a useful system to investigate how prevalent these phenomenon are in widespread natural toad populations across a large geographic region. Here we explore genomic diversity and structure of different populations of *Rhinella marina* and *R. granulosa* species complexes occurring across heterogeneous climates in South America. We use phylogeographic methods, incorporating ddRADseq data, to test genomic structure and gene flow across populations. Results from this study aim to improve knowledge about genomic patterns of hybridization and structure in natural widespread toad populations.

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

D Ross Robertson¹, Giacomo Bernardi²

¹Smithsonian Tropical Research Institute, Panama, Panama, ²University of California, Santa Cruz, California, USA

Hybridization among a population of IndoPacific damselfishes in the Gulf of Mexico

Neopomacentrus cyanomos is only the second IndoPacific reef fish known to have established a population in the Greater Caribbean. This species currently is confined to and spread throughout most of the Gulf of Mexico. DNA barcoding of the GoM population revealed the presence of the two most different of four distinct native-range haplogroups, which could be regarded as separate species. We are using RAD sequencing of a sample of individuals from the Southwest Gulf of Mexico to determine if those two haplogroups are hybridizing there and the pattern of any introgression between them.

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

Luiz Rocha

California Academy of Sciences, San Francisco, CA, USA

Preserved specimens benefit public education and generate compelling exhibits

Preserved specimens and scientific collections are important to scientists worldwide for providing verifiable data points for monitoring species health, distribution, and phenotypes through time. They are also extremely attractive to the general public and are invaluable tools for education and outreach. However, the public has very little access to them. Unlike university collections, public facing natural history museums constantly experiment with displaying

collections, both with real and virtual specimens. Here collections become great tools for engaging the public on several important societal issues such as climate change, invasive species, and the biodiversity crisis. During my presentation, I will show several examples of how the California Academy of Sciences is increasing the public presence of its collections, both virtually and in its public floor in San Francisco. Additionally, recently there have been several misguided attempts at characterizing scientific collections as damaging to the species we seek to study. Even though these attempts are based on isolated examples from a time when collections were done a lot less carefully than today, they always garner public attention and support. Even though these arguments might resonate with the public, in reality, scientific collection has a minimal impact, and one of the best ways of minimizing this negative connotation is by sharing collection stories widely.

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

Adolfo Rodríguez-Velázquez, Alberto Sabat-Guernica, Zabrina Santana-Navarro, Nelly Báez-Henry

University of Puerto Rico, Rio Piedras Campus, San Juan, PR, Puerto Rico

Evaluation of the use of Camera Traps to Study the Predation of the Puerto Rican Racer (*Borikenophis portoricensis*).

Through the development of visual censuses in the Cambalache State Forest, it was found that many *Borikenophis portoricensis* showed scars of possible predators. Researches on this type of behavior are complicated due to the secret conduct of snakes. Our objective in this research was to analyze the operation of the camera trap "Bushnell Trophy Cam 20MP", using snake models to identify potential predators of the *B. portoricensis* in the Cambalache State Forest. Cameras were positioned in areas in which snakes were observed most frequently. These were programmed to take sequences of photos and videos when a movement was sensed. The models used were covered with plasticine to detect any evidence of attacks that the cameras failed to capture. The data were evaluated according to the number of sightings of predation attempts. In the initial phase of the study, we were able to determine that the combination of two plasticine type was the best result due to the tropical climate. The models successfully became a part of the environment as both predators and prey showed expected behaviors towards them. It should be noted that the best performance obtained from them was in the activation of the high Censor PIR mode. The main predators observed in these cameras were invasive species such as domestic cats and rats. Most of the reported attacks were in the head and tail area. The use of cameras and models were useful because they allowed having real correlations in terms of the identification of predators and species.

590 Amphibian Conservation, Ballroom 2 – Cliff Lodge, Saturday 27 July 2019

John Romansic, Kevan Moffett, Nicolette Nelson, Jonah Piovia-Scott

Washington State University, Vancouver, Vancouver, WA, USA

Beaver Dams are Associated with Higher Amphibian Diversity in the Southern Washington Cascades

Land managers are increasingly using beavers and beaver dam analogs for stream restoration, conservation of imperiled salmonids, and climate change adaptation. However, more information is needed about the effects of these projects on wildlife. Beaver dams create large, deep ponds with long hydroperiods, which could greatly benefit wildlife species that depend on pond habitats. However, previous studies indicate that the relationship between beaver dams and some pond-breeding amphibians is variable and context-dependent. Benefits to some species might be balanced by negative effects on others, potentially preventing net increases in species diversity. We surveyed beaver-dammed and undammed sites in the southern Washington Cascade Range to investigate the relationship between beaver dams and species richness of pond-breeding amphibians. We observed far higher species richness in dammed compared to undammed sites. This pattern was driven mainly by the slow developing northern red-legged frogs and northwestern salamanders, which require at least 15 weeks to reach metamorphosis after egg deposition. However, site occupancy tended to be higher in 4 out of the other 5 species, all of which can reach metamorphosis within 8 weeks of egg deposition. Thus, rather than diluting the positive relationship between dams and pond-breeding amphibians, faster developers contributed to it, even though they were least dependent on the long hydroperiods provided by dams. The strong association between beaver dams and diversity of pond-breeding amphibians detected in our study suggests that beaver introductions underway in the region will likely help maintain amphibian biodiversity, especially as summertime drying intensifies under climate change.

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

John Romansic¹, Jonah Piovia-Scott¹, Allan Pessier²

¹*Washington State University, Vancouver, Vancouver, WA, USA*, ²*Washington State University, Pullman, WA, USA*

Evaluating the Susceptibility of Native Amphibians from Pacific States to the Pathogenic Fungus Bsal

The fungal pathogen *Batrochochytrium salamandrivorans* (Bsal) poses a serious threat to native amphibians, especially salamanders, in the Pacific Northwest and throughout North America. Bsal is thought to have originated in East and Southeast Asia and spread to Europe through the pet trade, where it is responsible for dramatic declines in *Salamandra salamandra* (fire salamander) populations in the Netherlands, Belgium, and Germany. To date, Bsal is not known

to have colonized North America, a global center for salamander biodiversity. Our study is part of a detailed assessment of the risk Bsal poses to native amphibians in Pacific states based on susceptibility measured in controlled laboratory exposure experiments. To date, we have conducted such trials for several taxa native to Pacific states, including *Taricha torosa* (California newt), *Hyla regilla* (Pacific chorus frog), and *Plethodon dunni* (Dunn's salamander). *Taricha torosa* became infected with Bsal following exposure and exhibited skin lesions consistent with Bsal chytridiomycosis. Some individuals displayed severe skin lesions, but none died during the 61-day exposure period. In contrast, preliminary results for *H. regilla* and *P. dunni* suggest that they are highly resistant to Bsal. Susceptibility trials are also planned for seven additional species. Taken together, our results provide insight into the risk Bsal poses to native amphibians, as well as the regional epidemiological dynamics that may occur if this pathogen invades western North America.

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

Willem Roosenburg, Alayna Tokash

Ohio University, Athens, OH, USA

Using K-12 Classrooms to Head-start Diamond-backed Terrapins and Evaluate Differences in Growth due to Temperature and Behavior

We used K-12 classrooms to raise Diamond-backed Terrapins, *Malaclemys terrapin*, during their first year of life to provide head-start terrapins for a population restoration project. Terrapin hatchlings emerging from natural nests were collected in the field and distributed to classrooms throughout the Maryland school system. After an eight month grow-out program the terrapins are PIT tagged and readied for release. During this program, we noticed substantial differences in size among head-start which we attributed to classroom differences in rearing environment. We initiated a paired rearing experiment in which a subset of classrooms were given two terrapins to rear at different temperatures. Students were responsible for all experimental maintenance including feeding controlled amounts, monitoring tank temperature, and measuring animals. The goal of the experiment was to maintain the tanks at 23C and 28C and control all other variables. Although growth diverge between the two temperatures the differences in size were not of the magnitude expected. We also monitored the basking platforms with Plotwatcher cameras and revealed that animals from the cooler treatment significantly increased their basking activity likely as a compensation for the cooler water treatment to achieve similar growth. We reveal an interesting behavioral adjustment to compensate for variation in the thermal environment by terrapins with data collected by young aspiring scientists.

280 Amphibian Conservation, Ballroom 2 – Cliff Lodge, Saturday 27 July 2019

Jonathan Rose¹, Brian Halstead¹, Robert Fisher²

¹Dixon Field Station, Western Ecological Research Center, U.S. Geological Survey, Dixon, CA, USA, ²San Diego Field Station, Western Ecological Research Center, U.S. Geological Survey, San Diego, CA, USA

Integrating Multiple Data Sources and Sampling Bias to Predict the Current Distribution of Western Spadefoot, *Spea hammondi*, in Northern California

Determining the spatial scale at which landscape features influence population persistence is an important task for conservation planning. One major challenge with landscape-scale analyses is that sampling biases confound factors that influence species occurrence with those that influence whether an area was surveyed. Recent developments in spatial Point Process Models (PPMs) enable researchers to leverage disparate data sources to disentangle biases from the sampling process from factors influencing ecological drivers of species' distributions. Western Spadefoots (*Spea hammondi*) have been extirpated from much of their historical range in California, with land-cover change identified as a key driver of declines. Review of this species' conservation status requires information on the current distribution of suitable habitat within its historical range. We created PPMs integrating historical presence-absence and presence-only data for Western Spadefoots and co-occurring amphibians and historical and modern land-cover data at multiple spatial scales. The occurrence of Western Spadefoots was positively related to the proportion of grassland in the surrounding landscape, with the strongest relationship found using a 2000 m buffer around occurrences. There was clear spatial sampling bias in presence-only data; amphibian occurrence records were more likely to be reported from areas near major roads and urban centers. Model results indicate that remaining habitat for Western Spadefoots is largely found in a narrow band along the edge of its historical range, in the foothills surrounding California's Central Valley. Our study illustrates how PPMs can improve both projections of habitat suitability and our understanding of the proximate drivers of species' distributions.

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

Adam Rosenblatt, Molly O'Brien

University of North Florida, Jacksonville, FL, USA

Effects of Simulated Climate Change on the Development of American Alligator Embryos

Many reptile species exhibit temperature-dependent sex determination (TSD), a trait that makes them uniquely vulnerable to climate change. As temperatures rise, egg incubation temperatures may rise as well, potentially leading to strongly biased hatchling sex ratios, egg mortality, or altered developmental phenology. These effects have been investigated in some TSD species, but research on American alligators has been limited. Understanding the effects of climate change on alligator populations is important because they are the dominant freshwater apex predator across much of the southeastern United States. We conducted an experiment that exposed 20 clutches of

alligator eggs to different simulated climate change scenarios: warming, increased precipitation, and warming + increased precipitation. We found that warming alone may not impact hatchling alligator sex ratios at all because the nesting material can act as an effective insulator against hot air temperatures. However, warming combined with increased precipitation can raise the egg incubation temperature, producing more males in the process. In addition, eggs in warmed nests hatched earlier than those in ambient nests, indicating that climate change may alter hatching phenology. Lastly, nests that experienced low humidity exhibited increased egg mortality, underlining the risk of drought for alligator recruitment. Our results highlight the risks of climate change for reptile population dynamics and provide important new directions for future research.

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

Erica Bree Rosenblum

UC Berkeley, Berkeley, CA, USA

A tale of two study systems

As scientists, we often have very influential relationships with our study systems. We find species, places, and questions that speak to us, and we invest immense curiosity and effort in getting to know these systems. In the years - or decades – we spend studying a particular system, our own lives also unfold. My career thus far has revolved around two very different study systems. One of these, the gypsum dunes of White Sands, has captivated me for nearly 20 years. As I have studied the evolution of the dune lizards, so too has the desert observed me. White Sands has watched me grapple not only with scientific questions but also with the constantly changing landscape of life. There are not many places to hide in the desert, and its solitude has always provided a place for honest self-reflection. Here I will share some reflections on White Sands with a focus on the lizards I love, the process of science, and the discovery of what might be our most interesting study system yet: ourselves.

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

Grace Roskar, Michael McCallister, Matthew Ajemian

FAU Harbor Branch Oceanographic Institute, Fort Pierce, FL, USA

Elasmobranch Community Dynamics in Florida’s Southern Indian River Lagoon

Many elasmobranch species utilize estuaries as parturition, nursery, or foraging grounds and certain estuaries have been established as essential or critical habitat for protected species.

Florida's Indian River Lagoon (IRL), an "estuary of national significance," has experienced myriad anthropogenic impacts in the past few decades. Unfortunately, there is a substantial data gap surrounding the status of elasmobranchs in the southern IRL. A long-term fishery-independent survey (longline/gillnet) was implemented to characterize the elasmobranch community and understand distribution patterns in the southern IRL (Sebastian to St. Lucie Inlet). From July 2016 - June 2018, 630 individuals of 16 species were caught and tagged, including two critically endangered smalltooth sawfish (*Pristis pectinata*). Bull sharks (*Carcharhinus leucas*), Atlantic stingrays (*Hypanus sabinus*), cownose rays (*Rhinoptera bonasus*), bluntnose stingrays (*Hypanus say*), and bonnethead sharks (*Rhizoprionodon terraenovae*) were the five most common species encountered, comprising 85% of the total catch. Some species exhibited differences in size among regions. The longline catch exhibited a significant difference in species composition among regions while the gillnet catch composition significantly varied among seasons. Although dependent on survey gear type, we found evidence of combinations of abiotic parameters (e.g., depth, salinity, water clarity, distance to a freshwater source, distance to an inlet) driving elasmobranch distribution in the southern IRL. Bull sharks and Atlantic stingrays dominated areas with frequently low salinities. This study provides the first baseline abundance indices for many elasmobranchs in the IRL and develops the capacity to understand how elasmobranchs may respond to further changes in this highly modified estuary.

368 Turtle Conservation/Amphibian Conservation, Ballroom 3 – Cliff Lodge, Friday 26 July 2019

Betsie Rothermel¹, Hunter Howell², K. Nicole White^{1,3}, Christopher Searcy², Tracey Tuberville³, Michael Yuan⁴, Kelly Zamudio⁵

¹Archbold Biological Station, Venus, FL, USA, ²University of Miami, Miami, FL, USA,

³University of Georgia, Athens, GA, USA, ⁴University of California-Berkeley, Berkeley, CA, USA, ⁵Cornell University, Ithaca, NY, USA

Demographic Consequences of Habitat Alteration and Inbreeding for a Gopher Tortoise Population in Southern Florida

The long-term viability of Gopher Tortoise (*Gopherus polyphemus*) populations is jeopardized by increased urbanization and habitat degradation owing to fire suppression. Our study aims to clarify the demographic consequences of suboptimal habitat management for a semi-isolated population of Gopher Tortoises in south-central Florida. We examined differences in demographic parameters among fire-suppressed sandhill, restored sandhill, and former sandhill (i.e., ruderal) habitats at Archbold Biological Station. Using program MARK, we estimated population size and sex-specific and habitat-specific survivorship based on 6 years of mark-recapture data. We also determined individual growth trajectories and clutch sizes and tested for effects of inbreeding on clutch viability and hatchling traits. Tortoises in the open, ruderal habitat exist at much higher density (8.24/ha) than in adjacent restored (1.73/ha) or fire-suppressed (0.30/ha) sandhill. Despite this dramatically higher density, both adult survivorship and body size were significantly higher in the ruderal habitat. Although there were no significant

differences among habitats in body condition, growth rate, or asymptotic body size, larger female body size in ruderal habitat resulted in slightly larger average clutch sizes. High parental relatedness resulted in smaller offspring and was correlated with reduced hatching success, suggesting this relatively small population (~113 adult tortoises) may be experiencing some negative effects of inbreeding depression. Our demographic data suggest that anthropogenic, grass-dominated habitats may be important components of the habitat mosaic currently available to this declining species.

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

Andrew Rothstein¹, Roland Knapp², Erica Bree Rosenblum¹

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Stepping into the past to conserve the future: amphibian skin swabs from extant and extinct populations inform conservation genetic management

Frogs in the mountain yellow-legged frog (MYLF) species complex (*Rana muscosa* and *Rana sierrae*) were once one of the most abundant vertebrates in California's montane communities. Over the last century, these amphibians, which play an important ecological role, have been lost from more than 90% of their historical range due to introduced predators and pathogens. Given this decline, active conservation strategies have included translocations and reintroductions. However, given limited knowledge of the genetic structure and variation of MYLF, researchers and managers have been restricted in frog movements to avoid introduction of novel genotypes to sub-populations. Leveraging archived skin swabs previously used for disease surveillance, our study combines a minimally-invasive samples and robust nuclear amplicon sequencing to create a population genetic framework for future MYLF recovery strategies. Notably, our study includes skin swab samples from both extirpated and extant lake basins – providing a critical comparison of past and present genetic variation for an endangered species. Our study addressed the following three objectives: 1) identify frog genetic management units 2) assess gene flow and potential admixture across population clusters, and 3) identify genetic diversity remaining in persisting lake basins. Results show that previously delineated population clusters are more nuanced with increased genomic resolution. Additionally, we find admixture across major landscape boundaries indicating increased levels of gene flow across frog management units. Current work is identifying sub-populations that hold high genetic potential for future translocations and reintroductions across MYLF range.

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

Kristopher Row, Luke Frishkoff

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Morphological limitations imposed on lizards facing urbanization

Urbanized area is rapidly increasing across the globe, replacing natural landcovers and threatening biodiversity. Urban environments pose unique environmental challenges that species must overcome, such as an increase in temperature, man-made impervious structures, pollution and more. While many species are unable to adapt to these environmental changes, some thrive in it. The reasons for urban success are not always clear, but morphological adaptation (or pre-adaptations) to urbanization may play an important role allowing some species to avoid being filtered out of the community by harsh urban conditions. In this study we seek to address three key questions related to the position, size, and overlap of morphospace occupied by urban versus non-urban lizards using 18 linear measurements of morphology from preserved museum specimens from across the US. We combine this morphological data with a measure of urban association derived from observational occurrence data from iNaturalist to ask: 1. Do urban tolerant species on average occupy distinct zones of morphospace from their natural counterparts? 2. Do urban species take up less morphospace? and 3. Are morphologies that succeed in urban zones broadly overlapping and redundant with those in natural environments? Morphology provides one of the key links between phenotype and fitness in natural biomes. Determining whether and how morphology equates to ecological success in human-modified environments constitutes a core requirement for explaining community structure in proliferating urban ecosystems.

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

Ethan Royal¹, Jessica Homyak², J.D. Willson¹

¹*University of Arkansas, Fayetteville, AR, USA*, ²*Weyerhaeuser Company, Seattle, WA, USA*

Effects of forest management on habitat structure and upland pine-associated herpetofaunal communities

Longleaf pine (*Pinus palustris*) savannah once covered much of the southeastern Coastal Plain and was characterized by open canopy, diverse herbaceous vegetation, and high amounts of bare soil. The unique structural and vegetative conditions of this habitat support many endemic species, including several reptiles and amphibians. Managed pine (*Pinus* spp.) stands now occur throughout the southeastern U.S. and have replaced much of the historic longleaf pine savannah. These managed stands can provide suitable habitat conditions for some open canopy-associated wildlife species if certain structural characteristics are maintained. However, little work has examined herpetofaunal communities. After performing repeated, low intensity herpetofauna surveys and vegetation surveys, we used hierarchical Bayesian occupancy modeling techniques

to assess the ability of managed pine stands in sandy soil regions of Northwestern Louisiana to support open pine-associated herpetofauna. We selected 81 sites across 7 management regimes: mechanically managed young and thinned mid-age loblolly pine (*P. taeda*) stands, fire-maintained young, mid-age and mature longleaf stands, and fire-maintained mid-age and mature loblolly stands. We performed repeated visual encounter surveys at each site over two field seasons. We quantified vegetation characteristics including canopy cover, overstory, midstory, understory, and groundcover. Preliminary results suggest that young stands and some mid-age fire-maintained sites most closely resembled open-canopy, fire-maintained mature pine stands in vegetation characteristics and herpetofaunal community composition. Some closed-canopy mature sites supported the most diverse herpetofauna communities, but lacked upland pine associated species. Our results provide insight into how forest management practices affect herpetofaunal communities and will help guide management strategies.

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

Sara Ruane

Rutgers, Newark, NJ, USA

Old Museum Specimens for Modern Molecular Systematics

Museums provide a wealth of information via preserved natural history specimens, including but not limited to dietary, morphological, and geographic distribution information. In the modern molecular age however, fluid-preserved museum collections have not been at the frontline for generating useable data, despite the fact that for some species, only museum specimens are known, with no fresh genetic materials available. We are now at a major shift in our ability to use museum specimens for molecular phylogenetics, where modern subgenomic sequencing techniques better allow for successfully sequencing dozens to thousands of phylogenetically informative loci for preserved specimens, including formalin and fluid-preserved reptiles, amphibians, and fishes. Here, I review the current state of the field, including methodologies and studies which have successfully generated molecular datasets using fluid-preserved specimens, particularly with respect to systematic studies. In an age where both museums and general collecting come under critique from the general public, this review emphasizes the continued importance of museum specimens across all subfields in the study of reptiles, amphibians, and fishes.

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

Margaret Rubin, Christopher Brochu

University of Iowa, Iowa City, IA, USA

Examination and placement of a new specimen in Alligatorine evolutionary history

Extant *Alligator* comprises two species – the American (*A. mississippiensis*) and Chinese (*A. sinensis*) alligators, but it has a fossil record extending back to the late Eocene. Nevertheless, a gap separates *Alligator* from its closest published relative in the late Paleocene (*Wannaganosuchus brachymanus*), which like other early Paleogene alligatorines was very small (≤ 2 m), short snouted, and with adaptations for durophagy, such as a robust palate and enlarged distal maxillary and dentary teeth. Here, we describe a new species from the middle Eocene (Uintan NALMA) Uinta Formation of Utah that fills the stratigraphic gap and represents an intermediate form between earlier durophagous alligatorines and more generalized modern species. It resembles earlier alligatorines in many ways – its snout was comparatively short, its suborbital fenestrae were relatively small, its narial chamber was not inflated, and its orbital margins were not upturned – but it lacks the enlarged cheek teeth that characterized earlier alligatorines. The nasals project into the narial space, but do not completely subdivide the naris. A phylogenetic analysis recovers the new Uintan form as the sister lineage to *Alligator*. The living American alligator is an ecological generalist, but it arose from more specialized ancestors; the transition from specialist to generalist largely occurred after generalized crocodyloids disappeared from North America, suggesting that it was in response to niche availability, but the new form co-occurred with some of these crocodyloids, suggesting that the transition was already underway before the sharp contraction of crocodylian diversity in the northern continents after the middle Eocene.

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

Braden Ruddy, Stephen Kajiura, Marianne Porter

Florida Atlantic University, Boca Raton, FL, USA

Aerial Drone Utilization in the Study of Elasmobranch Fishes

Until recently, aerial based studies were necessarily conducted with manned aircraft, which are expensive to operate, require specialized training, and are large and loud and, hence, disruptive. The recent advent of Unmanned Aircraft Systems (UAS) technology has provided researchers with the ability to inexpensively and unobtrusively observe animals in their natural habitat. UAS platforms are relatively easy to fly, making them accessible to a wide range of researchers, and are portable, enabling them to be operated from remote locations where aircraft would be impractical. The ability to hover over a target of interest permits data collection that would have been previously impossible without the use of a helicopter mounted cineflex system. Coupled with the development of UAS platforms has been the miniaturization of gimbal stabilization, high quality digital recording, and georeferenced imaging which combine to provide high resolution images of exceptional quality. The UAS platforms with their imaging capabilities allow researchers to record photos and videos from animals exhibiting natural behaviors. The utilization of aerial drones for elasmobranch research is an emergent and exciting

development that has provided a new tool for researchers to explore the life history and behaviors of various species. UAS platforms have been used in elasmobranch research to quantify species density, describe habitat utilization, document social and foraging behaviors, provide fine scale movement patterns, and quantify swimming kinematics. We present a review of aerial drone utilization in elasmobranch research and discuss potential future applications of this technology.

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

Ariana Rupp, Brad Moon

University of Louisiana Lafayette, Lafayette, LA, USA

How to Train Your Mud Snake: First Data on Juvenile Mud Snake Growth in a Laboratory Setting

The growth of juvenile mud snakes is very poorly known. The published literature on mud snakes is extremely limited and several publications cite the difficulty of acquiring and maintaining this species as the reason for this scarcity of information. Meade (1946) kept adult mud snakes in an outdoor enclosure in Gramercy, Louisiana, and had several clutches of eggs that he removed from the enclosure and incubated. After hatching, Meade failed to successfully feed the juveniles and released them onto his property. In the 73 years since that publication, few studies have come out on mud snakes and none has provided information on the growth of juveniles, their prey, or their maintenance needs in captivity. In the spring and summer of 2017, we acquired a dozen adult mud snakes from southern Louisiana, and in July of 2017, 8 of those individuals laid clutches of 6-11 eggs, for a total of 62 eggs laid. We incubated eggs away from the mothers and separately by clutch, and all but 3 eggs hatched in October 2017. All juveniles refused any food offered until after shedding their skin within one week of hatching. After the first shed, all juveniles accepted live tadpole prey, but refused other food items when offered. We present the first data on hatchling mud snake feeding and growth in a laboratory setting. We also provide insights on keeping mud snakes in the lab, which have been noted in many publications as difficult to maintain in captivity.

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

Krista Ruppert, Drew Davis, Richard Kline, Saydur Rahman

University of Texas Rio Grande Valley, Brownsville, TX, USA

Development, Application, and Assessment of an Environmental DNA Assay for Detection of the Rio Grande Siren

Environmental DNA (eDNA) assays have become a major aspect of amphibian surveys in the past decade. These methods are highly sensitive, making them well-suited for monitoring rare and cryptic species. Current efforts to study the Rio Grande Siren in the Lower Rio Grande Valley (LRGV) have been hampered due to the cryptic nature of these aquatic salamanders. Arid conditions in the LRGV further add to the difficulty in studying this species, as many water bodies they inhabit are ephemeral, sometimes constraining sampling efforts to a short window after heavy rain. Additionally, sirens are known to cease activity and reside underground when ponds begin to dry or as water temperatures increase. Conventional sampling efforts require extensive trap-hours to be effective, which is not always possible within the required sampling window. Here, we discuss the development of a novel eDNA assay technique for this elusive species and compare eDNA results with simultaneous trapping at multiple sites to assess the relative effectiveness of the procedure. This methodology gives promise for future work assessing the distribution and status of the Rio Grande Siren and has potential for use on other south Texas amphibians.

CANCELLED

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

Trevor Ruppert, Robert Espinoza

California State University, Northridge, Northridge, California, USA

Identifying the Physiological Limitations to Dispersal and Persistence of an Invasive Amphibian in Southern California

Introduced African Clawed Frogs (*Xenopus laevis*) threaten native amphibians across their invasive range. Once imported for use in human pregnancy testing, thousands of these aquatic frogs were released into Southern California waterways following the advent of pharmaceutical tests and quickly spread. *Xenopus* are highly fecund, eat any animal they can swallow, including each other, and are resistant to traditional methods of extermination (poisoning, habitat drying, and prolonged starvation). Yet despite their characterization as an archetypal invasive species, *Xenopus* have not achieved their anticipated invasive potential in Southern California. In fact, in areas with seemingly viable habitat some populations have gone extinct, while others persist in low abundance. Our goal is to determine which aspects of the biology of *Xenopus* have allowed some populations to endure, while others have failed. We are sampling for *Xenopus* throughout Southern California using traditional visual encounter and trapping surveys, as well as environmental DNA, to census potential and historic sites. Next, using an inferential approach, we will identify the environmental (hydroperiod, water quality, etc.) and physiological variables that limit the persistence and dispersal of *Xenopus*. Physiological variables include lab tests of thermal critical minimum and maximum, desiccation tolerance, and overland locomotor ability in laboratory-acclimated frogs and tadpoles. We hypothesize that a specific suite of variables (distance among viable habits, habitat quality, potential predator presence, etc.) limit

Xenopus from invading novel sites, and that lab-based physiological tests will confirm field-based correlations.

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

Elana Rusnak, Liza Merly

University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL, USA

Isolation and Characterization of Acute Phase Reactants in the Nurse Shark, *Ginglymostoma cirratum*

Sharks serve as models for the evolution of the vertebrate immune system in many studies. Few studies have focused on the immune function and health of sharks in wild populations and relating those assessments to population dynamics. Current monitoring programs, including tagging studies, present an opportunity to investigate health status in wild sharks. To evaluate health in these populations, metrics must be established that can be measured using a semi-non-invasive measurement of a blood sample to minimize additional anthropogenic impacts. Immunological proteins in the acute phase protein (APP) family, including C-reactive protein (CRP), serum Amyloid-P, and fibrinogen, may serve as useful biomarkers of inflammation. CRP is used clinically in many species, including humans, as a biomarker for both acute and chronic inflammatory states. The purpose of this study was to isolate and characterize various acute phase protein genes in nurse sharks (*Ginglymostoma cirratum*) as a first step in determining whether they might serve as useful metrics of shark health in future studies. To analyze serum proteins, small blood samples were taken from live, wild-caught nurse sharks in southern Florida. Preliminary health assessments using serum protein electrophoresis and leukocyte counts were conducted. Initial protein isolation has yielded a post-elution protein band containing a pentraxin domain, common to CRP and other APPs. Current work includes isolation and identification of nurse shark APPs at both the protein and gene level. Custom primers have been designed and putative gene products derived from liver samples are being analyzed.

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

Ellery Ruther^{1,2}, Jinelle Sperry³, Brett DeGregorio²

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Regional Trends in Spotted Turtle (*Clemmys guttata*) Movement Patterns

Herpetofauna ecology is influenced by environmental thermal conditions and these conditions, and thus behavior, often vary across latitude. Understanding latitudinal patterns of behavior may give important insight into responses to climate change, which is particularly important for wildlife inhabiting stochastic ecosystems, such as ephemeral wetlands. Spotted turtles (*Clemmys guttata*) inhabit ephemeral wetland systems and are experiencing declines across their range. The conservation of this species is especially complex due to their wide-ranging distribution and seasonal activity patterns. Spotted turtle populations are distributed along the east coast from Florida to Maine, and in disjunct populations along the great lakes in the U.S. and Canada. Though spotted turtles occupy a variety of habitat features across the range, seasonal variation in activity patterns and habitat use have been documented range-wide. To understand regional trends in seasonal spotted turtle movement patterns, I corroborated telemetry data from across the range and then examined the influence of latitude, surrounding landscape features, and climate conditions on inter-wetland movements and home-range using generalized linear mixed models. Turtle movement and home-range increased with surrounding landscape development, though turtle movement decreased with precipitation and higher temperatures. Unsurprisingly, turtle movement was highest along the southern latitudes of the range. These results suggest that turtle activity may increase due to rising global temperatures, which may further expose turtles to anthropogenic threats.

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

Megan Ryba, Kyle Piller

Southeastern Louisiana University, Hammond, LA, USA

Environmental DNA as a tool to survey the fish communities of artificial reefs in Lake Pontchartrain

Environmental DNA (eDNA) is a non-invasive technique that allows biologists to take a sample from the environment and determine what species are present. Environmental DNA is a relatively new approach that is used to monitor imperiled and invasive species, as well as monitor habitats that are difficult to sample by conventional approaches. The presence of eDNA is controlled by abiotic factors including, but not limited to, UV, temperature, and pH. Lake Pontchartrain is a large estuarine system in southeast Louisiana that has been subjected to substantial anthropogenic modifications over the last half century. Shell dredging has eliminated much of the hard substrate, resulting in a paucity of firm substrates for fishes. As a result, artificial reefs have been deployed to augment habitat. Currently there are 15 artificial reefs in Lake Pontchartrain comprised of concrete reef balls and crushed limestone/concrete rubble. Due to the high level of turbidity, monitoring the success of the reefs has been problematic. Therefore, the goal of this study was to utilize eDNA metabarcoding to examine the fish communities of six artificial reefs and their paired controls. The surveyed reefs consisted of three concrete reef ball reefs and three concrete/limestone rubble reefs that ranged in deployment age from 2001 to 2016. Results indicate significant differences in fish community profiles among controls and artificial reefs and significant differences in reef age and material. Abiotic data was

also monitored when samples were taken to determine what impact they have on the presence of eDNA in an estuarine system.

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

Wade Ryberg¹, Toby Hibbitts^{1,2}, Danielle Walkup¹, Brandon Bowers¹, Michelle Lawing³

¹*Texas A&M Natural Resources Institute, College Station, Texas, USA*, ²*Texas A&M University Biodiversity Research and Teaching Collection, College Station, Texas, USA*, ³*Texas A&M University Ecosystem Science and Management, College Station, Texas, USA*

Creating the Sauga Network: Using citizen science to enhance Western Massasauga research and conservation

Citizen science provides an opportunity to quickly answer questions at large spatial scales that would otherwise go unanswered or take many years to answer. In the realm of herpetology, citizen science also bridges the gap between hobbyists and professional researchers. For large scale research questions, professionals can benefit from hobbyists' local knowledge on species' abundance, activity, and distribution. Here, we present the origin story of the Sauga Network, a community of volunteers and scientists that partnered together to enhance Western Massasauga research and conservation. We also review recent research outcomes and tangible conservation successes derived from data collection efforts of the Sauga Network, which are on-going. These citizen science driven research and conservation successes have improved our understanding of patterns of genetic population structure in this species, and also helped characterize the potential past and future climate-driven changes in that population structure. In addition, they provided perspectives on how resources might be allocated for the species to achieve the greatest future conservation benefits for the lowest cost (maximize return-on-investments) through habitat conservation forecasting. Current and future research driven by efforts of the Sauga Network include a genomic analysis of the species, computed tomography (CT) scans to estimate micro-variation in species' morphology, continued climate modeling to track the history and fate of distinct population segments, and development of automated monitoring protocols for the species.

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

JungHwa Ryu, JinKoo Kim

Pukyong National University, Busan, Korea, Republic of

Marine fish diversity and the aspects of assemblage structure according to Tsushima warm current areas around the Korean peninsula

The Korean peninsula is surrounded by the Yellow Sea, the Korea Strait and the East Sea, being affected by various sea currents and water masses. Sound different characteristics of each sea have caused a great potential that the species diversity of marine fish has been driven from the paleo-climatic change and/or contemporary sea currents. In order to understand the current biogeography of fish species around the Korean peninsula, assemblage structure analysis was conducted based on fish species composition which was collected four times a year at 10 stations using set net. During the survey, a total of 154 fish species was collected, of which *Trachurus japonicus* (22.1%) was the most dominant, and followed by *Konosirus punctatus* (9.2), *Scomber japonicus* (8.7). The diversity of species was the highest at Gangjeong (in southern Jeju Island), but the lowest at Hanrim (in northern Jeju Island). Based on the Bray-Curtis similarity of 30%, 10 stations were divided into 3 subgroups, in which subgroup of A comprised two stations in the western and middle Korea Strait; subgroup of B comprised 4 stations in the East Sea; subgroup of C comprised 4 stations in Jeju Island, eastern Korea Strait and southern East Sea. The contribution species of these groups were *Nuchequula nuchalis* in subgroup of A, *Thamnaconus modestus* in subgroup of B and *T. japonicus* in subgroup of C. This grouping may be determined by the characteristics of the sea currents or water masses.

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

Johanna Imhoff¹, Dean Grubbs²

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

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

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

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

Callie Ingram

University of North Carolina Wilmington, Wilmington, NC, USA

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

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

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

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

Krone Isaac

UC Berkeley, Berkeley, California, USA

Ecological and Phylogenetic Patterns in Lizard Range Size

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

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

Kathleen Ivey¹, Hayley Crowell¹, Heather Neldner¹, Michael Westphal², Emily Taylor¹

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

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

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

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

Michael Izumiyama¹, Satoshi Awata², Karen Crow¹

¹San Francisco State University, San Francisco, CA, USA, ²Osaka City University, Osaka, Japan

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

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

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

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

SeoHa Jang, JinKoo Kim

Pukyong National University, Busan, Korea, Republic of

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

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

CANCELLED

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

Eric Januszkiewicz^{1,2}, Nicole Chinnici^{3,2}, Thomas LaDuke¹

¹East Stroudsburg University, Greentown, PA, USA, ²Northeast Wildlife DNA Laboratory, East Stroudsburg, PA, USA, ³East Stroudsburg University, East Stroudsburg, PA, USA

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

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

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

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

Sylvia Jiménez-Rosenberg¹, María Clara Arteaga², Clara Galindo-Sánchez², Anaid Saavedra-Flores², Javier Robles-Flores², Miguel Martínez², Jaime Gasca², Sharon Herzka²

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

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

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

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

Kasey L. Jobe¹, Carmen G. Montaña², Christopher M. Schalk¹

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

Caudates as prey: Predator diversity and size-relationship patterns

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

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

Kasey L. Jobe¹, Nick Schiwitz¹, Krista Ward¹, Dan Saenz², Christopher M. Schalk¹

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

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

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

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

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

G. David Johnson

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

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

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

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

Josiah Johnson

Colby College, Waterville, Maine, USA

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

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

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

Christian Jones¹, William Driggers¹, Kristin Hannan², Eric Hoffmayer¹, Diva Amon³, Brian Kennedy⁴

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

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

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

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

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

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

Southern Utah University, Cedar City, UT, USA

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

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

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

Katherine Jones, John Peterson

University of Wisconsin-Platteville, Platteville, WI, USA

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

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

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

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

Kenny Jones II¹, Michael Sandel¹, Bernie Kujahda²

¹The University of West Alabama, Livingston, Alabama, USA, ²Tennessee Aquarium Conservation Institute, Chattanooga, Tennessee, USA

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

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

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

Leonard Jones¹, Adam Leache¹, Frank Burbrink²

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

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

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

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

Jillian M. Josimovich¹, Amy Yackel Adams¹, Melia G. Nafus¹, Charlotte J. Robinson¹, Austin L. Fitzgerald¹, Lea' R. Bonewell¹, Robert N. Reed¹, Bryan G. Falk², M. Rockwell Parker³

¹U.S. Geological Survey, Fort Collins, CO, USA, ²National Park Service, Homestead, FL, USA, ³James Madison University, Harrisonburg, VA, USA

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

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

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

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

Kathlene Joyce^{1,2}, Malorie Hayes², Jacqueline Potter³, Craig Guyer²

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

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

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

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

Nathalie Jreidini

McGill University, Montreal, Quebec, Canada

Population dynamics of an endangered amphibian across a changing landscape

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

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

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

Bryan Juarez¹, Daniel Moen², Dean Adams¹

¹*Iowa State University, Ames, Iowa, USA*, ²*Oklahoma State University, Stillwater, Oklahoma, USA*

Does Morphology Predict Interspecific and Intraspecific Jumping Performance in Frogs?

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

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

Dovi Kacey^{1,2}, Luke Thompson³, Kelly Goodwin³, Anne Freire de Carvalho¹, Andrew Thompson¹

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

Metabarcoding to Increase Ichthyoplankton Sampling Capacity

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

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

Stephen Kajiura

Florida Atlantic University, Boca Raton, FL, USA

Impact on Elasmobranch Research of the Donald R. Nelson Award

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

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

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

Larry Kamees, Steven Beaupre

University of Arkansas, Fayetteville, Arkansas, USA

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

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

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

Benjamin Karin¹, Michael Lough-Stevens², Sean Reilly³, Anthony Barley⁴, Jimmy McGuire¹, Indraneil Das⁵, Todd Jackman⁶, Aaron Bauer⁶

¹*University of California Berkeley, Berkeley, CA, USA*, ²*University of Southern California, Los*

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

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

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

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

Nancy Karraker¹, Mirza Kusri², Jessica Atutubo¹, Ryan Healey¹, Aini Yasratul²

¹University of Rhode Island, Kingston, RI, USA, ²Institut Pertanian Bogor, Bogor, Indonesia

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

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

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

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

Emily Karwacki, Katherine Martin, Anna Savage

University of Central Florida, Orlando, Florida, USA

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

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

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

Anna Kase, Jacob Kerby

University of South Dakota, Vermillion, South Dakota, USA

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

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

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

Jerry Kattawar III, Kyle Piller

Southeastern LA University, Hammond, LA, USA

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

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

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

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

Jerry Kattawar¹, Kyle Piller¹, Rich Harrington², Dan MacGuigan², Tom Near²

¹*Southeastern LA University, Hammond, LA, USA*, ²*Yale University, New Haven, CT, USA*

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

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

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

Maureen Kearney

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

Structural Reform and Systemic Culture Change for STEMM

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

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

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

Bryan Keller¹, Bryan Frazier², Dean Grubbs¹

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

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

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

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

Allison Kelley¹, Shane Welch¹, John Holloway², Will Dillman³, April Atkinson⁴, Jayme Waldron¹

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

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

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

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

Meghan Kelley, Che Ka, Mary Mendonca

Auburn University, Auburn, AL, USA

Multimodel Signal Use in Gopher Tortoises

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

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

Audrey Kelly, Karin Pfennig

University of North Carolina, Chapel Hill, NC, USA

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

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

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

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

Megen Kepas¹, Ted Turner², Al Savitzky¹

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

Adrenal histology among snakes with differing levels of toad consumption

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

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

Jacob Kerby

University of South Dakota, Vermillion, SD, USA

An update on the Bsal Task Force

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

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

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

Emily Kerns, Kyra Cipolla, Dehiam Gonzalez, Matthew Gilg

University of North Florida, Jacksonville, FL, USA

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

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

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

Steven Kessel¹, Natasha Hinojosa², Henry Wilson³, Gina Clementi⁴, Chuck Knapp¹

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

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

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

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

JinKoo Kim, JungHwa Ryu

Pukyong National University, Busan, Korea, Republic of

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

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

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

Daniel Kimball¹, Michael Minicozzi², Alice Gibb²

¹*Northern Arizona University, Flagstaff, AZ, USA*, ²*Northern Arizona University, Flagstaff, AZ, USA*

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

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

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

Laura Kimmel, Joy Lauffenberger, Allyson Fenwick, Paul Stone

University of Central Oklahoma, Edmond, OK, USA

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

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

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

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

Randy L. Klabacka^{1,2}, Perry L., Jr. Wood^{1,3,2}, Jimmy A. McGuire⁴, Jamie R. Oaks¹, L. Lee Grismer⁵, Jesse L. Grismer⁵, Anchalee Aowphol⁶, Jack W., Jr. Sites²

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

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

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

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

Paul Klawinski

William Jewell College, Liberty, MO, USA

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

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

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

Peter Klimley

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

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

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

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

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

Peter Klimley¹, James Ketchum², Mauricio Hoyos-Padilla², Frida Lara-Lizardi²

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

The Creation of the Revillagigedos Islands National Park

North America's largest marine protected area is Mexico's Revillagigedos Islands National Park. This no-capture zone for sharks, manta rays, and other pelagic fish was expanded seven-fold by the Mexican government based on shark tracking data collected by researchers at Pelagios Kakunjá and the University of California, Davis. Located 556 km southwest of the Baja Peninsula, it encompasses 10,556 km² around a series of four volcanic islands, San Benedicto, Socorro, Roca Partida, and Clarion, in the Revillagigedo Archipelago. First, individually coded beacons were placed on members of seven species of sharks, and the migration of three, the Galapagos, silvertip, and tiger sharks were shown to move between the islands based on detections by autonomous receivers moored at each of the islands. Sharks were initially tagged during an expedition in 2010 by OSEARCH to film *Shark Men* for National Geographic Films; the tagging was continued until 2015 by members of Pelagios Kakunjá. The results from the automated receiver study indicated to Mexican resource managers that protection should be extended around the entire archipelago. Finally, satellite tagging indicated that the sharks moved to a distance of 74 km from the islands, thus leading to further expansion of the reserve. Environmental protection means little if not enforced. The Mexican Navy is currently patrolling the area with boats and drones to help ensure the protections are enforced, and this seems to be working. Shown will be satellite tracks of commercial fishing boats to demonstrate that fishing is being limited to outside the park boundaries.

CANCELLED

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

Blake Klocke^{1,2,3}, Brian Gratwicke^{1,2}, Roberto Ibañez^{1,2}, Jorge Guerrel^{1,2}, Orlando Garces^{1,2}, Elliot Lassiter^{1,2}, Heidi Ross²

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

USA

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

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

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

Ashley Kobisk, Matthew Kwiatkowski

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

Effects of Artificial Light at Night on Anuran Calling Behavior

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

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

CANCELLED

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

Paige Koehler¹, Marcus Drymon², Emily Seubert², Simon Gulak³, Brent Winner⁴, Toby S. Daly-Engel¹

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

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

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

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

Michelle Koo¹, Carol Spencer¹, David Blackburn², David Cannatella³, Alessandro Catenazzi⁴, Ann Chang¹, Joyce Gross⁵, Rebecca Tarvin¹, Vance Vredenburg⁶, David Wake¹

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

New Updates on AmphibiaWeb: All Amphibians, All the Time

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

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

Derek Kraft¹, Melanie Hutchinson^{2,3}, Brian Bowen¹

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

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

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

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

Alexandra Krak, Kenshu Shimada

DePaul University, Chicago, Illinois, USA

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

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

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

Andrea Kroetz¹, Dean Grubbs², John Carlson¹, Mark Bond³

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

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

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

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

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

Aaron Krolow, Kyle Piller

Southeastern Louisiana, Hammond, LA, USA

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

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

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

Chelsea Kross, John Willson

University of Arkansas, Fayetteville, AR, USA

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

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

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

Ariel Kruger, Peter Morin

Rutgers University, New Brunswick, NJ, USA

Predators Induce Morphological Changes in Tadpoles of *Hyla andersonii*

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

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

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

Kole Kubicek¹, Ralf Britz², Kevin Conway¹

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

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

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

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

Kole Kubicek¹, Ralf Britz², Kevin Conway¹

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

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

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

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

Shawn Kuchta

Ohio University, Athens, Ohio, USA

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

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

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

CANCELLED

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

Nathan Kudla, Eric McCluskey, Jen Moore

Grand Valley State University, Allendale, Michigan, USA

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

Populations with low gene flow can become negatively influenced by increased levels of inbreeding, lower genetic diversity, and reduced adaptive potential. Landscape genetics allows for spatial and genetic information to be analyzed simultaneously to better understand how the landscape influences gene flow. This information is then used to estimate population connectivity and identify landscape features which act as barriers or promoters of gene flow. The eastern massasauga rattlesnake (*Sistrurus catenatus*) is a federally threatened viper typically found in wetlands throughout the Great Lakes region. Due primarily to a loss of habitat, many remaining populations are small and isolated. This lack of connectivity brings into question the survival of these populations into the future. Unlike many other populations, the population of eastern massasauga rattlesnakes on Bois Blanc Island, Michigan lives in a relatively undisturbed habitat with a potential for high connectivity across the 88 km² landscape. We used landscape genetics to estimate genetic connectivity of eastern massasauga rattlesnakes across Bois Blanc Island. 102 individuals were genotyped at 15 microsatellite loci and pairwise genetic distances were calculated as the proportion of shared alleles (D_{ps}). We used resistance surface modeling to assess how the island landscape is influencing gene flow. Our research will be completed by the summer of 2019. The results will provide insight as to how eastern massasauga rattlesnake populations function in areas with limited human presence and minimal landscape alteration and if population connectivity can be maintained across a well-connected landscape with high abundance.

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

Sarah Kupferberg¹, Alessandro Catenazzi²

¹*Questa Engineering, Berkeley, California, USA*, ²*Florida International University, Miami, Florida, USA*

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

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

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

Shannon Kuznar

University of Louisiana, Lafayette, LA, USA

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

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

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

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

Matthew Kwiatkowski

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

Association Between Color Polymorphism and Habitat in Ornate Tree Lizards

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

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

Peter Kyne¹, Rima Jabado², Cassandra Rigby³, Dharmadi⁻⁴, Mauvis Gore⁵, Caroline Pollock⁶, Katelyn Herman⁷, Jessica Cheok⁸, David Ebert⁹, Colin Simpfendorfer³, Nicholas Dulvy⁸

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

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

Extremely high extinction risk in wedgefishes and giant guitarfishes

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

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

Emily S. Ladin¹, Larry G. Allen², Crystal D. Rogers¹

¹California State University Northridge, Northridge, California, USA, ²California State University Northridge, Northridge, California, USA

Developmental Ontogeny of Giant Sea Bass, *Stereolepis gigas*

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

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

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

Travis LaDuc¹, Drew Davis², James Christiansen¹

¹University of Texas at Austin, Austin, Texas, USA, ²University of Texas Rio Grande Valley, South Padre Island, Texas, USA

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

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

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

Krista Laforest, Emily Peele, Kara Yopak

University of North Carolina Wilmington, Wilmington, NC, USA

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

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

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

Jaedyn Lalonde, Lindsey Swierk

Binghamton University, Binghamton, New York, USA

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

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

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

Jennifer Y. Lamb, Matthew P. Davis

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

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

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

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

Max Lambert¹, Adam Roddy², Christian Gosser³, Charles Mettler³, William Robinson³, Brad Carlson³

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

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

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

Zachary Lange¹, James Watling¹, Andres Aponte²

¹John Carroll University, University Heights, Ohio, USA, ²National University of Colombia, Bogota, Colombia

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

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

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

John Larrimore, Michael Sandel, Kayla Fast

University of West Alabama, Livingston, AL, USA

Metabarcoding Freshwater Fishes of the Mobile River Basin

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

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

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

Matthew Larsen¹, Daniel Abel¹, Derek Crane¹, Bryan Keller², Dean Grubbs²

¹Coastal Carolina University, Conway, South Carolina, USA, ²Florida State University, Tallahassee, Florida, USA

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

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

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

Matthew Larsen¹, Daniel Abel¹, Derek Crane¹, Scott Parker¹, Bryan Keller², Dean Grubbs²

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

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

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

Halee Larson, James Gelsleitcher

University of North Florida, Jacksonville, Florida, USA

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

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

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

Elliot Lassiter¹, Orlando Garces¹, Jorge Gurrel¹, Roberto Ibañez², Brian Gratwicke³

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

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

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

Adam Leache¹, Matt Fujita², Jamie Oaks³

¹*University of Washington, Seattle, Washington, USA*, ²*University of Texas, Arlington, Texas, USA*, ³*Auburn University, Auburn, Alabama, USA*

Mechanisms of Diversification in West African Amphibians and Reptiles

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

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

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

Javion Lee¹, Caleb McMahan², Christopher Murray¹

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

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

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

Ryan Lehman¹, Jill Hendon², Dr. Gregg Poulakis³, Rachel Scharer³, Dr. Nicole Phillips¹

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

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

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

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

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

The College of Wooster, Wooster, OH, USA

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

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

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

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

Matthew Levendosky, Molly Lanier, Christine Bedore

Georgia Southern University, Statesboro, Georgia, USA

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

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

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

Enjie Li^{1,2}, Gregory Pauly¹, Sophie Parker², John Randall³, Brian Brown¹, Brian Cohen³

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

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

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

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

Peter V. Lindeman

Edinboro University of Pennsylvania, Edinboro, Pennsylvania, USA

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

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

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

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

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

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

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

Karen Lips

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

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

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

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

Allison Litmer¹, Christopher Murray²

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

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

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

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

Aimee Little¹, Jim Gelsleichter¹, Christine Bedore²

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

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

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

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

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

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

Ryan Logan¹, Jeremy Vaudo¹, Lara Souza², Bradley Wetherbee^{1,3}, Mark Sampson⁴, Mahmood Shivji¹

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

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

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

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

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

Cody Long, Dustin Siegel

Southeast Missouri State University, Cape Girardeau, MO, USA

All *-gnathus* salamanders lack nasolacrimal ducts.

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

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

Gary Longo¹, Krista Nichols¹, Jameal Samhour¹, Kelly Andrews¹, Greg Williams¹, Laurel Lam², Bonnie Brown², Scott Hamilton²

¹NOAA, Seattle, WA, USA, ²CSUMB, Moss Landing, CA, USA

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

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

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

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

Keira Lopez

University of Northern Colorado, Greeley, CO, USA

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

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

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

Christopher Lowe

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

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

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

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

William Ludt¹, Bruce Collette^{2,1}, Carole Baldwin¹

¹*Smithsonian NMNH, Washington, DC, USA*, ²*NOAA, Washington, DC, USA*

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

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

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

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

Kady Lyons¹, Katherine Wynne-Edwards²

¹Georgia Aquarium, Atlanta, GA, USA, ²University of Calgary, Calgary, AB, Canada

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

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

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

Amanda Macek¹, Bryan Franks¹, Steven Kessel²

¹*Dept of Biology and Marine Science, Jacksonville University, Jacksonville, Florida, USA,*

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

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

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

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

Stephen Mackessy¹, Cassandra Modahl²

¹*University of Northern Colorado, Greeley, CO, USA,* ²*National University of Singapore, Singapore, Singapore, Singapore*

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

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

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

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

Andrew MacLaren¹, Paul Crump², Michael Forstner¹

¹Texas State University, San Marcos, Texas, USA, ²Texas Parks and Wildlife Department, Austin, Texas, USA

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

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

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

John Maerz, Coles Ehlers, Angela Burrow

University of Georgia, Athens, Georgia, USA

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

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

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

John Maerz¹, Vanessa Terrell¹, Nathan Engbrecht², Rochelle Stiles³, Brian Crawford¹, Michael Lannoo²

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

Population dynamics of Threatened Crawfish Frogs Informs Targets for Management

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

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

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

Anne Maglia

University of Massachusetts Lowell, Lowell, MA, USA

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

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

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

Michael Mahr¹, Justin Autz¹, Jennifer Buchanan¹, Alexis Powell¹, Lynnette Sievert¹, David Edds¹, J. Daren Riedle²

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

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

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

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

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

Alex Maile, Matthew Davis

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

Patterns of Biofluorescence in the Rabbitfishes (Siganidae)

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

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

Jennifer Main, Ginny Adams, Reid Adams

University of Central Arkansas, Conway, Arkansas, USA

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

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

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

Justin Mann, Henry Bart

Tulane University, New Orleans, LA, USA

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

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

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

CANCELLED

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

Rachel Manning¹, Luke Tornabene², Carole Baldwin³

¹*School of Aquatic and Fishery Sciences, University of Washington, Shelton, Washington, USA,*

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

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

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

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

Elizabeth Marchio

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

The Art of Aquarium Keeping Communicates Science and Conservation

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

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

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

Madeline Marens^{1,2}, Dewayne Fox³, Bradley Wetherbee⁴, Amanda Southwood-Williard¹, Frederick Scharf¹

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

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

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

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

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

Robin Maritz¹, Luke Verburgt², Andre Coetzer³, Bryan Maritz¹

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

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

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

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

Mariana Marques^{1,2}, Luis Ceríaco^{3,2}, Edward Stanley⁴, Matthew Buehler⁵, Aaron Bauer⁵

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

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

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

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

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

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

Washington and Lee University, Lexington, VA, USA

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

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

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

Thomas Marshall¹, Drew Davis², David Hillis¹

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

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

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

Amanda Martin, Karen Root

Bowling Green State University, Bowling Green, OH, USA

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

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

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

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

Bradley T. Martin¹, Marlis R. Douglas¹, Tyler K. Chafin¹, John S. Placyk Jr.², Roger D. Birkhead³, Chris A. Phillips⁴, Michael E. Douglas¹

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

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

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

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

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

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

University of Central Florida, Orlando, FL, USA

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

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

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

Kelsey Martin, Greg Stunz

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

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

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

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

Kelsey Martin^{1,2}, Dan Abel², Derek Crane², Neil Hammerschlag³, Erin Burge²

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

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

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

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

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

Rene Martin¹, Abbey Dias², Adam Summers³, Mackenzie Gerringer³

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³*University of Washington, Seattle, WA, USA*

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

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

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

Lindsey Martin-Krikorian¹, Tristan Bulice¹, Matthew Gifford², Lorin Neuman-Lee

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Physiological tradeoffs in reproductive collared lizards

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

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

Angel L. Martínez-González

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

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

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

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

Ángel L. Martínez-González¹, Fredys F. Segura-Guevara¹, Glenys Tordecilla-Petro², William A. Pérez-Doria¹, Charles W. Olaya-Nieto¹

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

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

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

Ángel L. Martínez-González¹, Jesús Vargas-González¹, Fredys F. Segura-Guevara¹, Glenys Tordecilla-Petro², William A. Pérez-Doria¹, Charles W. Olaya-Nieto¹

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

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

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

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

Mariana Martins^{1,2}, Patrícia Costa¹, Otto Gadig², Adalto Bianchini¹

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

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

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

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

Katherine Maslenikov

University of Washington Fish Collection, Seattle, WA, USA

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

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

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

Robert T. Mason, Leslie Blakemore

Oregon State University, Corvallis, OR, USA

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

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

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

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

Alice Masper¹, Jose E. Pérez-López², Hector Espinosa-Pérez³

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Identification Guide of the Gulf of California Fish Otoliths

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

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

Emily Mausteller¹, Jayme Waldron¹, John Holloway², Will Dillman³, Alex Foote¹, Nicholas Bolin¹, Elizabeth Johnson¹, Shane Welch¹

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

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

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

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

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

Zachary May, Matthew Davis

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

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

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

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

Logan McCardle, Clifford Fontenot

Southeastern Louisiana University, Hammond, LA, USA

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

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

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

Margaret McClain¹, J. Marcus Drymon², Bryan Frazier³, Austin Gallagher⁴, R. Dean Grubbs⁵, Tristan Guttridge⁶, Neil Hammerschlag⁴, Matt Smukall⁶, Toby Daly-Engel⁷

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

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

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

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

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

Sara McClelland, Sarah Woodley

Duquesne University, Pittsburgh, PA, USA

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

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

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

Ashlie McIvor, Collin Williams, Michael Berumen

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

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

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

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

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

Donald McKnight¹, Deborah Bower², Lin Schwarzkopf¹, Ross Alford¹, Roger Huerlimann¹, Leah Carr¹, Kyall Zenger¹

¹James Cook University, Townsville, QLD, Australia, ²University of New England, Armidale, NSW, Australia

How do epizootics become enzootics? Clues from rainforest frogs

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

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

Samantha McPherson¹, Joseph Agugliaro², Craig Lind³, Terence Farrell¹

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

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

Energetic tradeoffs associated with metabolically costly reproductive events can impact future reproductive success of an organism. Although yolk allocated to offspring during vitellogenesis in pitvipers is thought to be the primary fuel for embryonic growth, there may be additional maternal energetic costs during pregnancy associated with exchange of gas, nutrients, and waste between maternal and fetal tissues. This maintenance cost of pregnancy (MCP) may be reflected by an increase in maternal resting metabolic rate (RMR) during gestation in excess of the metabolic demands of embryos. If the fecundity-independent MCP is relatively high, it may contribute to a low frequency of reproduction (LFR) observed in pygmy rattlesnakes and other viperid species. To investigate energetic costs of pregnancy in *S. miliarius*, we used flow-through respirometry to measure RMR (CO₂ production) of 23 late pregnant and 15 non-reproductive females collected July-August, 2018. We determined the difference in RMR between pregnant and non-reproductive snakes ($\Delta\dot{V}CO_2$), and used non-linear regression of $\Delta\dot{V}CO_2$ against total litter mass to estimate MCP as the y-intercept of this curve. RMR was significantly higher in pregnant snakes compared to non-reproductive females. Furthermore, there was a significant relationship between maternal RMR and the number of days before parturition; RMR of pregnant females increased when measured closer to parturition. Preliminarily, estimates of MCP were not significantly different from zero; these results indicate that MCP is a minor component of reproductive effort in pygmy rattlesnakes, and that LFR in this species may be a result of other costs associated with reproduction.

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

Jessica McQuigg, Erin Overholt, Craig Williamson, Michelle Boone

Miami University, Oxford, Ohio, USA

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

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

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

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

Hannah Medd¹, Gretchen Arndt^{1,2}, Deborah Azevedo¹, Kaitlyn Isaacson¹, Dan Tabatabai³, Steven Cooke⁴, Steven Kessel⁵, Vivian Nguyen⁶, Jacqueline Chapman⁴, Jill Brooks^{4,1}

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

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

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

Emily Meese, Christopher Lowe

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

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

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

Bruno F. Melo¹, Fabio F. Roxo¹, Luz E. Ochoa¹, Brian L. Sidlauskas², Brant C. Faircloth³, Thomas J. Near⁴, Jonathan Chang⁵, Jairo Arroyave⁶, Melanie L. J. Stiassny⁷, Ricardo C. Benine¹, Michael D. Burns², Kendra Hoekzema², Natália C. Sanches⁸, Michael E. Alfaro⁵, Claudio Oliveira¹

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

Phylogenomics and temporal diversification of characiform fishes

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

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

Tricia Meredith, Stephen Kajiura

Florida Atlantic University, Boca Raton, Florida, USA

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

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

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

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

Alexandra Meyer¹, Chris L. Chabot¹, Andrew Nosal², Daniel Cartamil², Felipe Galván-Magaña³, Larry G. Allen¹

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

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

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

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

Lauren Meyer, Madeline Green, Lachlan Fetterplace

Otlet, Sydney, NSW, Australia

Otlet – an online platform for sourcing biological samples

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

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

Lauren Meyer¹, Heidi Pethybridge², Peter Nichols², Crystal Beckmann³, Barry Bruce², Charlie Huveneers¹

¹*Flinders University, Adelaide, South Australia, Australia,* ²*CSIRO Oceans and Atmosphere, Hobart, South Australia, Australia,* ³*SARDI Aquatic Sciences, Adelaide, South Australia, Australia*

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

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

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

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

Kara Million

Indiana University, Bloomington, IN, USA

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

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

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

Michael Minicozzi, Alice Gibb,

Northern Arizona University, Flagstaff, Arizona, USA

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

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

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

Stephen Mirkin, Mary Tucker, Dean Williams

TCU, Fort Worth, Texas, USA

Predation release of Texas horned lizards living in small towns

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

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

Blake Mitchell, Jennifer Main, Ginny Adams, Reid Adams

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

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

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

Corey Mitchell¹, Todd Esque², Amy Vandergast³, Jill Heaton¹, Kirsten Dutcher¹, Steve Hromada¹, Kevin Shoemaker⁴, Kenneth Nussear¹

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

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

Mark-recapture sampling methods are an important tool that have been used to monitor populations of many species, including the federally protected Mojave desert tortoise (*Gopherus agassizii*). By incorporating spatial location data into conventional mark-recapture models, spatial capture-recapture models have the potential to reduce bias in estimates, and account for common assumption violations such as spatially heterogeneous detection probability and temporary emigration. We conducted mark-recapture surveys for desert tortoises at a 1-km² study plot in the Ivanpah Valley southeast of Jean, NV and collected desert tortoise movement data concurrently using radio-telemetry and GPS data loggers. Two closed-population mark-recapture surveys have been conducted at the study plot separated by three years, and quantification of GPS logger movement data over the survey period demonstrates that desert tortoises frequently exhibit temporary emigration outside the study plot, thereby complicating standard mark-recapture approaches for density estimation. We integrated mark-recapture survey data with telemetry data using a modified spatial capture-recapture method. This custom model, fitted in a Bayesian framework, allowed us to generate high-precision estimates of density for a species where detectability and abundance are low, enhancing the efficacy of long-term efforts to monitor population trends and informing recovery efforts. We discuss the implications of this new approach on desert tortoise conservation and management.

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

Haley A. Moniz¹, Vicki L. Thill¹, Robert E. del Carlo¹, Jessica S. Reimche¹, Edmund D. Brodie Jr.², Normand LeBlanc¹, Chris R. Feldman¹

¹University of Nevada, Reno, Reno, Nevada, USA, ²Utah State University, Logan, Utah, USA

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

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

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

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

Dillon Monroe, Robert Espinoza

California State University, Northridge, CA, USA

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

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

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

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

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

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

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

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

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

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

Cristiano Moreira¹, Kevin W. Conway²

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

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

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

CANCELLED

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

Clark Morgan, Dr. Jim Gelsleichter

University of North Florida, Jacksonville, Florida, USA

Distribution and community structure of First Coast shark assemblages

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

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

Joshua Moyer¹, Stephanie Shannon², Duncan Irschick³

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

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

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

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

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

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

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

Christopher Mull¹, Sebastián Pardo², Alastair Harry³, Luz Saldaña Ruiz⁴, Emiliano Garcia Rodriguez⁴, Brit Finucci⁵, Christopher Bird⁶, Cassandra Rigby⁷, Manuel Dureuil², Nicholas Dulvy¹, Holly Kindsvater⁸

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

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

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

Martha Munoz

Virginia Tech, Blacksburg, VA, USA

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

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

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

Matthew Murdoch¹, Lee Grismer², Todd Jackman¹, Aaron Bauer¹

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

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

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

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

Mason Murphy, Michelle Boone

Miami University, Oxford, OH, USA

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

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

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

Alexander Murray, Luke Frishkoff

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Does arboreality heighten sensitivity to habitat modification in anurans?

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

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

Lindy Muse¹, Kenzie Pereira ², Sarah Woodley², Clifford Fontenot ¹, Brian Crother¹, Demetra Kandalepas¹

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Chytrid Growth Inhibition in Two Fully Aquatic Salamanders

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

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

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

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

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