FEATURED PRESENTATION ABSTRACTS

(in order of presentation)

Title: An Update on Conservation Initiatives, Policies, and Growth of Southeast Partners in Amphibian and Reptile Conservation (SEPARC).

Author: Andrew W. Cantrell, Department of Biology and Environmental Sciences, Alabama A&M University, Normal, AL 357562; andrew.cantrell@aamu.edu

Abstract: The Southeast Partners in Amphibian and Reptile Conservation (SEPARC) has made much progress over the last few years. One major achievement has been our membership growth and participation. Over the last few years our annual meeting has brought 150+ individuals from academia, industry, state and federal organizations, as well as private land owners and herp enthusiasts together to present research project results and updates, news on conservation initiatives, and provide networking and collaboration opportunities. Our meeting provides a place for our Education and Outreach, Reintroduction and Translocation, Invasive Species, Roads, Diseases, Pathogens, and Parasites, and Gopher Frog, Crawfish Frog, and Hellbender regional task team members to meet and discuss their annual progress and new goals. With this growth in membership our organization realized the need for forming certain policies such as our Meeting Code of Conduct and a Social Media Policy, while also recognizing our need to protect and attempt to increase the diversity of our membership which influenced our issued Diversity Statement. Some additional works include a regional species prioritization list, which is near to completion, and will provide a better framework for individuals and agencies working on multi-state conservation initiatives. In all, our progress has been rewarding, though it has not come without challenges. We are excited to share with our neighbors, NEPARC, updates on our accomplishments, the challenges we are currently facing, how our two regions have benefited from each other, and discuss ways to increase multi-region conservation efforts.

Title: Snakes of the Eastern United States.

Author: J. Whitfield (Whit) Gibbons, Professor Emeritus of Ecology, University of Georgia, Savannah River Ecology Lab, Aiken, SC 29802; wgibbons@uga.edu

Abstract: Snakes are the quintessential hidden biodiversity among reptiles. Most lizards and crocodilians have no issue with showing themselves. Basking turtles are a common spectacle. But snakes go unseen most of the time. What makes them different? Despite extensive research, many mysteries remain unsolved and basic questions go unanswered. Why do so many snake species vary so greatly in color pattern? Why have the largest black swamp snakes reported been captured by eastern kingsnakes? Why do cottonmouths have a reputation for being aggressive towards humans? Why are copperheads responsible for most U.S. venomous snakebites to humans? Some scientists believe that humans innately fear snakes. If true, how do we educate the public about these fascinating creatures? Such questions will be addressed through use of photos provided for "Snakes of the Eastern United States."

Title: The Monkton Vermont Amphibian Underpasses.

Author: James S. Andrews, The Vermont Reptile and Amphibian Atlas, 642 Smead Road, Salisbury, VT 05769; jandrews@middlebury.edu

Abstract: In 1993, an amphibian road-crossing area was discovered on a busy two-lane, paved, town road in Monkton, Vermont. Monitoring of the site began in 1997 and it was determined to be a conservation priority crossing area for amphibians and other wildlife. Priority for conservation action was based on high numbers of amphibians crossing, high diversity of species, high-priority species of greatest conservation need present (*Ambystoma laterale*), and high mortality from traffic. The Monkton, Vermont Conservation Commission working with the Lewis Creek Association began raising money in 2008 for two amphibian underpasses to be built. Funds were raised from Defenders of Wildlife, The Davis Conservation

Foundation, a Federal Transportation Enhancement Grant, a Vermont Fish and Wildlife Department State Wildlife Grant, direct mail fundraising, and an online Indiegogo fundraiser. Fundraising covered the total construction, design, and oversight costs of $342,000. Construction took place during the summer of 2015 and the underpasses were functional during the spring amphibian migration of 2016. Cameras were installed in the culverts and programmed to take photos every minute from dusk through dawn between March 10 and May 3, 2016. These cameras recorded 2,208 amphibians crossing in one or both directions during this time period. Video is available at the Vermont Reptile and Amphibian Atlas Facebook page. Many other mammal and bird species are using the tunnel, ranging in size from *Peromyscus* sp. mice to porcupines and bobcat. Road surface monitoring continues.

ORAL PRESENTATION ABSTRACTS

(in order of presentation)

Title: Status of Green Salamanders (*Aneides aeneus*) in the Appalachian Plateau and Valley and Ridge Provinces of Southwest Virginia

Author: Walter H. Smith*, Department of Natural Sciences, The University of Virginia's College at Wise, Wise, VA 24293; whs2q@uvawise.edu; Kevin Hamed, Virginia Highlands Community College, Abingdon, VA 24210; khamed@vhcc.edu

Abstract: The Green Salamander (*Aneides aeneus*) is a partially arboreal rock outcrop specialist distributed across 13 states and centered on the Appalachian region. Green Salamanders' assumed rarity and sensitivity to disturbance have garnered the species formal protected status in six states, with recent petitions urging added protection for the species in the form of federal listing. However, little to no effort has been performed across much of this species' range to determine the actual status of the Green Salamander and its sensitivity to potential drivers of amphibian declines. We report the results of long-term work to determine the status of Green Salamanders across the Valley and Ridge and Appalachian Plateau of southwest Virginia. To date, this work has increased the number of known populations of Green Salamanders within our study area from approximately 15 to more than 70, has identified covariates of rock outcrop occupancy and detection for the species, and has uncovered potential corridors of population connectivity along several prominent landforms in the region. In addition, this work has documented the occurrence of both ranavirus and *Batrachochytrium dendrobatidis* in Green Salamanders for the first time and is currently gauging the species' response to mountaintop removal surface mining, prescribed burning, and wildfire. We will provide an overview of this work and discuss future directions and areas of need for determining this species' status rangewide.

Title: Partnerships to Protect the Imperiled Eastern Hellbender in Virginia

Author: William A. Hopkins*, Dept. of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA 24061; hopkinsw@vt.edu

Abstract: The eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) is among the largest amphibians in the world, with an historic range stretching from Missouri eastward to New York and northern Georgia. However, over the last 30+ years populations across the species' range have undergone precipitous declines and it is believed to now be extinct in many locations where it once occurred. Portions of southern Appalachia may be the last stronghold for this remarkable species. Over the last decade, we have teamed with several state and federal agencies, as well as scientists from 10 other Universities and museums, to determine the species' status in Virginia, document threats to its persistence, and develop techniques for monitoring populations and to curtail declines. Here, I will provide a broad overview of major threats to hellbenders in Virginia including habitat degradation, introduction of nonnative trout, persecution and fishing, parasites and pathogens, population isolation due to dams, and climate change. I will highlight some of our major findings to date, including a quantitative assessment of population dynamics in several streams in Virginia as well as anecdotal observations that suggest future research and management needs. Taken together, our observations suggest that while some hellbender populations in Virginia may be stable, others are likely declining and increasingly threatened by human activities. Finally, I will discuss our near-term research priorities centered on the use of artificial shelters in streams as a monitoring and mitigation tool.

Title: The Status and Conservation of the Wood Turtle (*Glyptemys insculpta*) in Virginia

Author: Thomas S. Akre*, Conservation Ecology Center, Smithsonian Conservation Biology Institute, Front Royal, VA 22630; akret@si.edu; Ellery Ruther, Conservation Ecology Center, Smithsonian Conservation Biology Institute, Front Royal, VA 22630; ruthere@si.edu; Elliot Lassiter, Conservation Ecology Center, Smithsonian Conservation Biology Institute, Front Royal, VA 22630

Abstract: Wood turtle (*Glyptemys insculpta*) populations have been severely impacted by human encroachment across the range and population declines and a general range contraction have been documented over the last several decades. Accordingly, the species is considered endangered by the IUCN and most recently has been petitioned for listing under the ESA. At the southern margin of its range in Virginia, the species is listed as threatened and considered a priority for conservation action due to natural rarity and a rapidly shrinking distribution. To address the need for a status assessment and the development of a conservation plan in the Commonwealth, we have worked in cooperation with the VDGIF and the USFS since 2010 to provide information for conservation in a multi-use management framework on the Forest. In addition, to support the development of a regional status assessment and conservation plan, we have also worked with our state agency and NGO partners across the Northeast since 2011, first with a NEAFWA RCN grant and then with a USFWS Comp SWG grant. Our conservation research has been broadly focused, first with investigation of nesting ecology, population demographics, and hatching behavior on the Forest, then with visual encounter and environmental DNA surveys to reveal patterns of occupancy and abundance across the Virginia range, and most recently with gps-telemetry based movement modelling to demonstrate movement patterns within and among population centers. We will present and discuss this research in the context of the management goals of the Commonwealth and the Northeast regional conservation plan.

Title: Overview of the Department of Defense Partners in Amphibian and Reptile Conservation (DoD PARC) Program

Author: Christopher E. Petersen*, DoD PARC National Representative, 6506 Hampton Blvd. Norfolk, VA 23508; Chris.petersen@navy.mil; David K. McNaughton, DoD PARC Representative, Ft. Indiantown Gap NGTC, Bldg.11-19 Utility Rd., Annville, PA 17003; davmcnaugh@pa.gov

Abstract: The Department of Defense (DoD) landscape is home to a significant and diverse array of amphibians and reptiles. These species are important for several reasons: they are a part of America's natural heritage, provide valuable indicators of ecosystem health, have scientific and medicinal value, are cultural icons, and in some cases are highly imperiled and legally protected. The DoD PARC program launched in 2009 to provide leadership, guidance, and support for the conservation and management of amphibians and reptiles on DoD lands in ways that help sustain the military's testing, training and operational mission activities. DoD PARC is voluntary, proactive, and non-regulatory, and consists of military and civilian personnel including members of regional PARC networks like NEPARC. This presentation will provide an overview of the DoD PARC program and talk about the goals and objectives of the group. In addition, the many products produced by this group (including the *Strategic Plan for Amphibian and Reptile Conservation and Management on Department of Defense Lands*; photo website; webinars; training modules; and update of over 300 military installation herpetofauna species lists) will be discussed.

Title: The Timber Rattlesnake, a 44-yr Study and an Overview.

Author: William H. Martin*, Catoctin Land Trust, P.O. box 107, Frederick, MD 21705. Home address: 1289 Engle Molers Rd., Harpers Ferry, WV 25425; whmartin@crotalus.org.

Abstract: The Timber Rattlesnake, *Crotalus horridus*, was studied over a 44-yr period with over 17,000 observations made. To gain baseline data on growth, reproductive, and survival rates mark-recapture studies on selected sites in the Blue Ridge of Virginia, West Virginia, Maryland, and Pennsylvania and on the High Allegheny Plateau of West Virginia were done from 1973-2000. Monitoring has continued into 2017. Eighteen sites are monitored on a regular basis of 1-4 visits per year. A similar number are monitored less than annually. An additional 300 plus sites are checked as time permits. Population sizes have increased in some areas and decreased in others. Decreases have occurred where residential development has

encroached. A large den was severely impacted by a wind-farm. Populations in Shenandoah National Park and the George Washington National have remained relatively stable. Some Maryland and most Pennsylvania populations have increased due to legal protection. Some populations, primarily outside of my main study areas, have apparently died out over the past half century due to encroachment, road traffic, snake hunting, and shading over due to forest succession. Long-term trends are difficult to predict due to uncertainty regarding local details of climate change and human population trends.

Title: What Widespread Species Can Tell Us About Population Responses to Climate Change

Student Author: Alexander J. Novarro, Department of Biology, University of Maryland, College Park, MD 20742; Anovarro1@gmail.com

Abstract: The eastern red-backed salamander (*Plethodon cinereus*) is the most widely distributed *Plethodon* species in the eastern United States, extending farther north than any other lungless salamander. This raises two major questions: How does *P. cinereus* thrive in such a wide range of temperatures, and does it possess adaptations that will buffer the consequences of climate change? To explore these questions, I measured behavioral and physiological traits in populations across the species' geographic range. Specifically, I aimed to (1) determine whether salamanders exhibit behaviors to avoid stressful temperatures, and (2) identify the drivers and constraints of thermal plasticity. To determine whether individuals choose temperatures that maximize fitness, I compared thermal performance and temperature preference in a single population of salamanders. To address my second aim, I measured critical thermal limits and thermal performance in 13 populations, from Maine to North Carolina. My results shed light on the relative importance of environmental temperatures and evolutionary history on individual physiology. When integrated with population ecology, we can use physiological traits to better predict population viability in the face of climate change. Thus, understanding the physiology of widespread species provides a window into the past and a model for the future.

Title: Injurious Wildlife Listing: How the USFWS Can Keep Invasive Wildlife Out of the United States

Author: Susan D. Jewell, Fish and Aquatic Conservation, U.S. Fish and Wildlife Service, 5275 Leesburg Pike, Falls Church, VA 22041; Susan_Jewell@fws.gov

Abstract: Invasive species are an increasingly serious threat to interests of the United States. Globalization and the growing trade in live wildlife for pets, aquaculture, and zoological display are among the reasons that billions of live animals and thousands of species have been imported into the United States. For example, from 2004 to 2009, more than 8.3 million wild reptiles were imported. Safeguards in place to prevent imported animals from being released or escaping can fail. Some of these species establish in the wild and become harmful to the environment. One of the strongest defenses the United States has to protect against such invasions is to prevent the importation of high-risk invasive species through the Lacey Act. While many natural resource managers and biologists are familiar with the animal and plant trafficking part of the Lacey Act, a lesser-known part gives the Department of the Interior the authority to federally designate wildlife species as injurious. This designation prohibits the importation of that species. Under the Department, the U.S. Fish and Wildlife Service (USFWS) writes the regulations that place wildlife species on the injurious list. USFWS used this authority to designate eight species of large constrictor snakes as injurious, including the Burmese python. We also designated 20 genera of salamanders because of the risk that they could carry the lethal fungus *Batrachochytrium salamandrivorans* into the United States. I will discuss the history of the injurious wildlife listing program and how the constrictor snake and salamander listings became agency priorities.

Title: The Fascinating Story Behind The Creation Of New England's First Timber Rattlesnake Preserve

Author: Mark P. DesMeules*, Executive Director & Senior Ecologist, Viles Arboretum, Augusta, Maine 04330; crotalus4748@gmail.com

Abstract: A true odyssey of an ecologist's discovery, perseverance, research and success in protecting one of the most important ecologically significant Crotalus horridus areas in New England. A fifteen-year journey begins during the renaissance era of The Nature Conservancy's Natural Heritage ecological inventory efforts in the early 1980's and it leads to the discovery, study and protection of one of the most amazing natural areas in Vermont and in New England. The story begins with the tracking down of museum specimens, an enlightened amateur herpetologist on his death bed, a friendship with the rough and tumble /hardscrabble land owners, and years of work documenting population dynamics, habits, threats, reproduction, protection needs and more. This initial fifteen years of work finally culminated in a major conservation success that is perhaps one of the best success stories for rattlesnake conservation and it continues to yield conservation lessons. Included in this presentation will be lessons learned regarding the study and protection of threatened species that are applicable to many other reptile and amphibian species.

Title: Migrants and Residents Ten Years Later: Long-term Survival in Two Amphibian Populations with Partial Migration

Student Author: Kristine Grayson, Department of Biology, University of Richmond, 28 Westhampton Way, Richmond, VA 23173; Andrew Levorse*, Department of Biology, University of Richmond, 28 Westhampton Way, Richmond, VA 23173; andrew.levorse@richmond.edu; Kayla Sherman, Department of Biology, University of Richmond, 28 Westhampton Way, Richmond, VA 23173; Larissa Bailey, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, 109D Wagar Building, Fort Collins, CO 80523

Abstract: Pond-breeding amphibians migrate to wetlands for breeding periods and then typically return to their terrestrial habitats. When more permanent aquatic habitats are available, species may prolong their time in ponds and can remain as pond residents overwinter. This strategy, termed partial migration, is found in a range of animal species where populations are composed of resident and migrant individuals. The Eastern Red-Spotted Newt (*Notophthalmus viridescens*) is known for its life cycle plasticity and is one of the best examples of a pond-breeding amphibian exhibiting partial migration. Here we returned to two newt populations at Mountain Lake Biological Station ten years after individuals were first marked. Our goals were to determine if known individuals remained and to provide long-term estimates of survival trade-offs between migration and residency. We used multi-state mark recapture models to determine survival probabilities. We captured 65 known individuals and our model rankings support the hypothesis that residents have higher long-term survival. Our new estimates were strikingly similar to projections from previous data, indicating that conditional life history differences remained between migrants and residents in these populations. Additionally, we found that red-spotted newts can persist for at least 10 years in the adult stage, resulting in impressive longevity given that the juvenile red eft stage can range from 2 – 8 years. Overall, this study provides evidence of long-term survival and migratory trade-offs in a common amphibian, where its site fidelity and tractability provides one of the longest running examinations of the mechanisms of partial migration.

Title: Responses of Individual Growth Rates to Warm Weather Conditions in Five Populations of the Red-backed Salamander, *Plethodon cinereus*.

Student Author: David Muñoz*, Ecosystem Science and Management, Penn State University, 435 Forest Resources Bldg., University Park, PA 16802; djm516@psu.edu; David Miller, Ecosystem Science and Management, Penn State University, 411 Forest Resources Bldg., University Park, PA 16802; dxm84@psu.edu; Tanya Matlaga, Science in Motion, Susquehanna University, 514 University Avenue, Selinsgrove, PA 17870; matlagat@susqu.edu; Chris Sutherland, Environmental Conservation, University of Massachusetts Amherst, Room 118 Holdsworth Hall, Amherst, MA 01003; csutherland@umass.edu; Sean Sterrett, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst, 160 Holdsworth Way, Amherst, MA 01003; mseansterrett@gmail.com; Evan Grant, Northeast Amphibian Research and Monitoring Initiative, United States Geological Survey, SO Conte Anadromous Fish Research Lab, 1 Migratory Way, Turners Falls, MA 01376; ehgrant@usgs.gov; Adrianne Brand, Northeast Amphibian Research and Monitoring Initiative, United States Geological Survey, SO Conte Anadromous Fish Research Lab, 1 Migratory Way, Turners Falls, MA 01376; abrand@usgs.gov

Abstract: While scientists are increasingly confident in how climate will change over the next century, there is little consensus on how such changes will impact wildlife or how their populations might respond. Here we present findings regarding individual growth rates of a common woodland amphibian, the red-backed salamander (*Plethodon cinereus*). We investigated how growth varied among seasons and by seasonal weather conditions. We use four to eight years of mark-recapture data on two Pennsylvania populations, one New York population, one Massachusetts population, and one Maryland population to estimate individual growth rates using von Bertalanffy growth models. We found that salamanders grow similarly on an annual basis, but their peak season of growth varies among populations. Our findings show that some populations may see reduced individual growth rates of 60-75% under warmer seasonal conditions. Our study suggests two important findings: 1) species responses to climate change are not static, and accounting for variation among populations is important for predicting species responses as a whole, 2) reduced individual growth rates suggest it will either take longer for salamanders to reach reproductive maturity or salamanders will have to reach reproductive maturity at smaller sizes. Unless populations can respond plastically or evolutionarily to reduced growth rates, our findings suggest climate change will threaten the persistence of many populations of a common and abundant woodland salamander.

Title: The Effects of Repeated Relocations on Movement Metrics of Eastern Box Turtles (*Terrapene carolina carolina*) in a Highly Urbanized Environment.

Author: Annette E. Spivy, M.S., Geographical Sciences Department, University of Maryland, College Park, MD 20742; aspivy@umd.edu; Lindsay Rohrbaugh*, M.S., Wildlife Biologist, Department of Energy & Environment, Washington, D.C. 20002; lindsay.rohrbaugh@dc.gov; Jennifer L. Murrow, Ph.D., Environmental Science and Policy: Wildlife Ecology and Management, University of Maryland, College Park, MD 20742; wildlife@umd.edu

Abstract: We examined the effects of repeated relocation attempts of individual Eastern box turtles (*Terrapene carolina carolina*) on turtle movements. We used radio-telemetry data collected on 10 turtles from 2011 to 2014 to identify movement patterns and differences in movement metrics between individual box turtles. Our analysis suggested 2 types of movement patterns for all turtles that were relocated and met our inclusion requirements: (1) they settled immediately or (2) they settled over additional attempts. A random forest classification analysis was performed to determine the ecological importance of several movement metrics (movement area size, bearing, and step-lengths) in relation to the number of relocation attempts. A Wilcoxon rank-sum test and a nonparametric analysis of variance were used to determine if there were statistically significant within-group and between-group differences in metrics. The random forest classification model indicated that distance from release point to center of movement area was the most important variable for predicting the number of relocation attempts needed. Results from the non-parametric tests indicated significant differences in both size of movement area and step-lengths between turtles that settled immediately and turtles that settled over additional relocation attempts. Furthermore, a negative correlation was detected between each additional relocation attempt and the size of the turtles' movement areas and step-lengths. Although this study did not investigate any demographic data associated with the relocations, it does suggest that if Eastern box turtles must be relocated within an urbanized area, management agencies should be committed to tracking and repeatedly relocating turtles for a minimum of three (3) years to obtain >50% retention of turtles in the general resettlement area.

Title: Priority Amphibian and Reptile Conservation Areas (PARCAs): Applying Quantitative Approaches and Expert Opinion to Identify Conservation Areas and Evaluate Vulnerability

Author: William Sutton*, Department of Agricultural and Environmental Sciences, Tennessee State University, Nashville, TN 37209; wsutton@tnstate.edu; Cynthia Loftin, U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit,Orono, ME 04469; cynthia.loftin@maine.edu; Kyle Barrett, School of Agriculture, Forest and Environmental Sciences, Clemson University,Clemson, SC 29631; rbarre2@clemson.edu; Phillip deMaynadier, Maine Department of Inland Fisheries and Wildlife, Bangor, ME 04401; Phillip.deMaynadier@maine.gov; Priya Nanjappa, Association of Fish and Wildlife Agencies, Washington, DC 20002; pnanjappa@fishwildlife.org; Allison Moody, Department of Wildlife, Fisheries, and Conservation Biology, University of Maine, Orono, ME 04469; amoody2@wisc.edu

Abstract: The PARCA project is a national initiative to map important amphibian and reptile habitats based on knowledge of priority species' distributions and habitat associations and reptile and amphibian species richness. We applied PARCA guidelines with species distribution modeling via the Maximum Entropy algorithm to model habitat suitability for northeastern herpetofauna of conservation significance. Our modeled PARCAs combined habitat suitability models based on known species occurrences and important abiotic variables with species richness and landscape integrity estimates. We evaluated our models by comparing predicted with observed data, identified gaps in species occurrence and richness datasets affecting model outcomes, consulted with state herpetologists to understand how our spatial application of the PARCA criteria captured quality habitat for modeled species, and evaluated representation of PARCAs in the network of current conservation lands. Understanding long-term persistence to ecological stressors is implicit in the evaluation of these areas. To that end, we developed a framework for assessing the long-term vulnerability of the proposed PARCAs to climate change. Our approach incorporates exposure (i.e., extent of climate change experienced by a species or locale), sensitivity (i.e., degree to which survival, persistence, or fitness may be affected), and adaptive capacity (i.e., capacity of a species or locale to cope with climate change). We used a variety of spatially-explicit metrics to assess climate change vulnerability of selected PARCAs, including projected temperature and land use change, species sensitivity, geographic context, patch size, and topographic relief. Our efforts can inform conservation of priority landscapes for northeastern herpetofauna, including assessment of the long-term vulnerability and climate resiliency of these habitats.

Title: Defining the Edge: Understanding the Range Limits of an Endangered Plethodontid Salamander in Shenandoah National Park

Student Author: Staci M. Amburgey*, Ecosystem Sciences and Management, Intercollege Graduate Degree Program in Ecology, Pennsylvania State University, University Park, PA 16802; sma279@psu.edu; David A.W. Miller, Ecosystem Sciences and Management, Pennsylvania State University, University Park, PA 16802; dxm84@psu.edu; Evan H.C. Grant, USGS Patuxent Wildlife Research Center, SO Conte Anadromous Fish Laboratory, Turners Falls, MA 01376; ehgrant@usgs.gov; A. Brand, USGS Patuxent Wildlife Research Center, SO Conte Anadromous Fish Laboratory, Turners Falls, MA 01376; abrand@usgs.gov; Andrew Dietrich, USGS Patuxent Wildlife Research Center, Laurel, MD 20708; adietrich@usgs.gov

Abstract: Models of species distributions have focused on the role of climate as a primary determinant of species distributions, but recent research has highlighted the importance of species interactions in determining range boundaries. Several studies support that these interactions can provide an important mechanistic explanation of patterns observed at the local scale and should be considered when creating targeted conservation plans. The Shenandoah salamander (*Plethodon shenandoah*) is a range-restricted, endangered species of terrestrial salamander endemic to only three mountain tops in Shenandoah National Park, Virginia. The red-backed salamander (*P. cinereus*) is a common, broadly distributed species found over much of the northeastern United States into Canada. The range of *P. shenandoah* is encompassed by the range of *P. cinereus*, and previous work has focused on the potential role of competitive exclusion and interspecific aggression in setting this range edge. We conducted two years of transect surveys and utilized spatially explicit two-species conditional occupancy models to gain better spatial resolution of the range boundary where these two species meet. Range overlap was historically assumed to be minimal between the species, and raw data showed that both species were not frequently simultaneously observed. However, spatial occupancy models gave a higher resolution image of this range edge and the zone of co-occurrence while correcting for imperfect detection. Individual characteristics of detected animals in these zones can be used to draw inference about competitive exclusion and co-occurrence. Understanding of local level pressures in setting range limits is necessary for management decisions of this endangered species.

POSTER ABSTRACTS

(alphabetical by first author last name)

Title: Cutaneous Bacterial Communities of Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) in the Monongahela National Forest.

Graduate Student Author: Rachel Arrick*, Marshall University, US Forest Service, 1 John Marshall Dr, Huntington, WV 25755; rachel.arrick@gmail.com; Dr. Jennifer Mosher, Marshall University, 1 John Marshall Dr, Huntington, WV 25755; mosher@marshall.edu; Dr. Jayme Waldron, Marshall University, 1 John Marshall Dr, Huntington, WV 25755; waldron3@marshall.edu

Abstract: Amphibian skin offers a specialized habitat for microbial communities. Characterizing and understanding the cutaneous microbiome of amphibians is a way to combat global amphibian declines due to pathogens. Hellbenders provide an ideal system to explore this because they require extensive conservation management across their range. An embodiment of the plight faced by amphibians and freshwater systems alike, the imperiled eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) is a fully aquatic salamander restricted to lotic habitats. Once historically widespread, hellbender populations have seen substantial declines throughout their range, which have been attributed to habitat loss, reduced water quality, disease, and lack of recruitment. A combination of snorkeling, rock turning, and nocturnal visual encounter surveys were employed to capture eastern hellbenders. Hellbenders were located in 5 rivers across the Monongahela National Forest in West Virginia from April to July 2017. We collected swabs from individuals of various age classes. We also collected sediment samples from microhabitats (within 1 meter of where the hellbender was found). Hellbender skin (dorsal and ventral surfaces, feet, cloaca, and any open wounds) were swabbed and samples were taken from the benthic sediment within 1 meter of the captured hellbender for microbial community structure analysis. Samples were also obtained from a captive, juvenile population. In the fall, gDNA will be extracted from the skin swab samples, and the V3-V4 region of the16S rRNA gene will be amplified and sequenced via Illumina Mi-Seq paired end high-throughput sequencing. Sequence data will be analyzed through QIIME. This study will help us better understand the bacterial communities typically associated with eastern hellbenders among various age classes and habitats in West Virginia. For future conservation purposes, research that simultaneously includes the discovery of interactions between microorganisms, hellbenders, and stream health plus the monitoring of hellbender abundance and distribution along an array of habitat disturbance regimes will be beneficial to land managers.

Title: Detecting the Emerging Infectious Disease Ranavirus In Amphibian Communities Of Vermont, USA

Graduate Student Author: Lauren V. Ash*, Department of Biology, University of Vermont, Burlington, VT, 05405; lvash@uvm.edu; C. Brandon Ogbunugafor, Department of Biology, University of Vermont, Burlington, VT, 05405; bogbunug@uvm.edu; James Andrews, Middlebury College, Middlebury, VT, 05753; jandrews@middlebury.edu; Aswini Cherukuri, Department of Biology, University of Vermont, Burlington, Vermont, 05405; Aswini.Cherukuri@uvm.edu; Nicholas J. Gotelli, Department of Biology, University of Vermont, Burlington, VT, 05405; Nicholas.Gotelli@uvm.edu

Abstract: Ranaviruses are a group of emerging pathogens negatively impacting amphibian communities around the globe. This disease has the capability of causing mass mortality events; yet, its distribution and natural variation are not entirely understood. Virtually no ranavirus studies have been conducted in the natural amphibian communities of Vermont, and so we do not know whether it is present in the state. The goal of this study was to estimate ranavirus prevalence and host abundance in northwestern Vermont. We collected toe or tail tissue from a total of 1,822 amphibians across 18 sites every other week from May to August 2016. A random subset of samples (n=220) was tested for virus using qPCR to amplify a conserved region in the major capsid protein and to obtain prevalence estimates for the state. No mass mortality events were witnessed throughout the summer, however our results indicated ranavirus was present in 11 of the 220 samples (5%) and in 7 of the 18 sites (38.9%), which is lower than prevalence estimates from previous studies in surrounding states. Additionally, ranavirus was found in 7 of the 10 species collected and in all life stages. We hope to expand our results and eventually inform amphibian conservation efforts by identifying disease hotspots in the state. To better understand the complexities of this disease, it is imperative for its distribution and prevalence to be identified in locations it has not been previously found and for its impacts on host populations to be revealed.

Title: A Summary of Herpetological Surveying Methods at Fort Indiantown Gap NGTC

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Abstract: Fort Indiantown Gap (FIG) is a National Guard Training Center (NGTC) located in Central Pennsylvania. This site has been the location for military training, including live fire training, since 1931. As public land held in the taxpayer's interest, Department of Defense properties including FIG place high priority on their natural resources, both rare and common. Several studies are currently being conducted by FIG's Wildlife Office to quantify and observe the rare species that call the installation home. This illustration is designed to display an overview of recent methods used to study, survey, or collect herpetological species by the Wildlife department of FIG. Staff has performed planning level surveys and participated in the state herpetological atlas project, providing a comprehensive list of all herpetological species observed. Coverboards, pitfall traps, and aquatic traps have supplemented these efforts while also providing their own monitoring data. In addition to observational data, the team has also used mark-recapture techniques and telemetry to determine population level data such as population estimates and onsite species home range. Radio telemetry has been used on spotted turtles and timber rattlesnakes, while mark-recapture has been used on Eastern box turtles, spotted turtles, and wood turtles. These methods are not used in isolation, providing collaboration with the Pennsylvania Natural Heritage Program, the Pennsylvania Fish and Boat Commission, Temple University, Shippensburg University, the Nature Conservancy, and the State Museum of Pennsylvania. Results have also been shared with organizations like NEPARC, including the Northeast Wood Turtle Working Group, and DODPARC.

Title: Conservation risk of *Batrachochytrium salamandrivorans* to endemic brook salamanders

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Abstract: *Batrachochytrium salamandrivorans* (Bsal), a recently described fungal pathogen has caused declines in fire salamander (*Salamandra salamandra*) populations in several European countries. Initial Bsal challenge experiments provided limited data on the susceptibility of North American amphibian species. Brook salamanders (*Eurycea*) are a diverse group of amphibians endemic to the USA comprised of 28 species, 2 of which are listed as endangered, with another 10 species listed as vulnerable by the IUCN. To assess the potential threat Bsal poses to this genus, we performed a Bsal susceptibility trial with Blue Ridge Two-lined salamanders (*Eurycea wilderae*). We randomly assigned 20 salamanders to one of 4 Bsal exposure treatments: 5x10^3, 5x10^4, 5x10^5 and 5x10^6 zoospores (n=5/treatment plus 5 controls). Animals were exposed to Bsal zoospores in a water bath for 24 hours and monitored for 47 days. Every sixth day each animal was swabbed and at the end of the experiment toes and a small section of skin from the abdomen were collected for real-time quantitative PCR testing. Salamanders in the highest Bsal exposure treatment experienced 100% mortality, and 20% mortality was observed in the 5x10^5 treatment. Quantitative PCR revealed that 40, 100 and 100% of the salamanders in the 5x10^4, 5x10^5 and 5x10^6 treatments tested positive for Bsal DNA, respectively. Histopathology confirmed Bsal chytridiomycosis in animals that died, and Bsal zoosporangium in subclinically infected individuals. These results indicate that *E. wilderae* and possibly other *Eurycea* species are suitable hosts of Bsal, and risk population declines if Bsal is introduced to North America.

Title: Interaction of Hydroperiod and Ranavirus Leading to Possible Amphibian Population Declines in The Great Smoky Mountains National Park

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Abstract: Within the United States, ranaviruses are the most common pathogen associated with disease-related amphibian mortality events. Great Smoky Mountains National Park has experienced reoccurring ranaviral disease outbreaks at Gourley Pond (GP) in the Cades Cove region since 1999. Ranavirus outbreaks and larval mortality have been observed in five amphibian species at GP: *Ambystoma maculatum, A. opacum, Lithobates sylvaticus, Pseudacris crucifer,* and *P. ferriarum*. To better understand ranavirus dynamics within Cades Cove, we designed a surveillance study to monitor ranavirus prevalence within the amphibian community at GP and Little Gourley Pond (LGP) (i.e. a small pond <100m from GP). Our goals were to determine ranavirus prevalence in the amphibian community at GP and LGP, estimate population sizes of larval and post-metamorphic amphibians, determine possible routes of ranavirus introduction, and determine potential environmental stressors that might contribute to ranavirus outbreaks and limited amphibian recruitment. We captured a total of 16 species and 1972 adult amphibians in pitfall traps between Feb – May 2016. Due to insufficient hydroperiod duration at the ponds in 2016, successful metamorphosis was not documented at GP, and recruitment was minimal for *A. opacum* at LGP. We detected ranavirus infections at low prevalence in adult *L. sylvaticus, Notophthalmus viridescens*, and *A. maculatum*. No disease outbreaks were documented prior to the ponds drying. Our results suggest that the catastrophic losses of the larval cohort during ranavirus outbreaks combined with limited recruitment during years with abbreviated hydroperiods may lead to amphibian population declines in the Great Smoky Mountains National Park.

Title: Susceptibility of North American Newt Species to *Batrachochytrium salamandrivorans*

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Abstract: The recently discovered fungal pathogen *Batrachochytrium salamandrivorans* (*Bsal*) has caused population declines of wild fire salamanders (*Salamandra salamandra*) in Europe, and experimental challenges show that *Bsal* is highly pathogenic to species in the family Salamandridae. In particular, the eastern newt (*Notophthalmus viridescens*) is highly susceptible to *Bsal*. There are two other species of *Notophthalmus* native to North America (the black spotted newt, *N. perstriatus*, and the striped newt, *N. meridionalis*), both of which are of high conservation concern. It is unclear whether these species are also susceptible to *Bsal*, and understanding the susceptibility of these species to *Bsal* is essential to estimating risk of *Bsal* emergence and planning conservation strategies for these species. Thus, our goal was to robustly estimate the susceptibility of species in the genus *Notophthalmus* to *Bsal*. We hypothesized that *N. viridescens*, *N. perstriatus*, and *N. meridionalis* will experience dose dependent mortality from exposure to *Bsal*. We conducted experimental challenges with the fungus by exposing individuals of each species to *Bsal* in a water bath at one of four zoospore concentrations ($5x10^{3-}$

[6]) or to a water only control for 24h, then monitored their condition for 6wks. Clinical signs of disease varied by dose, the most common of which were skin sloughing and ulcerative lesions, and in some cases death. Indeed, all species experienced dose dependent mortality, with 100% mortality observed in the highest zoospore dose. These results demonstrate that *Bsal* is a significant conservation risk to amphibian biodiversity in North America.

Title: A Regional Population Viability Approach for Threatened and Endangered Species Management on Army Installations

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Abstract: Spotted turtles (*Clemmys gutatta*) are considered "Endangered" by the IUCN, and are a Species of Greatest Conservation Need in all 21 U.S. states within their natural range, including Virginia. Despite the need for conservation efforts, little is known about the distribution and status of this species across its range. Spotted turtles were therefore used as a focal species in a project recently started by the Army Corps of Engineer's Engineer Research and Development Center. Wildlife populations rarely occur as discrete units, instead, they occur as interconnected patches of populations with some level of immigration and emigration connecting them (i.e. metapopulations). However, traditional wildlife population management approaches maintain a rigid framework for treating populations as discrete units. This project will provide information about the status and distribution of spotted turtles on and around the Fort Belvoir regions, how turtles move across and utilize fragmented landscapes, and assess metapopulation viability. This data will be collected through visual surveys to determine habitat occupancy, mark-recapture population demographic analysis, genetic sampling to determine diversity and population structure and connectivity, and radio telemetry to document fine-scale individual movement and habitat use patterns. Results from the first season (March-July 2017), including population demographic estimates (e.g. population size, recapture rate, survival, recruitment), and range distributions using continuous-space, continuous-time stochastic movement models will be presented. As of May, 2017, 20 spotted turtles have been fitted with radio-telemetry units and have been located every other day. Additionally, 230 spotted turtles have been captured and marked by trapping and visual surveys.

Title: Behavioral Responses of Adult and Larval Wood Frogs to Increased Salinity

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Abstract: Amphibians are highly vulnerable to aquatic pollutants. Due to the permeability of their skin and their aquatic larval stages, pollutants are easily absorbed into the body, which can have adverse effects on performance, survival, and fitness. This has prompted research on how environmental pollutants, especially road deicers such as sodium chloride (NaCl), affect amphibian populations. NaCl can have a negative impact on both adult and larval stages of amphibians with reduced breeding success, morphological abnormalities, and even mortality. However, less is known about the behavioral responses of adults and especially larval amphibians to increased environmental salinity. In this study, the behavioral responses of both adult and larval Wood Frogs, *Lithobates sylvaticus*, to increased salinity were studied via salinity choice trials. For both adults and tadpoles, time spent in salt solutions decreased with increasing salinity. The threshold for response was approximately 0.15 M (slightly hyperosmotic). Since increased salinity has been associated with decreased fitness, behavioral avoidance of high salinity and preference for lower saline systems could be advantageous for Wood Frogs, giving adults the potential to select breeding sites with lower solute levels and tadpoles the potential to select appropriate microhabitats within a vernal pool.

Title: Scarlet Kingsnake in Virginia: a Case of Mistaken Identity

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Abstract: For several decades, Virginia was considered part of a broad zone of intergradation between the Eastern Milksnake (*Lampropeltis triangulum triangulum*) and the Scarlet Kingsnake (*L. triangulum elapsiodes*). This belief was based on intermediate phenotypes observed in many individuals, including eight specimens from eastern Virginia, and sometimes referred to as *L. triangulum temporalis* (Hardy 1972. Chesapeake Sci. v. 13; Williams 1988. Milwaukee Publ. Mus.). Based on molecular studies, Pyron et al. (2009. Molec. Phylogenetics & Evol. V. 52) elevated *elapsiodes* to full species status. Further genetic and phenotypic investigations confirmed the Scarlet Kingsnake does indeed occur in Virginia (Roble et al. 2007. Catesbeiana v. 27; Kleopfer and Dyer 2016. Unpublished data). Phenotypic variation is illustrated below in snakes from the Blue Ridge Physiographic Province (Nelson Co.), southwestern Piedmont (Pittsylvania Co.) and Coastal Plain (New Kent Co. and City of Virginia Beach). Because the Harlequin Coralsnake (*Micrurus fulvius*) does not occur in Virginia, the incomplete banding in many individuals is theorized to be the result of a lack of mimicry pressure (Pfennig et al. 2007. Behav. Ecol. Sociobiolo. V 61). This discovery brings into question whether hybridization between *L. elapsiodes* and *L. triangulum* does occur.

Title: Phylogeographic Patterns Among Eastern Newts (*Notophthalmus viridescens*)in the Southeastern United States

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Abstract: Recent molecular phylogenetic and statistical parsimony analyses of eastern newt populations in South Carolina found evidence of introgressive hybridization among the three subspecies occurring in the state (Lawson and Kilpatrick 2014). To evaluate the regional extent of these patterns, we sequenced 530 bp of the NADH dehydrogenase (ND2) and the flanking $tRNA^{Met}$ genes in 456 specimens from a total of 55 populations in South Carolina, North Carolina and Virginia. Haplotypes did not group by taxonomic designation supporting our original hypothesis of introgressive hybridization. Statistical parsimony analysis recovered two population groups whose contact zone coincides roughly with the North and South Carolina border. Additionally, there is evidence of genetic exchange between the groups at their shared boundary, particularly in the Coastal Plain. We suggest these groups represent ancient populations that dispersed from southeastern Atlantic coastal refugia northward along the eastern flank of the Appalachians and southward into the Gulf Coast. Unique genetic identities were then established due to physiographic barriers preventing genetic exchange. The exchange detected in our analyses represents secondary contact following retreat of the ice sheets. Additional samples from Georgia, Tennessee and Virginia will be collected and analyzed from 2017 – 2018 to determine the regional extent of each haplotype and further characterize unique ecological units and occurrence trends with conservation significance.

Title: Novel Salamander Guild Differentially Affects Small- and Large-Bodied Species through Niche Partitioning

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Abstract: Interspecific competition is often minimized through the organization of species into guilds, or a group of species that utilize a shared resource in a similar way. This partitioning of resources and corresponding microhabitats between guilds contributes to species coexistence. Terrestrial lungless salamanders in the genus *Plethodon* exhibit body size divergence following patterns of resource utilization and coexist in high density, multi-species communities, providing an excellent

system for studying coexistence among body size guilds. We sought to explore how community composition and microhabitat utilization is impacted by the introduction of an intermediate size guild at Mountain Lake Biological Station (MLBS) in Pembroke, VA. There are two native species of *Plethodon* at MLBS: *Plethodon cinereus* (small size guild) and *P. glutinosus* (large size guild). Between the years 1935 to 1945, the intermediate-sized *P. montanus* (previously known as *P. jordani*) was released at MLBS and has now formed a stable population. Although competition between *P. montanus* and the large-bodied species is minimal, competition between *P. montanus* and the smaller species is significant. We observed a strong negative density dependent relationship between the relative abundances of *P. montanus* and *P. cinereus.* Furthermore, increased abundance of *P. montanus* inhibits vegetation climbing in the smaller *P. cinereus*. Surprisingly, climbing behavior of the intermediate-sized *P. montanus* is not affected by competition with the small or large size guild. Thus, the heightened ability of the intermediate species to acquire limited elevated vegetation has increasingly led to the exclusion of the smaller guild from its preferred microhabitat.

Title: Preliminary Assessment of Salt Tolerance in Coastal Breeding Spotted Salamanders (*Ambystoma maculatum*) in Acadia National Park, ME

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Abstract: The extent to which increased salinity in vernal pools negatively impacts the breeding success of amphibians that rely on these pools as seasonal breeding habitat has been the focus of numerous studies in recent years, especially in the context of road salt run-off. For amphibians that breed in wetlands near or at the coast, salinity levels that are higher and/or more persistent than that encountered in the past due to rising sea levels represent another potential environmental stressor to anurans and salamanders. In Acadia National Park, Maine, USA, a population of Spotted Salamanders (*Ambystoma maculatum*) breeds in vernal pools located on coastal bluffs, approximately 4.0 vertical meters above high tide zone. Since 2015, we have collected baseline data at this site on 1) spatial and temporal variation in salinity levels of breeding pools, 2) salt tolerance of breeding adults via avoidance behavior trials, and 3) embryonic and larval survivorship. Salinity levels varied greatly among pools with breeding adults in 2015 and 2016 (0.1-31 ppt) but less so in 2017 (0.1-4.5 ppt). Adults observed in pools with salinity ≥ 10 ppt were either in apparent osmotic distress (thrashing) or confined to the surface (salinity ≤ 3.5 ppt). Preliminary behavioral data suggest that salamanders at this site avoid salinities above 5.8 ppt, a response congruent with that seen in salamanders breeding in inland woodland pools. Our findings also suggest that *A. maculatum* egg masses are more sensitive to salinities than adults, with 100% egg mortality occurring in experimental pools above 3.9 ppt.

Title: Genomic Diversity of Northern Isolate Squamates in the New Jersey Pine Barrens

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Abstract: The Pine Barrens of southern New Jersey are an unusual ecosystem where several taxa distributed throughout the southeastern US reach their northern distributional limit as isolated populations. Among these are several imperiled species, including the state endangered Corn Snake (*Pantherophis guttatus*), state threatened Northern Pine Snake (*Pituophis melanoleucus*), and state threatened Pine Barrens Treefrog (*Hyla andersonii*), as well as both habitat specialists and generalists. We are examining the genomic diversity of these northern isolate populations in several species of habitat specialist and generalist squamates. First, we use museum voucher records to estimate the degree of habitat specialization by testing if specimens have been collected in sandy habitats significantly more frequently than expected given the availability within each species' distribution. Samples from the throughout the Pine Barrens, along with samples from a comparative population from the core range (the Carolina Sandhills region) will then be sequenced for several thousand ultra-conserved elements loci to estimate levels of genomic diversity. These data will be used to test how diversity varies

among taxa within the Pine Barrens and between Pine Barrens and core range populations, as well as how these patterns vary between habitat specialists and generalists. Finally, we will use a comparative approach to test if these ecologically disparate taxa colonized the Pine Barrens at a similar time. Combined, these data will yield considerable insight into the evolutionary origin of these northern isolate Pine Barrens populations, and, more broadly, into the impacts of isolation and specialization on genomic diversity.

Title: Contrasting the Genomic Structure of Long-tailed Salamanders in Pond vs. Stream Networks in Northern New Jersey

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Abstract: For wild species to sustain healthy populations, movement between habitats and some degree of dispersal is essential. Maintaining connectivity across a wide variety of landscapes is especially important for amphibians, most of which are moisture dependent and possess limited dispersal ability. The range of the long-tailed salamander (*Eurycea longicauda longicauda*) spans across several hydrologic and geologic features throughout eastern North America and populations in New Jersey are threatened with extinction. However, little is known about their specific distributions or movement patterns. Studying movement directly requires intensive, large-scale and long-term demographic studies; therefore, genetic methods serve as an indirect, more efficient method. In this study, we investigate the genetic structure and connectivity of long-tailed salamanders in two different hydrogeomorphic landscapes, ponds in the Ridge & Valley province and stream networks in the Piedmont province, to understand how the species' genetic structure and patterns of movements are influenced by local hydrology and geology. Tissues samples and morphometric measurements are being collected from salamanders between the months of May and September from five sites in isolated pond networks and five sites in stream networks across northern New Jersey. Using ddRADseq, genetic variation of pond-associated salamanders will be compared to genetic variation of stream-associated salamanders with the expectation that salamanders in stream networks will be more genetically similar, and therefore more connected, due to the continuous habitat offered by streams. Understanding how hydrology and geology affects salamander genetic structure and movement will help delineate populations and will inform effective management for this threatened species.

Title: Spatial Ecology of the Spotted Turtle (Clemmys guttata) at Fort Indiantown Gap, Pennsylvania

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Abstract: Anthropogenic land use along streams alters both terrestrial and aquatic habitats and detrimentally impacts aquatic species. Military installations across the U.S. utilize conservation management plans to protect threatened species, and buffer known aquatic resources and land cover to provide protections to wetlands and many rare species. The Spotted Turtle (Clemmys guttata), uses a wide variety of wetland habitats with soft bottoms and aquatic vegetation and may also utilize brackish tidal streams. In Pennsylvania, spotted turtles occur both in the southeastern Coastal Plain and Piedmont and in the west, but tend to be scarce in most of the Ridge and Valley Providence and north-central and northeastern portions of the state. Fort Indiantown Gap, located in Annville, PA, is one exception. We used radio telemetry to track the aquatic and terrestrial movements of spotted turtles at three sites within the Fort Indiantown Gap military corridor. We tagged a total of six males and three females with external transmitters over the 2015 and 2016 field seasons. We compared methods of the programs LOAS and BIOTAS and a novel method, created by our GIS staff member, Mark Brady, to accurately triangulate positions of turtles.

Title: Effects of Individual and Combined Pesticide, Fertilizer, and Salt Treatments on the Corticosterone Levels and Growth of Larval Amphibians

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Abstract: Human activities have introduced a variety of chemicals into the environment that have had deleterious effects on the organisms inhabiting these areas. Pesticides such as atrazine are commonly applied to crops to control nuisance weeds and nitrogenous fertilizers increase crop productivity. In addition, salt based deicing agents are seasonally applied to roads to reduce vehicular hazards. All of these chemicals can have an adverse impact on the environment. Due to their permeable skin and continuous transfer of water and ions to maintain homeostasis, amphibians are especially susceptible to absorption of these chemical pollutants. To determine the possible synergistic effects of these chemicals on amphibian development and stress levels, southern leopard frog (*Rana sphenocephala*) larvae were exposed to 7 individual and combined treatments of atrazine, nitrogen, and salt. Tadpoles were raised in 1.5 L of chemical solution and 50% water changes kept chemical concentrations constant. Stress levels, indicated by the release of the stress hormone corticosterone, were measured pre-metamorphosis at 8 weeks (Gosner stage 25). Water hormone samples were processed using ELISA kits from Cayman Chemical to analyze corticosterone levels. Changes in tadpole growth were determined by surface area measurements taken from biweekly photographs analyzed with IMAGEJ software. Data collection is ongoing, however, preliminary results indicate an increased stress response in frogs exposed to multiple chemicals at a time. As amphibians are exposed to multiple chemicals simultaneously in the environment, assessing the effects of a combination of contaminants on amphibians is necessary to better manage the application of these chemicals.

Title: Conservation of Pennsylvania's Snakes

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Abstract: The state of Pennsylvania is a hub for snake conservation in the northeastern United States, in part because it retains more adequate habitat than neighboring states. Pennsylvania's snakes are threatened by habitat loss due to urbanization, and to direct persecution, both related to a general lack of popular knowledge about and appreciation of snakes' benefits to natural ecosystems. This case study analyses a traveling education program – a partnership between Penn State's Shaver's Creek Environmental Center and the Juniata Valley Audubon Society - that has taken a small collection of Pennsylvania native snakes, including a Timber Rattlesnake, into local primary and secondary schools to promote conservation. Results indicate that the education that took place was not only beneficial but also contributed to changing attitudes about snakes. Furthermore, this case study discusses the wider significance of these results in the context of snake conservation. This case study concludes with attendance and a presentation at the Austrian Herpetological Society's annual conference in Vienna, Austria.

Title: Humans versus Computers: An Evaluation of Photo Recognition Methods for Identifying Four-toed Salamanders (*Hemidactylium scutatum*)

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Abstract: Identifying individuals allows researchers to utilize mark-recapture to answer a variety of life history, abundance, and survivorship questions. Historic marking methods were often invasive and recent technological innovations are often costly and not always suited for small animals. Computer-assisted photo-identification methods are less invasive and have been utilized to recognize individuals with unique body marks. However, matching success varied based on the type of software used and marking patterns of an animal. We evaluated the efficacy of human observers and computer-assisted photographic identification utilizing 3 software programs (Wild-ID, Foto-Spottr, and I^3S Spot) to match 331 photographs of

ventral spot patterns on four-toed salamanders from 7 nesting seasons (2009–12; 2015–17). Human observers identified 100% of matching photographs and outperformed software programs. Open source programs (Wild-ID and I^3S Spot) match more photographs than Foto-Spottr that required purchasing MatLab licenses. The total time need per match was less using human observers than the total time required to prepare images and run computer software. The use of human observers also created citizen science and experiential learning opportunities for students as well as an opportunity to increase focal species awareness.

Title: Examining adult survival and nesting in a marked population of northern diamondback terrapins (*Malaclemys t. terrapin*) in southern New Jersey.

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Abstract: In southern New Jersey, northern diamondback terrapins face threats including road mortality, habitat loss, unsustainable harvest, and drowning in crab pots. As part of a multifaceted effort to study and conserve terrapins, scientists at The Wetlands Institute (TWI) have conducted a long-term mark-recapture study of the terrapin population since 1997 to better understand local demographics and population trends. For this preliminary analysis, we examined adult females that were captured near TWI or nesting on the property, and head-started female terrapins released into the local marsh. All individuals were marked using PIT tags. Over all nesting seasons, we recaptured by hand or recovered dead 393 of 492 marked females (79.8%) and 23 of 1,449 (1.6%) marked head-starters on TWI property or local roads. The high recapture rate for adult females demonstrates strong site fidelity, further supported by multiple recaptures of individuals within and among years. The lower rate for head-starters could be due to dispersal or low survival and capture probability for juvenile terrapins. However, some head-starters returned to nest, suggesting head-starting may benefit the local population. On average, 7.9 years lapsed between release and hand recapture of head-starters, and several have been recaptured nesting multiple years. An initial analysis of survival probability for females nesting at TWI from 2002-2015 suggested high annual survivorship of adult terrapins (90.1%) which did not vary among years despite persisting threats. Work to estimate population parameters is ongoing. These results will help evaluate the local terrapin population's status and management needs.

Title: Examining Eastern Box Turtle (*Terrapene carolina carolina*) Population Characteristics and Habitat Selection in a Remnant Maritime Forest

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Abstract: The eastern box turtle, (*Terrapene carolina carolina*), has experienced declines throughout its range due in part to habitat loss and alteration. Barrier islands along the southern New Jersey coastline, though extensively urbanized, continue to support box turtle populations in remnant forest patches. Since 2014, we have monitored eastern box turtle populations in a 9 ha patch of remnant maritime forest on a barrier island in southern New Jersey. Native vegetation at the site is dominated by black cherry (*Prunus serotina*), American holly (*Ilex opaca*), common greenbrier (*Smilax rotundifolia*), poison ivy (*Toxicodendron radicans*) and red cedar. In addition, the site is heavily impacted by invasive plants such as English ivy (*Hedera helix*) and Japanese honey suckle (*Lonicera japonica*). Turtles were captured by hand during opportunistic mark-recapture surveys, measured, and then notched using a triangular file. To date, 64 individuals, (45% adult males, 34% adult females, and

21% juveniles) have been marked, and 17 have been recaptured. To better understand habitat use and inform continued management of the site, habitat characteristics at turtle capture locations and paired random locations were compared using logistic regression. Results of continued studies will help increase understanding of box turtle habitat selection in coastal ecosystems in New Jersey, provide insight on the status of the local box turtle population, and help guide future management of maritime forest patches to ensure that they continue to support populations of eastern Box Turtles.

Title: Discovering Virginia's Public Pools

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Abstract: Isolated wetlands (vernal pools) on public lands in Virginia are being identified, documented, and monitored by a state-wide coalition of partners and citizen scientists. Led by Virginia Commonwealth University's Rice Rivers Center, the Virginia Department of Game and Inland Fisheries, and the Virginia Master Naturalist Program, VA Master Naturalist volunteers are being recruited from across the state and trained to identify and collect data on these imperiled habitats. By connecting these volunteers with agencies and resource managers at local, state, and federal levels, we hope to spread awareness of these often overlooked systems and conservation practices that can protect pools and the obligate species that depend on them for survival. Additionally, data from this project is being provided to the North Atlantic Landscape Conservation Cooperative for their Vernal Pool Mapping and Conservation Project.

Title: Identification of Bufadienolides from the Boreal Toad, *Anaxyrus boreas*, Active Against a Fungal Pathogen

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Abstract: Amphibian granular glands provide a wide range of compounds on the skin that defend against pathogens and predators. We identified three bufadienolides - the steroid-like compounds arenobufagin, gamabufotalin, and telocinobufagin - from the boreal toad, *Anaxyrus boreas*, through liquid chromatography mass spectrometry (LC/MS). Compounds were detected both after inducing skin gland secretions and in constitutive mucosal rinses from toads. We described antimicrobial properties of each bufadienolide against *Batrachochytrium dendrobatidis* (Bd), an amphibian fungal pathogen linked with boreal toad population declines. All three bufadienolides were found to inhibit Bd growth at similar levels. The maximum Bd inhibition produced by arenobufagin, gamabufotalin, and telocinobufagin were approximately 50%, in contrast to the complete Bd inhibition shown by antimicrobial skin peptides produced by some amphibian species. In addition, skin mucus samples significantly reduced Bd viability, and bufadienolides were detected in 15 of 62 samples. Bufadienolides also appeared to enhance growth of the anti-Bd bacteria *Janthinobacterium lividum*, and thus may be involved in regulation of the skin microbiome. Overall, our results suggest that bufadienolides can function in antifungal

defense on amphibian skin and their production is a potentially convergent trait similar to antimicrobial peptide defenses found on the skin of other species. Further studies investigating bufadienolide expression across toad populations, their regulation, and interactions with other components of the skin mucosome will contribute to understanding the complexities of amphibian immune defense.

Title: Inhibition of Pathogenic Fungi Using Volatile Organic Compounds Produced by Bacteria

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Abstract: Emerging infectious diseases caused by fungi have increased over the past few decades and have become some of the most prevalent diseases affecting wildlife. We focus on recently emerged pathogens in wildlife: Batrachochytrium dendrobatidis, Batrachochytrium salamandrivorans, and Fusarium keratoplasticum in amphibians, Mucor hiemalis in fish, Pseudogymnoascus destructans in bats, and Ophidiomyces ophiodiicola in snakes. These pathogens typically cause skin lesions, keratitis, and blood infections, with high mortality being reported. Symbiotic skin bacteria can be applied to treat and protect hosts from infection as some bacteria can produce airborne volatile organic compounds (VOC) for defense against pathogens. We tested 30 bacterial isolates from amphibian skin to determine which microbes are capable of inhibiting fungal growth through VOC production. We applied a bacterial isolate to one side and a fungal isolate to the other of a segmented petri plate and compared fungal growth between experimental and control plates. A Dunnett's test was performed to determine if the bacteria significantly inhibited fungal growth. Bacterial isolates were quantified in terms of broad to narrow-scale antifungal activity, and isolates were identified for next steps including soil inoculation and testing for host infection clearance. We will be experimentally inoculating soil with these potential probiotics to see if the bacteria can colonize the soil and if so, is it able to inhibit these fungal pathogens. By applying these beneficial bacteria to sites where susceptible hosts congregate, there is an increased chance of inoculating hosts with probiotics, or of reducing environmental reservoirs, thus protecting hosts from fungal infection.

Title: The Physiologic Limitations of *Batrachochytrium salamandrivorans* in Various Environmental Conditions

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Abstract: Amphibians are increasingly threatened by emergent fungal pathogens, such as *Batrachochytrium dendrobatidis* (Bd) and *Batrachochytrium salamandrivorans* (Bsal). Bd was implicated at the agent of massive amphibian declines globally in the 1970's and 1980's, but Bsal has recently emerged in Europe, has decimated fire salamander populations, and seems to be spreading rapidly. While Bd is well characterized in the literature, Bsal is less well understood and needs to be examined for physiologic differences from Bd to help target conservation efforts and avoid another global expansion and amphibian population declines. Here we examined the physiological ranges for pH, salinity, and temperature that Bsal can tolerate under controlled laboratory conditions. Determining the range of environmental conditions that Bsal can survive will help determine geographic areas and species of most and least concern in regard to Bsal infection for North America, if Bsal spreads globally.

Title: Creation of Wood Turtle (*Glyptemys insculpta*) Nest Sites in Pennsylvania for Conservation

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Abstract: Volunteer scientists created a replacement nest site on private property for three Wood Turtle nests (32 eggs) rescued from a bridge reconstruction site in mid-June of 2016. This was a permitted long term study area for the Pennsylvania Fish and Boat Commission. Nesting resulted from anthropomorphic and natural conditions that created an ideal location for oviposition. Trees were cut in April for the bridge, providing a new sunlit location. A flash flood event on June 2nd deposited 10 to 30 centimeters of alluvium substrate on a terrace. This resulted from improper hydraulics of the bridge structure to be replaced in July and August. Nesting activity was monitored daily with a spotting scope until egg-laying was completed. Eggs were relocated to new nest sites which were created on a southwest slope 70 meters from the original site. Eggs were kept in the positions found and were placed 5 to 15 centimeters deep in a sandy alluvium substrate collected from the construction site. The new nests were protected with caging to prevent predation. Emergence for the first and third nests occurred 8 days apart, 64 days after deposited. The final nest was carefully excavated due to concerns for root invasion by *Cyperus strigosis*; emergence then commenced and the gestation time was 65 days. 27 hatchlings were studied, marked and released at three nearby locations. 84.4 percent hatching success resulted. Original nests would have been destroyed by the bridge project without intervention. As of May 1, 2017, one hatchling was recaptured twice.