MUSEUM OF NATURAL HISTORY

2018 Annual Report

Auburn University Museum of Natural History

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Auburn University Museum of Natural History

The mission of the Auburn University Museum of Natural History is to conduct biodiversity research, preserve and document our region and planet's biodiversity, and to lead and promote activities related to natural history education and outreach for Auburn University and all citizens of the state of Alabama. Our vision is to emerge as the primary repository for all natural history collections currently maintained at Auburn University and to function as a center of excellence for biodiversity research, education, and outreach. We will capitalize on strengths of the biodiversity heritage collections in our care and the vast organismal knowledgebase of the curators and staff to establish a gateway through which all segments of society can come discover the natural sciences and appreciate the relevance of biodiversity to human health and quality of life. We will preserve and document the rich natural heritage of Alabama while concurrently creating opportunities for students and teachers from regional schools, the general public, students at Auburn University, and researchers to explore our planet's biodiversity. We seek to inspire an appreciation of nature and the environment so that we might better conserve it for future generations.

Location

AU Museum of Natural History
Biodiversity Learning Center
Auburn Unversity

Alabama Natural Heritage Program®
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Websites

Auburn University
Museum of Natural History:
aumnh.org

www.facebook.com/AUMNH

ALNHP:
www.alnhp.org

Affiliated Websites

NatureServe
www.natureserve.org

From the Director:

2018 saw some good times and bad times for AUMNH and the Alabama Natural Heritage Program. The bad was that we saw two long-term colleagues leave. Our GIS (Geographical Information Systems), specialist, Michael Barbour, took a job at the Arizona Natural Heritage Program and our outreach coordinator, Kay Stone, retired. Michael was instrumental in the development of our natural heritage tracking database and took with him some essential field skills. Kay was the founder of our educational outreach programs, bringing them with her when she moved to the museum from the Environmental Institute. I relied on both of them heavily as I learned my job as director, and we all miss them and their contributions to the museum's mission. We rehired both positions in 2019 with Dr. Katelyn Lawson taking over as GIS Analyst and Toni Bruner taking over as Outreach and Educational Coordinator, but that will be a story for next year.

In addition, our first Director, Dr. Jason Bond, took an endowed position at the University of California, Davis. Dr. Bond was instrumental in building our facility, setting up our outreach programs, uniting the museum and Alabama Natural Heritage Program, having the Entomology Collection join AUMNH, and extending our research mission. We are grateful for all that he accomplished at Auburn, and we wish him the best in his new position.

As for the good times, the museum received a National Science Foundation grant to provide compactors for the alcohol collections. Alcohol collections require specialized space in order to be safe. This includes fire walls, fire suppression, vents that would relieve pressure if there was an explosion, and a fire suppression system. Don't worry, this has not happened in the 500-year history of museum collections, but what it means is that there was little of this specialized space in the building, and we have been adding quickly to those collections. The compactors are like rail cars that hold the shelves that one can easily move with the crank of a handle. It allows us to have only one aisle in each room, thus we can add a lot more shelves. We were able to move some of the large invertebrates to the space and have room for at least a decade's worth of growth. This also alleviated some of the space concerns elsewhere in the building.

New in 2018 was also our Boos and Bones exhibit. Conducted in conjunction with the Davis Arboretum and Auburn University Veterinary Medicine, we placed skeletons throughout the Arboretum and invited the community to come out and see the scary sights. I always find it hard to gauge the success of a program, but as the day wore down to a close, I saw two kids leaving with their parents. One said, "You know, I had a really good time." And his brother added, "Yeah, that was the best day ever!". Those are good enough reviews for me. We hope to put on the show again this year; look for us around Halloween. We also helped usher in the Eastern Indigo Snake and Wildlife Festival in the Conecuh National Forest. Eastern Indigo Snakes are the largest snakes in the region, and the museum and partners have a long-term program to reintroduce the snakes to Alabama. 2018 also brought in over $300k to keep up our research efforts on the Indigo Snake that are led by Jim Godwin.

On the horizon, the museum is looking to shake things up in the building, and we hope to add some more traditional displays. We will remain a research-focused museum, but hopefully also have a few more things to look at when you visit.

Dr. Jonathan Armbruster

Director, Auburn University Museum of Natural History

The new fish collection compactors in the AUMNH

Primary funders (in alphabetical order)

Alabama Department of Conservation and Natural Resources, Division of Wildlife & Freshwater Fisheries
- Turkey Creek Musk Turtle Status
- Map turtles
- Mississippi gopher frog survey
- Hellbender multi-state survey
- Indigo snake monitoring
- Alligator snapping turtle
- White Fringeless Orchid Modeling
- Dysbiosis of Freshwater Mussels
- Southeastern Cooperative Fish Parasite and Disease Project
- Propagation Bottlenecks for Freshwater Mussels

Alabama Department of Conservation and Natural Resources, State Lands Division
- Environmental Science and Art - AUMNH Outreach at Wehle

Department of Defense
- Arnold Air Force Base gopher frog survey

National Science Foundation
- RAPID: Aquatic refuge and recovery in the face of drought in a biodiversity hotspot
- Compactorized Shelving for the Wet Collections of AUMNH
- Collaborative Research: Red Carotenoids as Signals of Respiratory Chain Function
- DDIG: Copepod Mate Choice

NatureServe
- Mountain Longleaf Vegetation Assessment

The Nature Conservancy
- Waterdog and musk turtle eDNA survey

U.S. Army Garrison - Redstone
- Planning Level Survey of Redstone Arsenal for At-risk Species and Ecologically Significant Communities

U.S. Environmental Protection Agency
- Establishment of Wetland Reference Sites in Alabama

U.S. Fish and Wildlife Service
- Gentian Pinkroot Status Assessment
- Bog Spicebush Status Assessment
- Wherry's Phlox Status Assessment
- Turkey Creek Musk Turtle
- Biodiversity, phylogeny of *Myxobolus* spp.
- ANS, *Myxobolus cerebralis*, whirling disease in salmonids

U.S. Forest Service
- eDNA analysis for Bankhead National Forest

Virginia Department of Conservation and Recreation
- Southeastern Cooperative Fish Parasite and Disease Project
- Biosecurity of trout fish hatcheries
- Hatchery checks supporting salmonid culture

AUMNH COLLECTIONS

John D. Freeman Herbarium

Accessions/Acquisitions/Exchanges/Loans

The herbarium continues to be very active and has grown to include greater than 80,000 specimens of vascular plants, mosses, liverworts, lichens and fungi from all over the world. Exchange specimens and acquisitions have added greatly to the broad diversity and growth of the international collections. The herbarium received 628 specimens on exchange or as gifts and sent out 4 loans of 256 sheets to other botanists. Approximately 60 specimens were sent from Auburn as exchange or gifts to other institutions. A multi-year effort to mount and prepare over 2100 sheets of grapevines (the genus *Vitis*), is nearing completion. Auburn will have one of the premier collections of *Vitis* in the southeastern US and beyond.

Digitization/Database Development

Over 1,700 specimens were glued, processed and added to the Specify database during 2018. Herbarium specimens, including vascular plants, lichens, bryophytes and fungi, are searchable on the Web at the AUMNH website (aumnh.org/research-collections/plants/search-plant-database/). Our Alabama vascular plants are searchable on the Alabama Plant Atlas website (www.floraofalabama.org) and Morphbank (www. morphbank.net) and many of our lichens and bryophytes may be found on the Symbiota web portals, http://lichenportal.org/portal/ and http://bryophyteportal.org/portal/, respectively.

Lichens outreach event in DeSoto State Park

Outreach event in the Herbarium

Teaching, Students, & Volunteers

Volunteers are critical to the successful management of specimens and in 2018 we have had great support. We've had volunteer help from John Perkins and Phillip Barlow, who have done great a job gluing specimens and working through our backlog. Chris Taylor has been working throughout 2018 to finish gluing the entire *Vitis* collection of over 2,000 sheets—a heroic task. Several honors biology students spent volunteer hours helping to glue plants. Systematic Botany continues to be successfully taught every spring semester with students gaining knowledge and experience in plant identification.

Research & Collections Related Activities

Graduate student Nathan Hall published a paper documenting the complete plastid genome sequence of Eleusine indica. Dr. Hall finished up his dissertation which included, in part, *Marshallia* (Asteraceae) phylogenetics using the mitochondrial and plastid genomes and the genomics of and *Eleusine* (Poaceae). We wish Dr. Hall the best in future career as an expert in bioinformatics.

Curtis Hansen finished work at the Redstone Arsenal collecting lichens as part of ongoing biological survey work contracted to AUMNH. His work culminated in the publication of a checklist of the lichens of U.S. Army base (Hansen 2018).

The Freeman Herbarium houses historic plant collections from the St. Bernard Herbarium, formerly located in Cullman Co., AL and that were transferred to the herbarium in 1995. These collections are now getting more attention by being repaired and prepared for incorporation into the main collection.

Herbarium collections manager Curtis Hansen (left middle) and Museum Director Jon Armbruster (right middle) preparing for a Junior Curator Camp nature walk - 2018

Ichthyology Collection

The fish collection was very busy in 2018 with the addition of almost 20,000 new specimens in 2,100 lots. Most of the new material came from collections received from the Florida Fish and Wildlife Conservation Commission, ongoing surveys in Bankhead National Forest and Redstone Arsenal, and an expedition to Peru. The collection sent out 27 loans, totaling 556 lots, that were requested by researchers in the United States, Brazil, and Canada. Requests for loan material were evenly split between whole voucher specimens and tissue samples. The amount of tissue samples requested has steadily increased year-to-year, and it is anticipated to keep doing so into the foreseeable future. Nineteen research papers on topics that include taxonomy and systematics, ecology, functional morphology, and biogeography cited AUMNH Fish Collection specimens in 2018. In addition to all of this, the collection was completely moved out of and then back in to its space to allow for compactable shelving to be installed.

In August, Jonathan Armbruster, David Werneke, and Corinthia Black travelled to Peru to collect fishes with researchers from the Royal Ontario Museum and graduate students from Peru. Between August 15th and August 28th they sampled 21 localities between Lima and the Ecuadorian border to the North. Their work yielded 893 voucher specimens and 290 tissue samples that were deposited in the AUMNH Fish Collection upon their return. Included in this material were representatives of two new families to the collection and at least two species new to science. Additionally, some of the specimens collected will be used by Corinthia Black as part of her dissertation on *Hypostomus niceforoi*.

Crew seining fishes in Peru

Crew processing fish specimens collected in Peru. Pictured: D. Werneke (left), J. Armbruster (middle), and C. Black (right).

Herpetological Collections

The Division of Herpetology continues its efforts to uphold and advance the museum's mission to document, study and educate the public about the biodiversity of Alabama and the world. Division staff, students and associates continue to conduct and promote collection growth and curation, participate in collections-based research, and in facilitate the dissemination of information through scholarly publication and museum outreach.

Accessions/Acquisitions/Exchanges/Loans

Although the herpetological collections were shut down for much of the year to allow for the installation of compactors and tank racks in the alcohol room, 2018 saw continued growth in the herpetological collections. Just under 400 amphibian and reptile specimens were added to the alcohol collection representing a collections increase close to 1%. The specimens included adults, larvae, eggs, and associated stomach contents and tissues. Many of the new specimens arrived as a result of ongoing research associated with the herpetology labs on campus. As was the case over the last two years, Melissa Miller's doctoral work on snake parasites with Dr. Craig Guyer continues to produce snake specimens from the southeastern United States. Additionally, other herpetological projects in the labs of Dr. Jamie Oaks and Dr. Daniel Warner have contributed lizard and turtle specimens.

There was moderate growth in the other herpetological collections with over 60 digital vouchers added to our photo/audio/video voucher collection. Associated with these new specimens, were 308 new tissues samples added to the herpetological tissue collection.

The herpetology collections were also well utilized by researchers over the two year period. During this time, a total of 8 loans were sent out and more than 20 data and tissue requests were processed.

Digitization/Database Development

The work of digitizing and serving the herpetological databases online continues. The majority of the wet collections are available online through the museum's website. The remaining specimens should be added shortly. The frozen tissue collection has been organized and is now digitized. It now awaits being inputted in to Specify. Additionally, we continue also to add to and maintain a series of ecological databases that are available online through our website. Last year also saw the beginnings of efforts to photograph the museums specimens. These photographs will be added to our Specify database and be made available online, allowing researchers and the public to see each individual specimen as they search the database.

Teaching, Students, & Volunteers

The Museum's herpetological scientific and teaching collections were also extensively utilized by undergraduate and graduate courses for class use, class projects and individual research. The availability of room 251 as a lab instructional area has allowed several courses to teach their labs within the museum. These include Vertebrate Biodiversity, Herpetology. Not only did students utilized the herpetological teaching collections for lab, several student class projects were based out of the herpetological collections as well and several undergraduate research projects were conducted in the herpetological collections.

A crucial component of our museum family is the group of dedicated and talented volunteers that work with us at the museum. The herpetology collections benefited from the hundreds of hours of tireless work of over 8 volunteers (see list) who worked in just about every corner of the collections including: the wet collections, the skeletal collection, the beetle colony, the frozen tissue collection and in the live animal room. Their work is invaluable to the mission of the museum.

<u>Volunteers</u>
Sarah Bailey
Nicole Gassman
Katie Kreider
Morgan Meeker
Caroline Nelson
Vahab Rajaei
Cindy Scruggs
KayLene Yamada

Citizen Science

The museum continues to participate in citizen science programs that allow Alabamians to participate in the collection of real scientific data and add to our knowledge base on the calling phenology of our state's frog species as well as the geographic distribution of our herpetofaunal diversity. The AUMNH is home to a chapter of FrogWatch USA, a nation-wide citizen science program where volunteers monitor frog call activity to help conserve amphibians and wetlands. Over the last two years, several volunteer workshops have been held throughout the state. The museum is also home to the Alabama Herp Atlas Project (AHAP), a citizen science program where citizens can send in photo, audio or video documentation of any amphibian or reptile species. These records are curated and added to both our photo voucher catalog our geographic distribution maps for those species. As describe above, over 60 vouchers were accessioned in 2018, several of which represented county records. We hope to soon develop educational components to each of these programs.

Live Animal Collection

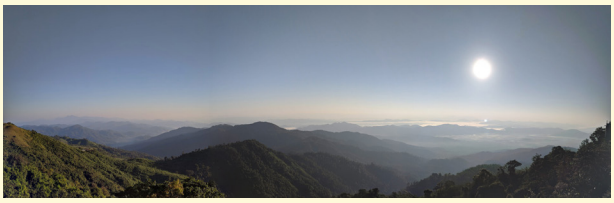
Continuing our long tradition, the live animal room, now located in nearby Funchess Hall, has been an indispensable resource, which we utilized during both tours and outreach programs. Moreover, our live animals are utilized by other campus programs and departments, further increasing both the impact of the museum collections and the visibility of the museum. In all, live animals were utilized in over 23 events in 2018 and were seen by over 2,500 people.

Research & Collections Related Activities

Herpetology personnel continued producing original collections-based and collections-related research. In 2018, no less than 8 papers and notes related to the herpetological collections were published, with another half dozen in press and in review at the end of the year. These papers showcase the breadth of research being conducted at the AUMNH and cover among other topics: basic ecology and natural history, herpetofaunal diversity and geographic distributions, taxonomy, behavior, invasive species, as well as the conservation of threatened and endangered species. Additionally, 2017 saw 6 oral presentations and 5 poster presentations. All major groups of Alabama amphibians and reptiles were represented in the above publications and presentations.

AUMNH Curator Dr. Jamie Oaks, along with Dr. Perry Wood Jr. (AUMNH), Dr. Lee Grismer (La Sierra University, and Dr. Evan S.H. Quah (Universiti Sains Malaysia), traveled to Myanmar November 5-15, 2018 for a collecting trip. The group spent two weeks collecting reptiles and amphibians from granite mountains east of the southern Irrawady Basin, karst towers in the northern Salween Basin, and karst formations on the Shan Plateau.

The team at Mount Schwegabin



Sunrise in Kyaikto

Ansonia sp.

In total, 315 specimens were collected representing 85 species of reptiles and amphibians, including several potentially new species of geckos. The specimens will be split between La Sierra and the AUMNH, and the AUMNH has tissue samples from all the specimens.

Trimeresurus sp. Wingabar Cave Pinlaung

Date	Location	Description
5–6 Nov	Kyaikto	Collected near the Kyaiktiyo Pagoda, which is on the southren end of a range of granite mountains that border the eastern side of the Irrawaddy Basin
6–10 Nov	Hpa an	Collected from several limestone karst towers, including Mount Shwegabin, at the northern end of the Salween Basin, near Hpa-An
10 Nov	Kaylar Thapha	Visited an isolated set of granite mountains off of the southern end of the range that borders the eastern side of the Irrawaddy Basin (south of Kyaikto)
11–13 Nov	Pinlaung	Drove up to the Shan Plateau and collected from karst towers in and around Pinlaung
14–15 Nov	Kalaw	Collected from two sites near Kalaw, also on the Shan Plateau

Ornithological Collections

Accessions/Acquisitions/Exchanges/Loans

The ornithological research collection consists of about 2500 bird skins, 50 bird nests with eggs, and 50 empty bird nests. A great majority of the material originates in Alabama. Of the remaining material, the skins are primarily from elsewhere in the Southeast, although a few specimens collected in Central America and Europe are represented. Many of the skins represent the first documentation of that species in the state, and a few remain the only documentation of the species for the state.

As was the case with all of the herpetological collections this year, the ornithological collection was shut down for much of the year to allow for the installation of the compactors in the alcohol rooms.

Digitization/Database Development

The ornithological collections are housed in Specify and are available online. There is more data available for each bird however. These data are located on the hand written specimen tags which are affixed the foot of each specimen. Museum volunteer, Abigail Shashikanth continued her efforts to digitizing all remaining data located on the specimen tags.

Teaching, Students, & Volunteers

In addition to the research collection, the AUMNH houses a large teaching collection consisting of about 100 bird skins, bird nests, and taxidermy mounts of birds. Most of the skins in the teaching collection were prepared from salvaged carcasses by students taking Ornithology. The teaching collection is used by several classes in the Department of Biological Sciences to teach bird identification and avian anatomy. The two spring semesters saw over 70 students enrolled in Ornithology, and the Vertebrate Biodiversity courses had over 80 enrollees.

Junior Curator Camp 2017

Mammal Collection

Accessions/Acquisitions/Exchanges/Loans

The AUMNH mammal collection is comprised of just over 5750 specimens, primarily from east-central Alabama. The collection has a focus on insectivores, bats, rodents and carnivores and consists of traditional skin and skull preparations with numerous taxidermy mounts, completed skeletons, fluid-preserved specimens and frozen tissues. Museum specimens are accompanied by standard measurements, such as tail length, mass, and total length, along with information about the collection site and date. To complement its research collections, the museum houses a separate teaching collection used in courses such as Mammalogy and Natural History of the Vertebrates. Over the last year, two mammal data requests were received and one scientist visited the mammal collection. Additionally, one tissue loan was taken in 2018.

Teaching, Students, & Volunteers

During 2018, the collection benefited greatly from three dedicated and highly motivated volunteers. Their efforts helped maintain and organize the collection. Of note was the preparation of dozens of skins and hundreds of skulls and skeletons that were prepared during the year. These specimens are now properly prepared and ready to be accessioned into the collection.

Digitization/Database Development

As with all of the museum collections, the mammal database is in the process of moving over to the Specify platform.

Research & Collections Activities

In 2018, we began the process of accessioning over 750 alcohol preserved bats into the mammal collection. These bats come from throughout Alabama and are part of historic rabies vaccine studies in the state.

Vertebrate Paleontology Collection

Accessions/Acquisitions/Exchanges/Loans

The vertebrate paleontology collections at Auburn University include close to 2,500 specimens. The collection focuses on the state of Alabama, but also includes significant material from other portions of the southeastern United States. The Vertebrate Paleontology Collection contains Mesozoic material, both terrestrial and marine, primarily from the Cretaceous period. This includes terrestrial dinosaurs as well as marine groups such as Plesiosaurs and Mososaurs. It also contains important collections of terrestrial mammals form the Cenozoic Era.

This past year saw the start of preparations for the museum's first public display. The first display will be of our dinosaur egg! Originally discovered by Prescott Atkinson, the egg represents the only dinosaur egg known from east of the Mississippi River and the only egg in the world found in marine sediment. The museum is now working on developing a public display for the egg on the campus of Auburn University.

Dinosaur Egg. Photo Credit: Joel Sartore/National Geographic Photo Ark

Teaching, Students, & Volunteers

Claire Wilson and Skye Walker continued to provide incredible volunteer help in organizing the vertebrate paleontological collection. Through their continuing efforts, the collection is being more accessible and organized and the fossils' housing is being improved.

Volunteers
Claire Wilson
Skye Walker

Invertebrate Paleontology Collection

Accessions/Acquisitions/Exchanges/Loans

The museum's invertebrate paleontological collections were first curated in 2016. The museum is home to a small collection of over 120 invertebrate fossils.

Digitization/Database Development

The invertebrate paleontology database is digitized and awaits preparation and transfer to the Specify platform.

Entomology Collection

Accessions/Acquisitions/Exchanges/Loans

The entomology collection grew considerably during 2018. Curator Dr. Charles Ray and his lab added 16,000 pinned specimens to the collection this year. Charles Stephen, a PhD student in DBS, added 1,900 arachnids and 700 insects. Dr. Sarah Zohdy, faculty in SFWS, deposited mosquitoes from Madagascar as well as from an Alabama state survey her lab conducted this year. Dr. Debbie Folkerts, faculty in DBS, retired this year and deposited her collection of arachnids and insects into the museum. Dr. Joe Eger, scientist at Dow AgroSciences, donated ~400 Pentatomoidea from Uruguay, Mexico, Suriname, Paraguay, French Guiana, and the USA. Additionally, AUMNH staff added specimens collected from the Redstone Arsenal survey during the summer of 2018.

This year, we had three loans and anticipate our collection will be utilized by more and more researchers as we get our collection digitized and available online.

Digitization/Database Development

Over 4,100 insects and 2,700 arachnids were digitized in 2018. Our two databases are in the process of being published on GBIF and will also be searchable through our museum web portal on the AUMNH website (http://aumnh.org/research-collections/arachnids-myriapods/) and (http://aumnh.org/research-collections/entomology/). To date, we have over 204,000 insects and 11,000 arachnids and myriapods digitized.

Teaching, Students, & Volunteers

Once again, we had a wonderful group of students working and volunteering in the entomology collection this year. Their hard work prepping specimens, digitizing, and helping with outreach events is greatly appreciated!

Nicole Garrison (PhD student, DBS)

Rebecca Godwin (PhD student, DBS)

Holly Goodwin (undergraduate, DBS)

Amelia Grider (Undergraduate, DBS)

Alan Jeon (Undergraduate, Entomology)

Lacie Newton (PhD student, DBS)

Matthew Paek (undergraduate, DBS)

Charles Stephen (PhD student, DBS)

Wood's jewel scarab *Chrysina woodii*

Invertebrate Collection

Accessions/Acquisitions/Exchanges/Loans

The Invertebrate Collection saw continued growth in 2018, adding over 3000 lots to the collection. The specimens included representatives of all major invertebrate taxa. Most of the new specimens came from Dr. Ken Halanych's Antarctic research cruises, with the rest coming from private collectors and museum trips. Additionally, other projects in the lab of Dr. Nanette Chadwick have contributed tropical marine invertebrate specimens. We had a total of two out-going loans, totaling 23 specimens. These loans were freshwater mussels to Auburn University Montgomery and freshwater isopods to Cave, Karst, & Groundwater Biological Consulting.

Digitization/Database Development

We digitized over 3000 lots in 2018, as the invertebrate collection is continually digitized as it is accessioned. All of the information is added to our Specify database, and each specimen is given a barcode for more efficient tracking. We are in the process of reworking the data in the Specify database to make specimens more easily found. The data should soon be available online at the AUMNH website, and shared with GBIF, iDigBio, as well as other online sources.

Research & Collections Related Activities

There have been many collecting expeditions by personnel in the Invertebrate collection this year. The most notable being the ichthyology collecting trip to Peru, which yielded many new crustaceans and mollusks. Charles Stephen, a PhD student, collected cave invertebrates throughout the United States. Jim Godwin with the Natural Heritage Program consistently brings freshwater mussels and other aquatic invertebrates back from his trips around Alabama and Tennessee. Additionally, we have begun to receive tropical marine collections from Nick Parr, a PhD student, in addition to live donations for the newly established Saltwater Display Aquarium.

Teaching, Students, & Volunteers

The invertebrate collection has benefitted from the amazing students and volunteers who have worked on specimen collection, upkeep, accessioning, digitization, and outreach. We are grateful for all of their contributions.

Amelia Grider (Undergraduate, DBS)

Alan Jeon (Graduate, Entomology)

Nicholas Lockert (Undergraduate, DBS)

Sarah Odom (Graduate, DBS)

Kayla Wilson (Undergraduate, DBS)

Lauren Wilson (Undergraduate, DBS)

Brittany Woodruff (Undergraduate, DBS)

AUMNH Research Projects

Redstone Arsenal Planning Level Surveys

Redstone Arsenal contracted with ALNHP and AUMNH to conduct planning level surveys to document the precise of species of conservation concern on the installation. Surveys focused on areas designated as Ecologically Sensitive Areas but also included other areas of suitable habitat for rare species. Surveys in 2018 focused on insects, arachnids, fishes, plants, and natural communities.

Lichen work continued in 2018. From a total of 464 collections across the nine ecologically sensitive areas, 151 species in 64 genera were identified, including 12 state records and three new species currently being described. Prior to this study, only eight lichen species had been documented from the Redstone Arsenal and less than 40 were known from Madison County. Newly reported lichens for Alabama include *Caloplaca pollinii, Clauzadea chondrodes, Enchylium coccophorum, Hypotrachyna dentella, Lepraria xanthonica, Phaeophyscia hirsuta, Phaeophyscia leana, Physciella chloantha, Physconia leucoleiptes, Physconia subpallida, Punctelia graminicola*, and *Usnea halei*. Results from this study represent the first lichen survey of the Redstone Arsenal and will serve as a baseline for future studies.

The rare plant and natural community component of the Redstone Biological Assessment were completed in late 2018. The study consisted of two components: 1) updating existing records of occurrences documented during the first base-wide biological assessment conducted by ALNHP in the mid-1990s; and 2) documenting new occurrences of taxa monitored by ALNHP. Seven existing occurrences representing six species of rare plants

were updated and nine occurrences representing nine previously unrecorded species were documented. Most noteworthy is the discovery of cypress-knee sedge (*Carex decomposita*) and cream-flowered tick-trefoil (*Desmodium ochroleucum*), two globally imperiled taxa unknown from the installation prior to this study. Also of significance is the presence of Price's potato-bean (*Apios priceana*), a federally listed species originally reported from the installation in the 1990s. This occurrence has been the subject of several research efforts and is undergoing long-term monitoring. In addition to the rare plant surveys, classification of significant natural communities has also been conducted, with occurrences having been identified and cross-walked with the National Vegetation Classification ecological system framework. Five existing occurrences of natural communities were

updated and twenty-one new records were generated as part of the study.

Cream-flowered tick-trefoil.

We also surveyed the insect and arachnid diversity of seven of the ecologically sensitive areas at Redstone Arsenal during 2018. We used a combination of pitfall traps, beat sheeting, pan traps, and hand-collecting with and without nets. We are currently sorting and identifying the specimens.

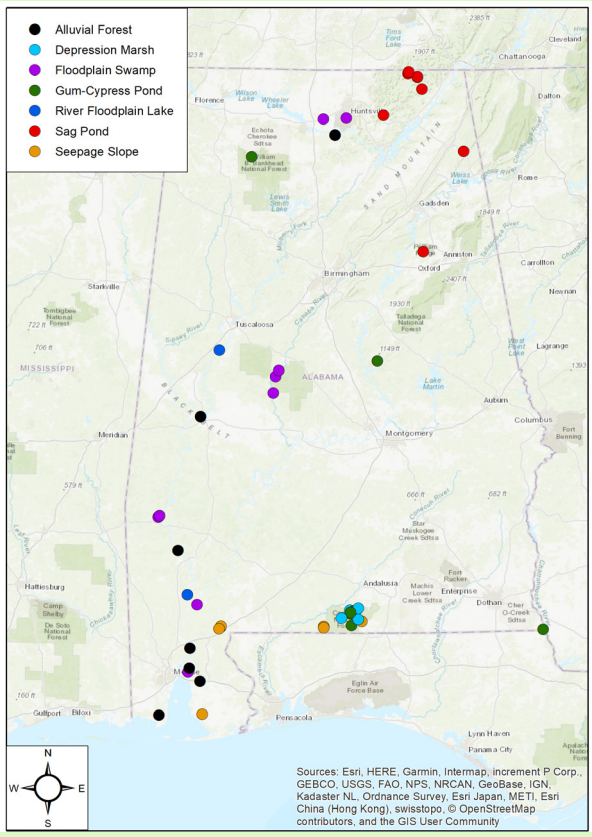
Fish surveys on Redstone Arsenal were conducted in 2018. McDonald Creek and several of its tributaries were sampled using a seine. Two darter species, *Etheostoma duryi* and *Etheostoma flabellare* were collected at three of the four McDonald Creek System sites. Fish surveys continue in 2019.

Black Darter *Etheostoma duryi*

Fantail Darter *Etheostoma flabellare*
Photo Credit: Matthew Ignoffo

Reference Wetlands Study

In 2018, the Environmental Protection Agency awarded AUMNH/ALNHP a grant to conduct a reference wetland study. The Museum has partnered with Troy University to accomplish the study, whose primary goal is to enhance recognition and protection of wetlands throughout Alabama by establishing permanent wetland reference sites across the state using an Ecological Integrity Assessment framework. This framework developed by NatureServe and the Natural Heritage Network, was designed to support planning and management for the conservation of wetlands and other natural communities through quantifying ecological integrity based on metrics of biotic and abiotic condition, size, and landscape context. Reference wetland sites will provide a standard against which to measure the condition of similar wetland types – a starting point for establishing desired future conditions to inform land management and conservation efforts. Wetland integrity will be evaluated focusing on intensive field assessments of flora and fauna. These assessments will include collecting data to support a floristic quality assessment and indices of biotic integrity for faunal taxa. The final product is anticipated to complement and strengthen the state's ability to implement a comprehensive water quality monitoring and wetlands assessment program by providing baseline data to fill information gaps. Deliverables include wetland GIS data and maps, a database of completed field assessment forms, and hard and electronic copy of final report summarizing the project results. This information can be used for setting conservation priorities, identifying restoration strategies, and monitoring the effectiveness of conservation actions.



Map of high quality wetlands from which reference sites will be selected.

ALABAMA NATURAL HERITAGE PROGRAM[SM]

The mission of the Alabama Natural Heritage Program[SM] (ALNHP) is to provide the best available scientific information on the biological diversity of Alabama to guide conservation action and promote sound stewardship practices. ALNHP is administered by the Auburn University Muesum of Natural History, Department of Biological Science. Established by The Nature Conservancy in 1989, it is one of a network of such programs across the United States, Canada, and Latin America, collectively known as the Natural Heritage Network (NHN). As a member of the NHN, ALNHP is represented by its membership organization NatureServe. NatureServe works to aggregate data from individual Network Programs and is dedicated to the furtherance of the Network and the application of Heritage data to biodiversity conservation.

Natural Heritage Programs have three broad functions:

- to collect information on the status and distribution of species and natural communities,
- to manage this information in a standardized way, and
- to disseminate this information to a wide array of users.

Natural Heritage Programs use a standardized information management system to track biodiversity data including taxonomy, distribution, population trends, condition, and viability. ALNHP provides the following services: biodiversity data management, inventory, biological monitoring, conservation planning, Geographic Information System services, and land management expertise.

NatureServe
A Network Connecting Science With Conservation

NatureServe is a non-profit conservation organization that provides the scientific information and tools needed to help guide effective conservation action.

NatureServe represents an international network of biological inventories - known as natural heritage programs or conservation data centers - operating in all 50 U.S. states, Canada, Latin America and the Caribbean. NatureServe and its network of natural heritage programs are the leading source for information about rare and endangered species and threatened ecosystems.Together we not only collect and manage detailed local information on plants, animals, and ecosystems, but develop information products, data management tools, and conservation services to help meet local, national, and global conservation needs. The objective scientific information about species and ecosystems developed by NatureServe is used by all sectors of society - conservation groups, government agencies, corporations, academia, and the public - to make informed decisions about managing our natural resources.

Project Summaries

Black Warrior waterdog and flattened musk turtle eDNA survey of Locust Fork

The Locust Fork of the Upper Black Warrior River basin supports a suite of federally listed aquatic species including snails, fish, and mussels, plus an amphibian and reptile. The U.S. Fish and Wildlife Service, Alabama Department of Conservation and Natural Resources, and Geological Survey of Alabama have prioritized watersheds in the state to focus management and conservation actions for aquatic species restoration and recovery. These watersheds have been designated Strategic Habitat Units (SHUs) and the Locust Fork is one of the recognized SHUs.

The Black Warrior waterdog (*Necturus alabamensis*) and the flattened musk turtle (*Sternotherus depressus*) are endemic to the Upper Black Warrior River, are ecologically linked by habitat, and are federally listed. Based on recent survey work using eDNA and conventional sampling outside of the streams within the Bankhead National Forest, the Locust Fork appears to have the best remaining populations of these species. This project, as part of a larger project funded by the National Fish and Wildlife Foundation to The Nature Conservancy, is to survey the entire free-flowing reach of the Locust Fork for both species using eDNA. Results from these surveys will be used in a larger landscape and water quality analysis to provide guidance for habitat restoration and watershed conservation.

Flattened Musk Turtle

Preliminary Status Assessments

Three preliminary status assessments for the U.S. Fish and Wildlife Service were finalized in 2017. Reports summarizing the range-wide statuses of the west Florida cowlily (*Nuphar ulvacea*), hairy-peduncled beakrush (*Rhynchospora crinipes*), and Mississippi witch-hazel (*Hamamelis ovalis*) will be used by the Fish and Wildlife Service to assist with future protection efforts.

Turkey Creek Flattened Musk Turtle Survey

Turkey Creek near Pinson, AL is a major tributary of Locust Fork in thehe Turkey Creek near Pinson, AL is a major tributary of Locust Fork in the Upper Black Warrior River watershed and stream of interest for the USFWS regarding the potentional presence of the federally threatened flattened musk turtle (Sternotherus depressus). A hatchling flattened musk turtle was observed and photographed in the summer of 2014 from Turkey Creek. Surveys were conducted in the summers of 2017 and 2018 to obtain additional documentation of specimens and determine the occurrence of the flattened musk turtle between Turkey Creek Nature Preserve and Morris-Majestic Road, a distance of approximately 12 stream miles. Conventional sampling with wading surveys and trapping was conducted upstream of the Morris-Majestic bridge and water samples for an eDNA analysis were collected between Turkey Creek Nature Preserve and Morris-Majestic Road. No additional flattened musk turtles were seen or captured, nor did the eDNA analysis return any positive detections.

Flattened Musk Turtle. Photo courtesy of Sarin Tiatragul, Auburn University

Status Assessment of Harper's Ginger (*Hexastylis speciosa*)

Harper's ginger is a narrowly restricted species endemic to a three-county region in central Alabama. The plant is a low-growing perennial herb that was first brought to the attention of the scientific community by Roland Harper in 1924, from specimens collected in Autauga County. Because of a low number of occurrences (less than 10) and an unknown status, the U.S. Fish and Wildlife Service has contracted with the AUMNH/ALNHP to gather data related to the biology of the species and to assess conservation needs. A final report will be submitted in 2019.

Alligator Snapping Turtle Status Survey

The alligator snapping turtle (*Macrochelys temminckii*) is the largest freshwater turtle in North America, and can attain a maximum size of 80 cm carapace length and a weight of 143.3 kg. The species has been reported from the major drainages of Alabama except the streams on the north side of the Tennessee River. Creeks, rivers, oxbows, sloughs, and occasionally brackish waters are habitats in which the turtle is found, and the species is almost wholly aquatic, seldom leaving the water except to lay eggs. The U.S. Fish and Wildlife Service has been petitioned to list the turtle as threatened or endangered. Objective of the study is to gather updated information on the status of the alligator snapping turtle that may be used by the Alabama Department of Conservation and Natural Resources and the U.S. Fish and Wildlife Service to aid with conservation or listing decisions.

Photo: U.S. Fish and Wildlife Service

ALNHP Herpetologist, Jim Godwin

Riverine reaches or tributaries have been selected for sampling based on available distributional records housed in the database of the Alabama Natural Heritage Program. At each sampling site hoop nets baited with fresh fish were set in shallow waters, with the top of the net exposed to air to prevent the drowning of captured turtles. During each sampling event 10 nets were set for two to three consecutive nights. Trap results have been compared on a trap-night basis as an index to abundance. Measurements for each captured alligator snapping turtle includes, mass, carapace and plastral lengths, total tail length, and length of tail from plastron to vent. The last measurement aids in sexing individuals. Maximum midline carapace length recorded for a female was 57 cm, and a weight of 28.2 kg; males attain larger sizes than females. Data collected from this study is being compared to data collected in 2004-2005 and 2008-2014 on alligator snapping turtles collected from the Coosa, Tallapoosa, lower Tombigbee, Mobile-Tensaw Delta, and rivers associated with Mobile Bay.

Escambia Map Turtle

There are more than 400 "at-risk" species in the southeast US currently petitioned for federal listing under the Endangered Species Act (ESA). Both Alabama and Florida contain more of these at-risk species than any other southeastern US state (NatureServe Central Databases January 2012). In response to a mega-petition filed by the Center for Biological Diversity to evaluate the need for listing of these approximate 400 aquatic species, the USFWS Southeast Region has implemented an at-risk species conservation strategy to work proactively with public and private partners to conserve these species over the next decade with the goal of eliminating the need to list these species under the ESA (http://www.fws.gov/southeast/candidateconservation/). One of the thirteen reptile species in the petition is the Escambia map turtle (Graptemys ernsti), a freshwater species found only in Alabama and Florida in the Conecuh-Escambia, Yellow, and Choctawhatchee-Pea rivers. Current information on the status of the Escambia map turtle in Alabama and Florida is limited; it is a State Wildlife Action Plan Priority 2 species, thus up-to-date information is needed for ADCNR in formulating conservation strategies for this species and for the USFWS decision regarding listing. The objective of the study is to obtain information on the current distribution and abundance of the Escambia map turtle (*Graptemys ernsti*) in Alabama and assess the conservation status of the species.

Map turtles as a group are noted for their drainage-specific endemism and well-developed basking behavior. Abundance and distribution data on basking map turtles are easily gathered with visual survey methods. Suitable riverine stretches, those with an abundance of dead wood for basking, were previously sampled in 2000 and 2002 with supplemental data collected in 2012. Data on turtles were collected through basking surveys by identifying turtles; all observed individuals were identified to species, and when possible, sex, and age class. Distinguishing sexual characters between male and female include 1) females achieving a much larger size, 285 mm carapace length, males ca. 170 mm carapace length; 2) females with conspicuously large head; 3) males with long and enlarged tail. Basking turtles of large size and enlarged head were categorized as "female," turtles of smaller size with a noticeably large tail were categorized as "male," turtles without distinguishable characters were categorized as "unclassifiable," these individuals may have been immature female, immature male, or adult male in which the tail could not be observed. Data were recorded per river kilometer, date, and river stretch to allow for a metric of turtles/river kilometer to be calculated for each sampling session.

In this study, selected river stretches in the Conecuh River from the 2000 surveys have been resurveyed, additionally sections not surveyed in 2000 were included in 2018. Surveys were conducted from either canoe or a 14' flat bottom boat equipped with a 25 hp outboard motor. Water depth was the primary determinant in the mode of transportation. Use of a motorized boat allowed both up- and downstream surveys while with a canoe only downstream surveys could be performed. Image stabilization binoculars were used to spot, identify, and sex basking turtles. Survey end points and survey length were recorded with a GPS. In smaller rivers, those with channel width of less than 75 m, both banks could be scanned for turtles. In large river channels, over 75 m wide, only one bank per survey effort could be sampled effectively.

During 2018, all surveys were conducted in the Conecuh River in Covington and Escambia counties. All surveys took place below Point A dam downstream to Brewton except for one section in the flowing reach above Gantt Lake. Surveys in 2000 also included Conecuh River, Sepulga River and Patsaliga Creek (Conecuh River drainage) and Yellow River (Figure 1).

In 2000, total survey distance in the Conecuh River was 45.7 river kilometers with an average of 12.3 *Graptemys ernsti*/ river km. The total survey distance in the Conecuh River in 2018 was 139.3 river km with an average of 7.9 *Graptemys ernsti*/river km. During both survey years, *G. ernsti* was the most commonly seen turtle in the Conecuh River. *G. ernsti* were observed at a higher density (12.3 vs. 7.9), in 2000 than in 2018. Underlying cause for difference in observed numbers is unknown at this time. River conditions in 2000 were at normal summer flow, while in 2018 water levels were higher. In 2018, many normally exposed bask sites were inundated forcing turtles to use basking structures that were often within thickets of riparian trees. In both survey years, females were observed more often than males or individuals that could not be assigned to an age/size class. Smaller individuals are more difficult to observe than larger females in the occluded bask site conditions. Additional surveys for Escambia map turtle will be conducted in 2019.

This project is being funded by the Alabama Department of Conservation and Natural Resources

Photo Credit: Mark Bailey

Eastern Hellbender

The Eastern Hellbender (*Cryptobranchus alleganiensis*) is one of the largest salamanders of North America and in Alabama occurs only in the Tennessee River system. Ideal habitat for this aquatic salamander is clear flowing streams with an abundance of slab rock and boulders over a substrate of clean gravel. Stream channelization, impoundment, and alteration of riparian habitats have degraded aquatic conditions resulting in increased water temperatures, sedimentation, and siltation, consequently leading to suspected declines in hellbender populations. Historical hellbender records include 11 localities in Franklin, Colbert, Lauderdale, Limestone, Madison, and Morgan counties. The earliest Alabama record is from the 1920s with records peaking in the 1960s and 1970s. The decline of records through the 1980s to the present support the need for renewed survey effort in Alabama. Surveys by Graham et al. failed to document the presence of the hellbender but that may have been due to limited search effort coupled with low detectability of the salamander.

Standard sampling techniques for the Eastern Hellbender include trapping, snorkeling, and visual searches. These methods can be effective in the capture of hellbenders but may be affected by limited access to sites, efficacy due to water level and clarity, and trap security. An emerging survey technique commonly known as environmental DNA (eDNA) has become more widely used for detecting aquatic species yet yields only presence data. Success with this technique for the hellbender has been demonstrated in Missouri, Indiana, Kentucky, and North Carolina. Environmental DNA can be used to complement standard sampling or can be employed as the sole survey method at sites where standard sampling

is constrained. In this study we are surveying historic and other localities for the presence of the Eastern Hellbender using standard sampling techniques and eDNA.

Ten streams in six counties were sampled and positive eDNA detections resulted from seven streams. Although Eastern Hellbenders have been collected in February-December in Alabama, field work is typically conducted in May-October with most effort occurring in August and September to coincide with the breeding period to increase our probability of positive eDNA detection. Water samples for eDNA analysis were processed and analyzed in the lab of Dr. Eric Larson, University of Illinois Urbana-Champaign.

Conventional sampling of snorkeling and lifting rocks was performed when canoeing streams during water sample collections. In general, limited visibility due to turbid waters from widespread siltation and sedimentation affected conventional sampling effectiveness; no Eastern Hellbenders were observed or captured. One dead Eastern Hellbender was discovered and reported from the Flint

River in August by a citizen scientist. The specimen was obtained and deposited in the Auburn University Museum of Natural History. The individual was a male and Dr. Rebecca Hardman, University of Tennessee, performed a necropsy. Only minor contusions were observed on the body, no evidence of broken bones or internal injuries that could have caused mortality were overserved. The cause of death remains unknown.

Graham et.al. (2011) failed to detect hellbenders during their survey efforts and concluded that the hellbender may still occur in the state in low numbers and may be facing extirpation. The low numbers of recent hellbender reports tend to support their conclusion, with only one record each in 2014, 2015, and 2016, the recent 2018, plus a 2013 observation from the Flint River. Suitable habitat remains in many of the streams of the Tennessee River basin but siltation is pervasive. Positive eDNA detections in 2015, 2016, and 2017 suggest that hellbenders continue to occupy streams of historic record, and the eDNA results suggest the Eastern Hellbender may occur in streams from which the species has not been reported.

Hellbenders photographed in 2013, collected in 2014, 2015, and 2018 and observed in 2016 were all adults. Viability of populations of these hellbenders cannot be determined based on these individual reports and captures. Although eDNA detections suggest more widespread distribution in occupied streams, the eDNA cannot return results on population viability, density, sex ratio, or other population parameters needed to adequately assess the status of populations of the hellbender. Habitat restoration through improvements in water quality are needed for the hellbender's survival in Alabama and additional studies on occupancy modeling of landscape parameters are needed to guide land-and-stream use conservation efforts.

Watershed conservation and restoration for the improvement of water quality is critical to the survival of the Eastern Hellbender. The Tennessee River basin supports 115 aquatic species of greatest conservation need (SGCN), or approximately 1/3 of the total of SGCN in Alabama. Land use actions to promote improved water quality for the Eastern Hellbender would confer benefits to other aquatic species, thus the Eastern Hellbender could serve as an umbrella species for Tennessee River basin watershed conservation and restoration.

This project is funded by the Alabama Department of Conservation and Natural Resources.

Eastern Indigo Snake

The eastern indigo snake was once a key species, and apex predator, of the longleaf pine ecosystem of south Alabama; it is now presumed extirpated from the state with the exception of snakes that have been purposefully releasedin Conecuh National Forest. The return of the eastern indigo snake as an ecological element of the longleaf pine and associated ecosystems of southern Alabama is being done through a reintroduction of the species. Captive breeding is the most efficient route to acquire the number of young snakes needed for this endeavor, and a concerted release effort at one site is in progress with the goal of establishing a viable population.

Conecuh National Forest (CNF) is situated within the historic range of the eastern indigo snake and has been selected as the initial reintroduction site for several reasons: (1) the U.S. Forest Service has undertaken a progressive longleaf restoration project; (2) CNF possesses the habitat heterogeneity needed for indigo snakes, which includes the presence of gopher tortoises; (3) and CNF is well placed in the Gulf Coastal Plain Ecosystem Partnership, Apalachicola-Blackwater River State Forest-Conecuh National Forest-Eglin Air Force Base corridor.

We set a goal of releasing 300 snakes over a 10 year period based on a preliminary analysis of population growth, while expecting to revise this total as new data was acquired and analysis refined.

All snakes released into Conecuh National Forest in 2018 were offspring of captive snakes maintained at the Orianne Center for Indigo Conservation. Twenty snakes were released at Nellie Pond in early May 2018. The sex ratio of released snakes was even at 10 males and 10 females. Five of the released snakes were hatched in 2014, and were therefore approximately 3 ¾ years old. Fifteen snakes were hatched in 2016, and were closer to the 21 month age-at-release class planned. Snakes were released at or in natural refugia (i.e., gopher tortoise burrow).

Our objective of the reintroduction project is to establish a sustainable population of the eastern indigo snake in Conecuh National Forest. We are collecting data through monitoring to

to assess survivorship, sex ratio, and, ultimately, demographics of the population of indigo snakes. We collect monitoring data by walking transects within suitable habitat and inspecting refuges (i.e. gopher tortoise burrows) in the fall and winter (October-March) when snakes are reproductively active.

Standardized visual searches were conducted between mid-February and mid-April, 2018. Fifteen sample sites were identified and sampled from one to nine times. Site selection was either the original release site, Nellie Pond release site, or clusters of gopher tortoise burrows. With each survey location,

date, time, observer(s), refuge type, and evidence of activity was recorded. The type of refuge (tortoise burrow, armadillo burrow, or stump hole) encountered was tallied. Snake evidence categories were snake, snake track on a tortoise burrow apron, or shed skin. No indigo snakes were documented.

Eastern indigo snake is an apex predator, with a strong proclivity to feed on other snakes. We are also sampling the vertebrate assemblage (amphibian, reptile, bird, small mammal) between sites with and without Eastern Indigo Snakes. To learn if indigo snake predation is altering the prey communities (amphibian, reptile, small mammal) we are sampling with drift fence arrays and box traps. Thirteen species of amphibians, 14 species of reptiles, and five species of mammals were captured. Mammals were *Didelphis virginianus* (n=2), *Peromyscus gossypinus* (n=2), *Sciurus niger* (n=1), *Sigmodon hispidus* (n=34), and *Sylvilagus floridanus* (n=4).

Eighteen drift fence arrays were open from late May to early July to trap indigo snakes. One male indigo snake released in early May 2018 was captured at the Nellie Pond drift fence, drift fence array nearest the release site, weighed and measured. Comparison of measurements at release and measurements at recapture indicted this male snake, from the 2014 cohort, had increased in length but lost mass. This individual was recaptured a second time in mid-August and measurement comparisons indicated he was increasing in both length and mass.

Gopher Frog Environmental DNA (eDNA) Survey at Arnold Air Force Base

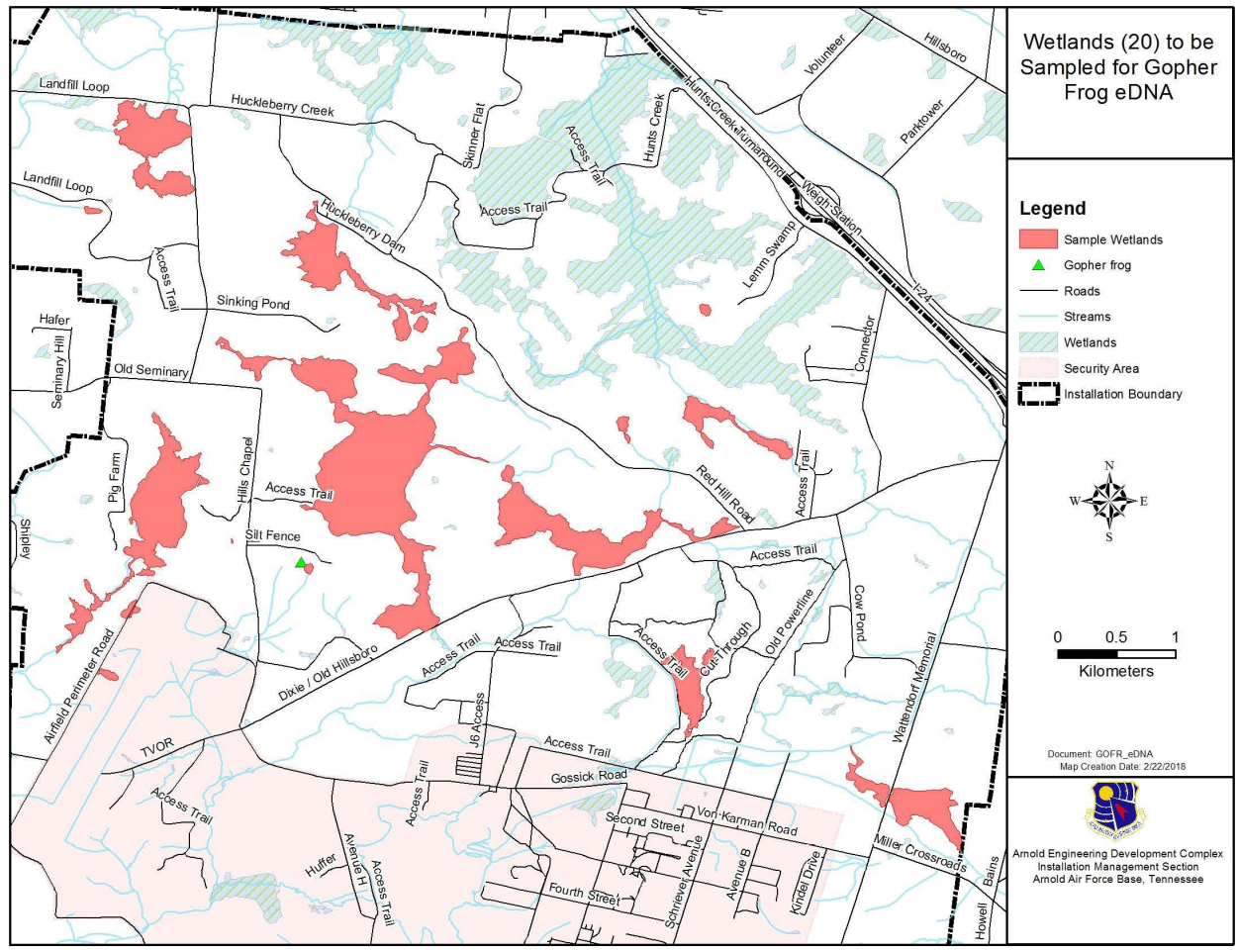
The gopher frog (Lithobates capito), formerly Rana capito, is under review for listing as threatened or endangered by the U.S. Fish and Wildlife Service. Primarily an inhabitant of the Coastal Plain, the gopher frog is a winter breeding species using ephemeral ponds that typically dry during summer months and fill with fall and winter rains. Metamorphic frogs exit ponds in early summer. Outside of the Coastal Plain, one historic population was documented in the Ridge and Valley of Alabama plus a second approximately 100 km north at Arnold Air Force Base (AFB) in Tennessee. The presence of the gopher frog at Arnold AFB is an anomaly, yet disjunct populations outside of the Coastal Plain have been reported, or example one in Shelby Co., AL. Two individuals, one a gravid female, were collected at Arnold AFB in the 1990s, yet no breeding ponds have been located despite intensive sampling efforts which have included night-time and automated aural surveys for calling males, egg mass and tadpole surveys, and drift fence trapping.

Environmental DNA (eDNA) is an effective detectiontool for rare species that can be used when conventional sampling fails. McKee et al. (2015) demonstrated that eDNA may be used to detect gopher frogs in ponds of Conecuh Forest at known and undocumented breeding sites. In the ponds at Arnold Air Force Base we will be using eDNA to sample for gopher frog presence. Approximately 20 wetlands on Arnold AFB have been identified as potential breeding sites for the gopher frog and from this list 12 have been selected as ponds to be sampled.

The gopher frog, if present, likely occurs in low density on Arnold AFB based on the collection of only two adult specimens, and presumably the adult breeding and tadpole developmental period is similar to that of other gopher frog populations from January to May. Sample collection during the activity period of the target species is critical to the detection of species with eDNA. We began water sample collections in January and will continue through May when tadpoles are expected to be in the ponds and eDNA concentrations may be elevated.

The second goal of this project is to determine which population the two gopher frogs captured from Arnold AFB in the late 1990s are nearest to genetically. Because these frogs have been preserved in formalin, new challenges must be overcome to successfully extract DNA from their tissues. Once that is done, we will compare the ultraconserved elements of the Arnold AFB gopher frogs to corresponding DNA segments from gopher frog tissues collected from southeastern US populations.

This project is funded through the Department of Defense.



Map of 20 wetlands on Arnold Air Force Base in Tennessee that will be sampled for Gopher Frog eDNA

Status Assessment of Wherry's Phlox (*Phlox pulchra*)

Wherry's phlox is a globally imperiled species currently known from five occurrences worldwide. The plant is endemic to Alabama, preferring open moist to dry open woodlands maintained by periodic fire. An herbaceous evergreen perennial, the species was described in 1929 by Edgar Wherry from plants he collected near Oakman in Walker County. Because of a low number of occurrences, the U.S. Fish and Wildlife Service commissioned the AUMNH/ALNHP to gather data related to the biology of the species and to assess conservation needs. The final report will be completed in 2019.

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Habitat Modeling and Site Verification for the White Fringeless Orchid in Alabama

The white fringeless orchid (*Platanthera integrilabia*) is one of many southern Appalachian plant species that are listed under the Endangered Species Act, for which suitable habitat is likely plentiful but remains unverified. The species assumes a relatively broad but sporadic distribution across the mountainous region of seven southeastern states. In Alabama, nine extant occurrences are known, all documented within the typical habitats reported for the species, which includes seepage wetlands generally associated with the origins of small streams and streamside seepage slopes. The plant was listed as a federally threatened species in October 2016 based on a small number of occurrences, a low reproductive capacity, and various threats that include habitat degradation (alteration, fragmentation, succession, and forest management practices) as well as direct damage to individual plants.

The objective of the project is intended to promote conservation of the white fringeless orchid in Alabama. The project will determine the rate of success in locating new occurrences of the species based on species occupancy models. The study will also focus on evaluating environmental conditions and assessing reproductive potential (e.g., census of reproductively active plants) in extant occurrences, thus enabling land managers and conservationists to prioritize sites for long-term protection.

The study is sponsored by ADCNR through Section 6 funding, and will be completed in December 2019.

Range-wide Status Assessment of Bog Spicebush

Bog spicebush (*Lindera subcoriacea*) is one of several southeastern Coastal Plain plant species that has become globally imperiled as an artifact of adverse modifications of its habitats: permanently moist to wet, shrub-dominated seepage wetlands embedded in a matrix of pine and mixed pine-hardwood uplands. The taxon is a clonal species currently represented by approximately 35 extant occurrences across seven southeastern states, several of which are small consisting of 1-5 genetic individuals. The small size of many occurrences, impending threats such as fire exclusion, and its inherently relatively narrow ecological niche serve as a testament to the dire conservation need the species now faces. This study will focus on updating existing records for known occurrences across the range of the species to further assess threats that will enable land managers determine appropriate conservation strategies. In 2019, surveys will focus on visiting occurrences in the Carolinas and Georgia to acquire data population biology, habitat, threats, and landowner use. A final report will be completed and submitted to the U.S. Fish and Wildlife Service at the end of the year.

Monitoring of Price's Potato-bean at Sauta Cave National Wildlife Refuge

Beginning in 2015 AUMNH/ALNHP entered into an agreement with the U.S. Fish and Wildlife Service to assist with recovery efforts of the Price's potato-bean (Apios priceana) at Sauta Cave National Wildlife Refuge (SCNWR) in north Alabama. The species was listed as federally threatened by the U.S. Fish and Wildlife Service (USFWS) in 1989, and is currently ranked as G3 by NatureServe suggesting it to be globally vulnerable. At the time of listing, the species had been collected from 21 sites in Alabama, Mississippi, Kentucky, Tennessee, and Illinois, with only 10 extant occurrences having been known and with 60% of those threatened by destruction. Since the discovery of the species on the refuge in August 2002, USFWS staff and Al Schotz had detected a marked decrease in reproduction and an overall decline in the vigor and number of plants. It was hypothesized that a high level of canopy closure was correlated to attrition of the species throughout the refuge. The amount of canopy closure in the area of plant disappearance has been observed numerous times during the

course of several years by USFWS staff and has shown a marked increase to nearly 100% coverage. Occurrences having the greatest vigor appear to be often associated with clearings in forests and along rights-of way, including roadsides and power lines. As of this study, it is unknown how much canopy opening is desirable to promote optimal growth and reproduction of Price's potato-bean.

This study was designed to span a five-year period in which canopy reduction efforts will be implemented to determine the ideal canopy cover necessary to promote and maintain optimal growth and reproduction of Price's potato-bean at SCNWR. It is anticipated the results of the project will have broader applications, serving as a resource guide as it relates to management across the range of the species. The project will be completed in 2019, with the results of the study proposed for publication in a peer-reviewed journal.

Teaching, Students, & Volunteers

Hellbender field survey in 2018 had participation of 8 volunteers.

Courtney Weyand, in the Armbruster Lab, was supported on an ADCNR grant to process eDNA samples.

Boos and Bones 2018

ALNHP Outreach Events & Participation

• NRCS Natural Resources Youth Camp, Mussel Creek Lodge, Butler County. June 2017. 30 participants.

• Eastern Indigo Snake release at Conecuh National Forest, 4 May 2018. Participants were school groups and public. Representatives present from Auburn University, Alabama Department of Conservation and Natural Resources, U.S. Forest Service, U.S. Fish and Wildlife Service, Zoo Atlanta, Orianne Center for Indigo Conservation, Birmingham Zoo, Longleaf Alliance. Partners not present include Alabama A&M and Auburn Extension

• Participated in the Urban Turtle Project, Birmingham, AL. 18-20 May 2018.

• Led Conecuh National Forest/indigo snake field trip for the AU Society for Conservation Biology student group; 3 February 2018

•Al Schotz taught school environmental education programs at Wehle Nature Center April-May, 2018.

•Al Schotz taught various school programs at the Davis Arboretum June-October, 2018.

•Participated at the AUMNH Open House, September 2018.

•Participated in the Davis Arboretum's Boos and Bones Octover 27, 2018.

Indigo snake release team includes folks from Auburn University, FWC, The Nature Conservancy and Orianne Center for Indigo Conservation.

Database Development

Biotics Biodiversity Database

ALNHP maintains a comprehensive database on the location and conservation status of species and ecological communities in Alabama. Biotics 5 is an integrated, web-enabled platform for tabular and spatial data management that centralizes the data and software hosting in a shared "cloud" environment. The database is maintained by NatureServe using a software-as-a-service delivery model. Biotics 5 provides a common data management platform for members of the NatureServe network to achieve and maintain a unified taxonomy and consistent application of our shared data standards and methodology. Biotics 5 provides the framework for managing taxonomic and biological data on elements of biodiversity and mapping known locations for elements of concern.

The Biotics database is supported by funding through our inventory and conservation planning projects. Although building and improving the database has always been a primary goal of the program, securing funding to support this important program area remains a challenge. ALNHP is currently tracking 1,499 rare plant and animal taxa (Fig. 1) plus 93 natural communities. There are 7,657 individual occurrences of these species and natural communities documented in Biotics, with the majority of the Element Occurrences (EO) being for vascular plants or aquatic species (Fig. 2).

Since March 2008, we have been working on improving our database compliance with the Benchmark Data Content Standards (BDCS) for natural heritage data. This past year's efforts focused on Updating the State Wildlife Action Plan status to match the latest SGCN list revisions and last observation date. Another focal area for database improvement was addressing the data backlog. This effort has led to the addition of 14 new Elements (species) to the database with an additional 496 Element records updated and the creation of 35 new occurrence records with an additional 537 occurrence records updated. We will continue working to improve the database with the goal of meeting all BDCS goals and reducing the backlog. The focus in the coming year will be reducing the data backlog, continued review of Benchmark Data Content Standards, and QC of EO Rank, EO Rank Date, and Survey Date.

One of the important tasks each heritage program performs is the regular compilation of a Rare Species Inventory List for the state that ranks each element tracked by the program based on the number and quality of occurrences. Our latest revised Alabama Inventory List was published August 2017, with the list distributed to cooperators and other interested parties and posted to the ALNHP website.

Data Requests

Over the past year, ALNHP has responded to 41 requests for data or information. This included 8 paid data requests and 33 requests from academia, conservation non-profits, government agencies, NatureServe, other Heritage Network members, or cooperating partners. The number of requests was slightly less than in previous years due to the resignation of our previous data manager, Michael Barbour.

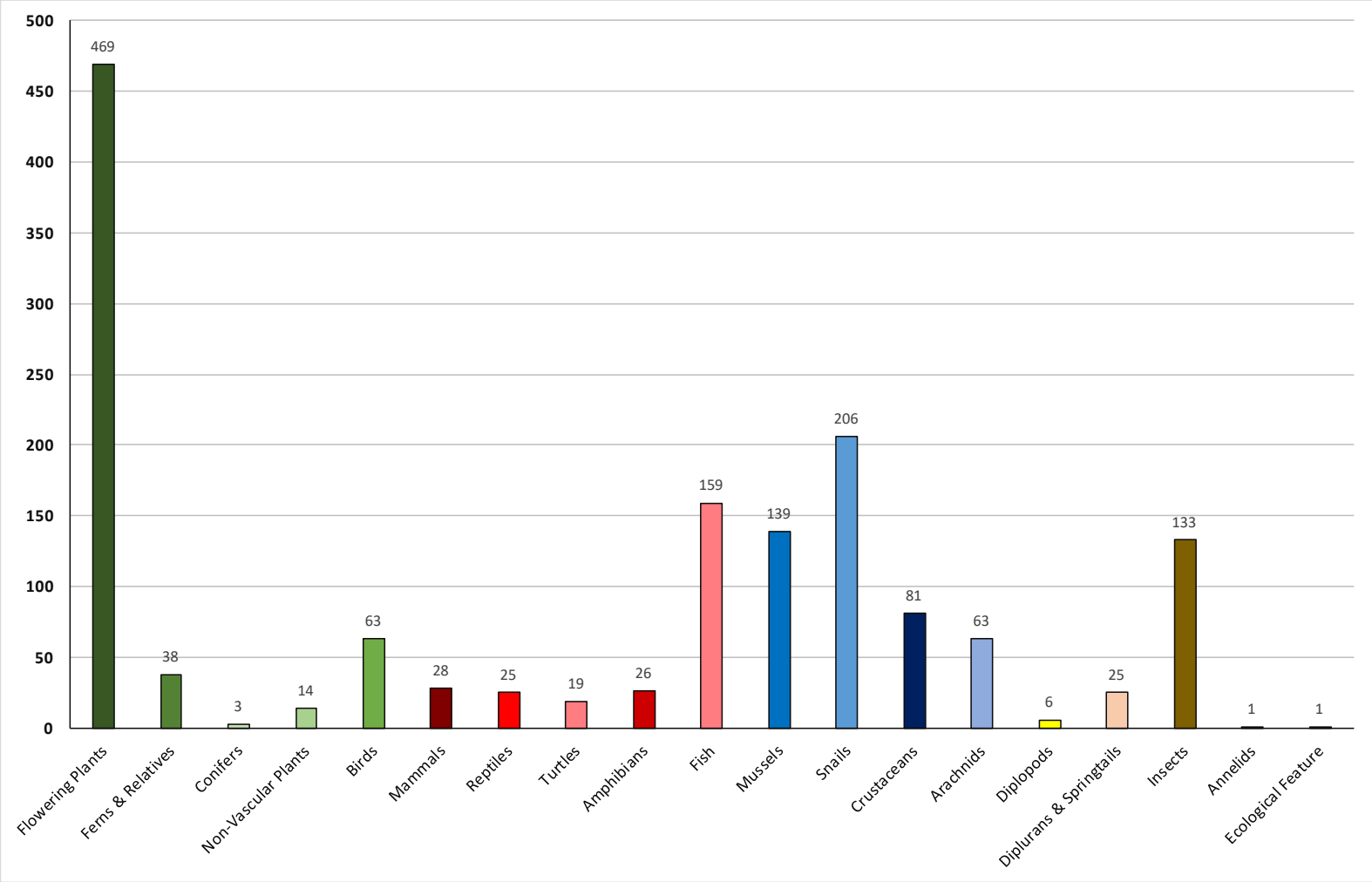


Figure 1. Number of rare plant and animal species tracked by ALNHP (total 1,499).

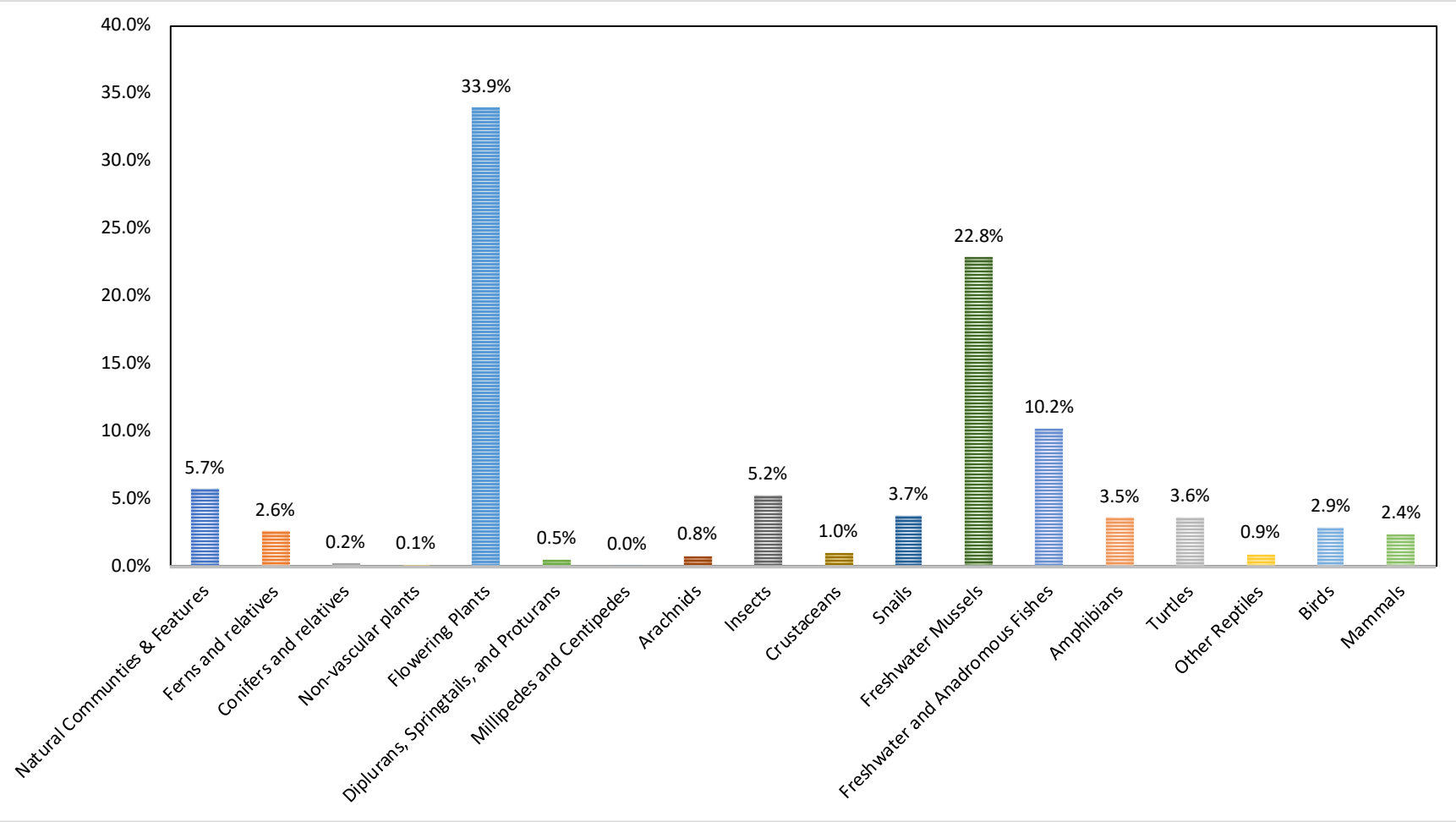


Figure 2. Percentage of 9,836 Element Occurrences in Biotics by major taxonomic group.

OUTREACH

The Auburn University Museum of Natural History (AUMNH) is committed to serving Auburn, the state of Alabama and the southeast region by conducting a variety of Outreach Programs. These programs range from monthly public tours to presentations at Alabama State Parks. Highlighting the research and education aspects of the Museum's work, outreach promotes conservation, awareness and enthusiasm for the natural world around us.

AUMNH served thousands of citizens in 2018 with ages ranging from pre-schoolers to members of senior organizations. The seventy plus events included the Museum's annual open house, two weeks of Junior Curator Camps in the summer, school programs for K-12 students in four east-central Alabama Counties, and the Boos and Bones event in the Arboretum. Charles Ray and 2 of his students participated in the Canoe Creek Bioblitz in St. Clair County, Alabama. This was an all-day event on August 17, 2018. A total of 121 insects were collected, curated and added to the collection. Museum staff featured insects associated with strawberries at Mary Olive Thomas Demnstration Forest in Auburn for the "strawberry science" event.

Collaborations with on-campus entities and outside organizations continue to produce greater impacts in education and public awareness of the Museum's research and conservation efforts. The Boos and Bones event, new in 2018, occurred on 27 October in partnerhip with the Davis Arboretum. The event was well-attended and will be held on an annual basis.

Beyond the AU Campus, the Museum engaged with the Alabama Department of Conservation and Natural Resources, State Lands Division to conduct 17 educational programs reaching a total of 354 students at the Wehle Nature Center for underserved schools in Macon, Bullock and Barbour Counties. Dr. Nate Hardy also taught 7th graders from Bullock County about insect diversity at the Wehle Center.

Museum tours served a variety of groups including various campus organizations, the Montgomery County Natural Resources, "Night at the Museum" tour attendees, and the general public during our monthly "first wednesday" tours.

SIGNIFICANT DISCOVERIES

Significant Botanical Discoveries

Over 30 lichens have been discovered as new state records from the Nature Conservancy's Bibb County Glades Preserve. This is work from the annual 2017 Tuckerman Workshop, a foray of lichenologists from around North America, that was held in Alabama. Curtis Hansen was one of the 20+ participants of that event and the species list is now being compiled into a manuscript for publication. Additional sites visited during this survey work led to the discovery of 24 additional new lichen records for the state.

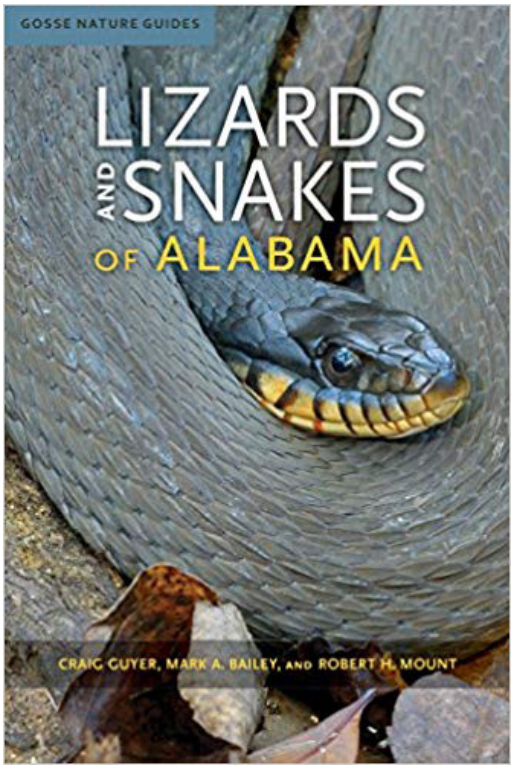
(A) Siren reticulata paratype specimen captured in Okaloosa County, Florida. (B) Location of Siren reticulata captured in 2009 by D. Steen and M. Baragona. (C) The type locality of Siren reticulata, Walton County, Florida.

Significant Zoological Discoveries

AUMNH Herpetology Curators Emeritus Dr. Craig Guyer and Dr. Robert Mount, along with their co-author Mark Bailey, published Lizards and Snakes of Alabama. This book represents the second of four books that will update Dr. Mount's seminal work "The Reptiles and Amphibians of Alabama".

The Reticulated Siren, *Siren reticulata*, was described in 2018 by two former graduate students in the department. AUMNH is now home to the holotype and several paratypes for this species.

Dr. Nate Hardy and collaborators described 14 new species of armored scale insects from New Caledonia



Cover of book by Guyer, Bailey and Mount published in 2018.

PUBLICATIONS & PRESENTATIONS

Asterisks (*) denote Auburn University student authors or presenters.

Peer-Reviewed and Published Articles

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Fish

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Books

Guyer, C., Bailey, M.A. and Mount, R.H., 2018. Lizards and Snakes of Alabama. University of Alabama Press.

Project Reports

ALNHP

Godwin, James. 2018. Escambia Map Turtle (*Graptemys ernsti*) Status Survey. Report submitted to the Alabama Department of Conservation and Natural Resources, Division of Wildlife and Freshwater Fisheries, Montgomery, Alabama. Alabama Natural Heritage Program®, Auburn University, Alabama. 9 pages.

Godwin, James. 2018. Hellbender Status Survey in Alabama using Standard Methods and Environmental DNA (eDNA). Report submitted to the Alabama Department of Conservation and Natural Resources, Division of Wildlife and Freshwater Fisheries, Montgomery, Alabama. Alabama Natural Heritage Program®, Auburn University, Alabama. 7 pages.

Godwin, James. 2018. Eastern Indigo Snake Reintroduction in Conecuh National Forest: Future Release Site Selection and Impact on Prey Species. Report submitted to the Alabama Department of Conservation and Natural Resources, Division of Wildlife and Freshwater Fisheries, Montgomery, Alabama. Alabama Natural Heritage Program®, Auburn University, Alabama. 4 pages.

Godwin, James. 2018. Turkey Creek Survey for the Flattened Musk Turtle.

Report submitted to U.S Fish and Wildlife Service, Mississippi Field Office, Jackson, MS. 9 pages.

Schotz, A. 2018. Species status assessment for *Spigelia gentianoides* (Gentian Pinkroot) in Alabama. Unpublished report for the U. S. Fish and Wildlife Service. 24 pp. including two appendices.

Meeting Attendance

ALNHP

Eastern Indigo Snake Reintroduction Committee meeting. 8-10 January 2018. Apalachicola Bluffs and Ravines Preserve, The Nature Conservancy near Bristol, FL.

Alabama Rivers and Streams Network Strategic Habitat Meeting 14 February; Crayfish and Mollusk meeting 15-16 February 2018. Hosted by USFWS and GSA; Crayfish and Mollusk meeting hosted by ADCNR. Central Alabama Electric Cooperative, Prattville, AL.

Southeastern Partners for Amphibian and Reptile Conservation. Unicoi State Park, Helen, GA. 22-25 February 2018.

Structured Decision Making Meeting, Eastern Indigo Snake. Gainesville, FL 23-27 July 2018. Participants U.S. Geological Survey, US. Fish and Wildlife Service, Alabama Department of Conservation and Natural Resources, U.S. Forest Service, Florida Wildlife Commission, The Nature Conservancy, Orianne Center for Indigo Conservation, Jones Ecological Center, Georgia Department of Natural Resources, The Orianne Society, Zoo Atlanta.

Turtle Survival Alliance meeting, Fort Worth, TX. 12-15 August 2018.

Meeting Presentations

Hansen, C.J. Lichen Biodiversity of the Redstone Arsenal, Madison County, Alabama. Poster presented at 79th annual meeting of the Association of Southeastern Biologists. March 28-31, 2018, Myrtle Beach, SC.

ALNHP

Godwin, James. 2018. Update on Conecuh National Forest Eastern Indigo Snake Reintroduction. Eastern Indigo Snake Reintroduction Committee meeting. 9 January 2018. Apalachicola Bluffs and Ravines Preserve, The Nature Conservancy near Bristol, FL.

Godwin, James, and Lesley de Souza. 2018. Imperiled Aquatic Salamanders in Alabama. Strategic Habitat Unit meeting, Alabama Rivers and Streams Network. Prattville, AL 17 February 2018.

Godwin, James, and Lesley de Souza. 2018. Imperiled Aquatic Salamanders in Alabama. Southeastern Partners for Amphibian and Reptile Conservation. Unicoi State Park, Helen, GA. 24 February 2018.

Godwin, James and Joshua Ennen. 2018. Map Turtles (Graptemys) in Alabama. Turtle Survival Alliance annual meeting. Fort Worth, TX. 14 August 2018.

Schotz, A. 2018. Native plant presentation and walk for annual meeting of the Alabama Wildflower Society. Lake Point State Park; March 22.

Schotz, A. 2018. Overview of the Black Belt prairies in Alabama. Meeting of the Black Belt Prairie Restoration Initiative; April 10.

Schotz, A. 2018. The making of a rainbow: the natural diversity of Alabama. Buffalo Safari Club, Buffalo, New York; June 11.

Funded Projects

Funding Source	Project Name	Responsible Party	Amount	Status
ADCNR	Indigo Snake monitoring	Godwin and Warner	$150,058	Ongoing
ADCNR	Indigo Snake monitoring	Godwin and Warner	$344,754	Ongoing
ADCNR	Hellbender multi-state	Godwin and Armbruster	$80,183	Ongoing
USFWS	Turkey Creek musk Turtle	Godwin and Armbruster	$5,000	completed
ADCNR	Map turtles	Godwin and Armbruster	$25,000	completed
ADCNR	Map turtles	Godwin and Armbruster	$25,985	Ongoing
ADCNR	Mississippi gopher frog	Godwin and Armbruster	$27,403	Ongoing
ADCNR	Hellbender	Godwin and Armbruster	$31,505	completed
ADCNR	Alligator snapping turtle	Godwin and Armbruster	$25,000	Ongoing
Department of Defense	Arnold Air Force Base gopher frog	Godwin and Armbruster	$47,500	ongoing
The Nature Conservancy	Waterdog and Musk Turtle eDNA Survey 2018-20	Godwin and Armbruster	$60,191	ongoing
USFWS	Gentian Pinkroot Status Assessment	Schotz	$15,000	Completed
USFWS	Bog Spicebush Status Assessment	Schotz	$25,000	Ongoing
USFWS	Wherry's Phlox Status Assessment	Schotz	$30,000	Ongoing
ADCNR	White Fringeless Orchid Modeling	Schotz	$39,000	Ongoing
NatureServe	Mountain Longleaf Vegetation Assessment	Schotz	$9,000	Completed
EPA	Reference Wetland Study	Armbruster et al.	$229,452	Ongoing
U.S. Army Garrison	Redstone Arsenal Biological Inventory	Armbruster et al.	$100,000	Ongoing
USDA Forest Service	eDNA Analysis for Bankhead National Forest	Armbruster and Godwin	$8,000	completed
NSF	Compactorized Shelving for the Wet Collections of AUMNH	Armbruster et al.	$195,450	Ongoing
NSF	Aquatic refuge and recovery in the face of drought	Armbruster et al.	$170,986	Ongoing
NSF	Collaborative Research: Red carotenoids as signals of respiratory chain function	Hill	$480,000	Ongoing
PAIR (internal)	Auburn Mitomobile	Hill	$600,000	Ongoing
NSF	DDIG: copepod mate choice	Hill/Weaver	$22,000	Ongoing

Funded Projects

USFWS	Biodiversity, phylogeny *Myxobolus* spp.	Whelan, Bullard	$102,000	Ongoing
AL-MRD	Fish disease monitoring, coastal	Bullard, Arias	$26,369	Ongoing
TWRA	Southeastern Cooperative Fish Parasite and Disease Project	Bullard, Arias	$80,000	Ongoing
ADCNR	Dysbiosis fw mussels	Arias, Bullard	$50,000	Ongoing
USWFS	ANS, *Myxobolus cerebralis*, whirling disease, salmonids	Bullard et al	$25,000	Ongoing
VDCR Inland Fisheries Division	Biosecurity, trout hatcheries	Arias, Bullard	$55,000	Ongoing
NCWRC	Whirling disease epidemiology	Bullard et al	$298,765	Ongoing
SRAC	LAMP assay for amyloodinium	Bullard et al	$99,987	Ongoing
ADCNR	Southeastern Cooperative Fish Parasite and Disease Project	Bullard, Arias	$60,000	Ongoing
NCWRC	Southeastern Cooperative Fish Parasite and Disease Project	Bullard, Arias	$80,000	Ongoing
SCDCNR	Southeastern Cooperative Fish Parasite and Disease Project	Bullard, Arias	$80,000	Ongoing
VDCR Inland Fisheries Division	Southeastern Cooperative Fish Parasite and Disease Project	Bullard, Arias	$80,000	Ongoing
GADNR	Southeastern Cooperative Fish Parasite and Disease Project	Bullard, Arias	$60,000	Ongoing
ADCNR	Propagation bottlenecks for freshwater mussels	Bullard, Arias	$213,058	completed
AL-MRD	Fish disease monitoring, coastal	Bullard, Arias	$26,309	completed
VDCR Inland Fisheries Division	Hatchery checks supporting salmonid culture	Arias, Bullard	$55,000	completed