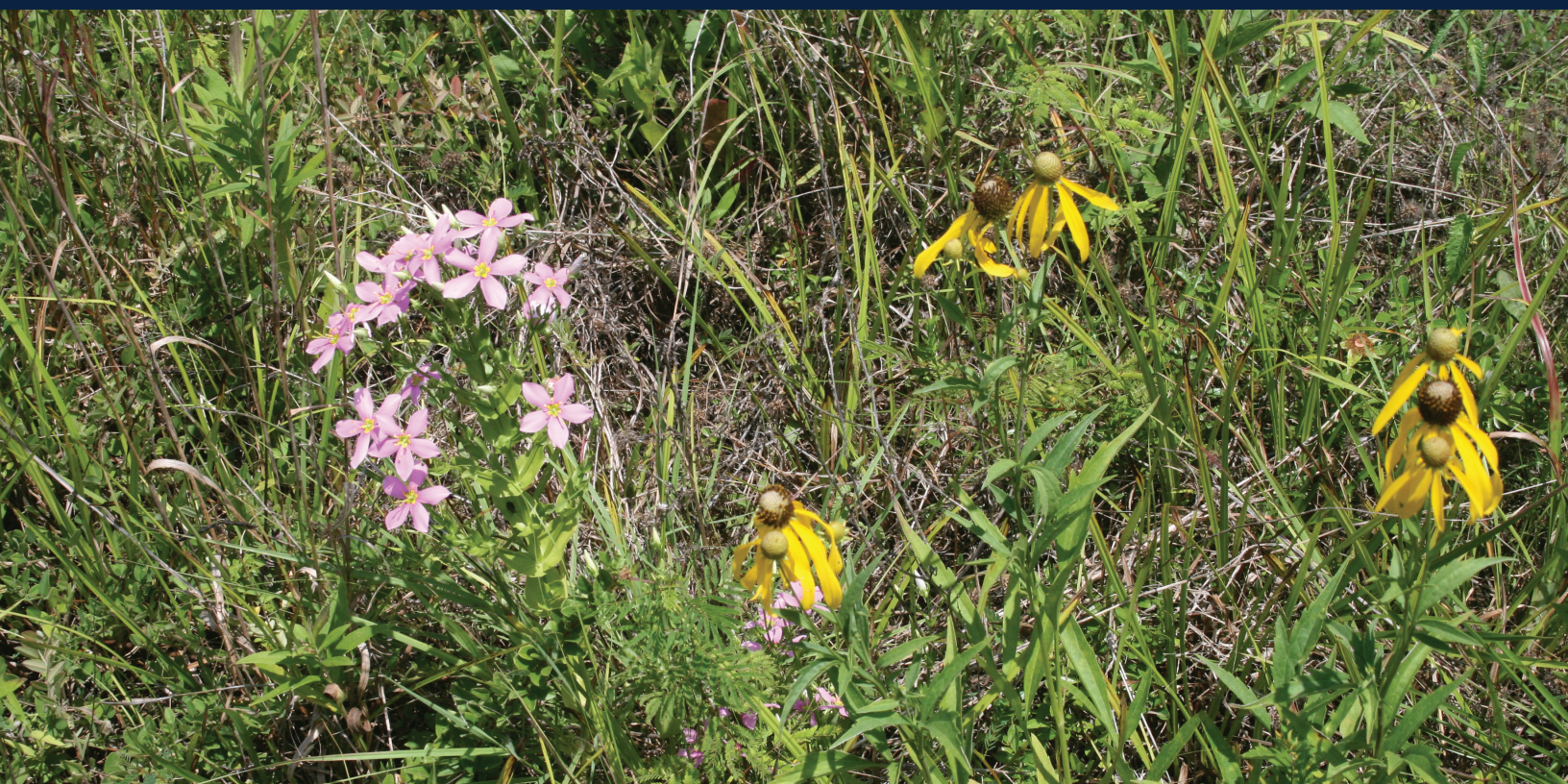
2022 Annual Report

MUSEUM OF NATURAL HISTORY
AT AUBURN UNIVERSITY

ALNHP
Alabama Natural Heritage Program



Letter from the Director

2022 saw the museum largely bouncing back from the pandemic and having a near complete set of experiences. Although this is nice, we are clearly not out of the woods as many of us and you have come down with COVID 19 in the past year.

Perhaps the biggest change in 2022 was the opening of our Dinosaur Egg Display, located in the Rouse Rotunda. Originally scheduled to open April 3, 2020, the egg display that had been under wraps for over two years opened June 1! Lots of people attended to see the unveiling and we had Prescott Atkinson (who discovered the egg) and James Lamb (who has been studying it) in attendance. The egg display represents our first foray into exhibits. We don't know if we will ever be an exhibit museum, but we would like to set up small displays like this around campus to bring knowledge of natural history to the Auburn Community. Already, we added the "It's Great to be a Tiger" exhibit to the Science Center Auditorium Building, will place a temporary display in the library in 2023, and have received funding from the Auburn University Concessions Board to beautify the entrance to the museum.

Besides that, the open house was back, our program at the Wehle Center was live in the Spring, and our Junior Curator Camps took kids out into nature. It feels almost normal again.

We did lose Toni Bruner as our outreach coordinator this year. Toni spent three years at the museum in some of the tensest times for outreach. Toni met the challenges by coming up with new ideas to keep the museum relevant during these rough times, and she helped us finally get the egg display done. We all miss Toni deeply and wish her well at her new position as Education Director at Alabama Legacy. We also lost Charles Ray, who put in countless hours curating the entomological collections and collecting specimens. We wish him well in his new position at Mississippi State University.

One new curator was added last year, Dr. Brian Counterman. Brian studies how butterfly wings develop and evolve. He often uses CRISPR to edit genes to study the effect of genes on the regulation of development. He demonstrates that museum science is broad and really just involves a commitment to studying the natural history of our planet.

To add to our accolades, Auburn University (through the leadership of the museum) won the first ever Marble Bowl against the University of Alabama! The Marble Bowl utilized the citizen science platform iNaturalist to document species throughout the state. Take a picture of any organism, and the artificial intelligence of iNaturalist can help you identify the species. AU had more observations, more observers, and more species observed than UA, but we will need to hold onto the crown in 2023. Watch for an announcement next football season for the 2023 version!

Jonathan W. Armbruster
Director, Auburn University Museum of Natural History
Curator of Fishes

Thank you to our funding agencies, partners, and collaborators!

2022 Funding Provided By:

Alabama Department of Conservation and Natural Resources
Louisiana Department of Wildlife and Fisheries
National Science Foundation
National Institutes of Health
Tampa Bay Estuary Program
US Department of Defense
US Environmental Protection Agency
US Fish and Wildlife Service

2022 Partners and Collaborators:

Alabama Department of Conservation and Natural Resources
Jule Collins Museum of Art at Auburn University
NatureServe
Orianne Center for Indigo Conservation
Royal Ontario Museum
The Nature Conservancy
University of Florida Tropical Aquaculture Lab
US Forest Service
US Geological Survey
Western Michigan University
Zoo Atlanta

MUSEUM OF NATURAL HISTORY
AT AUBURN UNIVERSITY

AUMNH by the Numbers - 2022

23
peer-reviewed publications

>6,026
new specimens accessioned

$5.47 million
in active grant funding

GBIF.org

219 number of citations on GBIF using our collections

50,675 number of times our data were downloaded on GBIF

>4300
specimens loaned for study

20
data requests completed

46 outreach events reaching **>2,000** people

118 visitors for research or tours

ALNHP
Alabama Natural Heritage Program

ALNHP by the Numbers - 2022

$1.03 million
in active grant funding

16
reports & publications

12 new element occurrences added to our Biotics 5 database

10,422 total element occurrences in our Biotics 5 database

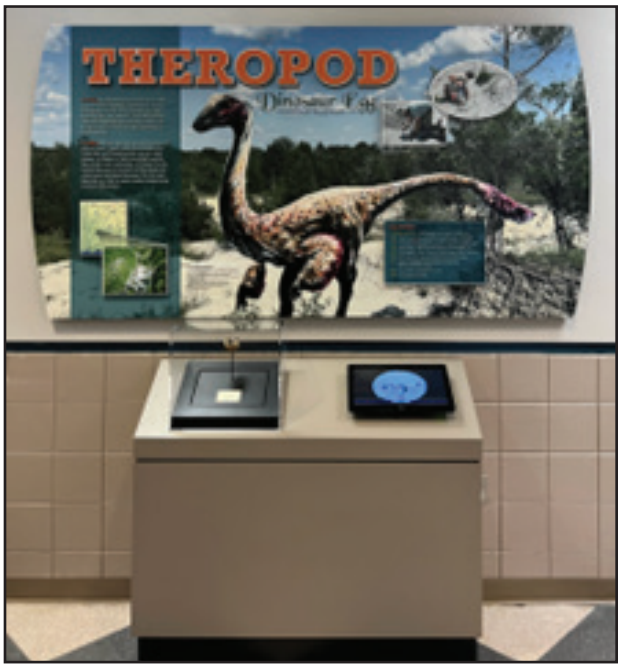
56
data requests completed

21
species added to our tracking list

1,727
species we are tracking

Exhibits

For the first time in our history, the museum has exhibits. These are located in the second-floor hallway of the Biodiversity Learning Center (National Geographic Photo Ark Collection), in the Rouse Rotunda (Dinosaur Egg Display), and the Science Center Auditorium Building (It's Great to be a Tiger". More will be added in 2023!



Dinosaur Egg Display

This display features the only intact dinosaur egg to be found in the eastern United States. The small egg is thought to be of an ornithomimid dinosaur (a type of small theropod that kind of looked like an exceptionally large ostrich). The egg has among the thickest shells found in a dinosaur egg, and the bones of the embryo are visible inside. Found in 1970 by Prescott Atkinson, the egg was a mystery until James Lamb of the Black Belt Museum of the University of West Alabama excavated and then CT-scanned it.

It's Great to be a Tiger

This display features species that are named for tigers. Tigers have been the inspiration for scientific and common names of other organisms, and we have a few on display.

Photo Ark

This is a project by Joel Sartore and National Geographic that seeks to photograph all species of animal alive today. Joel travels the world to capture images, and visited the museum a few years ago. On display are images of live specimens we had at the museum then.

Research and Collections

John D. Freeman Herbarium

The year 2022 found the Freeman Herbarium continuing forward with collection growth, loan and exchange activity, and facilitation of research. The number of total specimens housed in the Freeman Herbarium is over 90,000 and includes vascular plants, mosses, liverworts, lichens and fungi from all over the world.

The Freeman Herbarium partnered with the Jule Collins Museum of Fine Art once again on a successful exhibit titled, “Radical Naturalism” with visiting artist Manon Bellet. This exhibit explored Bellet’s concern with landscapes lost through the effects of time, global warming, or urban sprawl. Weloaned several herbarium specimens to display alongside the artist’s work.

During this field season, Curtis Hansen collected over 100 lichen specimens from Mississippi as part of the 2022 Tuckerman Workshop. He continues updating the checklist of lichens in Alabama and is writing a field guide to Alabama lichens. Hansen was awarded the 2022 Lily-Lovelace Distinguished Service Award presented by the College of Science and Mathematics.

Herbarium collections manager Curtis Hansen (right) with Dean Edward Thomas (left), receiving the 2022 Lilly-Lovelace Distinguished Service Award.

2022 Specimen Donations

- 500 plant specimens from Ecuador
- 244 macro-fungi from Alabama Mushroom Society
- 200 plant specimens from Charles Owsley
- 30 plant specimens from Harvard University

2022 Digitization

- Over 1,500 specimens were processed and added to the collections and Specify database during 2022. This included 1,069 vascular plants, 329 lichens, and 244 fungi.

2022 Loans

- Over 150 specimens were sent out on loan
- 84 specimens were received as loans from other institutions for researchers at Auburn University

2022 Students & Volunteers

We are thankful for our students who have been working and volunteering in the herbarium this year!

- Lia Hansen
- Kaylynn Low
- Aishida Madi
- Noah Yawn

2022 Research Highlights

- Esteban Pinto (Ph.D.) is doing an enormous amount of field work looking at plant assemblages along gradients in Ecuador. This research, in part, resulted in the herbarium acquiring 450+ plant collections from that South American country.
- Brannan Cliver (Ph.D) is working on sequencing and assembling the genome of Jamesianthus alabamensis (Asteraceae), a rare Alabama endemic plant and trying to elucidate the population genetics of this species. This research will result in herbarium specimen of J. alabamensis from across its natural range (1-2 collections per population from across Central and Northern Alabama) and will be the most thorough exploration of the species to date.

Research and Collections

John D. Freeman Herbarium

2022 Research Highlights (continued)

- Reid Selby (Research Assistant), Brannan Cliver (Ph.D), and Evie Moellering (undergraduate) are working on determining the natural origins of a cultivated species of Bidens (Asteraceae). To do this they are sampling and sequencing closely related species of Bidens, from across their natural ranges, on loan from 4-5 different herbaria to identify which may be most closely related to the cultivated variety.
- Zach Meharg and Laramie Smith, students of Dr. Alex Harkness, at Hudson-Alpha, in Huntsville, are using target-capture sequencing projects on Dahlia and Myricaceae, respectively, to investigate the genomics of these groups and the herbarium has been critical for them in facilitating loans of specimens to sample for DNA.
- Caroline Bendickson, graduate student also working with Dr. Alex Harkness at Hudson-Alpha, is studying the genus Trillium and is using the Angiosperms353 multilocus bait capture approach to construct a comprehensive, genus-wide phylogeny for this group. Dozens of Trillium specimens from the Freeman Herbarium have already been critical in her research. Caroline also received an award from the Alabama Wildflower Society to support her research.
- The herbarium began a collaboration with the Alabama Mushroom Society to be the permanent repository for their field collections documenting the fungal diversity of Alabama. This project has already yielded more than 200 new fungi specimens added to the herbarium last year. Curtis Hansen was invited to be one of the speakers at the first annual Alabama Mushroom Festival, held in Sylacauga, Alabama.
- 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 historic and important collections are continuing to get ongoing attention in curation and incorporation into the main collection. The herbarium also acquired an orphan Forest Service Herbarium (three cabinets) several years ago and processing has begun on these specimens. collection of Forest Service.
- Visiting researchers came to the Freeman Herbarium from near and far including, Tuskegee University, the University of Chicago, and Norway.

Curtis Hansen leading a plant walk as part of a bioblitz.

2022 Outreach Education

This has been a busy year for outreach education. Several programs were given on lichens and plants at the Wehle Center for elementary students. In addition to many museum tours, Hansen led lichen and wildflower walks over 4 days at the Great Smoky Mountain Wildflower Pilgrimage, participated in the museum-wide dinosaur egg display unveiling, helped with 2 weeks of Curious Curators Camp, collaborated on projects with the Jule Collins Museum of Fine Arts, coordinated the Dinius Park Bioblitz, manned the museum table at Destination STEM, and helped with the museum open house, among many other events.

Research and Collections

Entomology

2022 was a year of transition, discovery, and growth for the entomology collection. One of our curators, Dr. Charles Ray, retired. In his tenure at the AUMNH, he added well over 10,000 specimens to the collection, mentored numerous students, and was a wonderful colleague. In May, Dr. Brian Counterman joined as a curator! We had one important acquisition - a possible new state record of *Sphyracephala brevicornis* (Say, 1817) collected in Coosa County, Alabama on February 12, 2022 by C.H. Ray.

2022 Outreach Education

- AU Early Learning Center - Creepy Crawlies program (March 2022)
- Graduate Women in Science event - ants! (March 2022)
- Girl Scouts badge insect presentation (April 2022)
- Entomology lesson at Wehle Nature Center (April 2022)

2022 Students & Volunteers

We are thankful for our students who have been working and volunteering in the entomology collection this year. They worked diligently prepping specimens and digitizing them. Many thanks!

- Destiny Brasher
- Tanner Myers
- Allison Sharp

2022 Loans & Info Requests

- In 2022, we sent 4,000 specimens out on loan
- We completed 11 information requests

Sphyracephala brevicornis (Say, 1817)

2022 Digitization

- In 2022, we accessioned and digitized ~2,300 specimens
- Our insect and arachnid data are available through iDigBio: http://ipt.idigbio.org/resource?r=aum-entomology. They are also published on GBIF and SCAN Bugs.

Collections manager Melissa Callahan (right) with Curator Brian Counterman (left) getting ready for our open house event.

Research and Collections

Invertebrate Zoology

The Invertebrate Collection saw continued growth in 2022. Incoming specimens included representatives of all major invertebrate taxa. Most of the new specimens came from Dr. Halanych's previous Antarctic research cruises as part of AUMNH's commitment to digitizing 10,000 marine invertebrate lots for a multi-institutional NSF DigIn grant.

An AU art student made use of the invertebrate collection's coral collection for a ceramics art project on ocean acidification. The collection manager, Nusrat Noor, and an undergraduate student hire, Flynn Jones, participated in a Digitization Retreat with 19 other institutions nationwide to discuss and develop the future of digitizing marine invertebrates.

2022 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 their contributions.

- Flynn Jones
- Daniel McLendon
- Hannah Meade

2022 Digitization

- In 2022, we digitized over 1,400 lots of specimens!
- To date, we have over 21,000 lots of molluscan invertebrates and over 14,000 non-molluscan invertebrates digitized.

Collections manager Nusrat Noor, helping set up for the Dinosaur Egg Display unveiling event.

2022 Loans

- 37 specimens loaned - including 7 for a guest lecture at the Julia Tutwiler Prison, and one to Arkansas State University.
- 12 teaching specimens donated to EEAA

Collections manager Nusrat Noor teaching our Curious Curator campers how to collect and identify aquatic invertebrates.

Nusrat has participated in many outreach programs and activities in 2022 including the Spring into Science event, Garden in the Park, numerous tours of the museum, Curious Curator Camps, the Dinius Park Bioblitz, Destination STEM, and Wehle Nature Center programs for 5th and 6th graders.

Research and Collections

Ichthyology

2022 was a busy year for the fish collection. AU staff published 8 papers including a compendium of the Fishes of Guyana. AUMNH helped lead the modern interest in the Fishes of Guyana starting with an expedition in 1998. Also published was a phylogenomic analysis of shiners with major changes to the genus-level classification of North American minnows. Other important papers included papers on the morphology of catfishes, conservation of Central American Fishes, and species delimitation and convergence in African carps.

In March, David Werneke and Dan Akin were invited to join a survey of the flora and fauna of the Kwitaro River in southern Guyana. The survey was a three-week expedition led by the local indigenous population of Wapishana and was funded by the Center for International Forestry. The goal of the project was to document biodiversity in the region to better protect it from encroachment by nearby goldmining operations.

David Werneke, Jon Armbruster, and graduate student Dan Akin also completed an expedition to the Peruvian Amazon. The goal was to collect fishes in the Rio Ampiyacu, an area from which many species were described in the early 1800's. Also sampled was the Amazon River near Iquitos. Nearly 1000 vouchers and over 1400 tissue samples from 400 fish species were collected during the two weeks in the field.

Two students graduated this year with a Ph.D. (Corinthia Black) and a Master's (Daniel Akin). The fish collection saw many students working in the collections including in preparing a massive amount of materials received from AU Fisheries.

2022 Loans & Info Requests

- In 2022, we sent 109 lots out on loan to researchers around the world.
- Notable contributions to the museum include over 3000 lots received from the USGS Alabama Cooperative Fish and Wildlife Research Unit and 151 lots from the USGS Wetland and Aquatic Research Center in Gainesville, FL.

2022 Accessions

In 2022, we accessioned many collections:

- 735 voucher lots
- 221 tissue samples

Collecting fishes in Peru (left), and an angelfish collected in Peru (top).

Research and Collections

Herpetology

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.

2022 Accessions

- The herpetology collection continued to grow in 2022. Over 670 amphibian and reptile specimens were prepared and/or accessioned into the herpetological collections. This represents collection growth of 1.46%. These specimens included whole specimens, larvae, and skeletal preps. The majority of the specimens accessioned in 2022 were Brown Anoles (Norops sagrei) and Green Anoles (Anolis carolinenesis) from various projects in the Warner Lab. Additionally, a lesser number of Phrynosomatids and turtles were also accessioned.
- There were 439 tissue samples added in 2022. These include tissues from accessioned specimens, as well as others from animals that were photo vouchered and others from animals that were not collected.
- This year also saw addition of the osteological material, which had historically been cataloged with the paleontological material, to the herpetological database. While all of the osteological specimens will retain their historic AUMO (former AUMP) numbers for reference, they now all have AUM numbers associated with them.
- Another collection that was added to the AUM database was our National Park holdings.

2022 Loans & Info Requests

- During the year, a total of 11 loans and more than 9 data requests were processed.
- We were also happy to host 2 visiting scientists who utilized the museum's specimens to further their research.
- Additionally, the museum received the second group of paratypes associated with research exploring the southeast's *Desmognathus* salamander diversity. We now house paratypes of the newly described *D. pascagoula* and *D. cheaha*.

2022 Teaching, Students, & Volunteers

- The number of courses utilizing the musem classroom in Room 251, and the herpetological scientific and teaching collections continues to grow. This year, courses including Anthropology 3950 – Curation, ARTS 1110 – Drawing I, BIOL 3060 – Ecology, and BIOL 6800 – Introduction to Computational Biology visited the museum and used its resources in coursework.
- In 2022, the museum began to return to normal operations and our volunteers resumed with their important work. Their efforts allowed us to incorporate the osteological material and the National Park specimens into the herp database and allowed for significant progress to be made on the backlog of specimens, both in the skeletal and alcohol collections. Volunteers were also critical in completing the much-needed rearrangement and organization of our turtle tanks.
- In the live animal room, a dedicated group of volunteers made sure that the animals were well taken care of healthy and made that they received enough interaction given the reduced outreach load.

2022 Volunteers

- Lane Dominy
- Jarious Avery
- Maddie Edwards
- Wei Wei Guo
- Taylor King
- Kite Kite
- Olivia Kramer
- Stefan Larsson
- Tori Martin
- Natalie Moore
- Beckie Poore
- Natalie Powers
- Allision Sharp
- Ryan Sheinberg
- Vivian Sierra
- Levi Stamps
- Allison Tuggle
- Sidney Whitfield
- Lauren Wright

Research and Collections

Herpetology

2022 Live Animal Collection

Continuing our long tradition, the museum's live animal ambassadors continue to be an indispensable resource for both inhouse events and outreach programs. Additionally, 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 2022, the number of outreach programs began to return to pre-pandemic levels. In all, live animals were utilized in at least 20 events in 2022, reaching at least 1300 participants of all ages throughout the state. Below is a list of selected programs which utilized our live animals:

- Gross Out Camp
- AU Vet School Reptile Lab
- Outreach Program for Visiting Engineers
- Welcome Week
- AUMNH Open House
- Dinius Park Bioblitz
- Herpetology Class
- Zoo, Exotics, and Wildlife Club Reptile Handling Lab
- Wehle Center 4th Grade Gifted Program
- Destination STEM
- Junior Curator Camp
- Loachapoka Elementary School

2022 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. 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.

Herpetology Collection Manager David Laurencio teaching young students about the biodiversity of Dinius Park during our Bioblitz (left), and showing our Curious Curators some cool specimens in the Paleo collection (top).

Research and Collections

Ornithology

The AUMNH ornithology collection is comprised of approximately 4000 specimens, primarily from the south-eastern United States, but also with specimens from throughout North America and a few specimens from Central America, Europe, and Oceania. To complement its research collections, the museum houses a separate avian teaching collection with approximately 300 specimens used in courses such as Ornithology and Natural History of the Vertebrates. This teaching collection was prepared almost entirely by students taking Ornithology. These collections were utilized to teach both Vertebrate Biodiversity and Ornithology.

- In 2022, 23 bird skins were prepared and 72 feathers were added to the collection.
- We gave a Greater Shearwater loan to the Jule Collins Art Museum.
- Bird specimens were utilized at the Jr. Mad Scientist outreach event where elementary students learned about bird identification and ornamentation.
- A total of 42 undergraduate students and 4 graduate students took Ornithology in 2022 and used the collections during the course.
- Tissues from a variety of songbirds have been collected and retained in the museum as part of an NSF grant in collaboration with the University of Michigan.

Red Cockaded Woodpecker *Leuconotopicus borealis* (left)

Swamp Rabbit *Sylvilagus aquaticus* (right)

Mammalogy

The AUMNH mammal collection is comprised of just over 5,750 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.

- Tissues from a variety of small mammals have been collected and retained in the museum as part of an NSF grant in collaboration with the University of Michigan.
- 2022 marked the second year that the museum participated in March Mammal Madness. Led by Dr. Wendy Hood, our Curator of Mammals, participants were able to pick their brackets, learn about mammals and even win prizes during this unique tournament. We thank volunteers Natalie Powers, Hannah Eubanks, and Sloane Daley for assistance with this as well. We had a total of 96 participants in this competition!
- Several students, including Eric Ausborn and Dalton Bentley used the mammal collection in 2022 to learn local species.

Research and Collections

Vertebrate Paleontology

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.

- Our vertebrate paleontology volunteer Skye Walker continued to provide incredible help in the vertebrate paleontological collection.
- The vertebrate paleontology collection responded to one data request in 2022 and sent out one loan.

2022 Outreach
The museum celebrated a historic achievement when the vertebrate paleontology collection's fossil dinosaur egg was placed on public display in June of this year. This marked the first public display for the museum, and represented a first step in creating a public face for the museum. The unveiling was marked with a grand opening celebration and open house and was followed by the establishment of a second public display in the Science Center Auditorium.

Curator Ray Wilhite ready for our Open House (Top), and our new Dinosaur Egg Display, open to the public in the Rouse Life Science building atrium during business hours (Left).

Invertebrate Paleontology

- The museum's invertebrate paleontological collections were first curated in 2016. The museum is home to a small collection of over 120 invertebrate fossils.
- The invertebrate paleontology database is digitized and awaits preparation and transfer to the Specify platform.

Outreach & Education

This year began as a busy one for outreach, but ended slow as our Outreach Coordinator, Toni Bruner, left the museum to become the Director of Legacy, Partners in Environmental Education. Some highlights for the year include:

- Two weeks of Junior Curator Camp in June for 5-8th graders
- Four spring Wehle Nature Center sessions teaching 5th and 6th graders about environmental science
- The Dinosaur Egg Exhibit Unveiling
- Installation of the "It's Great to be a Tiger" Display in the Science Center Atrium building
- Dinius Park Bioblitz

Every year the AUMNH participates in COSAM's Science Matters summer camp. This year we held two weeks of Junior Curator Camp. The first week was for rising 7th and 8th graders, and the second week was for rising 5th and 6th graders. Campers learn how to use dichotomous keys, they learn all about different plants, aquatic invertebrates, insects, fishes, reptiles and amphibians, birds, and mammals. They also learn how to collect and preserve specimens! We take them out into the field and make sure they have lots of fun while learning a lot about the natural world around them.

New program offered in 2022

Herpetology collection Curator Dan Warner ran his inaugural teacher fellowship in summer 2022. This program is entitled "Student Teacher Education in Ecological Research" (STEER) and is funded by his NSF CAREER award. This program took place from June 21 – July 1. One middle school teacher from Columbus participated, and she undertook a local research project on beetle thermal behavior and physiology.

Museum Tours

Toni and museum staff led museum tours for classes and other groups in 2022 as first Wednesday tours and our open house were offered again. Approximately 120 people attended tours of the AUMNH this year.

Melissa Callahan teaching students about biomimicry at Destination STEM (left)

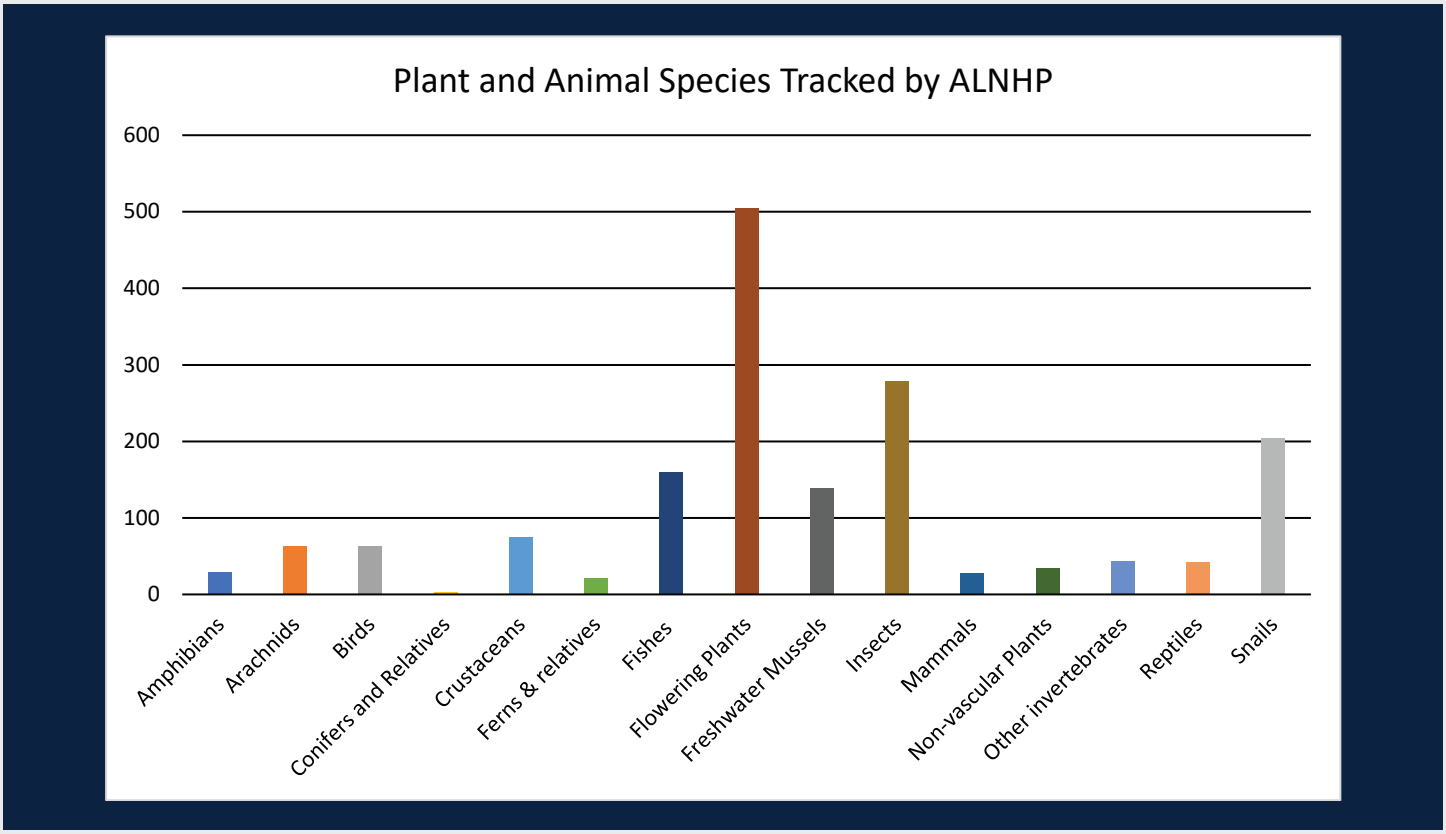
AUMNH staff says "see you later" to Outreach Coordinator Toni Bruner (right)

The Alabama Natural Heritage Program

Biotics Biodiversity Database

ALNHP maintains a comprehensive database on the location and conservation status of species and ecological communities in Alabama. The database, 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. Database statistics and highlights for 2022 include:

- 1,727 tracked species, up from 1,706 in 2021
- 10,422 element occurrences
    - 12 added since 2021, 2 deleted due to misidentification
- New tracking list created in November with a new, simplified format
    - 2 species received new state ranks
    - 21 species added to the tracking list
    - 5 species received taxonomic and/or nomenclature changes



Data Requests

The Alabama Natural Heritage Program receives dozens of requests from academia, government agencies, NGOs, and private companies and consulting firms every year. These data requests can range from data for much of the state, to an environmental review of a small parcel of land. In 2022, 56 data requests were completed.

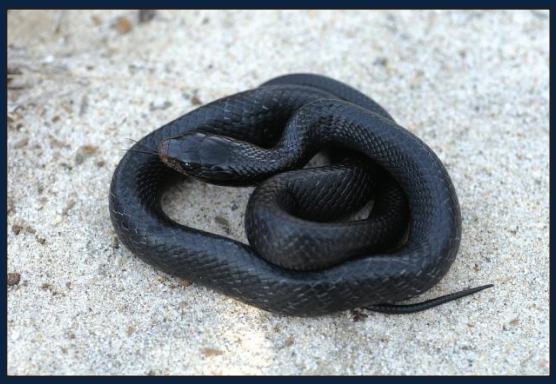
The Alabama Natural Heritage Program

Zoology Projects

Lead Zoologist Jim Godwin, GIS Analyst Katelyn Lawson, and Research Assistant Joe Jenkins completed 5 project reports for reptile and amphibian conservation projects in 2022 and made much progress on ongoing projects. Highlights for 2022 include:

- Released 25 captive-bred Eastern Indigo Snakes in Conecuh National Forest (June 2022)
- Camera trap arrays have detected indigo snake activity year-round
- Several juvenile snakes recorded on camera demonstrating successful breeding by captive bred and released snakes
- Captured and collected data on 67 Flattened Musk Turtles, a threatened endemic species
- Captured 20 Black Warrior Waterdogs, an endangered endemic species
- Sampled for eDNA over 175 river kilometers of the Locust Fork
- Sampled ponds across Louisiana for Western Chicken Turtle, Southern Crawfish Frog, and Tiger Salamander using traditional methods and eDNA

Eastern Indigo Snake Project



The Eastern Indigo Snake (Drymarchon couperi) was once an important species and apex predator of the longleaf pine ecosystem of south Alabama. The species was presumably extirpated from the state during the late 1950s or early 1960s. A project to reintroduce the Eastern Indigo Snake in Alabama, through the establishment of a population in Conecuh National Forest, began in 2006. 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 Eastern Indigo Snakes, which includes the presence of gopher tortoises; (3) and CNF is well placed in the GCPEP Apalachicola-Blackwater River State Forest-Conecuh National Forest-Eglin Air Force Base corridor.

This year, we released 25 more snakes bringing to total released to 227.

To assess survivorship, sex ratio, and, ultimately, demographics of the population of Eastern Indigo Snakes, we conducted Visual Encounter Surveys to collect individual recapture data, camera traps at Gopher Tortoise burrows, and drift fence camera trap arrays were deployed to monitor snake distribution and activity. Male survivorship is estimated to be 0.8032 and female survivorship 0.9400.

To document the effect of Eastern Indigo Snake introductions upon the prey base, drift fence/box trap data collected in 2005, 2014, 2016-2020 was analyzed. We found that the reintroduction of Eastern Indigo Snakes influenced the abundance of herpetofauna on which they feed and evidence for predator-moderation of prey populations by an apex snake predator. Benefits from this study will aid in formulating predictions of changes in amphibian, reptile, and small mammal communities at additional release sites within Conecuh National Forest (CNF), and in selecting future release sites of Eastern Indigo Snakes at other locations outside CNF.

Investigation of Alabama Red-bellied Turtle Nesting in American Alligator Nests

The Alabama Red-bellied Turtle (Pseudemys alabamensis) is a federally endangered freshwater turtle inhabiting the lower rivers of coastal Alabama and Mississippi, a region with dense American Alligator populations. Although listed under the U.S. Endangered Species Act the Alabama Red-bellied Turtle remains poorly studied particularly with respect to nesting and hatchling survival. Most of the information available on nesting and nest success is from studies and observations by D. Nelson in Alabama and P. Floyd in Mississippi. Nelson et al. studied Alabama Red-bellied Turtle nesting activity at four sites in the Mobile-Tensaw Delta, the spoil deposit on the north end of Gravine Island, the Mobile Bay Causeway, Big Island, and Meaher State Park. In Mississippi nest sites have been described from three locations. All nest sites described and studied have been anthropogenically altered, thus information is lacking on Alabama Red-bellied Turtle nesting in natural settings.
In Florida, the closely related Florida Red-bellied Turtle (Pseudemys nelsoni) nests both in well-drained soils near freshwater habitats and Alligator nests. Godwin suggested that the Alabama Red-bellied Turtle may use Alligator nests in a similar manner as the Florida Red-bellied Turtle, but this hypothesis has yet to be investigated. If found, any turtle eggshell remains will be genetically analyzed to identify the species.

Activities and observations in support of this project in 2022 include:

- Collaboration with Dr. Chris Murray, Southeastern Louisiana University, to locate alligator nests in the lower Mobile-Tensaw Delta
- Field check and examine 21 potential alligator nests for turtle eggshell remains
- Provide tissue samples to Tangled Bank Conservation to builda genetics library of the freshwater turtles of the region

Flattened Musk Turtle & Black Warrior Waterdog Research

The flattened musk turtle (*Sternotherus depressus*) and the Black Warrior waterdog (*Necturus alabamensis*) are two listed species endemic to the Cumberland Plateau physiographic province of the upper Black Warrior River watershed in Alabama, a designated strategic habitat unit (SHU). The flattened musk turtle was listed as threatened in 1987 and the Black Warrior waterdog was listed as endangered in 2018.

(1) Population Studies

Objectives of the study are to assess the population status of the flattened musk turtle and Black Warrior waterdog in Sipsey Fork and Brushy Creek. Activities and observations in support of this project in 2022 include:

- Captured 67 Flattened Musk Turtles with 11 individuals being recaptured.
- All age classes were captured with approximately 1/3 being young turtles.
- Captures of adult turtles was skewed toward females, approximately 2:1.
- During the winter of 2022 we captured 20 Black Warrior Waterdogs plus one in the early summer.

A Black Warrior Waterdog (*Necturus alabamensis*). One of two species for which we are using mark-recapture population studies to determine the status of their populations in the Bankhead National Forest.

(2) Genetic and Habitat Analyses to Support Recovery Efforts for the Flattened Musk Turtle

Objectives are to develop a habitat model to identify sites with quality flattened musk turtle habitat and sites where habitat restoration or protection is needed for future recovery efforts, identify areas with threat and areas with potential for population reintroduction, conduct field visits to assess sites, collect tissue samples from across the range to analyze genetic variability across the range and within populations. Activities and observations in support of this project in 2022 include:

- We compiled flattened musk turtle survey data from recent and historic field studies to inform our habitat analyses. We utilized those data in geographic level (1st order) analyses that inform our fieldwork locations going forward.
- We obtained sufficient genetic samples from the Sipsey Fork Watershed for analyses.
- Completed side-scan sonar mapping of the Locust Fork to identify areas to target future conservation efforts.

A Flattened Musk Turtle (*Sternotherus depressus*). The threatened, endemic species that is the subject of these genetic and habitat analyses

Occurrence of Western Chicken Turtle in Louisiana

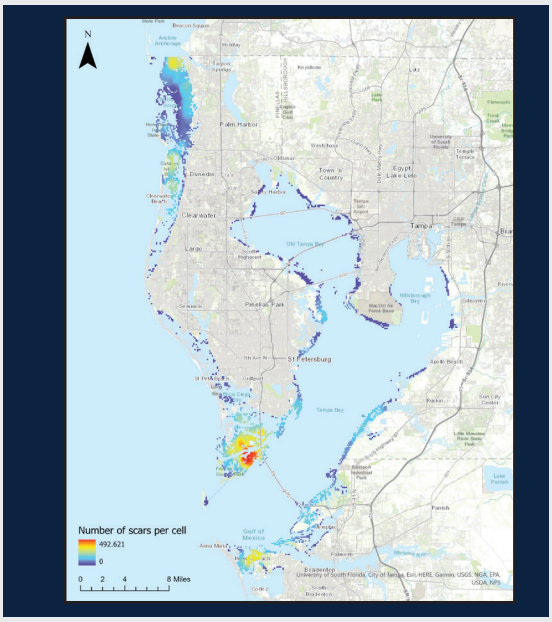
The Western Chicken Turtle (*Deirochelys reticularia miaria*), is distributed west of the Mississippi River in Arkansas, Louisiana, Missouri, and Texas. Chicken Turtles inhabit wetlands and use surrounding upland habitats for nesting and overwintering, and populations have been extirpated as bottomland hardwood and cypress swamps, and isolated natural ponds have been lost to agriculture, urbanization, and conversion of forests. Western Chicken Turtle has been reported from 61 localities and as Southern Crawfish Frogs inhabit similar isolated ponds an additional 11 historical Southern Crawfish Frog sites were included for initial examination. Objectives of this project ate to determine the current occurrence and distribution of the Western Chicken Turtle and identify potentially suitable habitat through species distribution modeling.
Activities and observations in support of this project in 2022 include:

- A habitat suitability model was completed for the Western Chicken Turtle in Louisiana
- Fifty-five historical localities were visited and evaluated, while the remaining historical localities were evaluated with aerial imagery.
- List of 33 potential sites was developed using aerial imagery and searching for isolated wetlands on public lands, wildlife management areas and national forests.
- Ponds have been sampled at least twice between February and June, the activity period of both the Western Chicken Turtle, Southern Crawfish Frog, and Tiger Salamander.
- Using eDNA as a sampling tool positive detections for the Western Chicken Turtle have been made at 10 ponds, for the Southern Crawfish Frog three ponds, and one pond for the Tiger Salamander.
- Tiger Salamander breeding was documented at one pond in December 2022
- A Western Chicken Turtle was captured in one pond in December 2022

Spatial Analysis Projects

Monitoring Seagrass Scars in Florida's Tampa Bay Using ArcGIS Pro Deep Learning

In collaboration with researchers at the University of Florida on a project funded by the Tampa Bay Estuary Program, GIS Analyst Katie Lawson sought to identify the location and density of seagrass scars in Tampa Bay so that targeted outreach campaigns for seagrass awareness could be deployed. Seagrass scars can be identified and manually digitized from high-quality aerial imagery to identify patterns of severity for targeted outreach, yet this is time-consuming and subject to bias. She used ArcGIS Pro 3.0 Deep Learning tools to develop a model that detects seagrass scars as objects. Through this process we reduced bias associated with manual digitization, saved time, and made this process repeatable and transparent year after year. Ultimately, approximately 23,000 seagrass scars were identified, and hot spots of scarring were identified (right).



Botany and Natural Communities Projects

Redstone Arsenal Invasive Plant Species Study

In 2020 the Alabama Natural Heritage Program partnered with Redstone Arsenal (RSA) to conduct a non-native invasive species mapping and monitoring initiative to foster a greater understanding how invasive plants are impacting natural areas on the installation. The goal of the proposed study was to assist RSA natural resource managers in preparing successful treatment plans to control weed infestations. Through mapping and monitoring efforts, resource managers will also acquire a greater understanding of the areas potentially subject to weed invasion, the biology of the invasion process and the means by which weeds spread, and the biological and economic impact of weed invasion. Three parcels were selected where infestations were identified and marked in the field using a GPS and delineated as either points or polygons depending on size. Survey data has been generated into maps denoting the identity, distribution, and size of each infestation. The monitoring component entails repetitive surveys to track weed populations over time. Permanent plots have been placed within select infestations where a 50-meter transect has been established, supplemented with quadrats at 3-meter intervals to calculate the frequency and density of a given species within each plot. The study was completed in December 2022, culminating into a final report containing management recommendations, species descriptions, natural history information, and GIS data.

EPA Reference Wetland Study

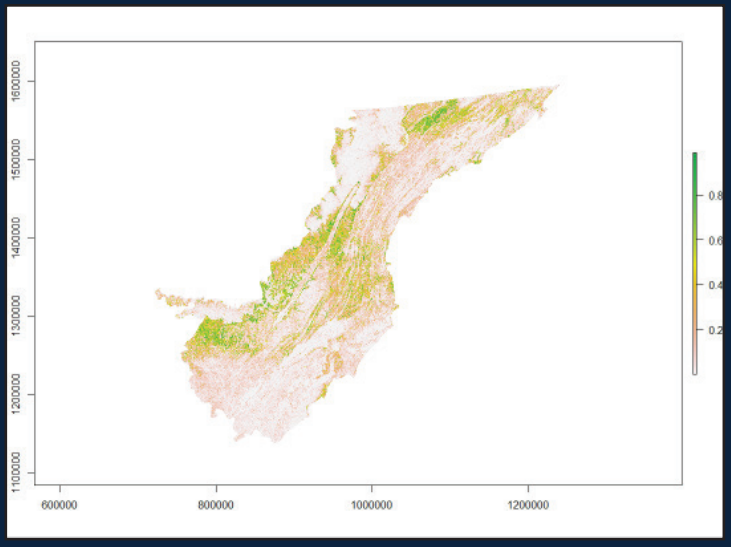
In 2018, the Environmental Protection Agency awarded AUMNH/ALNHP a grant to conduct a reference wetland study. The Museum has partnered with Troy University to accomplish the study, whose primary goal is to enhance recognition and protection of wetlands throughout Alabama by establishing permanent wetland reference sites across the state using an Ecological Integrity Assessment framework. The final product, anticipated in March 2023, is expected 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 effectiveness of conservation actions.

Statewide Status Assessment of Swamp Buckthorn

Swamp Buckthorn (*Sideroxylon thornei*) is one of several southeastern Coastal Plain plant species that has become globally imperiled as an artifact of adverse modifications of its habitats: forested wetlands associated with bottomlands. The taxon is a deciduous shrub currently represented by approximately 30-35 extant occurrences across three southeastern states, several of which are small consisting of no more than five plants. The small size of many occurrences, restricted reproduction capabilities, and its inherently relatively narrow ecological niche serve as a testament to the conservation need the species now faces. This study focuses on updating biological information for existing occurrences and surveying for new occurrences in Alabama, summarizing the ecological integrity of sites visited. The project was sponsored through Section 6 funding was completed in December 2022.

Habitat Suitability Modeling and Site Verification for the Large-Flowered Skullcap in Alabama

The large-flowered skullcap (*Scutellaria montana)* is one of many southeastern plant species that are listed under the Endangered Species Act, for which suitable habitat is likely more plentiful but remains unverified. The species is a narrow endemic restricted to the Cumberland Plateau and Ridge and Valley physiographic regions of northwest Georgia and adjacent Tennessee. The species remains undocumented from Alabama, but given that extant occurrences have been substantiated within 10 miles of the state line, the potential of the taxon to occur in the state is significant. Despite having been reclassified from federally endangered to threatened in 2002, S. montana continues to experience a decrease in numbers related to habitat degradation associated with residential development, logging, clearing of wooded areas for agricultural use, and wildfires. Because of ongoing threats and the closeness of known occurrences to Alabama, habitat modeling and site verification efforts were proposed for the northeastern portion of the state. The project was sponsored through Section 6 funding and completed in December 2022.



This habitat suitability model for *Scutellaria montana* incorporates known and background locations, modeled with generalized additive model (GAM); generalized boosted model (GBM); and maximum entropy (MaxEnt) in the R statistical environment . Presence data were in the form of element occurrence polygons obtained from Natural Heritage Network Programs in Georgia and Tennessee.

Range-wide status assessment of Ravine Sedge (*Carex impressinervia*)

Ravine sedge is a globally imperiled species currently known from less than 25 occurrences in four southeastern states. The plant prefers forested ravines often just upslope of drainage courses. An herbaceous evergreen perennial, the species was described in 1987 by Charles Bryson, Robert Kral, and James Manhart based on specimens collected near Centreville in Bibb County, Alabama. Because of a low number of occurrences, the U.S. Fish and Wildlife Service has commissioned the AUMNH/ALNHP to update existing records for known occurrences across the range of the species, assessing habitat integrity and threats that will enable land managers to develop appropriate conservation strategies. Field assessments are nearly completed with the final report to be submitted in 2023.

Ecological Assessment of Black Belt Prairies in Alabama

Beginning in 2023, the Alabama Natural Heritage Program will partner with other agencies and organizations to fulfill a three-year study assessing the ecological integrity of prairies in the Black Belt physiographic province in the central part of the state. The Black Belt prairies represent one of the poorest known ecological systems in the Southeast and one of the least preserved. Efforts will primarily focus on documenting species covered in Alabama's Wildlife Action Plan in select prairies across the region. In addition, to promote conservation efforts, a metric assessment will be developed to assist land managers and conservationists in evaluating the condition of prairies, furnishing critical information for prioritizing sites for protection and management. Monitoring plots are also proposed to evaluate the impacts associated with non-native invasive species, to be assessed in conjunction with applying several different treatment programs. To further recognition and protection, high quality prairie examples will be highlighted, discussing their biological significance and rationale for conservation.

Update of existing Element Occurrence Reports for the sun-facing coneflower (*Rudbeckia heliopsidis*) in Alabama

The sun-facing coneflower is a widely but sporadically distributed perennial herb of the Southeast extending from coastal Virginia south and southwestward to central Alabama. The species is currently verified from 20 sites in the state, many of which are small or are no longer extant. Despite not having been listed as a federally protected species, R. heliopsidis continues to experience a decrease in numbers related to habitat degradation associated with residential development, logging, clearing of wooded areas for agricultural use, and non-native invasive species. Because of outdated data detailing biological attributes and environmental conditions for occurrences in Alabama, site verification of existing records for the species will be implemented. Field surveys will be conducted in July and August, to coincide with peak flowering. The project is sponsored through Section 6, with a final report to be completed in December 2023.

ALNHP Outreach

ALNHP Staff assisted with several outreach events in 2022. Katie Lawson and Al Schotz both helped with the Open House-style tour at the beginning of October - Katie helped in the fish collection while Al helped in the herbarium.

Katie also helped with outreach at Opelika's Garden in the Park, Wehle Programs for 5th and 6th graders, the Dinosaur Egg unveiling, Curious Curators Camp, and Destination STEM.

Research by Jim Godwin often gains media attention. In March, 2022 his Black Warrior Waterdog project was covered by Garden & Gun magazine (link in publications section).

Katie Lawson's seagrass scar identification project was also covered by the media, including the Tampa Bay Times and Soundings magazine (links in publications section).

GIS Analyst Katie Lawson (left) and Entomology Collections Managet Melissa Callahan (right) at the Opelika Garden in the Park event. We set up some specimens and had a live snake to teach the public about our programs and natural history.

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Apodaca, J.J., A.R. Krohn, L. Collins, J.C. Godwin, L. Pearson, and A. Walde. In press. Re-evaluating population structure, conservation units, and taxonomy in extant alligator snapping turtles (genus Macrochelys) using next-generation sequencing. Southeastern Naturalist.

Godwin, James C., A. Coleman, and C. Guyer. In press. Distribution and status of the alligator snapping turtle (Macrochelys temminckii) in Alabama. Southeastern Naturalist.

Jenkins, A. J., J. C. Godwin, D. A. Warner, and D. A. Steen. 2022. Movement ecology of Flattened Musk Turtle (*Sternotherus depressus*). Journal of Herpetology 56:1-7.

Lawson, K.M., M.A.K Johnson, and A. Schotz. 2022. Habitat suitability modeling and site verification for the white fringeless orchid (Platanthera integrilabia) in Alabama. Southeastern Naturalist 21: 28-41.

Lawson, K.M. and J.E. Hill. 2022. Life history strategies differentiate established from failed non-native freshwater fish in peninsular Florida. Diversity and Distributions. doi: 10.1111/ddi.13448

Ribeiro, H.V., M.R. Acre, J. Faulkner, L.R. da Cunha, K.M. Lawson, J. Wamboldt, M.K. Brey, C.M. Woodley, and R.D. Calfee. 2022. Effects of shady environments on collective fish behavior. Scientific Reports 12(1):1-12.

Shook, A.K., C.D. Battaglia, K.M. Enge, C. Franklin, J.C. Godwin, A.C. Johnson, E.J. Kessler, E. Munscher, K. Norrid, L. Pearson, V. Ricardez, D.J. Stevenson, T.M. Thomas, and J.L. Carr. In press. Anthropogenic threats to alligator snapping turtles (Chelydridae: Macrochelys). Southeastern Naturalist.

Alabama Natural Heritage Program Project Reports

Godwin, J. 2022. Investigation of Alabama Red-bellied Turtle Nesting in American Alligator Nests. Final 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.

Godwin, J. 2022. Locust Fork Strategic Habitat Cooperative. Final Report submitted to The Nature Conservancy, Birmingham, AL.

Godwin, J. 2022. Reintroduction of the Eastern Indigo Snake onto Conecuh National Forest. Submitted to the Alabama Department of Conservation and Natural Resources.

Godwin, J., J.J. Apodaca, and K.M. Lawson. 2022. Occurrence of Western Chicken Turtle in Louisiana. Final Report Submitted to Louisiana Department of Wildlife and Fisheries, State Wildlife Grants.

Goertzen, L., C. Hansen, K. Lawson, and A. Schotz. 2022. Habitat suitability modeling and site verification for the large-flowered skullcap (Scutellaria montana) in Alabama. Unpublished report for the Alabama Department of Conservation and Natural Resources. 13 pp.

Jenkins, A. J. and J. Godwin. 2022. Genetic and Habitat Analyses to Support Recovery Efforts for the Flattened Musk Turtle. 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. 19 pages.

Jenkins, A. J. and J. Godwin. 2022. Flattened Musk Turtle and Black Warrior Waterdog Population Status Survey in Bankhead National Forest. Progress report submitted to U.S. Fish and Wildlife Service, Daphne, AL.

Schotz, A. 2022. Statewide status assessment for swamp buckthorn (Sideroxylon thornei) in Alabama. Unpublished report for the Alabama Department of Conservation and Natural Resources. 10 pp.

Schotz, A. 2022. Noxious weed monitoring and mapping at Redstone Arsenal, Alabama. Unpublished report for the Department of Defense, Redstone Arsenal. 108 pp.

Alabama Natural Heritage Program Popular Press Articles

Chesnes, Max. In Tampa Bay, boat propellers have killed seagrass. A new mapping project may help. Tampa Bay Times, December 7, 2022. https://www.tampabay.com/news/environment/2022/12/07/tampa-bay-boat-propellers-have-killed-seagrass-new-mapping-project-may-help/

Liles, Lindsey. Meet one of the South's Strangest - and Rarest - Amphibians. Garden and Gun, March 10, 2022. https://gardenandgun.com/feature/meet-one-of-the-souths-strangest-and-rarest-amphibians/

Sottile, Zoe. Rare snake found in Alabama for just the second time in 60 years. CNN, March 20, 2022. https://www.cnn.com/2022/03/20/us/rare-snake-alabama-trnd/index.html

Alabama Natural Heritage Program and AUMNH Active Grants Table

Sponsor	Project Title	Investigators	Amount	Years
USFS	Bankhead Aquatics eDNA Agreement	Godwin	$8,000	2022-2025
ADCNR	Investigation of Alabama Red-bellied Turtle Nesting in Alligator Nests	Godwin	$16,978	2022
ADCNR	Reintroduction of the Eastern Indigo Snake to Conecuh National Forest	Godwin	$72,010	2022
Lousiana DWF	Occurrence of western chicken turtle in Louisiana	Godwin and Oaks	$48,452	2022-2023
USFWS	Flattened Musk Turtle and Black Warrior Waterdog Population Status Study in Bankhead National Forest	Jenkins	$18,413	2022
ADCNR	Genetic and Habitat Analyses to Support Recovery Efforts for the Flattened Musk Turtle	Jenkins	$76,666	2022
TBEP	Propeller scarring hot spot analysis and behavior change/social marketing campaign for Tampa Bay	Lawson	$4,000	2022-2023
USFWS	Range-wide Assessment for Ravine Sedge (Carex impressinervia)	Schotz	$28,000	2022
DoD	Redstone Invasive Species Assessment	Schotz	$129,000	2020-2022
ADCNR	Habitat Suitability Modeling for the Large-flowered Skullcap (Scutellaria montana) in Alabama	Schotz	$28,750	2021-2022
ADCNR	Status Update for Swamp Buckthorn (Sideroxylon thornei) in Alabama	Schotz	$25,000	2022-2023
ADCNR	Status Assessment for Sun-facing Coneflower (Rudbeckia heliopsidis) in Alabama	Schotz	$27,500	2022-2023
ADCNR	Habitat Suitability Modeling for Apalachicola Wild Indigo (Baptisia megacarpa) in Alabama	Schotz	$25,000	2022-2023
ADCNR	Ecological Assessment of Black Belt Prairies in Alabama	Schotz	$297,160	2021-2024
EPA	Wetland Reference Study	Schotz and Armbruster	$229,452	2018-2022
NSF	Physiological genomics of sexually dimorphic developmental plasticity on butterfly wings	Counterman	$1,565,641	2022-2027
NSF	Developmental Architecture of Structure and Color on Butterfly Wing	Counterman	$456,763	2018-2022
NSF	Genomic Logic Underlying Adaptive Morphological Divergence	Counterman	$633,185	2017-2023
NSF	Collaborative Research: Red carotenoids as signals of respiratory chain function	Hill	$486,000	2019-2022
NSF	Collaborative Research: Understanding the rules of honest signaling	Hill	$324,379	2021-2025
NIH	Integrated Approach to Health and Longevity - Enhancing Drug Target Discovery (subaward)	Hill/Hood	$93,722	2021-2022
NSF	Comparative genomics of the capitulum: deciphering the molecular basis of a key floral innovation	Jones	$752,045	2022-Present
NSF	Testing alternative routes of adaptive phenotype-environment matching across heterogeneous landscapes in wild populations	Warner	$1,160,000	2020-Present