



2021 Annual Report



MUSEUM OF
NATURAL
HISTORY
AT AUBURN UNIVERSITY



ALNHP
Alabama Natural Heritage Program



Letter from the Director

2021 remained another strange year for everyone. We made and then had to cancel several events due to COVID-19, but things finally seem to be getting back to normal. One big thing we did was to meet with the President of NatureServe, who works with the Natural Heritage programs around the world to manage and deliver biodiversity information. We met Sean O'Brien and his team in the Conecuh National Forest and showed him some areas that are important to Alabama's biodiversity as well as our own research such as the Indigo Snake Reintroduction Program.



I had to leave the adventure briefly for a meeting, and of course that was when Jim Godwin caught an Alligator Snapping Turtle, a species I always wanted to see in the wild. At least it was for a good cause as I was meeting to discuss future funding for natural resources projects across the university.

Although we could not always go live, Outreach and Education Director Toni Bruner was able to present a virtual version of her Mountains to the Gulf Teacher Workshop. She had videoed segments from the mountains in Northern Alabama to the coast showing the diversity of biology and geography across the state and presented this virtually to teachers. In addition, we kept up a web presence with species spotlights and hosted our first March Mammal Madness thanks to Mammalogy Curator Wendy Hood. Join us in February/March 2023 to pick who you think will win the next matchup between world mammals and other organisms.

Fish Collection Manager Dave Werneke and I teamed with the University of South Alabama at the Dauphin Island Sea Rodeo. The USA team has been working the rodeo for many years, and Dave and I helped out by showing off some of the stranger catches, which we took back to the museum. Winner for Weirdest Fish came in at the end, a Keeltail Pomfret, a rarely encountered deepsea fish.

As life begins to swing more back towards normal, we hope to get people back into the museum or viewing our outreach programs in person. We have been ramping back up, and we should soon be back at full capacity provided the world doesn't get strange again!

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



Keeltail Pomfret

Taractes rubescens

Collected during the
Dauphin Island Sea Rodeo
in the Gulf of Mexico.

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

2021 Funding Provided By:

Alabama Department of Conservation and Natural Resources
Louisiana Department of Wildlife and Fisheries
National Science Foundation
NatureServe
US Department of Defense
US Environmental Protection Agency
US Fish and Wildlife Service

2021 Partners and Collaborators:

Alabama Department of Conservation and Natural Resources
Jule Collins Museum of Art at Auburn University
NatureServe
Orianna 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





38

peer-reviewed
publications

25,199

new specimens
accessioned

\$2.18 million

in active grant
funding



135 number of citations on GBIF using our collections

25,829 + number of times our data were downloaded on GBIF



1,594
specimens loaned
for study

18
data requests
completed



29 outreach events reaching **>1,000** people

82 visitors for research or tours



ALNHP

Alabama Natural Heritage Program

ALNHP by the Numbers - 2021



\$1.26 million

in active grant
funding

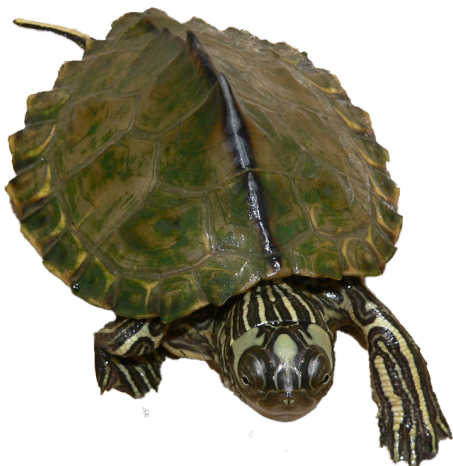
15

reports &
publications



312 new element occurrences added to our Biotics 5 database

10,412 total element occurrences in our Biotics 5 database



41

data requests
completed



43

species added to
our tracking list

1,706

species we are
tracking

Research and Collections

John D. Freeman Herbarium

The multi-year effort to accession over 2100 sheets of grapevines (the genus *Vitis*) was completed in 2021! This valuable collection will be available for researchers to study, both in person or through online queries of our database.

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 100 new fungi specimens added to the herbarium last year.

During this field season, Curtis Hansen collected specimens from Lee County, Bibb County, Cheaha State Park (Clay & Cleburne Cos.), Cheaha State Park, and Solon Dixon Forestry Education Center (Covington & Escambia Cos.). Hansen also coauthored a paper on the genome size of *Marshallia* and is working on an updated checklist of lichens in Alabama and a book, a field guide to Alabama lichens.

2021 Specimen Donations

- 500 lichens from Vitaly Charny
- 200 plant specimens from Charles Owsley

2021 Digitization

- Over 4,000 specimens were processed and added to the Specify database during 2021, half of these were 2,000+ *Vitis* collections that were accessioned
- 97 fungi and 1 lichen specimen were also digitized

2021 Research Highlights

- Graduate student Adekola Owoyemi is continuing research on the origin of *Eleusine* (Poaceae, Goose grass) in Africa and species distributions throughout the World using loans and online specimen data.
- PhD Student Marc Johnson is doing a plant inventory in the Yates Lake Wildlife Management Area, Elmore County, AL, including collecting specimens for the Freeman Herbarium and using museum resources to identify plants. He is also building habitat models for the endangered Relict Trillium, *Trillium reliquum*.
- Esteban Pinto 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 1000+ plant collections from that South American country.
- We are collaborating with Hudson-Alpha in Huntsville, Alabama, including studying plant sex chromosomes and genomics. Target-capture sequencing projects on various plant phylogenetic groups is being led by students who will utilize the herbarium to obtain loans for their research.
- Elsewhere, Dr. Clark Danderson, professor of nutrition and dietetics, is beginning to utilize herbarium and specimens for systematic work in the Apiaceae (Carrot Family).



Collections manager Curtis Hansen (right) with graduate student Adekola Owoyemi (left) pressing plant specimens in Bibb County, Alabama.

2021 Students & Volunteers

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

- Stewart Brown
- Luke Holland
- Alex Lahue

Research and Collections

Entomology

The entomology collection received many important acquisitions in 2021, some of which are new state records! These included:

- (1) The first *Triatoma lectularia* found in Alabama. This is a medically important insect because it can be a Chagas Disease vector. It was found in a home in Blount County, Alabama. It normally lives in squirrel and wood rat nests.
- (2) The first *Diaprepes abbreviatus* from Alabama, collected by Charles Ray.
- (3) Probable new state record of *Sciara humeralis*, collected by Charles Ray.
- (4) While not a state record, Charles Ray collected a second specimen of the rare bee, *Caupolicana electa*.
- (5) *Monoclona floridensis*, a mycetophilid, collected in Blount County, Alabama. Only 4 mentions in the literature: the Holotype, described in 1946, and three specimens from Louisiana and Mississippi in 1971.

2021 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!

- Alan Jeon
- Flynn Jones
- Allison Sharp

2021 Loans & Info Requests

- In 2021, we sent 9 loans with 688 specimens total
- We completed 7 information requests

2021 Digitization

- In 2021, we accessioned ~5,000 specimens and digitized ~3,000 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.



Eastern Lubber Grasshopper



Right - Collections manager Melissa Callahan at the James Audubon/AUMNH exhibit partnership at the Jule Collins Museum of Art in Auburn, Alabama.

Left - An AUMNH Curators camper with a beautiful swallowtail butterfly during a field excursion.



Research and Collections

Invertebrate Zoology

The Invertebrate Collection saw continued growth in 2021. Incoming specimens included representatives of all major invertebrate taxa. Most of the new specimens came from Dr. Ken Halanych's previous Antarctica research cruises.

Additionally, other projects in the lab of Dr. Nathan Whelan have contributed pleurocerid specimens. We had one out-going loan totaling 5 specimens that were sent to Troy University. We also had an internal loan of a freshwater mussel and a marine annelid as part of the Mobile Museum.

2021 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
- Harrison Carrell
- Taylor Cook
- Emalyn Middleton

2021 Digitization

- In 2021, we digitized over 2,800 lots of specimens!
- To date, we have over 21,000 lots of molluscan invertebrates and over 13,000 non-molluscan invertebrates digitized.
- All of the information is added to our Specify database and shared with GBIF, iDigBio, InvertEBase, as well as other online sources.



Crayfish collected during wetland sampling for the EPA reference wetland project.



Collections manager Nusrat Noor giving a tour of the invertebrates collection to students during the Curious Curators summer camp.

Nusrat has participated in many outreach programs and activities in 2021 including the Spring into Science event and Earth Day events at Auburn University, and Darterfest in Birmingham, Alabama.

Research and Collections

Ichthyology

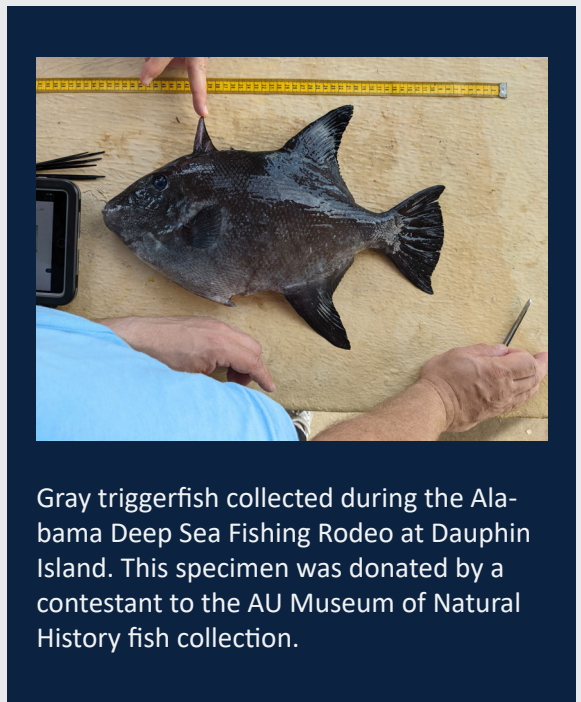
In 2021 the fish collection added a large number of specimens from Alabama, Florida, Georgia, Louisiana, and Tennessee. A portion of the Florida material came from collections made by the Florida Fish and Wildlife Commission across the panhandle between 2006 and 2011. Additionally, recent collections from ongoing surveys in the Apalachicola River in 2019 and 2020 made up a large volume of Florida accessioned material.

In July of 2021 we traveled to the Alabama Deep Sea Fishing Rodeo on Dauphin Island where we collected specimens and tissues from a wide variety of marine fish that were donated by contestants. Included in the material from the rodeo were species underrepresented in museums and new to our collection.

We also added material from Dr. Carol Johnston's and Dr. Elise Irwin's labs in the School of Fisheries and Allied Aquaculture. This material included specimens from Alabama, Georgia, Louisiana, and Tennessee.

2021 Loans & Info Requests

- In 2021, we sent 8 loans with 170 lots total
- The fish collection continues to see frequent use by graduate students in Biological Sciences and the School of Fisheries and Allied Aquaculture.
- One visitor from the National Park Service that came to photograph the Fort Pulaski National Monument specimens.



Gray triggerfish collected during the Alabama Deep Sea Fishing Rodeo at Dauphin Island. This specimen was donated by a contestant to the AU Museum of Natural History fish collection.

2021 Accessions

In 2021, we accessioned many collections:

- 10,673 specimens
- 1,066 lots
- 458 tissue samples



Fish specimens in the AU Museum of Natural History Fish Collection.

From left to right in the front row are (1) *Trichiurus lepturus*, the largehead hairtail. A common marine species with a wide range in temperate and tropical regions.

- (2) A pufferfish specimen
- (3) A cleared and stained fish specimen.

Research and Collections

Herpetology

In 2021, close to 20 publications were produced related to the herpetological collections were published by museum staff and students. These papers showcase the breadth of research being conducted at the AUMNH. Additionally, AUMNH herpetology specimens or data were utilized or reference in no less than 4 publications and 2 Master's theses in 2021. Several photographic vouchers were also featured in geographic distribution notes.

Work on the museum's EPA wetlands project continued. 2021 saw turtle trapping at 11 sites throughout the state. Over 150 turtles representing 10 different species were observed.

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. As described above, over 120 vouchers were accessioned in 2021, several of which represented county records.

2021 Accessions

- More than 1,000 specimens, included 400 lots of larval amphibians that were processed as part of the museum's EPA wetland project. The majority of the specimens processed in 2021 were from that project, whereas new acquisitions came primarily from work associated to several graduate student research projects and included various species of anoles, as well as and red-eared sliders (*Trachemys scripta*) and eastern fence lizards (*Sceloporus undulatus*).
- Over 125 tissue samples added in 2021 with an additional 400+ tissues associated with ongoing anole research were received in 2021. These tissues will be accessioned in the coming year.
- Last, we added over 200 digital vouchers to our photo/audio/video voucher collection.

2021 Loans & Info Requests

- In 2021, we sent 11 loans and completed more than 14 data requests
- We were also happy to host 2 visiting scientists who utilized the museum's specimens to further their research.
- Additionally, the museum was selected to house several paratypes associated with research which is exploring the southeast's *Desmognathus* salamander diversity. The first of these series arrived in 2021 and is now housed in the museum's type cabinets.

2021 Volunteers

- Alexia Alford
- Jarious Avery
- Maddie Edwards
- Morgan Hancock
- Olivia Kramer
- Stefan Larsson
- Tori Martin
- Natalie Moore
- Nicole Powers
- Allison Sharp
- Vivian Sierra
- Levi Stamps
- Allision Tuggle
- Sidney Whitfield



Herpetology Collection Manager David Laurencio examining a Coastal Plains Cooter (*Pseudemys floridana*) he caught during wetland surveys for our EPA reference wetlands project.

Research and Collections

Ornithology

The AUMNH ornithology collection is comprised of approximately 4000 specimens, primarily from the southeastern 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.

- Nick Justyn, doctoral student under Hill, used the bird collection extensively in a comparative study of mechanisms of color production.
- Volunteer Sophie Hirsh prepared many bird specimens in 2021
- Bird specimens were utilized at the Jr. Mad Scientist outreach event where elementary students learned about bird identification and ornamentation.
- 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 handwritten specimen tags which are affixed the foot of each specimen. The process of digitizing all remaining data located on the specimen tags continues.



European starling specimen accessioned in the AUMNH Ornithology Collection (left)

Conducting a seminar on Mammalogy for Alabama Master Naturalist, AU Extension Services at the Wehle Center (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.

- As with other museum collections, the mammal database is in the process of moving over to the Specify platform. The process of digitizing all remaining data located on the specimen tags continues.
- 2021 marked the first 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 and Hannah Eubanks for assistance with this as well.
- Several students, including Raul Quebrado, Caroline Silve, KayLene Yamada, and Natalie Harris used the mammal collection in 2021 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 from the Cenozoic Era.

- Our vertebrate paleontology volunteers Claire Wilson and Skye Walker continued to provide incredible help in organizing the vertebrate paleontological collection.
- Gates and Lamb (2021) used our *Lophorhothon* specimen (AUMP 2295) to redescribe the species.

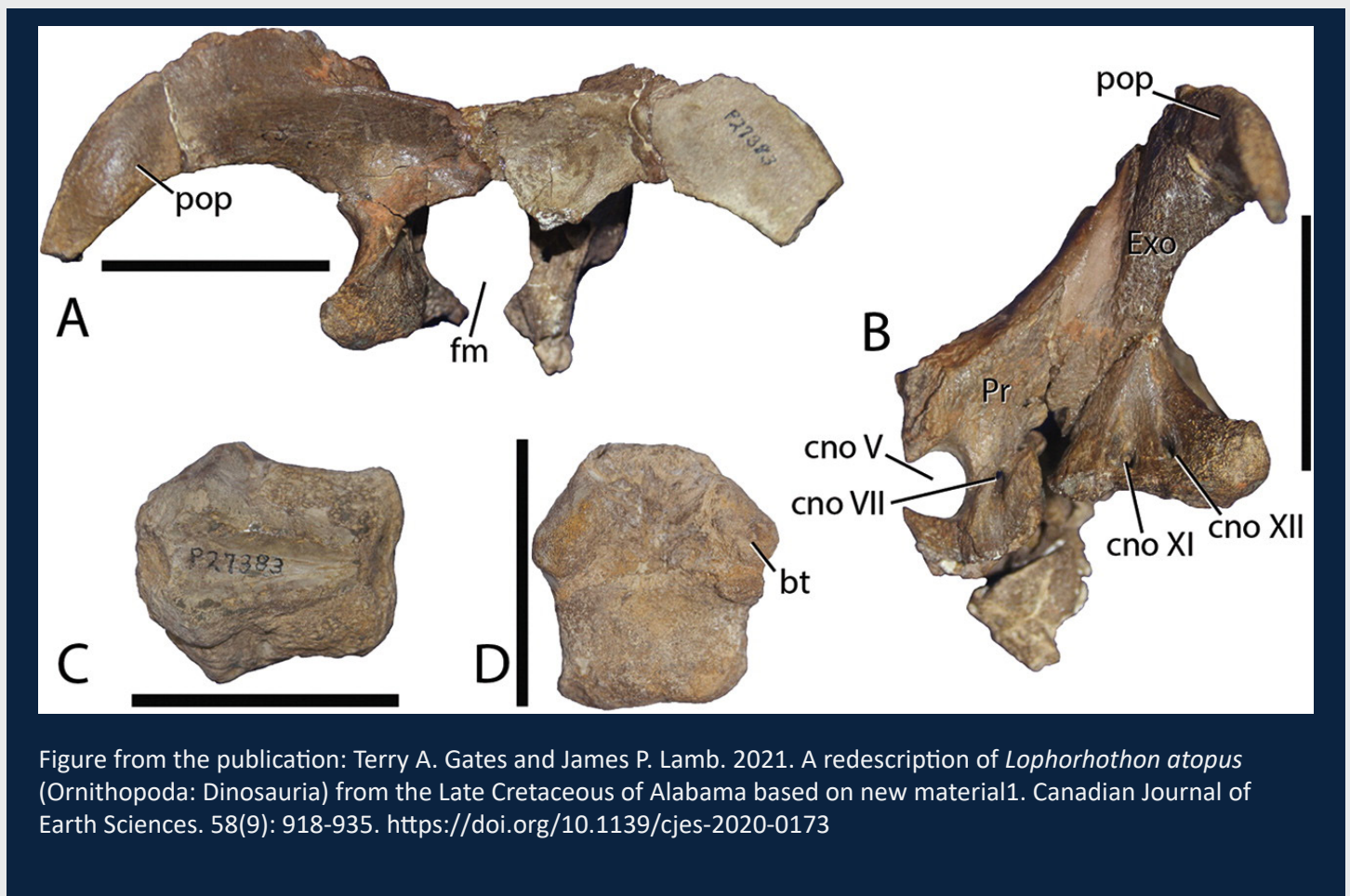


Figure from the publication: Terry A. Gates and James P. Lamb. 2021. A redescription of *Lophorhothon atopus* (Ornithopoda: Dinosauria) from the Late Cretaceous of Alabama based on new material¹. *Canadian Journal of Earth Sciences*. 58(9): 918-935. <https://doi.org/10.1139/cjes-2020-0173>

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 was a busy one for outreach as some programs were converted into a virtual format, and others were once again offered face-to face. Highlights and major accomplishments for this year included:

- Growth of our live animal collection and animal care volunteer crew
- Final planning for and first delivery of the virtual Mountains to the Gulf Program
- Audubon Exhibit partnerships with the Jule Collins Art Museum
- Darwin Day Scavenger Hunt
- We got our mobile museum finished and traveling exhibits created!
- Two weeks of Junior Curator Camp in June for 5-8th graders
- Fall Field Days at the Wehle Center
- Trained 13 students in the Department of Education to be Project Learning Tree instructors

Programs offered in 2021

Outreach Coordinator Toni Bruner conducted many one-day outreach programs at local schools, parks, and events, including:

- Cave workshop on March 10 for 11 people
- Spring into Science event on March 20
- Present the Mobile Museum to Alumni on April 24
- Water Wise Workshop on April 27 for 11 people
- Virtual field days for DCW school May 3 and 4
- Darter fest on May 23
- College Quest Summer Academy on July 22
- Cheaha Campfire Presentations on August 6 and 7
- COSAM Open House on August 25
- Cave Presentation in Calhoun County, September 22 for 18 people
- Cheaha Campfire Talks, October 22-23 for 32 attendees
- Trinity Christian School Herp presentation on October 26
- Jr. Mad Scientist October 26
- AU Alumni Live Animal presentation before kickoff October 30
- Cave Expedition on November 5 for 10 people
- Live animal program at VERITAS Christian School on December 10 for 21 students

Professional Development

Toni served on numerous boards in 2021, including Legacy, Partners in Environmental Education, and EEAA - the Environmental Educators of Alabama Association.

Toni also participated in JEDI training classes and is a member of the Department of Biological Science's Diversity, Equity, and Inclusion Committee.

Museum Tours

Toni led museum tours for classes and other groups upon request in 2021 as first Wednesday tours were still suspended. Approximately 65 people attended tours of the AUMNH this year.

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.



The Alabama Natural Heritage Program

NatureServe Visit

On May 4, NatureServe's CEO Sean O'Brien and Communication Specialist Jaclyn Aliperti journeyed to Alabama as part of the NatureServe Network Van Tour. The tour "provides a unique opportunity to evaluate the relationships between people and the natural environment one year since the start of the pandemic, as well as to connect science with stories about the future of biodiversity conservation throughout North America." We were proud to show off the cool work our biologists are doing in Conecuh National Forest.



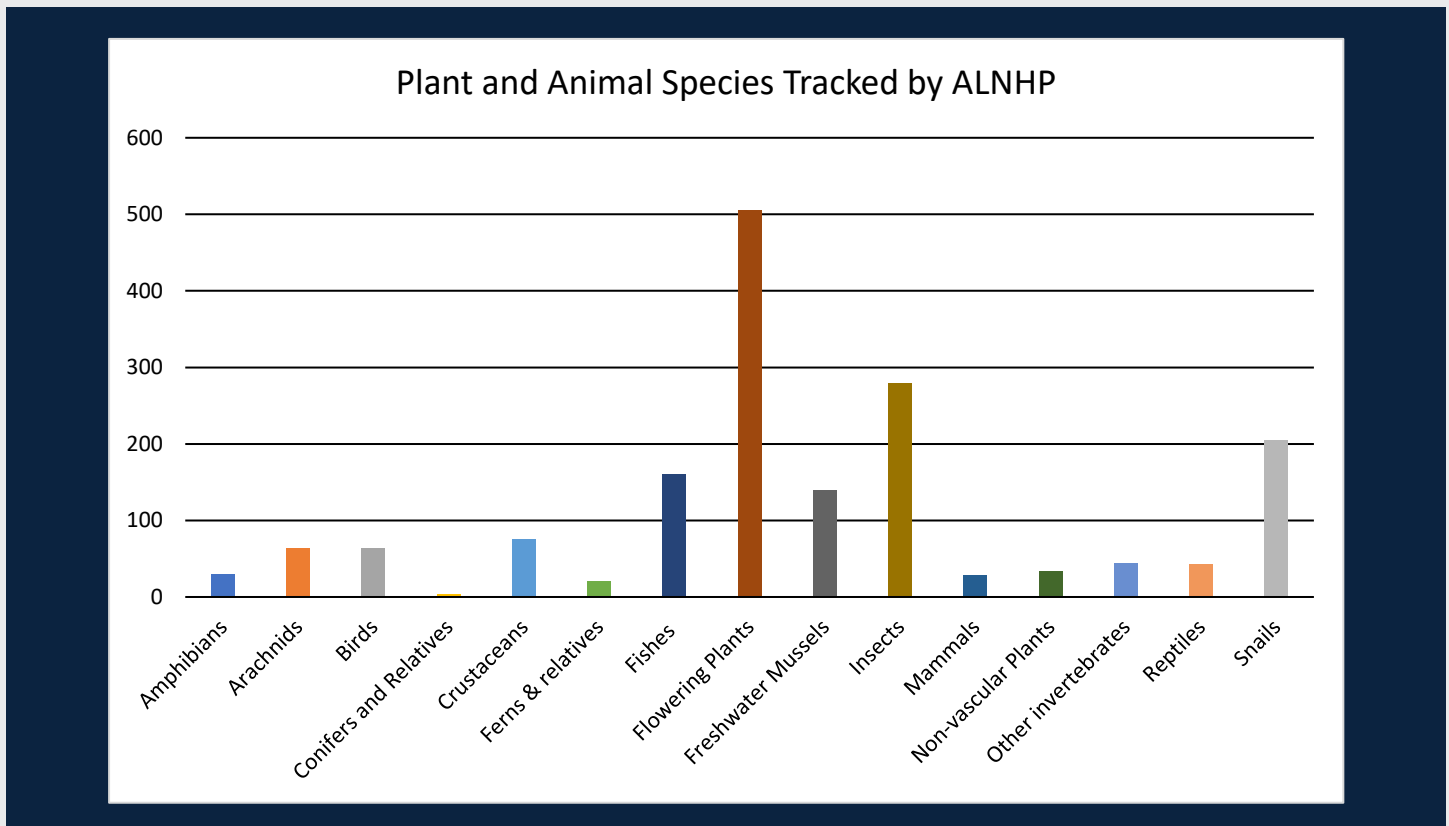
Derek Colbert of the US Forest Service used a camera probe to confirm the presence of a gopher tortoise inside of a known burrow (left). Later, the group gathered around a contraption used to temporarily trap and observe wildlife, particularly the reintroduced indigo snake; animals travel along the fencing until they enter the humane trap, then have a difficult time making their way out. Biologists use this noninvasive technique to monitor wildlife in the area, then release the captured animals (right).

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 2021 include:

- 1,706 tracked species, up from 1,669 in 2020
- 10,412 element occurrences
 - 312 added since 2020, many by our former Database Technician Hannah Seigel
- New tracking list created in October with a new, simplified format
 - 19 species received new state ranks
 - 43 species added to the tracking list
 - 24 species received taxonomic and/or nomenclature changes

The Alabama Natural Heritage Program



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 2021, 41 data requests were completed.

Zoology Projects

Lead Zoologist Jim Godwin, GIS Analyst Katelyn Lawson, and Research Assistant Joe Jenkins completed 7 project reports for reptile and amphibian conservation projects in 2021 and made much progress on ongoing projects. Highlights for 2021 include:

- Released 11 captive-bred Eastern Indigo Snakes in Conecuh National Forest (June 2021)
- Gravid female Indigos and 2 wild-born snakes have been captured, showing evidence of reproduction!
- Captured and collected data on 67 Flattened Musk Turtles, a threatened endemic species
- Captured 9 Black Warrior Waterdogs, an endangered endemic species
- Sampled for eDNA over 175 river kilometers of the Locust Fork
 - 15 detections for the Black Warrior Waterdog
 - 18 detections for the Flattened Musk Turtle
- Sampled ponds across Louisiana for Western Chicken Turtle and Crawfish Frog using traditional methods and eDNA

Eastern Indigo Snake Project

The return of the eastern indigo snake as an element of the longleaf pine and associated ecosystems of southern Alabama is an important step toward complete ecological restoration of Coastal Plain ecosystems. Our reintroduction of the Eastern Indigo Snake is through a partnership with the Alabama Department of Conservation and Natural Resources, U.S. Forest Service, and the Orianne Center for Indigo Conservation. Our goal is to establish a viable population with the annual release of captive bred, immature snakes.

Jim Godwin (left) has been an integral part of this project since it took off in 2008. He is seen here making sure that the unique tag implanted in each snake to be released is secure and working properly.

This year, we released 11 more snakes bringing to total released to 202. We have recaptured snakes over the years, some of which have been gravid females indicating reproductive success in the wild. We have also captured 2 wild-born snakes and wrapped up a 6-year monitoring study with over 4,500 vertebrate captures which will be analyzed soon. This project has been extended for another 5 years thanks to a State Wildlife Grant.



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 2021 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 2021 we captured 9 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 2021 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.

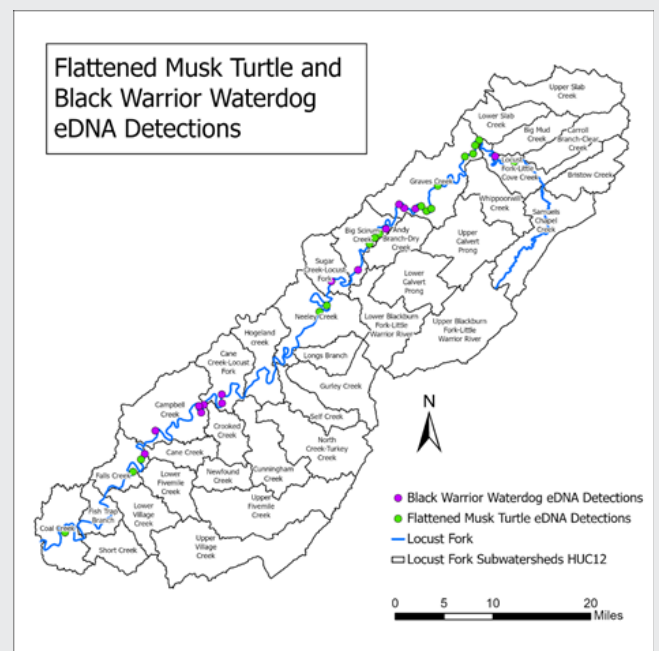
A Flattened Musk Turtle (*Sternotherus depressus*). The threatened, endemic species that is the subject of these genetic and habitat analyses



(3) Use of eDNA to detect Flattened Musk Turtle & Black Warrior Waterdog in Locust Fork

There have been recent detections of the Black Warrior Waterdog and Flattened Musk Turtle using environmental DNA in the Locust Fork, but data is needed on the complete distribution of these imperiled species. Objectives for this project were to survey for eDNA of these two species across the entire Locust Fork mainstem. Activities and observations in support of this project in 2021 include:

- A total of 175 river kilometers were sampled over both sampling seasons using an in-stream, canoe-based eDNA portable water filtration equipment.
- The Black Warrior Waterdog was detected at 15 locations and the Flattened Musk Turtle at 18.
- Historically the Black Warrior Waterdog had been reported from only one location in the mainstem of the Locust Fork and three tributaries. Positive eDNA detections from this study include the single historic mainstem locality plus 15 additional locations, these are roughly distributed as five single and three clusters of detections.



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 are 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 2021 include:

- An initial 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 and Southern Crawfish Frog.
- Using eDNA as a sampling tool positive detections for the Western Chicken Turtle have been made at 10 ponds distributed across the state on public lands.

Botany and Natural Communities Projects

Redstone Arsenal Invasive Plant Species Study

In 2020 the Alabama Natural Heritage Program partnered with Redstone Arsenal 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 study is to assist RSA natural resource managers in preparing successful treatment plans to control weed infestations.

- In 2021, three parcels were selected where infestations were identified and marked in the field using GPS technology, 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 through use of symbols to denote percent cover and codes for indicating weed species.
- 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 will be completed in September 2022, culminating into a final report containing management recommendations, species descriptions, natural history information, and GIS data.

EPA Reference Wetland Study

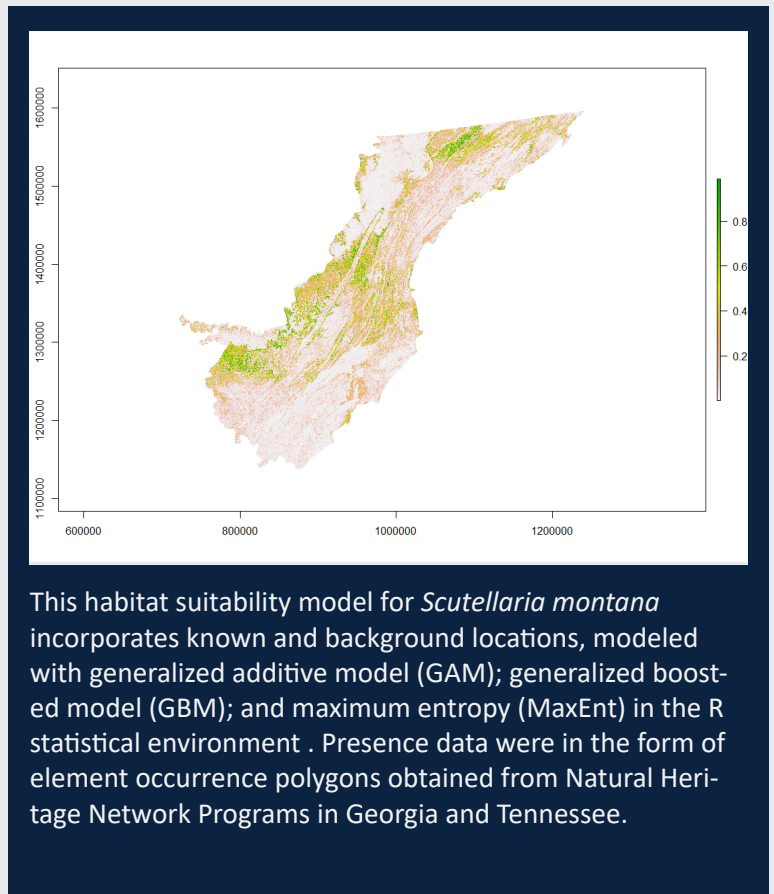
In 2018, the Environmental Protection Agency awarded AUMNH/ALNHP a grant to conduct a reference wetland study. The Museum has partnered with Troy University to accomplish the study, whose primary goal is to enhance recognition and protection of wetlands throughout Alabama by establishing permanent wetland reference sites across the state using an Ecological Integrity Assessment framework. In 2021, all field work was completed for this project, and deliverables will be completed and submitted in September, 2022. 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.

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 is sponsored through Section 6 funding with a completion date of 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 is sponsored through Section 6 funding with a completion date of December 2022.



Range-wide status assessment of Ravine Sedge

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.

AUMNH 2021 Peer-Reviewed and Published Articles

AUMNH Collections

Herbarium

Garnatje, T., J. Pellicer, J. Vallès, N. Hall, C. Hansen and L.R. Goertzen. 2021. First genome size assessments for *Marshallia* and *Balduina* (Asteraceae, Helenieae) reveal significant cytotype diversity. *Caryologia*. <https://doi.org/10.36253/caryologia-1206>.

Goertzen, L.R., J. Grimwood, and J. Schmutz. *Hydrangea quercifolia* 'HQ6' v1.1 DOE-JGI, https://phytozome-next.jgi.doe.gov/info/Hquercifolia_v1_1. [3 Feb 2021, published the assembled genome].

Fishes

Armbruster, Jonathan W., Nathan K. Lujan, and Devin D. Bloom. 2021. Redescription of the Guiana shield darter species *Characidium crandellii* and *C. declivirostre* (Crenuchidae) with descriptions of two new species. *Ichthyology & Herpetology*. 109(1):102-122.

Invertebrates

Bogantes, V. E. M. J. Boyle, K. M. Halanych. 2021. New reports of *Pseupodolydora* (Annelida: Spionidae) from the East Coast of Florida, including the non-native species *P. paucibranchiata*. *Biological Invasions* 10: 577-588.

Costa-Paiva, E. B. Mello, B. S. Bezerra, C. Coates, K. M. Halanych, F. Brown, J. de Moraes Leme & R. I. F. Trindade. Submitted. Molecular dating of the blood pigment hemocyanin provides new insight on the origin of animals. *Geobiology*.

David, K. T., K. M. Halanych. 2021. Proximity between polyploids across South American frog genera. *Journal of Biogeography* 48: 991–1000.

Galaska, M.P, D. S. Wetthey, A. Arias, S. F. Dubois, K. M. Halanych, S. A. Woodin. 2021. Hitching a ride: The impact of aquaculture on the genetics and distribution of the onuphid annelid *Diopatra biscayensis*. *Ecology and Evolution*. 11:6184–6194. DOI: 10.1002/ece3.7447

Garber, A. I., J. R. Zehnpfennig, C. S. Sheik, M. W. Henson, G. A. Ramirez, A. R. Mahon, K. M. Halanych, D. R. Learman. 2021. Metagenomics of Antarctic marine sediment reveals potential for diverse chemolithoautotroph. *mSphere* 6:e00770-21.

Halanych, K. M. 2021. Chapter 35 Hemichordata. In Eds. R. Desalle and B. Schierwater, *The Tree of Life Approaches to Invertebrate Zoology*. Academic Press.

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Halanych, K. M., D. Westerholm. 2021. Considerations for scientists, especially biologists, getting involved in oil spill research. *Oceanography* 34:112-123, <https://doi.org/10.5670/oceanog.2021.120>.

Murawski, S. A., M. Grosell, C. Smith, T. Sutton, K. M. Halanych, R. Shaw, C. A. Wilson. 2021. Chapter 10: Impacts of Petroleum, Petroleum Components and Dispersants on Organisms and Populations. *Oceanography* 34:136-151, <https://doi.org/10.5670/oceanog.2021.122>.

Oyekwe, O., K. M. Halanych. 2021. Genome-wide characterization of LTR retrotransposons in the non-model deep-sea annelid *Lamelibranchia luymesii*. *BMC Genomics* 22:466

Redak, C.A., A. S. Williams, J. T. Garner, K. M. Halanych, N. V. Whelan. 2021. Assessing genomic diversity, connectivity, and riverscape genetics hypotheses in the endangered Rough Hornsnail, *Pleurocera foremani*, following habitat disruption. *Journal of Heredity* 112: 635–645.

Tassia, M. G. , K. T. David, J. P. Townsend, K. M. Halanych. 2021. TIAMMAT: Leveraging biodiversity to revise protein domain models, evidence from innate immunity. *Molecular Biology and Evolution* 38:5806-5818.

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Entomology

Bird, G., Wilson, A.E., Williams, G.R. and Hardy, N.B., 2021. Parasites and pesticides act antagonistically on honey bee health. *Journal of Applied Ecology*, 58(5), pp.997-1005.

Crossley, M.S., Snyder, W.E. and Hardy, N.B., 2021. Insect–plant relationships predict the speed of insecticide adaptation. *Evolutionary applications*, 14(2), pp.290-296.

Birds

Gates, D.; Staley, M.; Tardy, L.; Giraudeau, M.; Hill, G. E.; McGraw, K.; Bonneaud, C. 2021. Levels of pathogen virulence and host resistance both shape the antibody response to an emerging bacterial disease. *Scientific Reports* 11, 8209. <https://doi.org/10.1038/s41598-021-87464-9>.

Hill, G. E. and Powers, M. J. 2021. Ecomorphs are not species: the case of the Cassia Crossbill. *J. Avian Biology* 2021: e02896

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Koch, R.E., Buchanan, K.L., Casagrande, S., Crino, O., Dowling, D.K., Hill, G.E., Hood, W.R., McKenzie, M., Mariette, M.M., Noble, D.W. and Pavlova, A. 2021. Integrating Mitochondrial Aerobic Metabolism into Ecology and Evolution. *Trends in Ecology and Evolution* 36: 321-332.

Powers, M. J. and Hill, G. E. 2021. A review and assessment of the Shared-Pathway Hypothesis for the maintenance of signal honesty in red ketocarotenoid-based coloration. *Integrative and Comparative Biology*. doi.org/10.1093/icb/icab056

Powers, M. Weaver, R. J., Barreto, F. S., Burton, R. S., and Hill G E. 2021. Evidence for hybrid breakdown in production of red carotenoids in the marine invertebrate *Tigriopus californicus*. *PLoS One* 16(11), e0259371.

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Herbarium

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Spaulding, D.D., J.T. Kartesz, H.E. Horne, B.J. Finzel, and J.K. England. 2021. Flora of Northern Alabama, part 5. Liliaceous Families. *Phytoneuron* 2021-30: 1–262. ISSN 2153 733X.

Fishes

- Chuctaya, J., A. C. Encalada, K. S. Barragán, M. L. Torres, K. E. Rojas, V. Ochoa-Herrera, and T. P. Carvalho. 2021. New Ecuadorian records of the eyeless banjo catfish *Micromyzon akamai* (Siluriformes: Aspredinidae) expand the species range and reveal intraspecific morphological variation. *Journal of Fish Biology*. 98(4):1186-1191.
- Faustino-Fuster, D. R., V. Meza-Vargas, N. R. Lovejoy, and N. K. Lujan. 2021. Multi-locus phylogeny with dense Guiana Shield sampling supports new suprageneric classification of the Neotropical three-barbeled catfishes (Siluriformes: Heptapteridae). *Molecular Phylogenetics and Evolution*. 162:107186.
- Henschel, E. and N. K. Lujan. 2021. Range extension of the miniature pencil-catfish *Potamoglanis wapixana* (Siluriformes: Trichomycteridae) into the Essequibo River basin, Guyana. *Journal of Fish Biology*. 99(5):1741-1745.
- Hunt, E. P., K. W. Conway, K. Hamilton, E.J. Hilton, K. R. Piller, J.J. Wright, and D. S. Portnoy. 2021. Molecular Phylogenetics of the Chub Suckers (Teleostei: Catostomidae: Erimyzon) Inferred from Nuclear and Mitochondrial Loci. *Ichthyology & Herpetology*. 109(2):626-635.
- Londoño-Burbano, A. and R. E. Reis. 2021. A combined molecular and morphological phylogeny of the Loricariinae (Siluriformes: Loricariidae), with emphasis on the Harttiini and Farlowellini. *PLoS one*. 16(3):e0247747.
- Londoño-Burbano, A., A. Urbano-Bonilla, and M. R. Thomas. 2021. *Loricaria cuffyi* (Siluriformes: Loricariidae), a new species of loricariin catfish from the Guiana Shield. *Journal of Fish Biology*. 98(1):154-167.
- Londoño-Burbano, A., M. B. Mendonça, and R. E. Reis. 2021. The distribution of *Cteniloricaria* (Siluriformes: Loricariidae): known and new records in Brazil suggest headwater captures as drivers of disjoint distribution.
- Peixoto, L. A. W., A. Datovo, N. A. Menezes, and C. D. de Santana. 2021. A new species of sexually dimorphic and rheophilic ghost knifefish (Apteronotidae: Gymnotiformes) from the Amazon basin. *Journal of Fish Biology*. 98(3):803-816.
- Sabaj, M. H., and M. Arce H. 2021. Towards a complete classification of the Neotropical thorny catfishes (Siluriformes: Doradidae). *Neotropical Ichthyology*. 19(4):e210064.

Alabama Natural Heritage Program Peer-Reviewed Publications

- 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., and J.E. Hill. 2021. Predicting successful reproduction and establishment of non-native freshwater fish in peninsular Florida using life history traits. *Journal of Vertebrate Biology*. DOI: 10.25225/jvb.21041
- Ridgway, J.L., K.M. Lawson, S.A. Shier, R.D. Calfee, and D. Chapman. 2021. An assessment of fish herding techniques: Management implications for mass removal and control of silver carp. *North American Journal of Fisheries Management* <https://doi.org/10.1002/nafm.10685>
- Tuckett, Q.M., K. M. Lawson, T.N. Lipscomb, J.E. Hill, W. Daniel, and Z. Siders. 2021. Non-native poeciliids in hot water; the role of thermal springs in facilitating invasion of tropical species. *Hydrobiologia* <https://doi.org/10.1007/s10750-021-04669-9>.
- Tuckett, Q.M., A.E. Deacon, D. Fraser, T.J. Lyons, K.M. Lawson, and J.E. Hill. 2021. Unstable intraguild predation causes establishment failure of a globally invasive species. *Ecology* 102: e03411.
- Tuckett, Q.M., K.N. Ressel, J.L. Ritch, K.M. Lawson, and J.E. Hill. 2021. Domestication and feralization influence the distribution and phenotypes of escaped ornamental fish. *Biological Invasions* 23:1033-

Alabama Natural Heritage Program Project Reports

- Godwin, J. 2021. Investigation of Alabama Red-bellied Turtle Nesting in American Alligator Nests. 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. 5 pages.

Godwin, J. and K.M. Lawson. 2021. Mississippi Gopher Frog (*Lithobates sevosus*) 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. 12 pages.

Godwin, J. 2021. 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. 6 pages.

Godwin, J. 2021. Locust Fork Strategic Habitat Cooperative. Final Report submitted to The Nature Conservancy, Birmingham, AL. 15 pages.

Godwin, J. and K.M. Lawson. 2021. Occurrence of Western Chicken Turtle in Louisiana. Progress Report Submitted to Louisiana Department of Wildlife and Fisheries, State Wildlife Grants. 19 pages.

Jenkins, A. J. and J. Godwin. 2021. 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. 2021. 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. 13 pages.

Lawson, K.M. et al. 2021. Planning level survey of Redstone Arsenal for At-Risk Species and Ecologically Significant Communities. Final report submitted to Environmental Management Division, U.S. Army Garrison, Redstone Arsenal, Huntsville, Alabama. 411 pages.

Schotz, A. 2021. Status assessment for Pondberry (*Lindera melissifolia*) in Alabama. Unpublished report for the Alabama Department of Conservation and Natural Resources. 21 pp.

Active Grants Table 2021 - Alabama Natural Heritage Program

Sponsor	Project Title	Investigators	Amount	Years
ADCNR	Investigation of Alabama Red-bellied Turtle Nesting in Alligator Nests	Godwin and Armbruster	\$60,125	2020-2021
Louisiana DWF	Occurrence of western chicken turtle in Louisiana	Godwin and Oaks	\$136,436	2019-2022
ADCNR	Reintroduction of the Eastern Indigo Snake onto Conecuh National Forest	Godwin and Warner	\$102,845	2021
USFWS	Flattened Musk Turtle and Black Warrior Waterdog populations study	Godwin and Armbruster	\$85,852	2021
ADCNR	Genetic and Habitat Analyses to Support Recovery Efforts for Flattened Musk Turtle	Godwin and Armbruster	\$159,048	2021
USFWS	Range-wide Status Assessment for Ravine Sedge (<i>Carex impressinervia</i>)	Schotz and Armbruster	\$28,000	2021-2023
ADCNR	Habitat suitability modeling for large-flowered skullcap in Alabama	Schotz, Lawson, Armbruster	\$28,750	2021-2022
DoD	Redstone Invasive Species Assessment	Schotz and Armbruster	\$129,000	2020-2022
ADCNR	Alabama Black Belt Prairie Assessment	Schotz, Lawson, Armbruster	\$297,160	2021-2024
EPA	Reference Wetland Study	Schotz, Armbruster	\$229,452	2018-2022

Active Grants Table 2021 - Museum Faculty and Staff

Sponsor	Project Title	Investigators	Amount	Years
ADCNR	Predictive habitat modeling of geographic distribution for the federally endangered Relict Trillium in Georgia and Alabama	Goertzen and Johnson	\$22,000	2020-2021
NSF	Collaborative Research: Documenting marine biodiversity through digitization of invertebrate collections	Halanych	\$34,019	2020-2024
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
University of Michigan/NIH	Integrated Approach to Health and Longevity - Enhancing Drug Target Discovery (subaward)	Hill/Hood	\$93,722	2021
University of Michigan/NIH	Integrated Approach to Health and Longevity - Enhancing Drug Target Discovery (subaward)	Hill/Hood	\$61,983	2021
NSF	Testing alternative routes of adaptive phenotype-environment matching across heterogeneous landscapes in wild populations	Warner	\$1,160,000	2020-Present