



Auburn University

Museum of Natural History



2014 Annual Report

Auburn University Museum of Natural History

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Auburn University Museum of Natural History

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

Location

AU Museum of Natural History
Biodiversity Learning Center
Auburn University

Alabama Natural Heritage Program®
1090 South Donahue Drive
Auburn University, AL 36849

Fax:

AUMNH: (334) 844-9234
ALNHP: (334) 844-4462

Websites

Auburn University
Museum of Natural History:
aumnh.org

ALNHP:
www.alnhp.org

Affiliated Websites

NatureServe
www.natureserve.org

From the Director:

This past year proved to be a very exciting and productive one for the Auburn University Museum of Natural History (AUMNH). Most notably it marks the completion of the first year in which the Museum and Alabama Natural Heritage Program (ALNHP) have joined forces. The Museum staff has now grown from four collections managers to two newly appointed research assistant professors (Drs. Brian Helms and David Steen), three full time collections managers (Davids Laurencio and Werneke, and Curtis Hansen), a zoologist (Jim Godwin), a botanist (Al Schotz), database manager (Michael Barbour), and outreach coordinator (Kay Stone); Jennifer Weber (former DBS undergraduate) has also joined the team temporarily this spring and summer to assist in the collections and with database management. We also added another curator to the ranks with the appointment of Dr. Ken Halanych as curator of Marine Invertebrates. The merger of the AUMNH and ALNHP has proved to be a tremendous boon to the research, education, and outreach missions of the AUMNH that will likely only grow as we move forward.

Although it is probably now time to revisit the AUMNH strategic plan, it is worth noting that we have made significant strides meeting our objectives over the past few years particularly with respect to infrastructure, collections growth, digitization, and education and outreach. The curators, staff, and students have settled nicely into the Biodiversity Learning Center. However, projected collections growth in the coming years will quickly outpace the space available. We have made significant strides in terms of databasing the AUMNH collections with the move to the Specify platform further facilitated by National Science Foundation funding via two TCN grants (Herbarium and Invertebrates totaling nearly a half a million dollars)

through the Expanding Frontiers Program. As in past years the collections based research continues to be very productive with respect to publications and grants. Finally, we have also had considerable success in fundraising with a couple of major gifts. In combination with grant and Foundation support, the AUMNH was able to provide summer assistantships for over 10 students and collections acquisition grants to five others.

The addition of the outreach coordinator position has greatly expanded the AUMNH capacity to provide educational opportunities for the citizens of Alabama, young and old. We had a really successful AU tailgate open house this past fall and now open the doors of the collections to the public every first Wednesday of each month. In collaboration with COSAM Outreach and its Science Matters summer program, summer 2015 will mark our first Junior Curator Camp (2 –weeks) with nearly 40 local middle school students in attendance. In total our outreach activities served over 3,000 folks this past year! And, I hope that everyone will again join me in congratulating Kay Stone for having been recognized as the 2014 Conservation Educator of the Year by the Alabama Wildlife Federation.

The AUMNH is incredibly proud to have the ALNHP as part of the collections and research enterprise. The Heritage Program is now working closely with Museum curators and staff, DBS faculty members and students to better integrate its mission and activities with those of the Museum and Department. As you will see in the details of the enclosed report, the ALNHP had a banner year in terms of publications, grants and conservation related activities. Major funding support has come from a tremendous and diverse number of sources that include Alabama Department of

Conservation and Natural Resources, US Fish and Wildlife Service, the EPA, and US Forestry Service. The breadth of projects spanning plant and animal diversity, most of which are threatened and endangered species, highlights the importance of the ALNHP with respect to

informing conservation policy and management decisions across the state of Alabama and the southeastern United States.

It's been a great year and looking forward to working with everyone as we move forward into 2015.

All the best,

Jason E. Bond, PhD

Professor of Biology and Director of the Auburn University Museum of Natural History



Primary funders (in alphabetical order)

Alabama Department of Conservation and Natural Resources, Division of Wildlife & Freshwater Fisheries

- Black Warrior Waterdog and Flattened Musk Turtle Status Survey using Environmental DNA (eDNA)
- Distribution, Abundance, and Health Assessment of the Gopher Tortoise (*Gopherus polyphemus*) in Alabama
- Distributional survey of the Southeastern Pocket Gopher (*Geomys pinetus*) in Alabama
- Historical Changes to Amphibian and Reptile Faunas in Five Key Alabama Watersheds
- Population Structure and Conservation Status of Burrowing Bog Crayfishes
- Red-cockaded Woodpecker Safe Harbor Agreement
- Reintroduction of the Eastern Indigo Snake onto Conecuh National Forest
- Status of the Endangered Alabama Red-bellied Turtle (*Pseudemys alabamensis*) In the Dog River and Rivers of Weeks Bay
- The Range and Relationships of Three Undescribed Species of *Typhlichthys* (Percopsiformes: Amblyopsidae) in Alabama

COYPU Foundation

- Aquatic Biodiversity of the Western Guiana Shield

NatureServe

- Natchez Trace Parkway Vegetation Classification and Mapping

National Institute of Health

- Eastern Equine Encephalitis in southeastern reptiles

National Science Foundation

- All Cypriniformes Species Inventory
- Digitization TCN: InvertEBase: Reaching Back to See the Future: Species-rich Invertebrate Faunas Document Causes and Consequences of Biodiversity Shifts
- Millipede Systematics: Developing Phylogenomic, Classification, and Taxonomic Resources for the Future.
- SERNEC TCN digitization: The Keys to the Cabinet

U.S. Environmental Protection Agency

- Ecogeomorphology of the Appalachian Plateau of Alabama and Tennessee
- Inventory, Classification, and Assessment of Alabama's Geographically Isolated Wetlands

U.S. Fish and Wildlife Service

- Mohr's Barbara-buttons Status Survey
- Price's Potato-bean Status Assessment
- Range-wide Status Assessment of Big-leaf Witch Hazel

U.S. Forest Service

- Alabama Streak-sorus Fern Monitoring
- Black Warrior Waterdog and Flattened Musk Turtle Studies in the Bankhead National Forest, Alabama

U.S. Geological Survey

- Behavior and Physiology of Invasive Argentine Tegus in Semi-natural Enclosures in Alabama

AUMNH COLLECTIONS

Herbarium

The Freeman Herbarium (AUA) is the largest herbarium (in total number of specimens) in the state of Alabama and has been designated as the state herbarium. As such, this collection is a critical resource for all areas of botanical and floristic research in Alabama, the southeastern United States and beyond.

The herbarium is an active resource for those studying plant topics such as, anatomy, identification, distribution, ecology, genetics,

phenology, palynology, rarity, nomenclature, conservation, invasive species, herbivory, floristics, historical collections, public awareness and outreach, medicinal & poisonous plants, forensic botany, plant & insect/animal interactions.

Highlighted below are the major activities of the Freeman Herbarium in 2014.

Accessions/Acquisitions/Exchanges/Loans

Exchanges continue to be received that add great diversity to the collection. In particular, we have received exchange material from some distant places including 160 vascular plants from Australian National Herbarium in Canberra, 20 specimens from France, and 28 lichens from Belarus. In addition, we received over 150 specimens from University of West Alabama and 40 from the University of Alabama. We sent out over 50 specimens as exchange to other institutions. We have sent out one loan 58 specimens and received 4 incoming loans totaling 423 specimens.

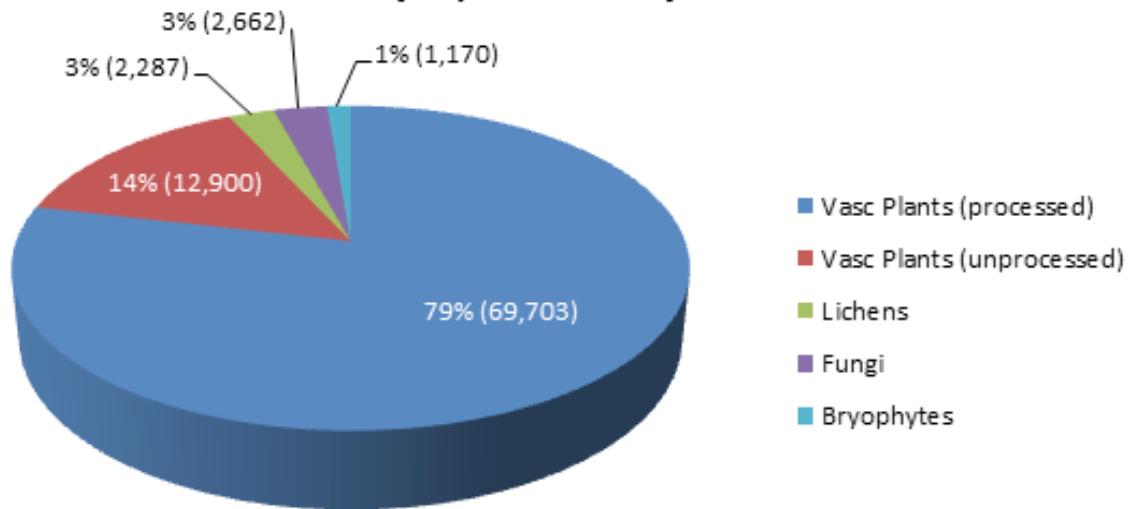
Teaching, Students, & Volunteers

Volunteers have helped immensely in the herbarium during 2014. Five students from Honors Biology had the opportunity to be trained and mentored in herbarium management techniques including mounting, filing, transcription and data entry. This group along with three additional volunteers made great progress in mounting our backlog of specimens during the spring semester of 2014. In the fall, volunteers Ross Adams, Rachel Hodges and Katherine Whitehead were trained in the herbarium where they continued to process our back log of specimens to be mounted. Ross was especially helpful in transcribing collection notebooks of Dr. Barry L. Comeaux, a grape vine (*Vitis*) expert, whose collection of over 2,000 *Vitis* specimens the herbarium is now processing.

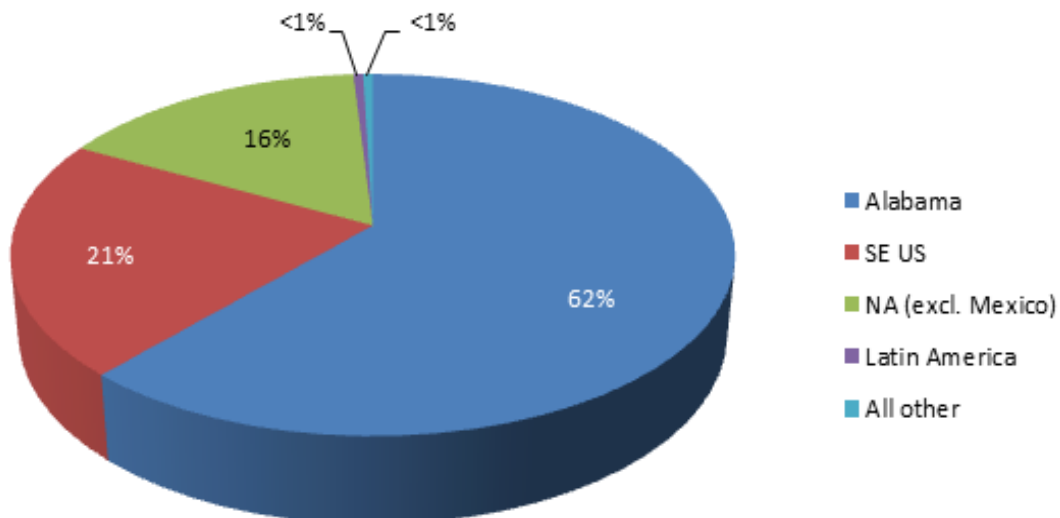
Digitization/Database Development

Freeman Herbarium continues efforts to go digital. Over 800 specimens were entered into the plant database in 2015. The program Specify is used to catalog and track plant specimens. Along with entering label data into the database, each sheet is receiving a barcode label to better track specimen data. Once each family is entirely barcoded the digitized information is sent to the Alabama Plant Atlas (APA) (www.floraofalabama.org) and made available online for other researchers. The Freeman Herbarium is a founding member and major contributor to the APA. With the recently awarded SERNEC TCN grant from NSF, digitization efforts are moving forward.

**Composition of Herbarium Specimens
(88,722 total)**



Distribution of Herbarium Specimens



Research & Collections Related Activities

***Marshallia* Genomics**

The Goertzen lab is focusing on the genomics of the wild sunflower genus *Marshallia* and amassing huge amounts of genomic resources for investigation. Over 1,000 sheets of *Marshallia* are on loan from dozens of herbaria for study by lab members who are gleaning information for morphological, phenological and distributional studies. The lab is working with collaborators in Spain to quantify the genome size of *Marshallia* through flow cytometry.

Curtis Hansen has been using high-throughput genetic sequencing data to explore the genomics of the genus *Marshallia* (Asteraceae), specifically targeting the ITS region of nrDNA and characterizing the chloroplast genome. He is actively engaged in final genomic analyses and writing his dissertation. His research has been funded by the US Fish & Wildlife Service, Auburn University, the Alabama Wildflower Society and The Nature Conservancy.

Nathan Hall has been working on genomic characterization of *Marshallia* and assisting in the assembly of the chloroplast genome. In addition he is characterizing transposable elements within *Marshallia*. He has received a grant from the Alabama Wildflower Society (\$1,000) and gave an oral presentation at the 2014 AU Graduate Research Forum titled, "Sequencing and Characterization of Del/Tekay chromoviruses in the wildflower *Marshallia obovata*."



Anthony Melton has conducted genetics research utilizing the *Marshallia* genomic and transcriptomic resources of the Goertzen lab to assemble and characterize the *Marshallia* Clade III CRF gene and examine RNA editing within the chloroplast genome. He is currently collaborating with Katherine Mincey of the Boyd lab on a phylogenetic analysis of the morphs of *Streptanthus polygaloides*. He received a \$4,000 AU-CMB Summer Research Fellowship and a \$250 AU Graduate School Thesis Grant. He presented a poster, "Phylogenetic, molecular evolutionary and functional genomic studies of *Marshallia* (Compositae) utilizing next generation sequencing technology," at the AU Graduate Research Forum and at the Alabama Academy of Sciences Meeting

Dr. Roland Dute, Professor in the Biological Sciences Department, continues to explore herbarium specimens looking for the presence of pit membranes in vascular plant tissue. Several groups of plants in the herbarium have been critical to his research including *Osmanthus*, *Schisandra*, and *Dirca*.

Specimen-based Research

In addition to the many tours through the museum, the herbarium was visited by at least 51 people who signed the log book including researchers and individuals from such organizations as the Alabama State Lands Division, Georgia Plant Conservation Alliance, Centre for National Sciences (Guinea), and The

Sierra Club. Researchers from on campus came from many departments including Horticulture, Agronomy & Weed Science, Forestry & Wildlife, Plant Pathology, and English. In addition, over 90 e-mail requests for identifications or other plant related questions were addressed by the herbarium collections manager.

Fish Collection

Digitization/Database Development

In June, the database was submitted to Specify to begin the conversion to that software and to VertNet for upload preparation. The conversion process for Specify was still ongoing at the end of the year. In October, the fish collection database was made available on VertNet, and

linked to FishNet2 and the Global Biodiversity Information Facility (GBIF). End-of-year VertNet reports show 118 searches, 4,720 records retrieved, and 1,519 records downloaded in the last quarter of 2014. In the nine months prior to this we had only eight data requests via email.

Accessions/Acquisitions/Exchanges/Loans

After the move to the new museum building in 2013, the fish collection resumed normal operations in 2014. The collection accessioned 2,149 lots (23,691 specimens) from 263 localities in 2014. This new material came from localities in the following eight countries: United States (1,716 lots), Guyana (271 lots), Uruguay (103 lots), Peru (49 lots), Ecuador (2 lots), Colombia (1 lot), Norway (1 lot), and South Africa (1 lot). Research projects in Bankhead National Forest, AL and Guyana provided 25% of the new material for the year, while backlog and donations provided the remainder. Researchers

not affiliated with Auburn University donated 106 lots to the museum, including two paratypes.

We had 19 transactions for the year comprised of: nine voucher loans totaling 112 lots, one voucher specimen gifted as a paratype, and nine tissue loans totaling 72 lots. Jon Armbruster, David Werneke, seven graduate students, 18 undergraduate students, and eight visiting scientists used over 1,360 lots for research projects. Specimens from the collection were cited in 16 journal articles on taxonomy, phylogenetics, ecology, and physiology.

Herp Collection

The Division of Herpetology continues its untiring efforts to uphold and advance the museum's missions. Division staff, students and associates are continually active in conducting and promoting collection growth and curation, in participating in collections-based research, and in facilitating the dissemination of information through scholarly publication and museum outreach.

Accessions/Acquisitions/Exchanges/Loans

In 2014, over 430 amphibian and reptile specimens were added to the alcohol collection. These included adults, larvae, egg masses and associated tissues. Additionally, several dozen skeletal specimens were added to the osteological collection and over 130 digital vouchers were added to our photo/audio/video voucher collection. Combined, these new herpetological specimens produced over 70 county records (the first documented individual of a species in a given county). The herpetology collections were also utilized by reserachers throughout the year. In 2014, a total of 11 herpetology loans were completed and no less than 23 data and tissue requests were processed.

Teaching, Students, & Volunteers

The Museum's herpetological scientific and teaching collections were also extensively utilized by undergraduate and graduate courses for class use, class projects and individual research. The conversion of room 251 into lab instructional area has allowed several courses to teach their labs within the museum. These include Vertebrate Biodiversity and Herpetology, two courses that rely on museum and teaching specimens for learning amphibian and reptile identification. The summer's Vertebrate Biodiversity course had 12 enrollees. In the fall a total of 77 students spent lab time in the museum as both Herpetology and Vertebrate Biodiversity held their labs in the classroom. Additionally, 12 student class projects were based out of the herpetological collections. We have also had the pleasure of working with 10 undergraduate volunteers and directing 3 undergraduate research projects over the last year.

Live Animal Collection

Continuing another decades long tradition, dating back at least to the tenure of Dr. Robert Mount, the live animal room, now located in nearby Funchess Hall, has been an indispensable resource, which we utilized during both tours and outreach programs. Moreover, our live animals are utilized by other campus programs and departments, further increasing both the impact of the museum collections and the visibility of the museum. In all, live animals were utilized in close to 50 events in 2014 and were seen by over 3,000 people.

Volunteers

Gabrielle Dunham	Christina Holbrook
Hannah Fuqua	Kathlene Joyce
Heather Gosse	Faith Lyles
Ashley Tyler Harris	Steven Mirkin
Rachel Hodge	Meagan Tyler

Research & Collections Related Activities

Scientists took advantage of our new space in the BLC to conduct collections-based research here at the museum on 6 different occasions. Use of the herpetology collections by outside scientists focused primarily on turtles and salamanders for both outgoing loans and visiting scientists.

Herpetology personnel were also diligent in producing original collections-based or collections-related research. In 2014, no less than 10 papers related to the herpetological collections were published. These papers showcase the breadth of research being conducted at the AUMNH and cover among other topics: basic ecology and natural history, herpetofaunal diversity, taxonomy, behavior, invasive species, as well as the conservation of threatened and endangered species. Additionally, the year saw six oral presentations and one poster presentation as well as more than 70 published amphibian and reptile county records, documenting the first occurrence of a species in a county. All major groups of Alabama amphibians and reptiles were represented in the above publications. Furthermore, at least 6 papers utilizing AUMNH herpetological specimens have been published over this same time period.

In 2014, the herpetology division had the following five collaborations based on AUMNH specimens: Drs. Ken Wray and Darin Rokyta at Florida State University (evolution of venom

systems in rattlesnakes), Dr. Kristin Bakkegard at Samford University (evolution of slimy salamanders), Dr. Jennifer Deitloff at Iowa State University (community ecology of *Plethodon websteri/ventralis* complex), Dr. Kirsten Nicholson at Central Michigan University (phylogeography of Central American *Norops*), Dr. Sean Graham at Sul Ross State University (phylogeography of dwarf salamander complex).

Citizen Science

Over the last year, we have also started one and revived another citizen science program that allow Alabamians to participate in the collection of real scientific data and add to our knowledge base on the geographic distribution of our herpetofaunal diversity as well as the calling phenology of our state's frog species. The AUMNH is now 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, and we have revived the Alabama Herp Atlas Project (AHAP) a citizen science program where anyone can send in photo documentation of any species of amphibian or reptile to add to both our photo voucher catalog our geographic distribution maps for that species. Many of these photo vouchers represented and were published as county records. We hope to soon develop educational components to each of these programs.

Bird Collection

Accessions/Acquisitions/Exchanges/Loans

The ornithological research collection consists of about 2000 bird skins, 50 bird nests with eggs, and 50 empty bird nests. A great majority of the material originates in Alabama. Of the remaining material, the skins are primarily from elsewhere in the Southeast, although a few specimens collected in Central America and Europe are represented. Many of the skins represent the first documentation of that species in the state, and a few remain the only documentation of the species for the state. The ornithological collection added 40 skins in 2014 as well as over 1,500 new photos. These photos range in geographic scope and include

the states of New York, New Jersey, Maryland, Washington D.C., Virginia, Florida, Californian and of course Alabama.

Photographs in the ornithological photo collection were utilized in three publications that came out during 2014. The year also saw two ornithological loan requests and two data requests. One of the loan requests was for material from the ornithology collection, namely two Red-cockaded Woodpeckers, to be used by the Jule Collins Smith Museum of Fine Arts for their “The Art of Vanishing” exhibit.

Teaching, Students, & Volunteers

In addition to the research collection, the AUMNH houses a large teaching collection consisting of about 100 bird skins, bird nests, and taxidermic mounts of birds. Most of the skins in the teaching collection were prepared from salvaged carcasses by students taking Ornithology. The teaching collection is used by several classes in the Department of Biological Sciences to teach bird identification and avian anatomy. The spring semester saw 48 undergraduate and 6 graduate students enrolled in Ornithology, and the summer’s Vertebrate Biodiversity course had 12 enrollees.



Red-cockaded Woodpecker (*Picoides borealis*)
photo by Derrick Hamrick

Vertebrate Paleontology Collection

Accessions/Acquisitions/Exchanges/Loans

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

collections of terrestrial mammals from the Cenozoic Era. This year saw the museum acquire a cast of "Auburn's Dinosaur" the theropod *Appalaciosaurus montgomeriensis*. Originally discovered by Dr. David King of Auburn's Geology Department, the cast represents the first cast of this species. The museum now holds all remaining portions of the cast outside of the head and leg that is currently on display in Petrie Hall on the campus of Auburn University.

Teaching, Students, & Volunteers

Another great development in the vertebrate paleontology collection was the great volunteer help provided by Claire Wilson. Through her efforts, the collection is being organized and the fossils' housing is being improved.

Mammal Collection

Accessions/Acquisitions/Exchanges/Loans

The AUMNH mammal collection is comprised of around 3900 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. A skeletal voucher of an Eastern Spotted Skunk (*Spilogale putorius*) a species of High Conservation Concern, highlighted the new material added to the mammal holdings. Two mammal data request and one loan request were received in 2014. The loan consisted of specimens of the endangered Alabama Beach Mice (*Peromyscus polionotus ammobates*) which were used as part of the Julie Collins Smith Museum of Fine Arts' "The Art of Vanishing" exhibit.

Research & Collections Related Activities

The mammal collections also had a working collaboration with Dr. John L. Hunt of the University of Arkansas at Monticello. Last, the year also saw the publication of "Mammals of Alabama", authored by the collection's curator Dr. Troy L. Best and its curator emeritus Dr. Julian L. Dusi (posthumously). The much needed and anticipated book is the first and only exhaustive guide to the state's mammals.

Teaching, Students, & Volunteers

During 2014, the collection benefited from a group of seven highly motivated undergraduate curatorial assistants. Their efforts helped maintain and organize the collection.

Curatorial Assistants

Jordan Traff

Spring, Summer, and Fall 2014.

Kaelyn M. Dobson

Spring and Summer 2014.

Victoria Self

Spring, Summer, and Fall 2014.

Molly Wright, Spring 2014

Lindsey Heim, Spring 2014

Alexis Hunter, Summer and Fall 2014.

Jennifer Parks, Fall 2014.

Invertebrate Collection

There was considerable activity in the AUMNH Invertebrate Collection (AUMNH-IC) during 2014. Multiple research projects were active/pursued and significant specimen acquisition/accesion occurred, most with multiple students involved. There was also significant AUMNH-IC representation in University teaching, technical/professional workshops, and international scientific meetings. These activities are outlined below.

Accessions/Acquisitions/Exchanges/Loans

Additions were made to the AUMNH-IC through significant student, volunteer, and personal efforts. A total of 2962 lots (10.2% growth) were accessioned in 2014. These included 1593 benthic marine invertebrates from Antarctica, 752 benthic aquatic macroinvertebrates from Alabama and Georgia, 255 crayfish, branchiobdellidans, snails, and freshwater inverts, and 362 other various inverts (pentastomes, pseudoscorpions, crustacea). These accessions occurred concomitantly with the migration to Specify 6.5. However databasing activities are still occurring in FileMakerPro as networking issues are resolved with Specify. Several collections were acquired during 2014. The internal move of Antarctic specimens collected by the lab of Ken Halanych resulted in the acquisition of approximately 1800 lots) in January 2014. The Invertebrate Collection also

acquired the Renate Wittig marine collection from East Carolina University in October 2014. This collection is still being sorted, but it is estimated to contain ~6000 lots of molluscs from around the world. In October 2014, the AUMNH-IC acquired the Marine Invertebrate Collection from University of South Alabama, estimated at 1500 lots. Finally, work is continuing on transferring the AL caddisfly acquisition from late 2012. The Renate Wittig, USA, and AL caddisfly collections have only partially been accessioned and their numbers are not reflected in total Accessions above.

A total of 8 loans were processed this year. Loans were requested from Jacksonville State University, Appalachian State University, Southern Illinois University, Martin Methodist College, and Auburn University

Teaching, Students, & Volunteers

During 2014, there were 6 graduate students associated specifically with the Invertebrate Collections. Stephen Sefick and Brad Schneid are both PhD candidates focusing on stream insect assemblages in the Southeastern Plains. Tim Roberts is a MS student studying the phylogeography of Florida spring snails. Eric Bauer is a PhD student exploring insect and crayfish assemblages in streams of the Appalachian Plateau. Mallary Clay, a current MS student, is examining the population genetic structure of burrowing crayfishes in south Alabama.

There were also several undergraduate researchers active in the Invertebrate Collections. Andrew Collins was an undergraduate researcher working on sorting and identifying invertebrates associated with crayfish burrows during Fall 2014. Meghan Neace was an REU Fellow during Summer 2014 who worked on integrating art and science by illustrating multiple specimens in the invertebrate collection, including integrating illustrations of 2 closely-related species of crayfish into currently studies. Richard West was an undergraduate technician who worked on sorting stream invertebrate samples for EPA 103-b grant during the Summer and Fall 2014.

Beyond research, there were 12 regularly occurring undergraduate volunteers associated with the Invertebrate collection in 2014. These individuals assisted in many routine curatorial duties, such as accessioning, organizing, and/or labeling specimens, checking alcohol levels, sorting collections, and assisting with outreach programs. These students are listed below:

Khori Dunn
Amelia Hand

Dennis Donegan
Isabelle Wagoner
Shannon Guin
Rachel Dedman
Richard West
Eric Jaegge
Robin Lloyd
Gabriel Dunham
Sara Emily
Stephen Mirken

Personnel associated with the Invertebrate Collection were also active in other teaching activities beyond individual mentorship. Museum staff led 5 students for BIOL 1037 in spring 2014 in a collective project in the Invertebrate Collection. This small-group project included weekly field and laboratory exercises, data collection, and interpretation. Invertebrate Collection personnel also co-taught Stream Biodiversity mini-course at Elmore Correctional Facility in spring 2014 as part of the SPARKS Prison Education program. Further, a laboratory session of Invertebrate Zoology was conducted in the collections during spring 2014 focusing on crayfish, insect, and spider identification and diversity (approx. 60 students). There were two informal lectures presented by Collections staff, one for the AU Society of Conservation Biology student group on Alabama aquatic biodiversity and a public lecture at Jule Collins Smith Museum on biodiversity crisis in Alabama on September 3. Finally, Collection staff joined STEM-IQ team focused on increasing participation and training area middle schools and high schools for regional science fairs. This involves participating in summer teacher training workshops, visiting local schools and training students and teachers, and judging regional science fairs.

Research & Collections Related Activities

Eco-Morphological Mitigation Design and Assessment Tools for the Alabama and Tennessee Appalachian Plateau

Student: Eric Bauer (DBS PhD student); Cade Kistler (CS&ES MS student); Richard West (DBS undergraduate)

Source: US Environmental Protection Agency

A multi-disciplinary team has been working in the Appalachian Plateau region of Alabama and Tennessee to:

a. Develop reference stream hydraulic geometry relationships (i.e. regional curves) for predicting stable stream morphology,

b. Determine stream/floodplain eco-morphological relationships for predicting stream and riparian ecological functions related to drainage area and morphological conditions and

c. Develop a checklist for rapid stream stability and ecological condition assessment test stream eco-morphological assessment tools for evaluating restoration potential and success. Museum staff are currently involved with surveying aquatic biota in relation to this project.

Population structure and conservation status of burrowing bog crayfishes (*Fallicambarus* spp.).

Student: Mallery Clay (DBS MS student)

Source: ALDCNR / Section 6

The marshes, swamps, and bogs of extreme southern Alabama are embedded in the critically endangered longleaf pine ecosystem and are home to 3 closely-related species of burrowing crayfishes (*Fallicambarus* spp.) almost exclusively found associated with pitcher plant

bogs of the Southern Pine Hills. All three species, which are of similar size, apparent life-histories, and often appearance, are considered to be of Greatest Conservation Need (GCN) and carry an Alabama state ranking of P1 or P2. We are currently identifying independent populations with molecular techniques to provide short-term management recommendations.

Distribution and population structure of branchiobdellidan worms in the Tallapoosa River drainage.

Student: None

Source: WormNetII

Branchiobdellidans, or crayfish worms, are leech-like clitellate worms that form an obligate ectosymbiotic relationship primarily with freshwater crayfishes. Most of the 140 described branchiobdellidan species live on surfaces of the host, with several reports of localized microhabitat preference. Researchers have long proposed that branchiobdellidans act as cleaning

symbionts, yet there is a general lack of support suggesting any sort of host specificity between worms and crayfish. We are investigating the geographic extent and host associations of branchiobdellidans in the Tallapoosa River drainage. This work is providing a baseline knowledge of these unknown distribution patterns and host associations which will serve as a foundation for future ecological investigations.

Population structure of the Slackwater crayfish (*Cambarus halli*) and the Tallapoosa crayfish (*Cambarus englishi*) in the Tallapoosa basin

Student: Rebecca Vaught (DBS undergraduate)

Source: ALDCNR / Section 6

Crayfishes reach their peak biodiversity in North America, with the Mobile Basin of the southeastern US harboring high levels of endemism. However, the genetic diversity and phylogeography of crayfishes from this region are poorly understood. Here, the genetic structure and shape variation among multiple populations of *Cambarus englishi* and *C. halli*, both endemic to the Tallapoosa River,

were examined from three catchments of the drainage (Upper, Little, and Middle) using molecular tools and geometric morphometrics. Data suggest that populations in nearly every stream sampled is genetically unique, genetic separation is manifested in part by shape variation and overall, these crayfishes appear to represent “cryptic species complexes”. Our data provide evidence that there is considerable population isolation and cryptic diversity within North American crayfishes.

Dynamics of crayfish inquiline communities.

Student: Andrew Collins (DBS undergraduate)

Although generally associated with open water, many crayfish species spend much of their lives in terrestrial burrows that extend to the groundwater. These burrows create spatially-defined habitat patches for other organisms (microcrustaceans, insects, vertebrates). Generally little is known about burrowing crayfish, considerably less the co-inhabitants and

community structure in their burrows. We have initiated a preliminary study with *Cambarus harti* (Piedmont Blue Burrower) in west Georgia to describe the assemblage structure within burrows and identify potential physical predictors. The overall objectives of this study are to shed light on the ecological role played by burrowing crayfish and the fundamental drivers of food webs.

Evaluation of a low-cost sampling protocol for a coordinated, crayfish life-history sampling effort

Student: multiple graduate and undergraduate volunteers

Despite the importance of life-history information to the design of efficient conservation strategies, as of 2013, life-history studies had been published for only 12% of the 347 crayfish species in the US and Canada. In

response to this need, the Southeastern Crayfish Biologist Working Group was formed to coordinate life-history research efforts amongst the southeastern states. As part of this effort we developed a preliminary core sampling protocol that could be reliably conducted on a frequent (monthly) basis with minimal funding.

The role of crayfishes as bioturbators in a southeastern Piedmont stream.

Student: Amelia Hand (DBS undergraduate)

Crayfish can act as keystone species and ecosystem engineers in small streams, but their comparative effects in flowing water are not well known. We used an enclosure–exclosure experiment to investigate the influence of two coexisting species of crayfish (*Cambarus*

englishi and *C. halli*, which occupy different habitats) on sediment accumulation and benthic invertebrates. Although analyses are still underway, our results suggest that these 2 species of crayfish may be functionally redundant in this community, despite differences in habitat association.

Research Manuscripts

There were several original research articles either published or submitted for publication in 2014 associated with the AUMNH-IC. Results of a study examining the predictive ability of measurements of bank erosion on stream invertebrate and fish assemblages suggest that fast measures of stream geomorphology can offer detailed insight into biotic composition (Simpson et al. 2014). This was coupled with a floristic study examining the influence of stream channel incision on streamside vegetation communities (Turner et al. *In press*). The identification and formal definition of stream reference condition in the Southeastern Plains was determined using stream geomorphology macroinvertebrate assemblages (Kosnicki et al. 2014). Other work on stream discharge estimation (Sefick et al. 2014) in the Southeastern

Plains further add to our budding knowledge of the physical and biological dynamics by providing tools to predict hydrologic flows this ecoregion. The role physical habitat plays in determining the outcome of symbiotic feeding relationships was explored using crayfish and branchiobdellidan worms, which are close relatives to earthworms and leeches and spend their entire lives on crayfish hosts (Ames et al., 2015). Also, the cryptic diversity of 2 closely-related crayfish species endemic to the Tallapoosa basin was examined with molecular genetics and geometric morphometrics (Helms et al. *in revision*). This study suggests that nearly every stream examined in the study area harbours a genetically and morphologically unique population of crayfish.

Meetings / Workshops / Talks / Abstracts

Several meetings and workshops highlighting pertinent research were attended by personnel of the AUMNH Invertebrate Collection during 2014. Original research and/or status updates were provided at each meeting. In January 2014 at Annual Alabama Mollusk and Crayfish Meeting in Cheaha State Park, Alabama, updates from across the state were given by researchers, agency personnel, and other scientists regarding freshwater snails, mussels, and crayfishes across the state. In February, personnel from the AUMNH-IC participated in the Alabama Biological Condition Gradient Workshop which was conducted jointly by the AL Department of Environmental Management and the US Environmental Protection Agency. This meeting, held in Columbiana, AL, was attended by fish and invertebrate experts across the southeast in an attempt to define biotic criteria for stream assessments according to USEPA standards for ADEM use. In March, a *Wetland Program Development Final Report* summary was presented to the EPA at their Region 4 Office in downtown Atlanta,

GA. This meeting allowed researchers and agency personnel to interact, give and receive feedback, and generally serve as a guide in future development of stream assessment tools. Finally, in May, several AUMNH-IC faculty and students presented a collaborative study highlighting the disparate responses of biota to land use change in different ecoregions at the Joint Aquatic Sciences Meeting (i.e., Society for Freshwater Sciences) in Portland, Oregon. Finally, in November, the Invertebrate Collection was represented at the Annual Meeting of the Southeastern Fishes Council in Asheville, NC. Beyond society meetings and workshops, staff from the Invertebrate Collection (Helms) was invited to give primary research talks at Columbus State University in March 2014 and Appalachian State University in October 2014.

Two abstracts were published in 2014 from researchers associated with the Invertebrate Collection, both featuring graduate students. Additionally, 6 abstracts were prepared in 2014 and presented early 2015 featuring Invertebrate Collection personnel.

ALABAMA NATURAL HERITAGE PROGRAM®

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

Natural Heritage Programs have three broad functions:

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

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



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

NatureServe represents an international network of biological inventories - known as natural heritage programs or conservation data centers - operating in all 50 U.S. states, Canada, Latin America and the Caribbean. NatureServe and its network of natural

heritage programs are the leading source for information about rare and endangered species and threatened ecosystems. Together we not only collect and manage detailed local information on plants, animals, and ecosystems, but develop information products, data management tools, and conservation services to help meet local, national, and global conservation needs. The objective scientific information about species and ecosystems developed by NatureServe is used by all sectors of society - conservation groups, government agencies, corporations, academia, and the public - to make informed decisions about managing our natural resources.

Project Summaries

Alabama Streak-sorus Fern Monitoring

The Alabama Streak-sorus Fern (*Thelypteris burksiorum*) is a federally threatened species endemic to the Sipsey Fork of the Black Warrior River in Bankhead National Forest. Since the initial comprehensive status assessment of the species in the early 1990s, comprehensive surveys to determine population viability, evaluate population trends and identify disturbances and potential threats have not been implemented. To update information on existing occurrences and to search for new sites, ALNHP partnered with the U.S. Forest Service and Alabama Power in 2013 to embark on a five-year project that also entailed establishing permanent monitoring plots to further assess the long-term effects of natural and human-derived disturbances.

All 19 previously known occurrences of Alabama streak-sorus fern have been surveyed. Plants at five sites could not be relocated as part of this project in 2013 and 2014. As an effort to place a greater emphasis in following NatureServe guidelines defining an element occurrence and the distances that separate them, boundaries of existing occurrences have been redefined. Occurrences documented previously in ALNHP's data system have now been combined and delineated to represent three occurrences. However, given ongoing surveys during 2015-2017, these boundaries are subject to change.



Photo by W. Testo.

Four permanent plots have been established at two colonies as an effort to monitor population dynamics. Site selection was based on ease of accessibility, as colonies in each occurrence generally require an extension ladder access the plants for census work. Each plot was delimited by inserting nails affixed with numbered metal tags in rock crevices. It is anticipated that long-term monitoring will serve as a platform to evaluate the impacts of climate change.

As part of this project, incidental observations of the Kral's Water-plantain (*Sagittaria secundifolia*), a federally listed species, were also made from four locations in the Sipsey Fork and Brushy Creek. Information reflecting the biology, colony dimensions, and locations will be updated in the data system of ALNHP. Additional colonies are expected to be found.

Behavior and Physiology of Invasive Argentine Tegus in Semi-natural Enclosures

In 2014, in collaboration with the United States Geological Survey, the Auburn University Department of Biological Sciences, and the Auburn University Veterinary School, we initiated a study to determine whether Argentine Tegus (*Tupinambus merianae*), currently invasive in South Florida, could survive and reproduce in Alabama.



In spring of 2014 we renovated a number of outdoor mesocosms (3 m wide fiberglass tubs) and outfitted them with camera traps, ibutton temperature recorders and artificial burrows. In summer of 2014 we obtained 19 adult tegus and surgically implanted them with radio-transmitters (in case of escape) and ibutton temperature recorders. Tegus were released into individual tubs following surgeries. We are currently monitoring tegus throughout the winter and will evaluate whether they can successfully survive the winter and if so, whether they successfully reproduce in the spring.

Two undergraduate students have been hired to assist on this project.

Natchez Trace Parkway Vegetation Classification and Mapping

ALNHP partnered with NatureServe and the U.S. Geological Survey to assist with a vegetation classification and mapping effort along the Natchez Trace, a 469-mile national parkway spanning Alabama, Mississippi, and Tennessee. The purpose of this project was to provide the National Park Service with scientifically credible information on the type, quality, and distribution of ecological communities along the length of the parkway to augment the implementation of proper management protocols. A second phase of the project will take place during the summer of 2015, where

an accuracy assessment of vegetation mapping will be conducted. Information from field studies implemented during 2014 to gather data on vegetation, topography, slope, and soils were used to interpret and delineate vegetation associations on aerial imagery. Field assessments in 2015 will determine the level of accuracy identifying vegetation associations through aerial photo interpretation by gathering vegetation data from pre-selected points. A final product highlighting the results of the project will be submitted in early 2016.

Black Warrior Waterdog (*Necturus alabamensis*) and Flattened Musk Turtle (*Sternotherus depressus*)

The Black Warrior River basin, above the Fall Line, is an area of aquatic endemism in Alabama; two of these species are the Black Warrior waterdog (*Necturus alabamensis*) and the flattened musk turtle (*Sternotherus depressus*). Both species are state protected while the flattened musk turtle is federally threatened and the Black Warrior waterdog a US Fish and Wildlife Service candidate species. The waterdog and musk turtle each inhabit, ideally, clear streams and rivers with permanent flow, reduced sedimentation, and a substrate of underwater rocks, crevices, and ledges,

although degraded water quality is thought to have impacted populations of these animals. Their ranges overlay to a very large extent and they occupy similar sites and habitats. Studies at sites within the Bankhead National Forest where these species are known to co-occur have revealed interesting seasonal patterns between these species. The Black Warrior waterdog is active during the winter months but as waters warm the salamander “disappears”, to be seemingly replaced by the flattened musk turtle from late spring through early fall.

Black Warrior Waterdog and Flattened Musk Turtle Status Survey using Environmental DNA (eDNA)

Black Warrior waterdog is thought to have experienced a precipitous decline in range as the most recent surveys have documented the species from only 14 localities. The flattened musk turtle is known from more localities, approximately 60, yet a large percentage (>50%) of its occupied habitat is thought to have been lost due to habitat fragmentation.



Based on known localities of both species and their shared habitat these species are considered to have very similar, if not nearly identical, distributions.

Typical sampling techniques for Black Warrior waterdog include dip netting leaf packs and the setting of baited minnow traps. Flattened musk turtles are generally collected with the setting of baited traps with wading and hand capture occasionally used. Drawbacks to waterdog and musk turtle sampling include limitations of dip netting to chest deep water and a dependence

upon the persistence of leaf packs. High water conditions preclude dip netting and may wash out leaf packs and inhibit the setting of minnow traps and turtle traps. Baited minnow traps and turtle traps must be checked regularly, at least once every 24 hours, and turtle traps must be set to avoid drowning of turtles, or checked more frequently than 24 hours.

The use of environmental DNA (eDNA) in presence/absence studies has proven to be quite effective and in numerous studies has been

shown to be more sensitive to detecting target species over conventional sampling. In this study we've used eDNA to resample known localities and identify new localities.

Sampling in 2012-13 included 26 sites that were chosen based on past collections of one or both species. These sites were distributed across the known range of both the Black Warrior waterdog and flattened musk turtle. Additional localities were sampled in 2013-14 across 6 stream reaches, Sipsey Fork and Brushy Creek in Bankhead National Forest, two on Locust Fork, and the lower Mulberry Fork and upper Warrior River. Water samples were taken by grab samples with a decontaminated 1-L Nalgene bottle. Three samples per site per season (winter and summer) were taken. From each water sample approximately 1,000 ml of water was filtered through a cellulose nitrate filter with a pore size of either 0.45 μ m or 0.8 μ m. Once filtration was completed the filter was stored in a vial containing 95% ETOH (2012-13) or CTAB (2013-14). Filtered samples were stored in a -200C freezer prior to lab analysis.



DNA was extracted from the ETOH stored samples using a Qiagen kit or if in CTAB with a chloroform technique. Molecular primers for each target species were developed; the CO1 gene for *Necturus alabamensis* and the 16S gene for *Sternotherus depressus*. To confirm target specificity primers were tested against congeneric taxa for both species.

Positive eDNA results for *N. alabamensis* were obtained from sites from which the salamander was last observed in 1991. Streams previously unknown to have *N. alabamensis* that yielded positive eDNA results were Gurley Creek in Jefferson County and Rush Creek in Bankhead National Forest. Three sites on Locust Fork were positive for eDNA. The Sipsey Fork and Brushy Creek in Bankhead National Forest had numerous positive points. Six sites on Sipsey Fork and 7 on Brushy Creek were positive expanding the known distribution in these streams.

Twelve sites of 26 were eDNA positive for *Sternotherus depressus*. At one of the positive sites, Clear Creek in Winston County, the last report for the turtle was in 1983. All of the 6 sampled stream reaches returned positive eDNA results for the musk turtle. Six sites on Sipsey Fork and 7 on Brushy Creek were positive, again documenting the importance of these streams in the Bankhead National Forest of critical importance to aquatic biota in the Black Warrior River drainage.

This project was conducted in collaboration with Dr. Lesley de Souza, Shedd Aquarium, Chicago, IL.

Black Warrior Waterdog and Flattened Musk Turtle Studies in the Bankhead National Forest, Alabama

The drainage area of the upper Black Warrior River basin is an estimated 3,095,559 acres and encompasses the 348,989 acre Bankhead National Forest, thus, the Bankhead National Forest totals ~11% of the total of the upper Black Warrior River basin. Considering that the ranges of the Black Warrior waterdog and flattened musk closely correspond to the upper Black Warrior River basin, and then the Bankhead National Forest contains approximately 11% of the range of these species. As many streams within the river basin are degraded, management of Forest Service lands to promote high water quality will be critical to the long-term survival of these rare aquatic species.

Over the duration of this 5-year project studies in the Bankhead National Forest will be to: 1) determine the distribution of the Black Warrior Waterdog and Flattened Musk Turtle in Sipsey Fork and Brushy Creek; 2) determine the status of these species in the Sipsey Fork and Brushy Creek; 3) collect data on the seasonal movements and nesting of the Flattened Musk Turtle; and 4) provide streamside management recommendations to the U.S. Forest Service pertaining to these species. This 5 year project is being funded by the U.S. Forest Service.

During summer of 2014 36 Flattened Musk Turtles of both sexes (14 males and 22 females) were outfitted with radio transmitters to track movements and located nest sites. Turtle movements are being studied at two non-overlapping sites on Sipsey Fork and one on Brushy Creek. One site on Sipsey Fork used in 2013 was dropped due to human activity. No nesting activity of a radio tracked turtle was documented. A total of 856 turtle telemetry points were collected from mid-June to January 2015 and individual turtles have been followed



Sipsey Fork

up to 395 days. Random in-stream and riparian habitat data plots have been completed for Sipsey Fork; habitat data collection for Brushy Creek will be completed summer 2015. The in-stream and riparian data is being used in a comparative analysis to similar data collected at turtle telemetry points to determine habitat features important to the Flattened Musk Turtle.

Sipsey Fork, Brushy Creek, and one locality on Rush Creek were surveyed in an eDNA analysis of the Black Warrior Waterdog and Flattened Musk Turtle. Prior to the eDNA survey the Black Warrior Waterdog was known by specimens from three localities on Sipsey Fork and one on Brushy Creek. Positive eDNA results were found at six of 13 sample points on Sipsey Fork; the Black Warrior Waterdog is known from two of these six sample points. Seven of 12 sample points on Brushy Creek were positive for Black Warrior Waterdog eDNA and the salamander is known from two of these localities. The site on Rush Creek sampled for the Black Warrior Waterdog was positive for eDNA and represents a new locality and occupied stream in the national forest.

Prior to the eDNA survey the Flattened Musk Turtle was known by specimens from two localities on Sipsey Fork and one on Brushy Creek. Positive eDNA results were found at 10 of 13 sample points on Sipsey Fork; the Flattened Musk Turtle is known from three of these 10 sample points. Eight of 12 sample points on

Brushy Creek were positive for Flattened Musk Turtle eDNA and the turtle is known from one of these localities. These new eDNA localities on Sipsey Fork and Brushy Creek extend the known distributions within these streams for both the Black Warrior Waterdog and Flattened Musk Turtle.

Mohr's Barbara-buttons Status Survey

A range-wide status survey on Mohr's Barbara-buttons (*Marshallia mohrii*) in Alabama and Georgia began in May 2012. The project was completed and a final report submitted in December 2014. A total of 34 extant occurrences are documented from four counties in Alabama (Bibb-12, Calhoun-3, Cherokee-3, Jefferson-1) and from one county in Georgia (Floyd-15). Of extant occurrences, five or 15 percent are protected on conservation lands (including three owned or partially owned by The Nature Conservancy, a private conservation organization). Unquestionably, the highest quality occurrences are found at The Nature Conservancy's Bibb County Glades Preserve in Alabama.

The habitat containing *M. mohrii* is vulnerable to timber production and invasive species infestations, and to a lesser degree, commercial and residential development. Results of this study show impacts from the above-mentioned activities to existing occurrences appear relatively major, having the greatest impact on occurrences associated with the Coosa Valley prairie system in northeast Alabama and adjacent Georgia. The habitat is also vulnerable to vegetation succession, with the long-term viability of plants at a minimum of nine sites appearing compromised as a result of fire exclusion. *Marshallia mohrii* is capable, however, of establishing large, viable occurrences, given the proper habitat.



Ongoing surveys in the appropriate habitat will likely disclose additional occurrences, particularly in Bibb County and portions of neighboring counties in the Ridge and Valley physiographic region in central Alabama, as well as the Coosa Valley prairie system in northeast Alabama and adjacent Floyd County, Georgia. To maintain the species as a viable component of the region's natural heritage, continuous management efforts addressing invasive species infestations, land development, and other aspects of human-induced changes will need to be achieved.

Distribution, Abundance, and Health Assessment of the Gopher Tortoise (*Gopherus polyphemus*) in Alabama

As the keystone species of the Southeast US coastal plain, the Gopher Tortoise has experienced population declines across its range. Currently, populations of the Gopher Tortoise, range-wide, are being studied with the goal of providing information to the US Fish and Wildlife Service regarding a final decision on federal listing. Due to a lack of basic information on the status of the Gopher Tortoise in Alabama, on public and private lands, this effort will be to conduct an in-depth study on the distribution, abundance, movement patterns, and health of Gopher Tortoises in Alabama. Additionally, because a potentially life-threatening emerging infectious disease, upper respiratory tract disease (URTD), has been



observed in tortoises across North America, an additional study will be done to further understand the mechanism that may be causing gopher tortoise mortality in Alabama, and how land management might help conserve this species. Over a four year timeline, basic data related to the current distribution and abundance of Gopher Tortoises in the state will be acquired to determine their status on public and private property.

URTD survey work was completed from one private property in Covington County (Solon Dixon Forestry Education Center) and from one public property (Geneva State Forest). Preliminary analyses of external symptoms indicate that URTD is present at both sites. Assays of baseline stress indicate that despite presence of disease, both populations are overall healthy.

Experimental manipulations investigating behavioral fever and context-dependent mechanisms of disease susceptibility are ongoing utilizing tortoises from Solon Dixon Forestry Education Center. Preliminary data indicate significant immunological changes in response to bacterial infection that are not directly paralleled by increases in body



temperature in tortoises during the active season. However, ongoing studies are being conducted to investigate possible fever responses during dormancy; preliminary data indicate that dormant tortoises maintain an elevated body temperature during acute bacterial infection. Lastly, a study related to seasonal shifts in the immune system has been finished, and data from this study were presented at the 2014 Gopher Tortoise Council in Albany, GA. This study indicated that tortoises have suppressed baseline immune function during dormancy; this study is currently in preparation for

manuscript submission to *Functional Ecology*.

In preparation to perform the LTDS surveys pilot surveys have been done at Perdido Wildlife Management Area, and initial field visits conducted at Wehle Nature Center and Lakepoint State Park. LTDS has been completed at three sites, Geneva State Forest and two of the three sites in Conecuh National Forest. Pilot survey has been completed on the third Conecuh National Forest site. Results on the three completed sites include total transect length surveyed, total estimated area surveyed, number of burrows scoped, number of occupied burrows, burrow occupancy rate, estimated tortoise density, estimated tortoise population, and the dates in which the LTDS was performed. Total transect lengths to complete LTDS at sites have ranged from 41,800 to 67,500 meters. Estimated tortoise densities from the sites completed range from 0.208 to 0.421 tortoises/ha, with estimated average population sizes ranging from 196 to 589 tortoises/ha.

This 4-year study is being funded by a State Wildlife Grant and is in collaboration with Dr. Sharon Hermann (PI), Dr. Mary Mendonca, Jeff Goessling (PhD student) (Department of Biology, Auburn University), and Dr. Robert Gitzen and Helen Tripp (MS student) Department of Forestry and Wildlife.

Distributional Survey of the Southeastern Pocket Gopher in Alabama

Southeastern Pocket Gophers (*Geomys pinetis*) are of increasing conservation concern because of an apparent rangewide distributional decline. Recent surveys have failed to detect populations in many previously occupied areas, particularly in central Georgia, west central Alabama, and south central Florida. Pocket Gopher surveys were conducted to identify the current distribution of the species in Alabama. Historic Southeastern Pocket Gopher locations were compiled from museum specimens, published records, and biodiversity databases. Mammalogists and other biologists also were contacted to request information on locations at which they had observed Pocket Gophers or Pocket Gopher mounds in the past. Additional areas of potential occupancy were identified by examining aerial photos for the presence of pocket gopher mounds. All sites at which pocket gophers had been observed in the past and potentially occupied areas identified from aerial photos were searched for the presence of pocket gopher mounds.

Southeastern Pocket Gophers are patchily distributed in Alabama but can be locally



Photo by John Trent.

common. Pocket Gophers were detected at 28 of the 94 total historic sites (29.8%) compiled from previous records and 27 new sites, for a total of 55 occupied sites. They were confirmed to be present at sites in Barbour, Bullock, Coffee, Crenshaw, Escambia, Henry, Houston, Macon, Montgomery, Pike, and Russell counties. There was no evidence of Pocket Gophers present at any of the sites previously occupied in Autauga and Baldwin counties.

The range of Southeastern Pocket Gophers has continued the decline reported by Skelly et al. (2001), with a continued contraction to the southeast on the periphery of the range. The populations in Autauga and Baldwin county appear to have been extirpated, and all extant populations are well to the south and east of the Alabama River. The range of the Southeastern Pocket Gopher now appears to be almost restricted to Choctawhatchee and Apalachicola basins. One cluster in Macon County extends into the Coosa-Tallapoosa Basin and one cluster was found in the Coosa-Tallapoosa Basin in Montgomery County. All other occupied sites were found within the Choctawhatchee or Apalachicola basins.

Historical Changes to Amphibian and Reptile Faunas in Five Key Alabama Watersheds

Amphibians and some reptiles are important sentinel species in conservation planning because of their ties to both terrestrial and aquatic habitats. Because amphibian populations can be adversely affected by change to either environment, they are particularly sensitive to factors such as global climate change, pollution, and habitat degradation. Alabama's rich amphibian and reptile faunas contain several



species of conservation concern because they require habitat features that do not persist in landscapes altered by human activities. For example, the Hellbender (*Cryptobranchus alleganiensis*) is documented from Alabama by a series of museum specimens, but no populations are known to remain in the state. This species likely had breeding habitat severely diminished as a result of impoundment of the Tennessee River and changes to water temperature, water flow, and rates of sedimentation associated with intensive large scale agriculture. Using historical and contemporary data for selected watersheds patterns of faunal persistence will be investigated with particular regard to species of high conservation concern. Watersheds selected for study include systems with extensive historical data and represent

portions of Alabama's physiographic variation. In addition, the streams in study have been designated as Strategic Habitat and River Reach units for aquatic species of conservation concern in Alabama: Bear Creek (Tennessee River drainage), Cypress Creek (Tennessee River drainage), Shoal Creek (Coosa River drainage), Five Runs Creek (Yellow River drainage) and Uphapee Creek (Tallapoosa River drainage). Finally, the data from this study will provide current information on the distributional status, relative abundance and habitat use of amphibians and reptiles within these systems.

In 2014 records for species collected or observed within the five target watersheds were compiled from Auburn Museum of Natural History, Alabama Museum of Natural History at the University of Alabama, Jacksonville State University, the University of South Alabama, Herpnet, Alabama Natural Heritage Program database and the Alabama Herp Atlas Project. These data were summarized to create the historical species accounts for this project. The searches yielded 3638 records: Bear Creek 271, Cypress Creek 300, Five Runs Creek 171, Uphapee Creek 2528, and Shoal Creek 368.

Bear Creek: In 2014 trap effort totaled 174 trap-nights. Twenty of the 57 species of aquatic reptiles and amphibians of historical occurrence within the watershed were documented plus five additional species were documented from the watershed, Southern Cricket Frog (*Acris gryllus*), Green Tree Frog (*Hyla cinerea*), River Cooter (*Pseudemys concinna*), Loggerhead Musk Turtle (*Sternotherus peltifer*), and Pond Slider (*Trachemys scripta*). One priority species of conservation concern the Southeastern Five-lined Skink (*Plestiodon inexpectatus*) was

documented. Species of conservation concern not documented this year were the Green Salamander (*Aneides aeneus*), Hellbender, Seepage Salamander (*Desmognathus aeneus*), and Alligator Snapping Turtle (*Macrochelys temminckii*).

Cypress Creek: In 2014 trap effort totaled 177 trap-nights. Eighteen of 57 species previously reported within the watershed were documented plus five species not previously documented, Spiny Softshell Turtle (*Apalone spinifera*), Northern Painted Turtle (*Chrysemys dorsalis*), Green Tree Frog, Pickerel Frog (*Lithobates palustris*), and Northern Red Salamander (*Pseudotriton ruber*). Priority species of conservation concern not documented were Green Salamander, Seepage Salamander, Tennessee Cave Salamander (*Gyrinophilus pallescens*), and Alligator Snapping Turtle. No species of conservation concern were documented by our trapping or survey efforts from this watershed. However, one record of a Hellbender from this watershed was submitted to the Alabama Herp Atlas Project.

Five Runs Creek: In 2014 trap effort totaled 22 trap-nights. Thirty seven of the 71 species historically documented from the watershed were confirmed. Two species previously unknown from the watershed were added to the faunal list, Spiny Softshell Turtle and Alligator Snapping Turtle. Priority species of conservation concern documented this year were the Gopher Frog (*Lithobates capito*)



Green Treefrog, photo by Ron Eakes

this year. In addition, these records represent the only documentation of this species from the Tuskegee National Forest.

Shoal Creek: In 2014 trap effort totaled 81 trap-nights. Fifteen of the 71 species historically reported within the watershed were documented plus four species not previously known from the watershed, Spiny Softshell Turtle, Common Snapping Turtle (*Chelydra serpentina*), Narrow-mouthed Toad (*Gastrophryne carolinensis*), and Loggerhead Musk Turtle. Priority species of conservation concern within this drainage are the Green Salamander, Alligator Snapping Turtle, and Seepage Salamander; none of these were documented this year.

Inventory, Classification, and Assessment of Alabama's Geographically Isolated Wetlands

In October 2011, we initiated a 3-year EPA-funded wetland mapping project to identify, classify, and assess geographically isolated wetlands in Alabama. We constructed GIS models of wetlands in Alabama using National Wetlands Inventory (NWI) data, Soil Survey Geographic (SSURGO) data, and geographic object based image analysis (GeOBIA) of 2011 National Imagery Program (NAIP). Expanding the methodology introduced by Tiner (2003), we created a GIS model that

identifies geographically isolated wetlands from each of the wetland models based on the USGS National Hydrography Dataset (NHD) and Federal Emergency Management Agency (FEMA) National Flood Hazard Layer (NFHL) database. A subset of the wetlands identified as geographically isolated in the total combined model were selected for field visits to verify the classification and to conduct an ecological classification and assessment.



Isolated wetlands in all models tended to be small, with a mean size generally <1 ha. The NWI model contained a higher number and acreage of wetlands than the other two individual models with the soils model containing the fewest. The number of geographically isolated wetlands uniquely identified in each model followed the same pattern. The total combined model identified 92,160 individual geographically isolated wetlands covering 70,664 ha.

Thirteen high quality ecological community types were identified from wetlands visited, with Pond Cypress (*Taxodium ascendens*), Swamp Black Gum (*Nyssa biflora*), and Myrtle-leaved

Holly (*Ilex myrtifolia*)-dominated associations appearing most numerous in the southern part of the state, whereas examples dominated by a combination of Sweetgum (*Liquidambar styraciflua*), Red Maple (*Acer rubrum*), and Swamp Black Gum were most prevalent of those wetlands documented in north Alabama. A host of rare plants monitored by ALNHP were also recorded, including some of the state's rarest species such as Epiphytic Sedge (*Carex decomposita*), Springs Clearweed (*Pilea fontana*), Chapman's Butterwort (*Pinguicula planifolia*), and Dwarf Burhead (*Echinodorus tenellus*).

Price's Potato-bean Status Assessment



A status assessment of the federally threatened Price's Potato-bean (*Apios priceana*) began in 2012 to update baseline information on all documented occurrences of the species throughout Alabama and Mississippi. The project was completed in September 2014 with a final report having been submitted to the U.S. Fish and Wildlife Service. This data will better enable the agency to determine the proper conservation needs and protection of the species at the federal level.

A total of 15 extant occurrences are documented from nine counties in Alabama (Autauga-2, Butler-1, Dallas-1, Lawrence-1, Jackson-2, Madison-5, Marshall-1, Monroe-1, Wilcox-1) and from three counties in Mississippi (Kemper-1, Lee-1, Oktibbeha-1). Of extant occurrences, nine or 50 percent are receiving protection on conservation lands (including those by private conservation land trusts). Unquestionably, the highest quality occurrences are found at Jones Bluff and Sauta Cave National Wildlife Refuge in Alabama and the Coonewah Preserve in Mississippi. All three occur on conservation lands, two under federal ownership and one under private ownership by the North Mississippi Land Trust. As now documented, the occurrences of *A. priceana* in Alabama and Mississippi likely contain no less than approximately 2,266 and 517 individuals, respectively, with a total of 2,783 plants among 18 occurrences between the two states. The total estimated area of coverage is roughly 17 hectares.

The habitat containing *A. priceana* is vulnerable to commercial and residential development and invasive species infestations, and to a lesser degree, timber harvesting. As of this report, impacts from the above-mentioned activities to existing occurrences appear relatively minor. The habitat is also vulnerable to vegetation succession, with the long-term viability of plants at a minimum of four sites appearing compromised through the lack of reproduction. *Apios priceana* is capable, however, of establishing large, viable occurrences, given the proper habitat. The species depends on insect pollinators for at least part of its reproductive success, but very little is known about the identity, specificity, rarity, status, current effectiveness, or population trends of these pollinators.

While several occurrences exist on conservation lands, the long-term viability of *A. priceana* may become jeopardized without protective management on public and private lands, and could remain as a threatened species. For the species to remain a viable component of the region's natural heritage, continuous management efforts addressing invasive species infestations, land development, and other aspects of human-induced changes will need to be accomplished.



Range-wide Status Assessment of Big-leaf Witch Hazel

The Big-leaf Witch Hazel (*Hamamelis ovalis*) is an attractive winter-blooming shrub that produces red to occasionally yellowish-orange flowers from late December to early February. The species was originally described by Steve Leonard from specimens gathered on the Camp Shelby training site in Perry County, Mississippi, in 2006. Subsequently, the species was discovered in Alabama from Clarke County in 2009 and from Tattnall County, Georgia in 2014, both state records made by Wayne Webb of Florida. The species has since been found in five more counties in the southwestern portion of the state, where it prefers well-drained soils of forested slopes and ridges. This study of *H. ovalis* will furnish an overall assessment on the abundance of the species, habitat preferences, apparent disturbances and potential threats, and management needs for the species. A final report will be submitted to the U.S. Fish and Wildlife Service in 2015.



Red-cockaded Woodpecker Safe Harbor Agreement

ALNHP is working with ADCNR and USFWS to encourage forest landowners to enroll property in the Red-Cockaded Woodpecker Safe Harbor program. Under a Safe Harbor Agreement, the landowner agrees to carry out activities expected to benefit red-cockaded woodpeckers, but no added federal restrictions will be imposed should the numbers (or occurrences) of the species expand beyond a “baseline” level when the agreement is entered into. Copies of the brochure describing the Safe Harbor Program have continued to be distributed to interested individuals.

ALNHP received annual monitoring reports from seven of the eight properties enrolled in Safe Harbor. The Enon-Sehoy Plantation agreement was amended to describe and clarify the original intent of the “woodpecker project” at Enon-Sehoy. The Net Conservation Benefit section of the original agreement lists several management practices that were agreed upon back in 2007. The original intent was for these practices to be done by a partnership including federal and state government agencies, volunteers, the Cooperator, etc. It was not the original intent for the Cooperator to do all of these things on their own. Clarifying that with this amendment will allow us, moving forward, to have clear expectations for the new owners of the parcels which have been sold.



Reintroduction of the Eastern Indigo Snake onto Conecuh National Forest



After four years of Indigo Snake releases onto Conecuh National Forest, our attention has shifted to monitoring of the existing population and planning for the experimental reintroduction of additional snakes in a nearby area. Further, we are expanding the project to determine how the reintroduction of the Indigo Snake has affected wildlife assemblages.

As a result, in February and March of 2014 we installed 18 drift-fence arrays to capture amphibians and reptiles both in the release site (six arrays) and in areas where there are no

Indigo Snakes (12 sites). Further, we commenced small mammal trapping in all of these sites in December 2014.

Time and area-constrained searches of the release site (303 person/hours between December 2013-March 2014) resulted in the capture of five individual Indigo Snakes (V7, K5, U6, U3 and O9). Interestingly, none of these snakes had been previously monitored with radio-telemetry and had not been observed since their release. Snakes U3, U6, and V7 had been released in 2013, O9 was released in 2012, and K5 was released in 2011. Two additional Indigo Snakes were captured in drift fence arrays, V7 (noted above) and C5-1, the latter had been released in 2013. A dead Indigo Snake (T1) was reported on the road in May 2014, it had been released in 2013.



Collaboration continues to be the key to this endeavor involving Auburn University (ALNHP/ Environmental Institute & Department of Biology), Alabama Department of Conservation and Natural Resources (ADCNR), The Orianne Society, U.S. Forest Service, U.S. Fish and Wildlife Service, Georgia Department of Natural Resources, Zoo Atlanta, and Ft. Stewart (US Army). Funding for the project has been through a State Wildlife Grants administered by ADCNR with The Orianne Society providing matching funds.

Status of the Endangered Alabama Red-bellied Turtle (*Pseudemys alabamensis*) In the Dog River and Rivers of Weeks Bay

Sampling for the Alabama Red-bellied Turtle for the collection of tissue samples to test for genetic exchange between populations and trap data to establish a baseline regarding the status of the species was completed in the Dog River and Fish and Magnolia rivers of Weeks Bay during the 2014 field season. This large herbivorous turtle occupies only eight drainage basins in coastal Alabama and Mississippi. Alabama locations of Alabama Red-bellied Turtle population centers are found around drainages around Mobile Bay and the lower Mobile-Tensaw Delta. The Mobile Bay rivers include Fish and Magnolia rivers of Weeks Bay, Bon Secour River, Dog River, and Fowl River. The objective is to provide baseline data on the population of the Alabama red-bellied turtle in the Dog River and Weeks Bay rivers and provide an assessment of the status of this species in these rivers. The Dog River, a smaller river on the western side of Mobile Bay, contains a population of the Alabama Red-bellied Turtle and other *Pseudemys* taxa identifiable as either the River Cooter (*Pseudemys concinna*), Florida Cooter (*Pseudemys floridana*), or putative hybrid. Limited trapping in the Dog River was performed previously in 2012 with the 2014 effort contributing substantially more information on the status of the Alabama Red-bellied turtle in this river system; with both years combined data was collected on a total of 30 Alabama Red-bellied Turtles.

Fish and Magnolia rivers of Weeks Bay have been sampled in 2011, 2012, and 2014. Data



was collected on 93 Alabama Red-bellied turtles across all years and equally between the two rivers. Cooter taxa also occur in the Weeks Bay rivers and are more common than the Alabama Red-bellied Turtle. Cooters occur in all rivers where Alabama Red-bellied turtle have been captured and the trend is has been for Cooters to be more common than Alabama Red-bellied turtles.

Genetic studies in collaboration with the Brad Shaffer lab at University of California at Los Angeles and Greg Pauly with the Los Angeles County Natural History Museum

Data and information from this study will be used in the revision of the USFWS recovery plan of the Alabama Red-bellied Turtle and in a manuscript on the Turtles of Mobile Bay (Graham et al. in prep).

Information Systems & Technology

Biotics Biodiversity Database

ALNHP maintains a comprehensive database on the location and conservation status of species and ecological communities in Alabama. In November 2014, we converted our Biotics database from Biotics 4 to Biotics 5, the newest generation of NatureServe's biodiversity data management software. Biotics 5 is an integrated, web-enabled platform for tabular and spatial data management that centralizes the data and software hosting in a shared "cloud" environment maintained by NatureServe using a software-as-a-service delivery model. Biotics 5 provides a common data management platform for members of the NatureServe network to achieve and maintain a unified taxonomy and consistent application of our shared data standards and methodology. Biotics 5 provides the framework for managing taxonomic and biological data on elements of biodiversity and mapping known locations for elements of concern.

The Biotics database is supported by funding through our inventory and conservation planning projects. Although building and improving the database has always been a primary goal of the program, securing funding to support this important program area remains a challenge. ALNHP is currently tracking 1,472 rare plant and animal taxon (Fig. 1) plus 93 natural communities. There are 7,239

individual occurrences of these species and natural communities documented in Biotics, with the majority of the Element Occurrences (EO) being for vascular plants or aquatic species (Fig. 2).

Since March 2008, we have been working on improving our database compliance with the Benchmark Data Content Standards (BDCS) for natural heritage data. This past year's efforts focused on redigitizing data imported from BCD to improve the spatial representation and QC of federal status data. We also concentrated on creating shapes for Managed Area records so that the mapped component for the area was included in the database. We will continue working to improve the database with the goal of meeting all BDCS goals. The focus in the coming year will be redigitizing data imported from BCD to improve the spatial representation and improving EO Rank completeness and quality. We will also begin a concerted effort to begin addressing the backlog of data entry.

One of the important tasks each heritage program performs is the regular compilation of a Rare Species Inventory List for the state that ranks each element tracked by the program based on the number and quality of occurrences. Our revised Alabama Inventory List was published October 2014, with the list distributed to cooperators and other interested parties and posted to the ALNHP website.

Data Requests

Over the past year, ALNHP has responded to 22 paid data requests; 43 requests from academia, conservation non-profits, government agencies, NatureServe, other Heritage Network members, or cooperating partners; and 17 requests for an environmental review. The number of requests was similar to past years.

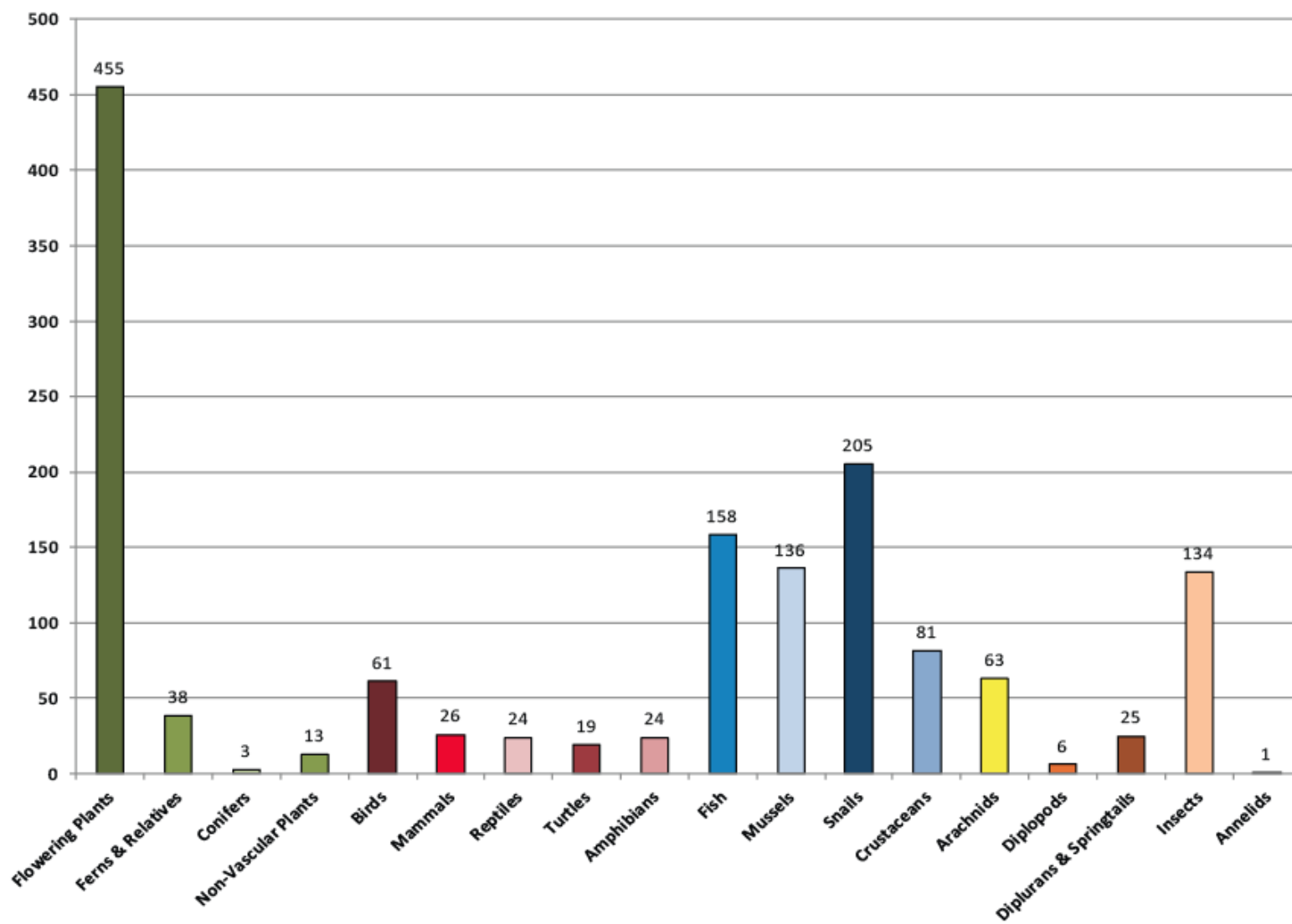


Figure 1. Number of rare plant and animal species track by ALNHP (total 1,472).

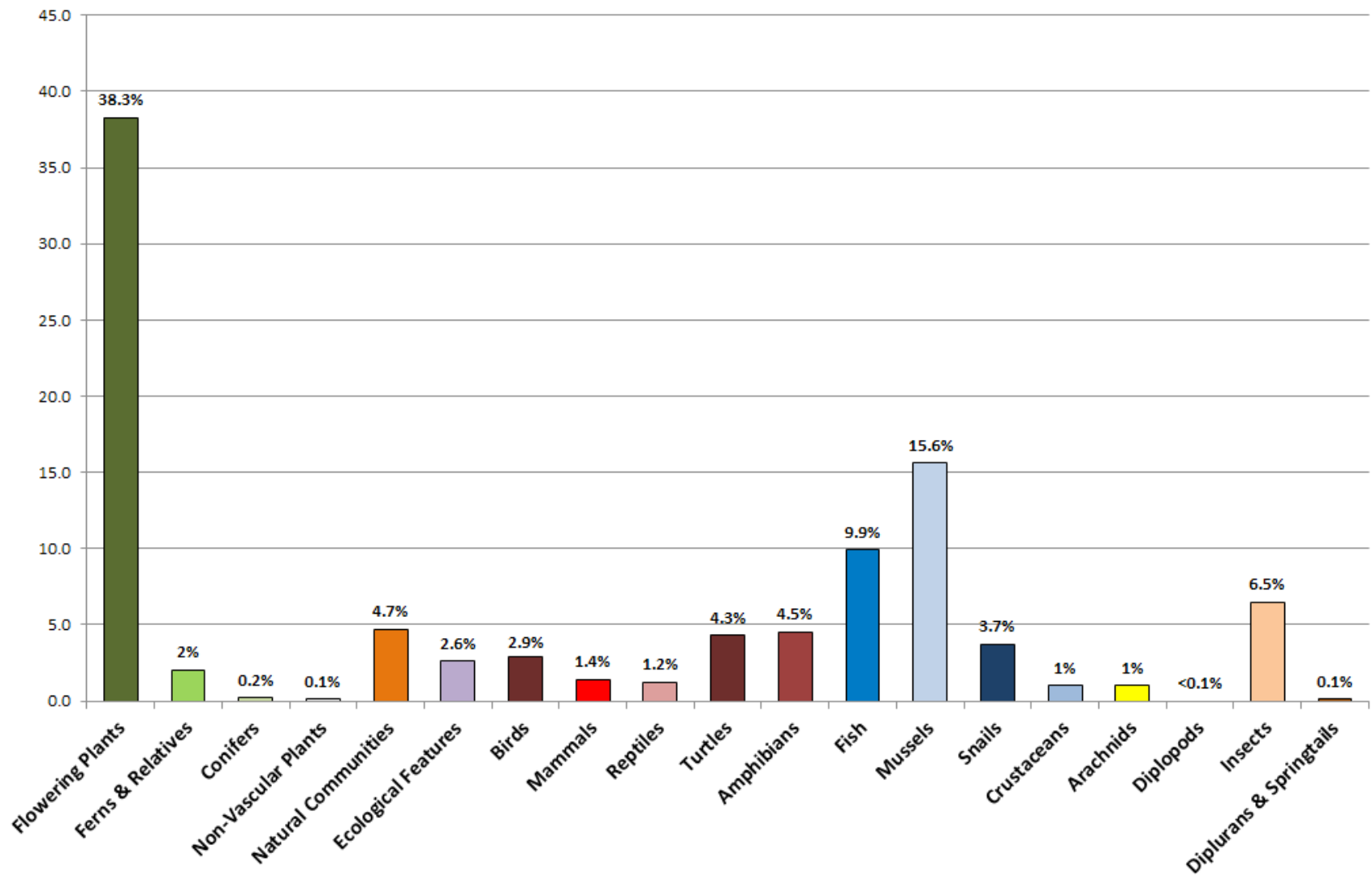


Figure 2. Percentage of 7,239 Element Occurrences in Biotics by major taxonomic group.

OUTREACH

Continuing the long tradition of providing museum-based educational outreach, both locally and throughout the state, museum staff members have been very active in promoting the education mission of the museum both by hosting tours of the museum and by providing outreach programs to the community. With last year's move to the new Biodiversity Learning Center, 2014 marked the first full year of having both an onsite space for outreach programs and the ability to hold tours of the museum's collections. Having these resources available has already paid great dividends in our ability to serve the citizenry. Through the combined efforts of museum staff and associates, over 5,000 people have been reached in one way or another since the AUMNH moved into the new building.

In 2014, our busy outreach calendar peaked during the summer months and consisted of informal science education programs presented in both formal and informal settings. Over the last year, AUMNH staff members and associates have participated in 58 non-tour outreach events. These events served over 2,200 people. The events were as diverse as our stakeholders, ranging widely in scope, age, pedagogy and content. As in the past, most, but not all of our outreach programs were held off campus. Outreach programs were conducted for groups

ranging from ages 3 and up, and most involved live animals. By numbers of attendees, the most served age group was elementary aged school children. Group sizes ranged from 5 to around 150 individuals and the programming and content was designed to fit the grade level and content needs of each group. Because the AUMNH does not as of yet have any public display and interpretation space, these programs are of paramount importance and they are our primary means of disseminating information to, and communicating with, the citizens we serve.

The move to the new BLC has created a positive buzz in the community and an increase in the museum's visibility. Because of this, we have seen a dramatic increase in the number of tour requests we receive. In 2014, the museum staff conducted close to 40 tours to dozens of different groups. Tour groups ranged in size from 1 to 350 persons, and in age from Elementary School students through retirees. Tour groups included, school groups, scouting groups, on-campus groups, dignitaries and even local service organizations. Additionally, 7 non-museum based lab sections from various courses toured the museum as part of one of their class or lab periods. We expect the demand for tours to increase as word spreads about the great resource that the community has here right in their own backyard.

Art of Extinction

During Fall 2014, personnel from the Invertebrate Collection co-organized and curated joint exhibit with the Jule Collins Smith Museum of Art entitled 'The Art of Extinction'. This exhibit included specimen displays from many of the AUMNH collections at JCSM, including rare, endangered, and extinct species, in conjunction with display of rare and

endangered representatives from the JCSM Audubon collection. Museum personnel also participated in public outreach events associated with this exhibit, including a panel discussion on endangered species and a public lecture on the diversity and conservation crises of Alabama aquatic organisms.

EGM Agency Field Day

In October of 2014, personnel from the AUMNH Invertebrate Collection, in conjunction with team members from Auburn University and North Carolina State University, led an agency training day in association with the Eco-Morphological Mitigation Design and Assessment grant. This

involved providing training and insight of current project methods and findings (including biotic assessment approaches) to stream assessment team members from the Alabama Department of Environmental Management in Bankhead National Forest.

Alabama Natural Heritage Program Workshop

On December 5, 2014, AUMNH hosted a workshop in efforts to use multiple perspectives to derive an updated direction and develop a more secure funding base for the Alabama Natural Heritage Program® (ANHP). This workshop was attended by ~20 people representing the ALNHP, AUMNH, AU DBS, Georgia Department of Natural Resources (GADNR), Florida Natural Areas Inventory (FNAI), and the US Forest Service (USFS). Presentations in the morning from Jennifer Ceska (GADNR), Mincy Moffett (GADNR), and Gary Knight (FNAI) provided perspective on similar programs in Georgia and Florida. Short-term (e.g., biotic surveys, small grants) and long-term (e.g., recurring Museum programs, fostering federal partnerships) approaches were presented during these morning presentations. During the afternoon session, a roundtable discussion ensued in attempt to synthesize ideas that had been put forth during the morning presentations so as to better address issues of direction and funding. Major points taken away from this roundtable include

- Efforts are needed to generate an Alabama Plant Protection Plan
- There is a need for a land classification system similar to that used by the USFS across Alabama
- There is a need for a standardized habitat protocol for all ALNHP and AUMNH projects.

- Efforts should be focused on identifying joint ALNHP/AUMNH that link respective specialties
- Development of an undergraduate course in 'Measuring and monitoring biodiversity' could be used to help raise profile of both ALNHP and AUMNH as well as serve as a student-base
- Use outreach as vestige for communication with State Lands and other entities
- Develop ALNHP Advisory Board to guide direction, define vision, provide minimal standards for a healthy program
- Pursue partnerships and 'Stewardship Contracts' with the USFS, particularly within the State and Private Forestry Section.
- Pursue 'non-traditional' funding sources such as those associate with fracking/oil extraction
- Redirect personnel to 'off-target' projects for hard funding

Results of this workshop provided ALNHP and AUMNH fodder for developing guiding direction and potential avenues for additional funding. This workshop also established working relationships with ALNHP/AUMNH and GADNR, FNAI, and USFS.

PUBLICATIONS & PRESENTATIONS

Asterisks denote Auburn University student authors or presenters.

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Barbour, Michael. 2014. Distributional survey of the southeastern pocket gopher in Alabama. Unpublished 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. 16 pages.

Barbour, Michael, Alfred Schotz, Tyler Jones, Luke Marzen, and Samuel Fowler. 2014. Inventory, classification, and assessment of Alabama's geographically isolated wetlands – November 2014 progress report. Unpublished report submitted to U.S. Environmental Protection Agency, Atlanta, Georgia. Alabama Natural Heritage Program®, Auburn University Department of Geology and Geography, and Auburn University Water Resources Center; Auburn University, Alabama. 17 pages.

Godwin, James C. 2014. Status of the endangered Alabama Red-bellied turtle (*Pseudemys alabamensis*) in the Dog River and rivers of Weeks Bay. Unpublished 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, James C. 2014. Black Warrior Waterdog (*Necturus alabamensis*) and Flattened Musk Turtle (*Sternotherus depressus*) status survey using environmental DNA (eDNA). Unpublished 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.

Schotz, Alfred R. 2014. Status Assessment of *Apios priceana* B.L. Robbins (Fabaceae), Price's Potato-Bean, in Alabama and Mississippi. Unpublished report submitted to the U.S. Fish and Wildlife Service, Jackson, Mississippi. Alabama Natural Heritage ProgramSM, Auburn University, Alabama. 57 pages.

Presentations

AUMNH Collections

Fish

Armbruster, J. W., C. C. Stout*, and M. M. Hayes*. 2014. "An Empirical Test for Convergence and Social Mimicry Using African Barbs (Cypriniformes)." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Burress*, E. D., J. M. Holcomb, and J. W. Armbruster. 2014. "The influence of phylogeny on minnow ecology, behavior, and physiology." Southeastern Fishes Council. Annual Meeting, Asheville, NC.

Burress*, E. D., M. Tan*, and J. W. Armbruster. 2014. "Ecological Diversification Among Adaptive Radiations of Neotropical Cichlids." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Burress*, E. D., M. Tan*, and J. W. Armbruster. 2014. "Ecological diversification among Neotropical Cichlid fishes." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August 2014.

Diallo, S., J. W. Armbruster, et al. 2014. "The Freshwater Fishes of Guinea." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Ferdous*, S. and J. W. Armbruster. 2014. "The Identity of Catfishes Identified as *Mystus gulio* (Hamilton, 1822) (Teleostei: Bagridae), and Designation of a Neotype." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Ferdous*, S. and J.W. Armbruster. 2014. "Molecular phylogeny of catfish genus *Mystus* (Siluriformes: Bagridae)." Asian Fish Biodiversity Conference (AFBC), Penang, Malaysia.

Hart*, P. B., and J.W. Armbruster. 2014. "Preliminary data for diagnosing putative lineages of the Southern Cavefish (*Typhlichthys subterraneus*) in Alabama." Southeastern Fishes Council Conference. Asheville, NC.

Hart*, P. B. and J. W. Armbruster. 2014. "Morphological Variation Among Southern Cavefish (*Typhlichthys subterraneus*) Lineages in Alabama." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Hayes*, M. M. and J. W. Armbruster. 2014. "Making Sense of the Confusion: A molecular assessment of the genus '*Barbus*' (Cypriniformes: Cyprinidae)." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Krahl, E. R., M. M. Hayes*, D. C. Werneke, C. C. Stout*, and J. W. Armbruster. 2014. "Genetic Structure and Dispersal Potential of the *Pteronotropis euryzonus* (Suttkus, 1955)." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Lujan, N. K., J. W. Armbruster, N. R. Lovejoy, and H. López-Fernández. 2014. "Multilocus Molecular Phylogeny of the Sucker mouth Armored Catfishes (Siluriformes: Loricariidae) with a Focus on the Subfamily Hypostominae." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August 2014.

Stout*, C. C., M. Tan*, A. R. Lemmon, and J. W. Armbruster. 2014. "Preliminary phylogeny of Cypriniformes based on anchored hybrid enrichment with a focus on Leuciscinae (true minnows)." Southeastern Ecology and Evolution Conference, Georgia Southern University, GA.

Stout*, C. C., M. Tan*, A. R. Lemmon, and J. W. Armbruster. 2014. Preliminary phylogeny of Cypriniformes based on anchored hybrid enrichment with a focus on Leuciscinae (true minnows)." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Tan*, M. and J. W. Armbruster. 2014. "What is Miniaturization? Evolution of body size in diminutive Southeast Asian minnows of the subfamily Danioninae." Auburn University Graduate Scholars Forum.

Tan*, M., C. C. Stout*, A. R. Lemmon, and J. W. Armbruster. 2014. "Many Trees for Mini Fishes: Phylogenomic analysis and gene tree discordance in paedomorphic cyprinid fishes." Southeastern Ecology and Evolution Conference, Georgia Southern University, GA.

Tan*, M., C. C. Stout*, A. R. Lemmon, and J. W. Armbruster. 2014. "Phylogenomics and the Evolution of Paedomorphism in the Cyprinidae." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Tan*, M., C. C. Stout*, A. R. Lemmon, E. M. Lemmon, and J. W. Armbruster. 2014. "Phylogenomics and the evolution of paedomorphism in Cyprinidae." Evolution 2014, Raleigh, NC.

Herpetology

Chivers*, J. M. and C. Guyer. 2014. "Characterizing pure and hybrid morphology of the species *Anaxyrus americanus*, *Anaxyrus fowleri*, and *Anaxyrus terrestris* in Alabama." Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August 2014.

Folt*, B. 2014. "Local-scale ecology of leaf-litter amphibians and reptiles in a Neotropical wet forest." John Carroll University – Biological Sciences' Seminar Series, John Carroll University, Cleveland, Ohio. 4 December.

Folt*, B. 2014. "Natural history, population and community ecology, and conservation biology of herpetofauna at La Selva, Costa Rica." La Selva Biological Station research seminar, La Selva Biological Station, Puerto Viejo de Sarapiquí, Costa Rica. 4 March.

Folt*, B., N. Garrison, C. Guyer, and J. E. Bond. 2014. "Phylogeography of the Red Salamander (*Pseudotriton ruber*).” Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August 2014. (poster)

Jensen, J.B. and B. Folt*. 2014. "Population demographics, growth rates, and age estimation of the alligator snapping turtle (*Macrochelys temminckii*) in Spring Creek, Georgia.” The Gopher Tortoise Council Meeting, Chehaw Park, Albany, Georgia. 17–19 October.

Invertebrates

Clay*, M., J. Stoeckel, and B. Helms. 2014. Burrowing site selection by juvenile *Cambarus diogenes*: the role of chimneys and herding.” Annual Meeting of the Southeastern Fishes Council, Asheville, NC, November.

Helms, B., S. Sefick*, S. Reithel*, E. Kosnicki, D. Werneke, B. Schneid*, J. Zink, J. Feminella, and G. Jennings. 2014. "Geomorphic assessments and instream ecological endpoints: integration for restoration and management.” Joint Aquatic Sciences Meeting, Portland, Oregon, May.

ALNHP

Barbour, Michael S. 2014. "Field Data Collection on a Tablet Using Quantum GIS, and a Comparison to ArcPad.” Organization of Fish and Wildlife Information Managers 2014 Conference and Annual Meeting, Flagstaff, AZ. 29 September - 2 October.

Godwin, James C. and Lesley de Souza. 2014. "Black Warrior Waterdog (*Necturus alabamensis*) and Flattened Musk Turtle (*Sternotherus depressus*) Survey using Environmental DNA (eDNA).” Southeastern Partners in Amphibian and Reptile Conservation (SEPARC). Lake Cumberland State Resort Park, KY. 15 February.

Godwin, James C. and Lesley de Souza. 2014. "Black Warrior Waterdog (*Necturus alabamensis*) and Flattened Musk Turtle (*Sternotherus depressus*) Survey using Environmental DNA (eDNA).” Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 3 August.

Steen, D. 2014. "Recent Investigations of Snake Community Ecology and Implications for Ongoing Indigo Snake Reintroductions.” Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August.

Steen, D. 2014. "Prevalence of Ingested Fish Hooks in Freshwater Turtles from Five Rivers in the Southeastern United States.” Joint Meeting of American Society of Ichthyologists and Herpetologists, Chattanooga, TN, 30 July – 3 August. (poster)

Steen, D. 2014. "Why is that Snake Here? How Habitat, Competition, and Predation Influence Snake Occupancy and Abundance.” Southeast Partners in Amphibian and Reptile Conservation (SEPARC) Annual Meeting, Lake Cumberland State Park, KY. February.

Funded Projects

Funding Source	Project	Responsible Party	Amount	Status
ADCNR	Black Warrior Waterdog and Flattened Musk Turtle Status Survey using Environmental DNA (eDNA)	Godwin	\$31,700	Ongoing
ADCNR	Continued Implementation of the Safe Harbor Plan for the Endangered Red-cockaded Woodpecker in Alabama	Barbour	\$13,334	Completed
ADCNR	Continued Implementation of the Safe Harbor Plan for the Endangered Red-cockaded Woodpecker in Alabama	Barbour	\$10,001	Ongoing
ADCNR	Distribution and Habitat Attributes of the Southeastern Pocket Gopher in Alabama	Barbour and Gitzen	\$26,667	Ongoing
ADCNR	Distribution, Abundance, and Health Assessment of the Gopher Tortoise (<i>Gopherus polyphemus</i>) in Alabama	Godwin	\$467,572	Ongoing
ADCNR	Distributional survey of the Southeastern Pocket Gopher (<i>Geomys pinetus</i>) in Alabama	Barbour	\$27,557	Completed
ADCNR	Gopher Frog survey	Godwin	\$20,000	Ongoing
ADCNR	Hellbender survey	Godwin	\$35,000	Ongoing
ADCNR	Historical Changes to Amphibian and Reptile Faunas in Five Key Alabama Watersheds	Godwin		Ongoing
ADCNR	Population structure and conservation status of burrowing bog crayfishes (<i>Fallicambarus</i> spp.)	Helms, Santos, and Bond	\$23,430	Ongoing
ADCNR	Reintroduction of the Eastern Indigo Snake onto Conecuh National Forest	Godwin	\$160,000	Ongoing
ADCNR	Reintroduction of the Eastern Indigo Snake onto Conecuh National Forest	Godwin	\$144,000	Ongoing
ADCNR	Status of the Endangered Alabama Red-bellied Turtle (<i>Pseudemys alabamensis</i>) In the Dog River and Rivers of Weeks Bay	Godwin	\$26,000	Completed
ADCNR	The Range and Relationships of Three Undescribed Species of <i>Typhlichthys</i> (Percopsiformes: Amblyopsidae) in Alabama	Armbruster	\$14,800	Completed

Funding Source	Project	Responsible Party	Amount	Status
COYPU Foundation	Aquatic Biodiversity of the Western Guiana Shield	Armbruster and Lujan	\$48,983	
EPA	Ecogeomorphology of the Appalachian Plateau of Alabama and Tennessee	Brantley (PI), Helms, and Werneke	\$355,330	Ongoing
EPA	Inventory, Classification, and Assessment of Alabama's Geographically Isolated Wetlands	Barbour, Schotz, Marzen, and Fowler	\$488,362	Completed
JMR Architecture	Pelham Range Plant Inventory	Schotz	\$129,000	Ongoing
NatureServe	Natchez Trace Vegetation Assessment	Schotz	\$18,000	Completed
National Geographic Society	Whence white? Evolutionary origins and current status of the Namib's 'white' darkling beetles	Bond (co-PI) and Lamb (PI, ECU)	\$19,258	Ongoing
NSF	All Cypriniformes Species Inventory	Armbruster	\$780,000	
NSF	Collaborative Proposal: Millipede Systematics: Developing phylogenomic, classification, and taxonomic resources for the future. DEB 1256139.	Bond	\$784,049	Ongoing
NSF	Collaborative Research: Digitization TCN: InvertEBase: Reaching Back to See the Future: Species-rich Invertebrate Faunas Document Causes and Consequences of Biodiversity Shifts.	Bond	\$308,289	Ongoing
NSF	Dissertation Research: Species delimitation and the evolution of dwarfism in the North American tarantula genus Aphonopelma. DEB 1311494.	Bond	\$19,240	Ongoing
NSF	NSF-ABDC Grant - SERNEC TCN digitization: The Keys to the Cabinet	Goertzen	\$78,199	Ongoing
SSAR	Society for Study of Amphibians and Reptiles Grants in Herpetology Program (Education), "Living Alongside Wildlife: an online resource for amphibian and reptile outreach and conservation"	Steen	\$500	Completed

Funding Source	Project	Responsible Party	Amount	Status
USFS	Black Warrior Waterdog, Flattened Musk Turtle, Streak Sorus Fern & Kral's Water Plantain Studies	Godwin	\$112,000	Ongoing
USFWS	<i>Hamamelis ovalis</i> Status Survey	Schotz	\$8,000	Ongoing
USFWS	Characteristics Of The Highly Endemic Silt Snail Genus, <i>Floridobia</i>	Bond and Schulthies (PI, Stetson University)	\$28,903	Ongoing
USFWS	<i>Marshallia mohrii</i> Status Assessment	Schotz	\$28,000	Completed
USFWS	<i>Rhynchospora crinipes</i> Survey	Schotz	\$9,000	Ongoing
USFWS	Status Assessment for <i>Apios priceana</i>	Schotz	\$26,000	Completed
USFWS	Status Update for <i>Platanthera integrilabia</i> in Alabama	Schotz	\$10,000	Completed
USGS	Behavior and Physiology of Invasive Argentine Tegus in Semi-natural Enclosures in Alabama	Steen	\$35,000	Ongoing