

SOUTHERN
ALABAMA'S SURPRISING BIODIVERSITY
WONDER

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For all who labor to protect
and restore Alabama's biodiversity
so future generations can enjoy
the state's extraordinary natural heritage

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Number One in the East

WHO KNEW?

Honestly, I can't remember when I first heard the statistic, but I clearly remember my reaction—I didn't believe it. How could it be possible that Alabama, *Alabama*, could lead most of the nation, and *all* of the eastern United States in the number of species within its borders? I concluded that I had misheard the statistic or this was a result from some convoluted ranking scheme.

My skepticism was fueled by my overconfidence that I knew a thing or two about Alabama and southeastern biology. I grew up in the Florida panhandle raised by two renowned birders and naturalists; our family spent many spring and fall weekends looking for migrating birds on Dauphin Island and the Fort Morgan Peninsula. I knew Alabama had impressive bird diversity, but so do all the southern states. The statistic didn't mesh with my preconceptions of Alabama, and in my arrogance I dismissed it.

My initial ignorance about Alabama's biodiversity may be forgivable to a small degree. In 2002 I had just moved to Birmingham from Gainesville, Florida, and I was in my first year of teaching at Birmingham-Southern College. With a demanding teaching load, a young child, and my wife pursuing her career, I had little time to explore my new stomping grounds. After I settled into a routine and planned my lectures, I finally began meeting other biologists and conservationists. About this time Bruce Stein published his report "States of the Union: Ranking America's Biodiversity," which presented biodiversity statistics for all US states. Soon, Alabama's statistics began to come up in conversation with colleagues, though often with a degree of incredulity and reservation. This was, after all, a community of people accustomed to discouraging biodiversity data. After hearing the rumor several times, I looked it up myself. I easily found the report on the

internet, and sure enough, there it was on page 12, Table A: “Alabama: rank 5, species = 4533.”

Such a compilation of numbers is not easy to produce. Species inventories from states can be incomplete and out of date, and states may use different species classification systems. Yet, once reliable biodiversity statistics for a region are available, they begin to demonstrate their power. Researchers can find relationships in the data that inspire new ideas about patterns of species distribution, while conservationists can use the data to identify priority regions or taxa for protection.

Stein’s report identified Alabama as a biological superstar on the North American continent. The only states surpassing Alabama’s species diversity are California, Texas, Arizona, and New Mexico, all large western states with tremendous ecological range. Among the 26 states east of the Mississippi River, Alabama is at the very top. Furthermore, for several major freshwater taxa including fishes, snails, mussels, turtles, and crayfishes, Alabama leads the nation in biodiversity.¹

Stein also reported Alabama ranks highly for its endemic species, those restricted to a relatively small area, in this case just Alabama. With 144 endemics, Alabama ranks seventh in the United States. California leads with nearly 1,300 endemics, followed by Hawaii with 1,101. Other than fourth-ranked Florida (269 endemics), endemic totals among Alabama’s neighboring states don’t even come close:

The endangered Vermilion Darter, endemic to Turkey Creek, Jefferson County. Courtesy of Bernard R. Kuhajda/Tennessee Aquarium Conservation Institute.



Georgia (63), Tennessee (49), and Mississippi (23). A few Alabama endemics have achieved local or national fame and their names may be familiar, including Red Hills Salamander (the official state amphibian), Alabama Beach Mouse, and Alabama Sturgeon. Other endemics have unusual names rarely printed or spoken outside of professional circles: Armored Marstonia, Dark Pigtoe, Deceptive Marbleseed, and Pygmy Sculpin. Some are confined to a distinct geologic land form. Many are restricted to a single stream or river. Alabama’s endemics, perhaps more than any other assembly of species, represent what is most unique and distinctive about the natural character of the state.

Sadly, 10 years after Stein’s report, few of Alabama’s citizens are aware that Alabama harbors one of the richest collections of biodiversity outside the tropics. This is regrettable, because Alabama’s citizens and visitors enjoy the rewards of the state’s biodiversity every day, and the abundance and diversity of life in its forests and streams constitute one of Alabama’s greatest riches.

WHY SO MANY?

Upon learning of Alabama’s biodiversity rankings, I began wondering why the state has so many species. I wasn’t alone—others began asking this, too. This question falls within the realm of biogeography, the study of geographic distributions of species. Several questions came to mind and I began investigating.

Is state size a factor? After all, the four states ahead of Alabama in Stein’s US rankings are large western states among the top six states for land area. However, size alone isn’t a sufficient explanation. Alabama is midsized, ranking 30th in land area, and the Alaskan goliath, our largest state, finishes nearly last in species diversity.

What about latitude, a measure of distance from the equator? The top seven states are aligned along the southern perimeter of the United States, and southern states have longer growing seasons and milder winters. Species diversity does generally correlate with latitude, with ecosystems at lower latitudes usually having more species than those at higher latitudes. It is true that if Alabama had Minnesota’s latitude, it would have far fewer species than it does. Nevertheless, latitude alone cannot explain Alabama’s biodiversity rank. Mississippi, which shares

similar size and latitude, is 17th in the United States for species biodiversity. Florida is partly subtropical but ranks seventh for biodiversity, and Hawaii, our only fully tropical state, ranks dead last.

What about mountains and exposures of rock? Mountainous terrain, wherever found, supports ecosystems unlike those in the lowlands, and rock exposures create unique habitats. The Southern Appalachians begin at the heart of Alabama and mountainous topographies dominate 33 percent of the state's area. However, Tennessee, North Carolina, Virginia, and several western states are more topographically and geologically diverse than Alabama and have less biodiversity.

Could it be coastline? Alabama's position along the Gulf of Mexico and adjacent plains certainly increases its diversity of ecosystems and species. Then again, if coastal ecosystems were the overriding factor, Florida and Louisiana should rank higher for species diversity, and New Mexico and Arizona should rank lower.

With time, I realized no single feature was responsible for Alabama's biodiversity. Instead, three overarching natural factors have shaped the state's biodiversity. First, Alabama's warm, wet climate has nurtured productive ecosystems throughout the state. Second, and more influentially, geological processes guided the state to its current latitude, created a topographically diverse terrain, and exposed a great range of rock and soil types at the surface. Alabama's combination of a mild climate and diverse terrain supports 64 distinct terrestrial and wetland ecological systems. The more ecological diversity there is in a geographic area, the higher the species count. This is a portable truth about biodiversity you can apply anywhere at any scale.

A third factor, biological evolution, is a product of the other two. Radical changes in Alabama's climate and landscape have continuously forced its flora and fauna to adjust through evolutionary adaptations. Evolution is a complex process explored later in this book, but suffice it to say that these adjustments over millions of years led many populations to become distinct species living nowhere else but in Alabama.

There is a fourth reason that Alabama has so many species, but it fits awkwardly with the others. For reasons beyond the scope of this book, Alabama's boundaries were drawn such that within the state are several distinct geographic regions, each with a unique suite of ecosystems. These include a corner of an ancient mountain range, an exten-



Above: Talladega Mountains at sunset, Talladega and Clay counties. Courtesy of Frank Chitwood.



Left: Brackish coastal lagoon at Fort Morgan State Historic Site, Baldwin County. Photo by R. Scot Duncan.

sive swath of coastal plain, 50 miles of coastline, a piece of the largest temperate watershed in the world, and one of the most biodiverse watersheds in the temperate world.

WHAT'S AHEAD?

As I studied the scope and origins of Alabama's biodiversity, I encountered many amazing natural history stories. This book is an attempt to share these stories to help readers appreciate the range of biodiversity in the state. Some stories can excite the 10-year-old child in all of us. There will be strange and, sometimes, dangerous creatures lurking in the state's large rivers; sharks of the Gulf of Mexico and Alabama's bays; and tales about the first peoples of Alabama who just a few thousand years ago hunted bear-sized ground sloths and elephant-sized mammoths.

These stories will solve some of the state's natural mysteries: Why are shark teeth and other marine fossils found hundreds of miles from the coast? How could a blind fish species live underground in northern Alabama? What happened to the state's American Mastodons and Sabre-toothed Cats? Why are carnivorous plants abundant and diverse in southern Alabama?

And finally, these stories are for explorers who hunger to escape into wildernesses including the second-largest river delta in North America, the rugged Appalachians' forest-cloaked peaks, the labyrinth of box canyons in the Sipsey Wilderness, or the reefs at the edge of the Continental Shelf.

This opening chapter contains an overview of why Alabama has so many species. How ecosystems work is reviewed in chapter 2 by studying a critically endangered mouse and its unusual ecosystem. chapter 3 explains Alabama's mild climate and why Alabama should be a desert, but isn't. In chapter 4, the geologic processes shaping the state's terrain are examined, from sedimentary rock formation to plate tectonics. Chapter 5 is an epic journey through millions of years to understand how the state's ecology, climate, and geology have changed, and how this history shapes today's biodiversity. Chapter 6 provides a review the mechanics of evolution and why Alabama is at the epicenter of species evolution for several taxa.

The second part of the book is an application of the concepts from the first part via an exploration of the major ecological regions, or ecoregions, within the state. Alabama is a global hot spot for aquatic biodiversity, so chapter 7 begins with the state's rivers. Explorations of Alabama's terrestrial ecoregions begin in chapter 8 on the Southern Coastal Plain, the ever-shifting margin of the continent, a living mosaic of barrier islands, marshes, tidal swamps, flatwoods, oyster reefs, and seagrass meadows. Chapter 9 is an inland venture across the Southeastern Plains, including its fire-hungry pine woodlands, a poorly understood hill country, and black soil prairies that have nearly disappeared. Chapter 10 is a journey into the Southern Appalachian Mountains to explore the Ridge and Valley ecoregion, a geologically tortured terrain where sedimentary rocks hundreds of millions of years old support wildly diverse ecosystems.

Chapter 11 is a wandering through the Southwestern Appalachians ecoregion, an elevated plateau whose margins bear narrow canyons, labyrinthine valleys, steep escarpments, and underground caverns whose species and ecosystems seem otherworldly. The lonely Piedmont ecoregion is explored in chapter 12. Though still scarred from an abusive agricultural history, the Piedmont's old soils and ancient rocks harbor many surprises, including the lonesome monadnocks, Alabama's most prominent mountains. Chapter 13 is a tour of the Interior Plateau ecoregion, where the Tennessee River has ground down the region's bedrock, deposited fertile soils, and exposed another warren of underground caverns. The geographic expeditions finish in chapter 14 with a journey into Alabama's blue wilderness, the Gulf of Mexico. The northern Gulf supports far more species diversity than most appreciate. Areas of upwelling attract more than two dozen whale species, surface waters harbor menacing predators and the largest clonal organism on earth, and relic coral reefs sustain colorful sponge gardens and dense schools of fishes.

I conclude in chapter 15 with a look to the future of Alabama's biodiversity, including threats to the state's biodiversity, what's at stake for Alabama's citizens, and what's being done to protect the state's natural heritage. I'll explain why this may be a century of tremendous biological discovery in Alabama.

DOES IT MATTER?

There is a small community of biologists, conservationists, and naturalists who are well aware of Alabama's exceptional natural heritage. We share a profound fascination with the seemingly infinite variety of species on earth and the ways they interact. With its rich biodiversity, Alabama is overflowing with ecosystems to explore and species to encounter.

However, for many of us there is a deeper, darker cause for our obsession. We who study the natural world also understand how the survival of our own species depends on the health of our ecosystems. These ecosystems function best when all of their component species are present and flourishing. To put it simply, people need biodiversity to survive. This is the most important lesson ecologists have provided to mankind. This assertion is backed by many millions of hours of empirical research, and tens of thousands of studies across the planet. What's more, archaeologists and anthropologists have amassed a large and sobering collection of stories of past civilizations that collapsed when they undermined the integrity of their ecosystems.

Despite our wondrous technological advances and wealth of knowledge, we are creatures dependent on our ecosystems for survival. This can be hard to fathom, especially for those of us who spend most of our life within cities, buildings, and cars. However, trace the production path of the book in your hand, the food on your plate, or the water in your cup, and soon you find a forest, field, or river where native species and natural ecological processes are essential for its production. The conversion of natural resources to food, fiber, and fuel tightly binds our fate to the land and ocean and is one of the most fundamental relationships on which our civilizations, and our individual lives, are built.

Examples of this dependence are everywhere in Alabama. Drinking water is taken from rivers and streams. Forests provide lumber, paper, and jobs in rural communities. Commercial fishers haul fish and shellfish from the rivers, bays, and Gulf. Farmers work soils deposited by seasonal river flooding. The benefits of Alabama's rich natural heritage extend beyond resource extraction and commodity production. Alabamians have a fervent love of outdoor recreation, and hunting,



Striped Mullet, the author's favorite catch. Courtesy of Lucy Rutland Duncan.

fishing, camping, hiking, and wildlife observation clearly depend on healthy ecosystems.

Seen or unseen, Alabama's thousands of native species play important roles in the ecosystems sustaining the state's economy and culture. Impaired ecosystems offer us little, and when they collapse there is loss of livelihood, property, and, sometimes, life. Consider flooding in overdeveloped watersheds or the trauma in coastal communities when fisheries collapse. When we lose biodiversity, we lose opportunity and ecological security. Ultimately, biodiversity protection is people protection.