



FOCUS QUESTIONS

- Why is the longleaf pine ecosystem so important to protect and conserve?
- Why is the gopher tortoise considered a keystone species in its habitat?
- How does the eating behavior of the Eastern indigo snake help protect other species of animal?
- How does fire function to increase the biodiversity of an ecosystem?
- How does captive breeding work as a conservation strategy?

OVERVIEW

"We should all care about Eastern indigo snakes and gopher tortoises just like we care about wolves and tigers."
- Dr. Chris Jenkins, Wildlife Biologist and Chief Executive Officer, The Orianne Society

In *The Serpent's Lair* we hear from biologists Dr. Chris Jenkins and Dr. James Brogan about their efforts to protect and restore the populations of two American reptiles, the Eastern indigo snake (*Drymarchon couperi*) and the gopher tortoise (*Gopherus polyphemus*). Both species thrive in the longleaf pine (*Pinus palustris*) forests of the Southeast United States but centuries of habitat loss and fragmentation has sent the snake and tortoise populations into a steep decline.

The two species are uniquely interconnected where the Eastern indigo snake controls predator populations and the gopher tortoise dens provide overwintering habitat for the snake in the northern part of its range. Fortunately, Jenkins and his team are working to purchase land and restore habitat in areas where the tortoise can thrive while Brogan's team works on captive breeding of the snakes to reintroduce them into the new habitat, complete with burrows to protect them.

KEY CONCEPTS

- **Habitat loss and fragmentation:** Over the last two centuries 97% of the longleaf pine forests of the Southeast United States have been lost to agriculture and urban development. The decimation of the longleaf pine ecosystem has had a devastating effect on biodiversity, including species like the Eastern indigo snake and gopher tortoise.
- **Biodiversity:** The International Union for the Conservation of Nature lists more than 44,000 species threatened with extinction and agriculture is the major threat for more than half of these species. Restoring and conserving critical natural habitats like the longleaf pine ecosystem can help mitigate the threats to biodiversity and even bring many species back from their threatened and endangered status.
- **Conservation biology:** The practice of conservation biology recognizes the intrinsic value of the Earth's natural diversity of organisms. Conservation biology works to understand how the natural world operates, how humans affect nature, and how we can use collective scientific and cultural knowledge to conserve Earth's biological diversity.
- **Apex predator:** Eastern indigo snakes are apex predators because they are at the top of their food chain in their habitat and they have no natural predators. As a result, the Eastern indigo snake controls the populations of other predatory snakes by eating them, thus protecting the populations of many other species in their habitat.
- **Keystone species and species diversity:** Gopher tortoises are an important keystone species because their burrows provide habitat for hundreds of other animal species which in turn provide stability for local food webs. Without gopher tortoise burrows much of the local animal community biodiversity would collapse.



- Ecosystem engineers: As part of their function as keystone species, gopher tortoises physically modify the abiotic environment of the longleaf pine ecosystem by digging their burrows. In doing so they modulate the availability of resources to other species who can further modify the burrows to fit their needs. For example, gopher tortoise burrows are often re-engineered by Florida mice (*Podomys floridanus*) and other rodents that dig smaller side-burrows and pockets.
- Commensalism: In a commensalism relationship, one species obtains food, shelter, or other benefits without harming or benefiting the other. Because gopher tortoise burrows provide shelter for so many other species, a thriving gopher tortoise population is necessary for their commensal species populations to exist.

BACKGROUND

The Eastern indigo snake was officially designated as a Federally threatened species in 1978 and was thus listed as protected by the Endangered Species Act of 1973. Nine years later, in 1987, the gopher tortoise was also listed as Federally threatened. Currently there are only 53 known breeding populations of Eastern indigo snakes in the wild, mostly in Florida. The latest estimate of the gopher tortoise population throughout its range is roughly 150,000 individuals, down significantly from a pre European settlement estimate of 2.1 million. Both species thrive in the longleaf pine forest ecosystems that used to cover as much as 100 million hectares from Maryland south to Florida and as far west as eastern Texas. Longleaf pine ecosystems are the most biodiverse ecosystems in North America, providing a home for over 500 plant and animal species.

One characteristic of the longleaf pine ecosystem that makes this species richness possible is its patchwork of forest and grassy savanna. However, to maintain this heterogeneous structure longleaf pine ecosystems must be disturbed by fire every few years. Unfortunately, decades of fire suppression along with logging and urbanization has reduced and fragmented the longleaf pine ecosystem to nearly 3% of its pre-European settlement area. This reduction in habitat and disruption of the critical ecosystem function of fire has made it difficult for many species to survive, including the Eastern indigo snake and the gopher tortoise.

In *The Serpent's Lair* we meet two hopeful scientists, biologist Chris Jenkins and snake veterinarian James Brogan. Jenkins works for the nonprofit Oriante Society and Brogan works for the Oriante Center for Indigo Conservation at the Central Florida Zoo and Botanical Gardens. Jenkins and Brogan and their teams are using a combination of approaches to bring the two species back from their declines. Their strategy includes purchasing and protecting prime gopher tortoise habitat, managing the habitat with controlled burns, and breeding Eastern indigo snakes in captivity before releasing them to the wild. The captive breeding program is showing incredible success with hundreds of snakes being bred in captivity and released into the wild over the last decade.

BIODIVERSITY THREATS

The major threats to the Earth's biodiversity can be grouped into seven categories that spell the easily recalled acronym H.I.P.P.O.: **H**abitat destruction and fragmentation, **I**ntroduced species, **P**ollution, **P**opulation growth, and **O**verharvesting. Many species are threatened by a combination of these factors, but habitat loss is the greatest threat to biodiversity. In *The Serpent's Lair* we learn that over the last two centuries the Southeast United States has lost 97% of its longleaf pine ecosystem and which has caused a steep decline in the populations of Eastern indigo snakes and gopher tortoises and in turn has disrupted the ecosystem's biodiversity.

DISCUSSION QUESTIONS

- [Before showing the film] Have students brainstorm ideas for how the presence of a snake and a tortoise in the same habitat could help maintain overall animal biodiversity.



- Have students sketch a diagram that shows how an increase in gopher tortoise populations influences the populations of Eastern indigo snakes, the populations of venomous carnivorous snakes, and the animal biodiversity of the longleaf pine ecosystem. Consider providing students the hint that the Eastern indigo snake and the gopher tortoise influence the local biodiversity in two different ways.
- In the film we learn about a three-pronged approach to restoring and conserving the gopher tortoise and Eastern indigo snake populations: (i) purchase the most important habitat for the gopher tortoise in Georgia, (ii) use controlled burns to restore the longleaf pine forest understory where necessary, (iii) increase the number of Eastern indigo snakes through a captive breeding program. Have students discuss why only focusing on one or two of the three approaches would not be enough to restore the populations of both species.

Curriculum Connections

NGSS

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- LS2.D: Social Interactions and Group Behavior
- LS4.D: Biodiversity and Humans

HS-LS4 Biological Evolution: Unity and Diversity

- LS4.B: Natural Selection
- LS4.C: Adaptation

ETS1.B: Developing Possible Solutions

AP Biology (2021)

Enduring Understandings

- Energetics (ENE)
 - ENE-4: Communities and ecosystems change on the basis of interactions among populations and disruptions to the environment.
- Systems Interactions (SYI)
 - SYI-1: Living systems are organized in a hierarchy of structural levels that interact.
 - SYI-2: Competition and cooperation are important aspects of biological systems.
 - SYI-3: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

IB Biology (First Exam May 2025)

A. Unity and Diversity: Common ancestry has given living organisms many shared features while evolution has resulted in the rich biodiversity of life on Earth.

- A3.1 Diversity of organisms
- A4.2 Conservation of biodiversity

B. Form and Function: Adaptations are forms that correspond to function. These adaptations persist from generation to generation because they increase the chances of survival.

- B4.2 Ecological niches

C. Interaction and Interdependence: Systems are based on interactions, interdependence and integration of components. Systems result in emergence of new properties at each level of biological organization.

- C4.1 Populations and communities

D. Continuity and Change: Living things have mechanisms for maintaining equilibrium and for bringing about transformation. Environmental change is a driver of evolution by natural selection.

- D4.2 Stability and change



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CREDITS

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