

Repatriation of eastern indigo snakes to conservation lands in South Alabama, USA

Sierra Stiles¹, James Stiles², James C. Godwin³, Christopher Jenkins⁴, Elizabeth M. Rush⁵, Brad Lock⁶, Valerie M. Johnson⁷, Michael Wines⁸ & Craig Guyer⁹

- ¹ - Graduate Assistant, Department of Biological Sciences, Auburn University, Auburn, AL 36849, USA stiles@auburn.edu
- ² - Graduate Assistant, Department of Biological Sciences, Auburn University, Auburn, AL 36849, USA, stileja@auburn.edu
- ³ - Advisor II, Environmental Institute, Auburn University, Auburn, AL 36849 USA jcg0001@auburn.edu
- ⁴ - Chief Executive Officer and Executive Director, The Oriannes Society, 579 Highway 441 South, Clayton Georgia 30520, USA cljenkins@oriannesociety.org
- ⁵ - Associate Professor and Project Veterinarian, School of Veterinary Medicine, St. Georges University, University Centre, Grenada, West Indies zuvet9@yahoo.com
- ⁶ - Assistant Curator of Herpetology, Zoo Atlanta, 800 Cherokee Avenue, Atlanta, Georgia 30315, USA block@zooatlanta.org
- ⁷ - Research Assistant I, Department of Biological Sciences, Auburn University, Auburn, AL 36849, USA johnsvm@auburn.edu
- ⁸ - Research Assistant I, Department of Biological Sciences, Auburn University, Auburn, AL 36849, USA mpw0005@auburn.edu
- ⁹ - Professor, Department of Biological Sciences, Auburn University, Auburn, AL 36849, USA guyercr@auburn.edu

Introduction

The eastern indigo snake (*Drymarchon couperi*), historically, ranged across the Coastal Plain of the United States from southeastern Georgia, south through Florida, and west across southern Alabama and Mississippi (Conant & Collins, 1998). But, these large predators likely never were abundant and populations of them were vulnerable to habitat loss and fragmentation, mortality associated with increased roads and vehicle traffic, and collection for the pet trade. In 1978, eastern indigo snakes were listed as Threatened under the federal Endangered Species Act, and, more recently, were classified by IUCN as Least Concern. Wild populations of eastern indigo snakes currently are known only from southeastern Georgia and Florida. Here, we describe an attempt to repatriate eastern indigo



Eastern indigo snake

snakes to the Conecuh National Forest, in south-central Alabama. We build on previous repatriation efforts by Speake (1990), who demonstrated how to rear young for release, but who failed to establish breeding populations at 36 sites chosen for repatriation (Hart, 2002). Our project focuses on a single site, where a minimum of 300 one to two-year old snakes will be released. Within the context of repatriating this species to Alabama, we assess the utility of soft releases as a repatriation strategy for large snakes.

Goals

- Goal 1: Assess utility of soft releases for large snakes.
- Goal 2: Compare movement patterns of repatriated snakes to those published for free-ranging individuals in native habitats.
- Goal 3: Compare habitat selection of repatriated snakes to that published for free-ranging individuals in native habitats.
- Goal 4: Establish reproduction of free-ranging snakes at a repatriation site.
- Goal 5: Document spread of a population from the release site.

Success Indicators

- Indicator 1: Reduced home range size and increased home range overlap for soft released individuals relative to those that are hard released.
- Indicator 2: Home range size of repatriated males and females are within range of values published for Georgia source populations.
- Indicator 3: Patterns of habitat selection of repatriated males and females are within range of values published for Georgia source populations.
- Indicator 4: Production of viable offspring from at least one repatriated female.
- Indicator 5: Discovery of at least one unmarked individual captured at a distance from the release site that is longer than the diameter of an average adult male home range.

Project Summary

Feasibility: Three main questions determined whether this project was feasible? i) can we find a reasonable repatriation site?, ii) can we generate stock for repatriation at this site while minimizing effects on source populations?, and iii) can we raise sufficient offspring to generate stock for repatriation?

Implementation

Question 1: We selected the Conecuh National Forest as the release site. The last known occurrence of eastern indigo snakes in this region was made by Neill (1954). The area has received two decades of restoration of longleaf pine forests, transforming the landscape into one that mimics the structural features of old-growth forest. Growing populations of gopher tortoises are present and provide vital refugia for released snakes. The custom of local snake hunters, who used gasoline fumes delivered to the bottom of gopher tortoise burrows to drive out eastern diamondback rattlesnakes, has been outlawed, removing one source of mortality for released indigo snakes. Finally, the site has a similar road density to that of source populations, limiting a second source of mortality to reasonable levels.

Question 2: We established a cooperative effort with the following agencies: Auburn University, Alabama Department of Conservation and Natural Resources, Georgia Department of Natural Resources, The Orianne Society, United States Fish and Wildlife Service, United States Forest Service, and Zoo Atlanta to conform to state and federal laws and to establish consistent funding for the expected

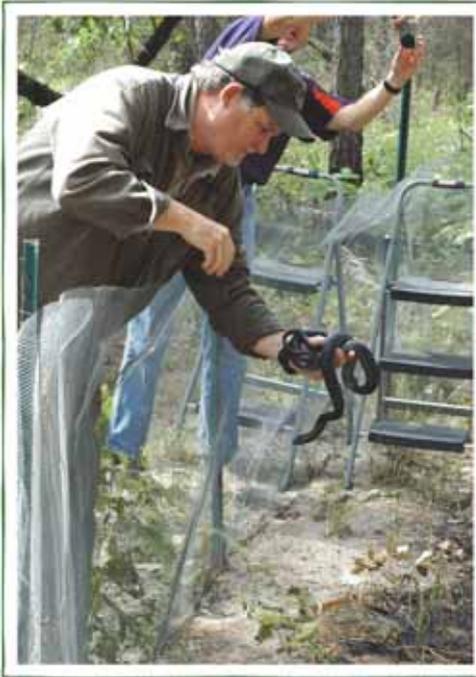


Snake release pen

10 year life span of the project. We limited removal from source populations to gravid females that were retained in captivity until each produced a clutch of eggs; this was followed by release of each adult female back to its source population. A maximum of two individuals were used per source site per year to minimize our effect on the demography of the source populations. We required 6 - 8 gravid females per year over a four-year period to produce stock for a Florida breeding facility (to be used for future repatriation projects) and to produce an average of 30 offspring per year for repatriation to Alabama.

Question 3: Collaboration with Zoo Atlanta was a vital component of the project. This allowed us to raise large cohorts of offspring in controlled environments over two growth years. These offspring were then maintained at Auburn University in outdoor enclosures for 2 - 4 weeks prior to release in the spring. This final stage allowed us to acclimatize snakes to field conditions by giving them access to sun and shade provided by a variety of shelters, as well as training them to seek appropriate live prey.

Post-release monitoring: Initial three cohorts (hatched 2008 - 2010 and released 2010 - 2012) included an average of 20 snakes per year with radio transmitters implanted. Individuals were monitored 3 - 5 times per week during spring and summer and once per week during fall and winter. Locations were recorded by GPS and mapped to GIS layers for the release area. Most of the year, snakes used xeric longleaf pine and mixed pine-hardwood sandhills and the adjacent riparian zones of blackwater creeks and other wetlands. Shelters used included primarily gopher tortoise burrows and stumpholes, but also included armadillo and small mammal burrows and downed woody debris. In winter, snakes remained in upland habitats, where a majority of individuals occupied gopher tortoise burrows. Home ranges of males were larger than home ranges of females. Movement patterns, habitat use and home range sizes observed post-release were similar to descriptions published previously for free-ranging



Eastern indigo snakes in release pen

individuals studied near the source population sites (Hyslop, 2007). Females established relatively small home ranges near the release site regardless of whether they were soft released or hard released. Soft released males had home ranges of similar size to those that were hard released but retained those home ranges near the release site so that soft released males had increased home range overlap with females compared to overlap patterns associated with hard released males. Survival was not significantly different for hard and soft released snakes. Multiple females were observed to spend significant portions of the breeding season cohabiting refugia with males. One young female, captured in 2011 and refitted with a radio-transmitter, was gravid but had unviable eggs. Two additional females captured in 2012 laid eggs that produced 9 offspring. No unmarked individuals have yet been captured. Continued post-release

monitoring will be important to the assessment of Indicator 5 and the evaluation of other project goals.

Major difficulties faced

- Novel disease issues for captive snakes (new species of *Fusarium*; developmental anomalies).
- Behavioral differences between snakes retained only in indoor cages and those that experience outdoor cages before release.
- Early escape from pens through underground root channels and mammal burrows.
- Long distance dispersal of males and emigration to private lands.
- Road mortality difficult to prevent, even in areas with low road density and low traffic.

Major lessons learned

- Soft release may be an effective release strategy for minimizing excessive dispersal.
- Females establish stable home ranges more readily than males.
- Soft release improves reproductive opportunities for females.
- Education can help prevent intentional harm and garner community support.

Success of project

Highly Successful	Successful	Partially Successful	Failure
	√		

Reason(s) for success/failure:

- Home range size and habitat use are comparable to values from source areas.
- Soft release snakes had decreased home range size and dispersal relative to hard release.
- Home range overlap documents opportunities for reproduction by repatriated snakes are improved by use of soft release.
- Successful production of viable offspring was documented for two repatriated females.
- An additional seven years of releases are required to assess whether the population is spreading.

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