

# **Draft Eastern Indigo Snake**

## **Recovery Implementation Strategy**



Eastern Indigo Snake photo courtesy of Dirk J. Stevenson©

U.S. Fish and Wildlife Service  
Southeast Region (Region 4)  
Atlanta, Georgia  
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## **DISCLAIMER**

This Recovery Implementation Strategy is an advisory document, not a regulatory document. It does not obligate parties to implement the recommended activities contained within it and may not represent the views nor the official positions or approval of any individuals or agencies identified in the document, other than the U.S. Fish and Wildlife Service (Service). This RIS provides guidance for implementing recovery activities to carry out recovery actions identified in the Draft Revised Recovery Plan for the Eastern Indigo Snake (Service 2019a).

The strategy provides the expanded narrative and the implementation schedule for the eastern indigo snakes recovery activities. The implementation schedule estimates the cost for implementing recovery activities for delisting from threatened. Additionally, this strategy document restates the criteria for determining when the eastern indigo snake should be considered for delisting. A Species Status Assessment (SSA, Service 2019b), which provides information on the species' biology and status and a discussion of factors limiting its populations, is available at <http://www.fws.gov/athens/endangered/teherps.html>. The RIS and SSA will be updated on a routine basis.

Suggested literature citation:

U.S. Fish and Wildlife Service. 2019. Draft Eastern Indigo Snake Recovery Implementation Strategy. Atlanta, Georgia. 37 pp.

## ***Recovery Strategy***

The recovery strategy for the eastern indigo snake is to ensure the long-term viability of the species by maintaining and enhancing existing populations via habitat conservation, restoration and management; monitoring the status of existing populations; identifying and securing additional eastern indigo snake populations and habitat; repatriating populations through translocations or reintroductions; and supporting research that guides land management and provides demographic and ecological data. The recovery strategy for the eastern indigo snake requires that habitat is protected and managed and, that populations are connected to promote the stability and growth of multiple populations across the species' range.

Recovery of the eastern indigo snake is based upon the ecological principles of resiliency, redundancy, and representation (Smith *et al.* 2018). **Resiliency** is positively related to population size and growth and describes the ability of a population to withstand stochastic disturbance. Highly resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in temperatures (environmental stochasticity), or the effects of anthropogenic (human-driven) activities.

**Representation** describes the ability of a species to adapt to changing environmental conditions over time as characterized by the breadth of genetic and ecological diversity within and among populations. The more representation, or diversity, a species has, the more it is capable of adapting to changes in its environment. **Redundancy** spreads the risk among multiple populations and describes the ability of a species to withstand catastrophic events. Redundancy gauges the probability that there is a margin of safety for the species to withstand or bounce back from catastrophic events. It is measured by the number of populations, and their resiliency, distribution, and connectivity.

The SSA (Service 2019b) estimated fifty-three (53) extant eastern indigo snake populations based on verified species occurrence records buffered by the snake's estimated maximum home range width (5 mi or 8 km). The SSA highlighted the importance of maintaining large, unfragmented patches of good quality habitat (e.g., shelter sites and habitat diversity) and that eastern indigo snake populations need to be connected to support highly resilient populations. Habitat loss, degradation and fragmentation from development and sea level rise were identified as the primary negative factors influencing resiliency of populations. The populations were distributed across four (4) geographic regions (North Florida; Panhandle; Peninsular Florida; Southeast Georgia) that represented the species' genetic and ecological diversity. In the SSA we explored a potential targeted conservation scenario using 16 Conservation Focus Areas (CFAs) (Service 2019b) that have the greatest chance of maintaining or restoring sufficient habitat (quality and quantity) and connectivity among populations. In this RIS, we incorporate the CFAs to focus recovery actions to meet recovery criteria. See Appendix A for more detail on CFAs.

Habitat protection and management plans should be developed and implemented for all recovery populations. Appropriate habitat management includes maintaining corridors with low road density allowing dispersal between occupied upland and lowland habitats; minimizing soil disturbance and loss of native herbaceous ground cover vegetation; conducting prescribed burning, particularly during the growing season; maintaining appropriate lowland habitat; and restoring degraded upland habitat. Tracts of habitat in private ownership that could be managed for eastern indigo snakes need to be identified. Site analyses and habitat management actions that improve the connectivity between upland and lowland habitats utilized by eastern indigo snakes are needed. Population data for eastern indigo snake populations are poorly known. Long-term monitoring programs to better define populations, track population trends and the response of this species to habitat management activities are needed for all recovery populations. Gopher tortoise populations should be regularly monitored, and augmented if necessary, at areas where both eastern indigo snakes and tortoises co-occur. Monitoring programs should be critically evaluated and revised as needed. Since recovery of the eastern indigo snake will necessitate finding new or repatriating populations, assessment of potentially suitable habitat within the range of the species and additional presence/absence surveys are needed. Suitable habitat for repatriating populations needs to be identified, and programs developed and implemented to establish and monitor these new populations and manage the habitat that supports them. A range-wide monitoring protocol needs to be developed and implemented so it can be used to determine when recovery criteria have been met.

### ***Recovery Goal***

The goal of the recovery plan is to assure the long-term viability of the eastern indigo snake which will allow for its removal from the *List of Endangered and Threatened Wildlife* (50 CFR 17.11). This RIS provides guidance for implementing recovery actions to meet recovery criteria described in the Draft Revised Recovery Plan for the Eastern Indigo Snake. Criteria and the recovery strategy will be reevaluated as new information becomes available.

### ***Recovery Criteria***

*The eastern indigo snake should be considered for removal from the List of Endangered and Threatened Wildlife when:*

- 1) At least fourteen (14) populations exhibit a stable or increasing trend evidenced by natural recruitment, and multiple age classes (Addresses Factors A, C, and E).
- 2) Populations (as defined in criteria 1) are distributed across at least 12 Conservation Focus Areas (CFAs) (see Appendix A) with at least 2 populations within each of the 4 representative regions (North Florida; Panhandle; Peninsular Florida; Southeast Georgia) (Addresses Factors A, C, and E).

- 3) Populations within the North Florida, Peninsular Florida, and Southeast Georgia regions naturally maintain their genetic and ecological diversity (Addresses Factors A, C, and E).
- 4) Conservation measures (e.g., habitat protection and management) and commitments are in place to manage threats of habitat loss, degradation and fragmentation such that sufficient habitat quantity and quality exists for the species to remain viable into the foreseeable future (Addresses Factors A, C, D and E).

### ***Recovery Actions Narrative with Stepped-down Activities***

1. Protect existing eastern indigo snake populations via land protection and appropriate habitat management and conservation techniques identified in site-specific management plans. Protection and management efforts should focus on maintaining, enhancing, and restoring essential components of eastern indigo snake habitat. Priority should be given to populations occupying large blocks of habitat (minimum of 5,000 acres (ac) or 2,000 hectares (ha)) and to sites representative of the species' total geographic range and diversity of habitat types. Information from genetic studies will also be useful in prioritizing protection efforts (Task 3.2.4). Habitat protection will be achieved when habitat restoration has been accomplished and long-term commitments for habitat maintenance have been formalized.
  - 1.1 Protect habitat of existing eastern indigo snake populations on public lands (federal, state, and local) and develop habitat management plans. Eliminate impacts to eastern indigo snakes and their habitats on public lands and reduce conflicts between the needs of the species and the activities of the agencies. Management should focus on maintaining, enhancing, and restoring essential components of both the terrestrial and wetland habitat supporting eastern indigo snake populations.
    - 1.1.1 Work with public landowners to develop habitat management plans that support eastern indigo snake recovery.
    - 1.1.2 Implement management actions as identified in population-specific management plans for public lands. Incorporate any beneficial management and restoration actions discovered during research implemented under Task 3.0.
  - 1.2 Protect the habitat of existing eastern indigo populations on private land. Find mechanisms and incentives to help our private lands partners to facilitate habitat protection as developed under Task 1.1.

- 1.2.1 Establish partnerships with private landowners that have property supporting eastern indigo snakes and develop protective agreements and management plans.
- 1.2.2 Identify programs, financial incentives, and other opportunities to assist private landowners with eastern indigo snake habitat protection and management.
- 1.2.3 Connect eastern indigo snake recovery efforts with initiatives for private landowners that protect or reestablish other species endemic to the longleaf pine ecosystem (e.g., red-cockaded woodpecker and gopher tortoise).
- 1.3 Utilize existing regulations to promote eastern indigo snake recovery. Using these regulations, minimize adverse effects of proposed actions to the eastern indigo snake and its habitat, and maximize proposed actions to enhance recovery of the species. Implement by working with our Federal partners through use of the Act's Section 7 consultation process (via 7(a)(1) and 7(a)(2)) and by expanding other existing programs to further support recovery of the eastern indigo snake such as those utilized by the Department of Defense, Forest Service and Natural Resources Conservation Service.
- 1.4 Minimize impact of development. The location of known eastern indigo snake populations should be considered when development planning occurs.
  - 1.4.1 Minimize impact of roads. Prevent increases in road mortality by placing new roads around areas of large unfragmented habitat rather than through such sites.
  - 1.4.2 Protect known eastern indigo snake habitat from development.
  - 1.4.3 Work with Regional Planning Councils. Provide information on eastern indigo snakes to Regional Planning Councils or other local planning agencies as they develop Comprehensive Growth Management Plans.
- 2. Monitor known eastern indigo snake populations and the habitat that supports them. Initiate and continue long-term monitoring of selected recovery populations across the geographic range of the species based on recovery goals. Survey work should be conducted according to established biosecurity protocols to avoid transmission of pathogens between sampling sites (see 10a1A Permit Handling Protocol, Service 2016).

- 2.1 Gather baseline population data. Baseline population data are needed to assess the effectiveness of management efforts.
  - 2.1.1 Assess eastern indigo snake presence/absence every 3 to 5 years at selected sites.
  - 2.1.2 Initiate long-term (20+ years) monitoring of selected recovery populations across the species' geographic range.
- 2.2 Gather baseline data on physical characteristics of occupied habitat and monitor habitat conditions over time. Collect data relative to vegetation, soils, fire history, and upland habitat disturbance. Document the response of vegetation to various management regimes or techniques and identify forms of forest management that are supporting eastern indigo snake recovery populations.
- 2.3 Assess and reduce threats to recovery populations and their habitats.
  - 2.3.1 Assess existing threats to recovery populations and their habitats. Look for relationships between population changes and environmental factors (natural or human-induced). Include assessment of habitat structure and fragmentation.
  - 2.3.2 Identify the tasks necessary to reduce threats to recovery populations.
- 2.4 Revise and implement population-specific management plans based on results of Tasks 2.1 - 2.3. Within plans, describe the physical characteristics of habitat, threats to populations, population stability, and include a procedure to assess, at specific intervals, the success of strategies that have been implemented to meet recovery goals.
- 3. Expand knowledge of basic ecology and demography of eastern indigo snakes. Identify data gaps in knowledge of the basic ecology and demography of eastern indigo snakes and conduct research to fill these gaps. Elements critical to the perpetuation of populations need to be determined to ensure long-term survival for the species. Use results of studies to perform a population and habitat viability analysis (PVA), Task 3.2.
  - 3.1 Develop and test methods for reliably documenting and censusing eastern indigo snake populations. Expand on studies of previously tested methods. Finalize a protocol for using detector dogs in surveys if this method is determined to be useful and practical.

3.2 Conduct a PVA.

- 3.2.1 Conduct a study of gravid female eastern indigo snakes. Identify nesting habitat and preferred nest site location; clutch size; and hatching success.
- 3.2.2 Conduct demographic studies. Expand on data collected in 3.2.1 by studying an eastern indigo snake population which has demonstrated long-term stability (10+ years) to determine as many other life history metrics as possible, such as survival estimates for different life stages, the proportion of females breeding in a given year, age at first reproduction, the probability of an egg becoming a reproducing adult, birth and mortality rates, longevity, dispersal, etc.
- 3.2.3 Develop a method to estimate population size.
- 3.2.4 Assess existing data on geographic genetic variability and conduct additional genetic studies if needed. Use these data to study genetic connectivity and to identify source and recipient sites for reestablishing populations.
- 3.2.5 Develop techniques to determine the dispersal patterns of adults and juveniles. Identify preferred upland microhabitats used as den sites, especially in areas where gopher tortoise burrows are not used.
- 3.2.6 Model the effects of global climate change as it potentially relates to eastern indigo snake recovery.
- 3.2.7 Conduct a range-wide PVA analysis using the results of Tasks 3.2.1 through 3.2.6 and amend what defines a population and adjust population-specific management plans, as necessary. Estimate the minimum number of individuals necessary to sustain a viable population and determine the amount and quality of habitat needed. Assess geographic differences. Amend definition of a viable (or resilient) population, as necessary.

3.3 Conduct population health assessments at selected sites within the range of the eastern indigo snake to determine whether disease is a significant threat.

3.4 Study the interaction of eastern indigo snakes with other animals that may be predators and/or competitors.



- 3.4.1 Determine if fire ants prey upon eastern indigo snake eggs and whether they represent a threat to the species.
  - 3.4.2 Identify eastern indigo snake competitors and determine whether they represent a threat to the species.
- 4. Repatriate populations within habitat historically occupied by eastern indigo snakes where feasible.
  - 4.1 Develop a captive propagation and reintroduction plan.
    - 4.1.1 Establish guidelines for repatriating populations through the use of a captive breeding program. Determine the appropriate life stage to use in repatriation.
    - 4.1.2 Develop a methodology for identifying and selecting repatriation sites. Insure potential threats to the eastern indigo snake have been removed and, if possible, determine the reason for the local extirpation of the species.
  - 4.3 Determine, through monitoring and other techniques, if repatriated populations can be used to establish viable populations.
  - 4.4 Repatriate populations as necessary to meet recovery goals.
- 5. Develop range-wide habitat suitability models incorporating pertinent results from a Population Viability Analysis (PVA). Models need to allow for geographic variation in climate, vegetation, soils and other habitat variables across the range of the eastern indigo snake.
  - 5.1 Develop and field test a model for eastern indigo snake habitat in the northern part of the species' range.
  - 5.2 Develop and field test a model for eastern indigo snake habitat in the southern part of the species' range.
- 6. Establish a centralized range-wide Geographic Information System (GIS) database for data storage, analyses, and recovery review.
  - 6.1 Identify GIS data sources and formulate and maintain an eastern indigo snake GIS database of site records, ownership of occupied areas, and potential habitat

- delineated by state. Build on established databases in Florida and Georgia and develop coarse grain and fine grain filters for the eastern indigo snake database.
- 6.1.1 Develop a plan to ensure eastern indigo snake site records are accurate and updated regularly in the GIS database. Records should be obtained from various sources including direct reports as well as State and citizen science databases (e.g. HerpMapper).
  - 6.2 Ground-truth the GIS database. Periodically review the accuracy of data.
  - 6.3 Use the GIS database to look at landscape level connectivity and habitat quality within the species' range to identify populations and habitat essential to accomplishing recovery goals.
    - 6.3.1 Identify potential recovery populations within Conservation Focus Areas. Amend population boundaries, as needed, using information from the PVA (3.2) and site records (6.1-6.2).
    - 6.3.2 Identify which recovery populations would benefit from acquisition of essential habitat, conservation easements, and/or support for management and implementation planning.
    - 6.3.3 Use the GIS database and results obtained under Task 2 to further refine the estimate of the amount of habitat needed to sustain a viable population.
  - 6.4 Search for additional populations using the GIS database. Survey work should be conducted according to established biosecurity protocols to avoid transmission of pathogens between sampling sites (see 10a1A Permit Handling Protocol, Service 2016).
  - 7. Develop and distribute public educational materials and outreach programs supporting eastern indigo snake recovery. Develop Fact Sheets and other tools to provide the public with information on the eastern indigo snake, its habitat and its protected status. Provide information for stakeholders on prescribed burning, protection of soil and groundcover, importance of restoring longleaf pine, and Best Management Practices relating to timber management techniques which may support eastern indigo snake conservation.
    - 7.1 Form a multi-agency partnership to develop outreach materials; disseminate information to the public; coordinate and promote recovery activities; and establish cooperative research projects to promote recovery.

8. Coordinate all recovery activities, evaluate success, and revised recovery plan as appropriate.

- 8.1 Review the results of population-specific management plans, monitoring, survey efforts, and research at five-year intervals to determine success of recovery efforts. Conduct biennial recovery meetings to assess recovery progress.
- 8.2 Develop a Conservation Action Plan to facilitate recovery efforts. To assist action agencies with section 7 consultations or applicants drafting Habitat Conservation Plans, develop a range-wide (or State-specific) Conservation Action Plan that describes conservation measures, avoidance, best management practices, and potential compensatory actions that support recovery actions.

***Summary of threats, criteria, actions, and activities***

| Listing Factor | Threat                                       | Criteria | Action           | Activity                                                           |
|----------------|----------------------------------------------|----------|------------------|--------------------------------------------------------------------|
| A              | Habitat loss and modification                | 1,3,4    | 1,2,3,4, 5,6,7,8 | 1.1-1.4; 2.1-2.4; 3.1-3.4; 4.1-4.4; 5.1-5.2; 6.1-6.4; 7.1; 8.1-8.2 |
| B              | Over-collection                              | 1        | 2,7,8            | 2.1-2.3; 7.1; 8.1-8.2                                              |
| C              | Disease and predation                        | 1,2,3    | 2,3,8            | 2.3; 3.3-3.4, 8.1-8.2                                              |
| D              | Inadequacy of existing regulatory mechanisms | 1,4      | 2,8              | 2.3, 8.1-8.2                                                       |
| E              | Direct mortality and climate change          | 2,3,4    | 2,3,5,7,8        | 2.3; 3.2.6; 5.1-5.2; 7.1, 8.1-8.2                                  |

## REFERENCES

- Smith, D.R., Allan, N. L., McGowan, C. P., Szymanski, J. A., Oetker, S. R., and Bell, H. M. 2018. Development of a Species Status Assessment Process for Decision under the U.S. Endangered Species Act. *Journal of Fish and Wildlife Management*. Volume 9 (1): 1-19.
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- U.S. Fish and Wildlife Service. (Service) 2019a. Draft Revised Recovery Plan for the Eastern Indigo Snake. Atlanta, Georgia. 8 pp.
- U.S. Fish and Wildlife Service. (Service) 2019b. Species status assessment report for the eastern indigo snake (*Drymarchon couperi*). Version 1.1. July, 2019. Atlanta, GA.

## IMPLEMENTATION SCHEDULE

Recovery schedules are intended to assist the Service and other stakeholders in planning and implementing actions and activities to recover and/or protect endangered and threatened species. The following Implementation Schedule indicates task numbers; task descriptions; task duration; potential stakeholders and responsible agencies; and estimated costs. It is a guide for planning and meeting the objectives discussed in this strategy. The Implementation Schedule outlines recovery actions and activities, and their estimated costs for the first 30 years of this recovery program and the estimated cost and date for full recovery. **Actual expenditures by agencies and other partners are contingent upon appropriations and other budgetary constraints.**

While the ESA assigns a strong leadership role to the Service for the recovery of listed species, it also recognizes the importance of other Federal agencies, States, and other stakeholders in the recovery process. The “Responsible Parties” column of the Implementation Schedule identifies partners who can make significant contributions to specific recovery tasks. **The identification of agencies and other stakeholders within the Implementation Schedule does not constitute any additional legal responsibilities beyond existing authorities (e.g., Endangered Species Act, etc.).**

## Key to acronyms used in the Implementation Schedule

|          |                                                                                                                                                                                                    |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ADCNR    | -Alabama Department of Conservation and Natural Resources                                                                                                                                          |
| DOD      | - U.S. Department of Defense                                                                                                                                                                       |
| DOT      | - Departments of Transportation/ states of Florida and Georgia                                                                                                                                     |
| FFA      | - Florida Forestry Association                                                                                                                                                                     |
| FFS      | - Florida Forest Service                                                                                                                                                                           |
| FWC      | - Florida Fish and Wildlife Conservation Commission                                                                                                                                                |
| FHA      | - Federal Highway Administration                                                                                                                                                                   |
| FLDEP    | - Florida Department of Environmental Protection                                                                                                                                                   |
| GADNR    | - Georgia Department of Natural Resources                                                                                                                                                          |
| GFA      | - Georgia Forestry Association                                                                                                                                                                     |
| GFC      | - Georgia Forestry Commission                                                                                                                                                                      |
| OCIC     | - Central Florida Zoo's Orianne Center for Indigo Conservation                                                                                                                                     |
| OTHER    | - Other governmental agencies in Florida with proportionately small landholdings. These include Brevard County, Florida, Manatee County, Florida, and Southwest Florida Water Management District. |
| PRIVATE  | - Private landowners                                                                                                                                                                               |
| RESEARCH | - Independent researchers                                                                                                                                                                          |
| TNC      | - The Nature Conservancy                                                                                                                                                                           |
| TOS      | - The Orianne Society                                                                                                                                                                              |
| USFS     | - U.S. Forest Service                                                                                                                                                                              |
| USFWS    | - U.S. Fish and Wildlife Service                                                                                                                                                                   |
| USNPS    | - U.S. National Park Service                                                                                                                                                                       |

| IMPLEMENTATION SCHEDULE            |                |                                                                                                                                                |                  |                                                                                        |                                  |            |             |             |             |             |                            |                                                                                                                                                                                                                                                                                              |
|------------------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------------------|----------------------------------|------------|-------------|-------------|-------------|-------------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Eastern Indigo Snake Recovery Plan |                |                                                                                                                                                |                  |                                                                                        | U.S. Fish and Wildlife Service   |            |             |             |             |             |                            |                                                                                                                                                                                                                                                                                              |
| TASK<br>PRIORITY                   | TASK<br>NUMBER | TASK<br>DESCRIPTION                                                                                                                            | TASK<br>DURATION | RESPONSIBLE<br>PARTIES                                                                 | COST ESTIMATES (\$K) (YR = Year) |            |             |             |             |             |                            | COMMENTS                                                                                                                                                                                                                                                                                     |
|                                    |                |                                                                                                                                                |                  |                                                                                        | YR<br>1-5                        | YR<br>6-10 | YR<br>11-15 | YR<br>16-20 | YR<br>21-25 | YR<br>26-30 | Total<br>Recovery<br>Costs |                                                                                                                                                                                                                                                                                              |
| 1                                  | 1.1            | Protect habitat of existing eastern indigo snake populations on public lands (federal, state, and local) and develop habitat management plans. | Continuous       | ADCNR<br>DOD<br>FFS<br>FWC<br>FLDEP<br>GADNR<br>GFC<br>OTHER<br>USFS<br>USFWS<br>USNPS | 200                              | 200        | 200         | 125         | 125         | 125         | 900                        | Some expenditures for management planning and implementation covered under existing program costs. Initial implementation costs (yrs 1-10) will be higher due to habitat restoration efforts. Costs are management planning and implementation only. Costs for land protection not included. |
| 1                                  | 1.2            | Protect habitat of existing eastern indigo snake populations on private land.                                                                  | Continuous       | ADCNR<br>FFA<br>FFS<br>FWC<br>GADNR<br>GFA<br>GFC<br>PRIVATE<br>TNC<br>TOS<br>USFWS    | 185                              | 185        | 125         | 125         | 125         | 125         | 870                        | Some expenditures for management planning and implementation covered under existing program costs. Initial implementation costs (yrs 1-10) will be higher due to habitat restoration efforts. Costs are management planning and implementation only. Costs for land protection not included. |

| IMPLEMENTATION SCHEDULE            |                |                                                                        |                  |                                                                                        |                                  |            |             |             |             |             |                            |                                                                                |
|------------------------------------|----------------|------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------------------|----------------------------------|------------|-------------|-------------|-------------|-------------|----------------------------|--------------------------------------------------------------------------------|
| Eastern Indigo Snake Recovery Plan |                |                                                                        |                  |                                                                                        | U.S. Fish and Wildlife Service   |            |             |             |             |             |                            |                                                                                |
| TASK<br>PRIORITY                   | TASK<br>NUMBER | TASK<br>DESCRIPTION                                                    | TASK<br>DURATION | RESPONSIBLE<br>PARTIES                                                                 | COST ESTIMATES (\$K) (YR = Year) |            |             |             |             |             |                            | COMMENTS                                                                       |
|                                    |                |                                                                        |                  |                                                                                        | YR<br>1-5                        | YR<br>6-10 | YR<br>11-15 | YR<br>16-20 | YR<br>21-25 | YR<br>26-30 | Total<br>Recovery<br>Costs |                                                                                |
| 1                                  | 1.3            | Utilize existing regulations to promote eastern indigo snake recovery. | Continuous       | ADCNR<br>DOD<br>FFS<br>FWC<br>FLDEP<br>GADNR<br>GFC<br>OTHER<br>USFS<br>USFWS<br>USNPS |                                  |            |             |             |             |             |                            | Expenditures covered under existing program costs.                             |
| 1                                  | 1.4            | Minimize impact of development.                                        | Continuous       | ADCNR<br>DOD<br>DOT<br>FFS<br>FWC<br>FHA<br>FLDEP<br>GADNR<br>OTHER<br>USFS<br>USFWS   |                                  |            |             |             |             |             |                            | Cost to be determined. Some expenditures covered under existing program costs. |



| IMPLEMENTATION SCHEDULE            |                |                                                                                                                |                  |                                                                               |                                  |            |             |             |             |             |                            |                                                                               |
|------------------------------------|----------------|----------------------------------------------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------------|----------------------------------|------------|-------------|-------------|-------------|-------------|----------------------------|-------------------------------------------------------------------------------|
| Eastern Indigo Snake Recovery Plan |                |                                                                                                                |                  |                                                                               | U.S. Fish and Wildlife Service   |            |             |             |             |             |                            |                                                                               |
| TASK<br>PRIORITY                   | TASK<br>NUMBER | TASK<br>DESCRIPTION                                                                                            | TASK<br>DURATION | RESPONSIBLE<br>PARTIES                                                        | COST ESTIMATES (\$K) (YR = Year) |            |             |             |             |             |                            | COMMENTS                                                                      |
|                                    |                |                                                                                                                |                  |                                                                               | YR<br>1-5                        | YR<br>6-10 | YR<br>11-15 | YR<br>16-20 | YR<br>21-25 | YR<br>26-30 | Total<br>Recovery<br>Costs |                                                                               |
| 1                                  | 2.1            | Monitor known eastern indigo snake populations and the habitat that supports them.                             | Continuous       | ADCNR<br>DOD<br>FFS<br>FWC<br>GADNR<br>OTHER<br>TOS<br>USFS<br>USFWS<br>USNPS | 300                              | 150        | 150         | 150         | 150         | 150         | 1050                       | Initial monitoring costs will be higher to design program and identify sites. |
| 1                                  | 2.2            | Gather baseline data on physical characteristics of occupied habitat and monitor habitat conditions over time. | Every 3 years    | ADCNR<br>DOD<br>FFS<br>FWC<br>FLDEP<br>GADNR<br>TNC<br>TOS<br>USFS<br>USFWS   | 100                              | 100        | 100         | 100         | 100         | 100         | 600                        | Some expenditures covered under existing program costs.                       |
| 1                                  | 2.3            | Assess and reduce threats to recovery populations.                                                             |                  | ADCNR<br>DOD<br>FFS<br>FWC<br>FLDEP<br>GADNR<br>TNC<br>TOS<br>USFS<br>USFWS   |                                  |            |             |             |             |             |                            | Expenditures covered under task 2.2 and other program costs.                  |

| IMPLEMENTATION SCHEDULE            |                |                                                                                                   |                        |                                                                                               |                                  |            |             |             |             |             |                            |                                                    |
|------------------------------------|----------------|---------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------|----------------------------------|------------|-------------|-------------|-------------|-------------|----------------------------|----------------------------------------------------|
| Eastern Indigo Snake Recovery Plan |                |                                                                                                   |                        |                                                                                               | U.S. Fish and Wildlife Service   |            |             |             |             |             |                            |                                                    |
| TASK<br>PRIORITY                   | TASK<br>NUMBER | TASK<br>DESCRIPTION                                                                               | TASK<br>DURATION       | RESPONSIBLE<br>PARTIES                                                                        | COST ESTIMATES (\$K) (YR = Year) |            |             |             |             |             |                            | COMMENTS                                           |
|                                    |                |                                                                                                   |                        |                                                                                               | YR<br>1-5                        | YR<br>6-10 | YR<br>11-15 | YR<br>16-20 | YR<br>21-25 | YR<br>26-30 | Total<br>Recovery<br>Costs |                                                    |
| 1                                  | 2.4            | Revise and implement population-specific management plans based on results of tasks 2.1-2.3       | Continuous             | ADCNR<br>DOD<br>FFS<br>FWC<br>FLDEP<br>GADNR<br>GFC<br>PRIVATE<br>TNC<br>TOC<br>USFS<br>USFWS |                                  |            |             |             |             |             |                            | Expenditures covered under existing program costs. |
| 1                                  | 3.1            | Develop and test methods for reliably documenting and censusing eastern indigo snake populations. | At least every 3 years | ADCNR<br>DOD<br>FWC<br>GADNR<br>RESEARCH<br>TOS<br>USFWS                                      | 100                              | 100        | 100         |             |             |             | 300                        |                                                    |
| 1                                  | 3.2            | Conduct a PVA.                                                                                    |                        | ADCNR<br>FWC<br>GADNR<br>RESEARCH<br>TOS<br>TNC<br>USFS<br>USFWS                              | 150                              | 150        | 150         | 150         | 150         | 150         | 900                        | Includes multiple research studies on demography.  |

| IMPLEMENTATION SCHEDULE            |                |                                                                                                                                                            |                  |                                                                                 |                                  |            |             |             |             |             |                            |                                                                                                   |
|------------------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------|----------------------------------|------------|-------------|-------------|-------------|-------------|----------------------------|---------------------------------------------------------------------------------------------------|
| Eastern Indigo Snake Recovery Plan |                |                                                                                                                                                            |                  |                                                                                 | U.S. Fish and Wildlife Service   |            |             |             |             |             |                            |                                                                                                   |
| TASK<br>PRIORITY                   | TASK<br>NUMBER | TASK<br>DESCRIPTION                                                                                                                                        | TASK<br>DURATION | RESPONSIBLE<br>PARTIES                                                          | COST ESTIMATES (\$K) (YR = Year) |            |             |             |             |             |                            | COMMENTS                                                                                          |
|                                    |                |                                                                                                                                                            |                  |                                                                                 | YR<br>1-5                        | YR<br>6-10 | YR<br>11-15 | YR<br>16-20 | YR<br>21-25 | YR<br>26-30 | Total<br>Recovery<br>Costs |                                                                                                   |
| 1                                  | 3.3            | Conduct population health assessments at selected sites within the range of the eastern indigo snake to determine whether disease is a significant threat. | Continuous       | ADCNR<br>DOD<br>FWC<br>GADNR<br>RESEARCH<br>USFS<br>USFWS                       | 75                               | 75         | 75          |             |             |             |                            | Most cost covered under 2.1, 2.2, and 2.3. Additional cost for disease analysis to be determined. |
| 1                                  | 3.4            | Study the interaction of eastern indigo snakes with other animals that may be predators and/or competitors.                                                | Continuous       | ADCNR<br>FWC<br>GADNR<br>RESEARCH<br>TOS<br>TNC<br>USFS<br>USFWS                | 50                               | 50         | 25          |             |             |             | 125                        |                                                                                                   |
| 2                                  | 4.1            | Develop a captive propagation and reintroduction plan.                                                                                                     | 2 years          | ADCNR<br>DOD<br>FWC<br>GADNR<br>OCIC<br>RESEARCH<br>TNC<br>TOS<br>USFS<br>USFWS |                                  |            |             |             |             |             |                            | Expenditures covered under existing program costs.                                                |

| IMPLEMENTATION SCHEDULE            |                |                                                                                                                             |                  |                                                                                 |                                  |            |             |             |             |             |                            |                                                                                                                                            |
|------------------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------|----------------------------------|------------|-------------|-------------|-------------|-------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Eastern Indigo Snake Recovery Plan |                |                                                                                                                             |                  |                                                                                 | U.S. Fish and Wildlife Service   |            |             |             |             |             |                            |                                                                                                                                            |
| TASK<br>PRIORITY                   | TASK<br>NUMBER | TASK<br>DESCRIPTION                                                                                                         | TASK<br>DURATION | RESPONSIBLE<br>PARTIES                                                          | COST ESTIMATES (\$K) (YR = Year) |            |             |             |             |             |                            | COMMENTS                                                                                                                                   |
|                                    |                |                                                                                                                             |                  |                                                                                 | YR<br>1-5                        | YR<br>6-10 | YR<br>11-15 | YR<br>16-20 | YR<br>21-25 | YR<br>26-30 | Total<br>Recovery<br>Costs |                                                                                                                                            |
| 2                                  | 4.3            | Determine, through monitoring and other techniques, if repatriated populations can be used to establish viable populations. | Continuous       | ADCNR<br>DOD<br>FWC<br>GADNR<br>OCIC<br>RESEARCH<br>TNC<br>TOS<br>USFS<br>USFWS |                                  |            |             |             |             |             |                            | Expenditures covered under task 4.4, 3.1 and 3.2.                                                                                          |
| 2                                  | 4.4            | Repatriate populations as necessary to meet recovery goals.                                                                 | Continuous       | ADCNR<br>DOD<br>FWC<br>GADNR<br>OCIC<br>RESEARCH<br>TNC<br>TOS<br>USFS<br>USFWS | 1170                             | 1150       | 750         | 150         | 150         | 150         | 3520                       |                                                                                                                                            |
| 2                                  | 5.1            | Develop and field test a model for eastern indigo snake habitat in the northern part of the species' range.                 | 3 years          | RESEARCH<br>USFWS                                                               | 150                              | 25         |             |             |             |             | 175                        | This task will require the completed GIS database and the results of the PVA. This task is likely to extend beyond the 1-5 year timeframe. |

| IMPLEMENTATION SCHEDULE            |                |                                                                                                                                                                                          |                  |                                                                  |                                  |            |             |             |             |             |     |                                                        |                                                                                                                                                                         |
|------------------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------------------------------------------------|----------------------------------|------------|-------------|-------------|-------------|-------------|-----|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Eastern Indigo Snake Recovery Plan |                |                                                                                                                                                                                          |                  |                                                                  | U.S. Fish and Wildlife Service   |            |             |             |             |             |     |                                                        |                                                                                                                                                                         |
| TASK<br>PRIORITY                   | TASK<br>NUMBER | TASK<br>DESCRIPTION                                                                                                                                                                      | TASK<br>DURATION | RESPONSIBLE<br>PARTIES                                           | COST ESTIMATES (\$K) (YR = Year) |            |             |             |             |             |     | Total<br>Recovery<br>Costs                             | COMMENTS                                                                                                                                                                |
|                                    |                |                                                                                                                                                                                          |                  |                                                                  | YR<br>1-5                        | YR<br>6-10 | YR<br>11-15 | YR<br>16-20 | YR<br>21-25 | YR<br>26-30 |     |                                                        |                                                                                                                                                                         |
| 2                                  | 5.2            | Develop and field test a model for eastern indigo snake habitat in the southern part of the species' range.                                                                              | 3 years          | RESEARCH<br>USFWS                                                |                                  |            |             |             |             |             |     |                                                        | Cost covered under Task 5.1. This task will require the completed GIS database and the results of the PVA. This task is likely to extend beyond the 1-5 year timeframe. |
| 2                                  | 6.1            | Identify GIS sources and formulate and maintain an eastern indigo snake GIS database of site records, ownership of occupied areas, and potential habitat delineated by state.            | 5 years          | ADCNR<br>DOD<br>FWC<br>GADNR<br>RESEARCH<br>TOS<br>USFS<br>USFWS | 150                              |            |             |             |             |             | 150 | Some expenditures covered under existing program costs |                                                                                                                                                                         |
| 2                                  | 6.2            | Ground-truth the GIS database                                                                                                                                                            | Every 3 years    | ADCNR<br>DOD<br>FWC<br>GADNR<br>RESEARCH<br>TOS<br>USFS<br>USFWS | 15                               | 3          | 3           | 3           | 3           | 3           | 30  | Some expenditures covered under existing program costs |                                                                                                                                                                         |
| 2                                  | 6.3            | Use the GIS database to look at landscape level connectivity and habitat quality within the species range to identify populations and habitat essential to accomplishing recovery goals. | Continuous       | ADCNR<br>DOD<br>FWC<br>GADNR<br>USFS<br>USFWS                    |                                  |            |             |             |             |             |     | Expenditures covered under existing program costs      |                                                                                                                                                                         |

| IMPLEMENTATION SCHEDULE            |                |                                                                                                                                                                                                                    |                  |                                                                                                                |                                  |            |             |             |             |             |                            |                                                    |
|------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------|------------|-------------|-------------|-------------|-------------|----------------------------|----------------------------------------------------|
| Eastern Indigo Snake Recovery Plan |                |                                                                                                                                                                                                                    |                  |                                                                                                                | U.S. Fish and Wildlife Service   |            |             |             |             |             |                            |                                                    |
| TASK<br>PRIORITY                   | TASK<br>NUMBER | TASK<br>DESCRIPTION                                                                                                                                                                                                | TASK<br>DURATION | RESPONSIBLE<br>PARTIES                                                                                         | COST ESTIMATES (\$K) (YR = Year) |            |             |             |             |             |                            | COMMENTS                                           |
|                                    |                |                                                                                                                                                                                                                    |                  |                                                                                                                | YR<br>1-5                        | YR<br>6-10 | YR<br>11-15 | YR<br>16-20 | YR<br>21-25 | YR<br>26-30 | Total<br>Recovery<br>Costs |                                                    |
| 2                                  | 6.4            | Search for additional populations under Task 2 to further refine the estimate of the amount of habitat needed to sustain a viable population.                                                                      | Every 3 years    | ADCNR<br>FFWCC<br>GADNR<br>RESEARCH<br>TNC<br>TOS<br>USFWS                                                     |                                  |            |             |             |             |             |                            | Expenditures covered under existing program costs  |
| 3                                  | 7.1            | Form a multi-agency partnership to develop outreach materials; disseminate information to the public; coordinate and promote recovery activities; and establish cooperative research projects to promote recovery. | Continuous       | ADCNR<br>DOD<br>FFS<br>FWC<br>FLDEP<br>GADNR<br>GFC<br>PRIVATE<br>OCIC<br>TOS<br>TNC<br>USFS<br>USFWS<br>USNPS | 25                               | 25         | 25          | 25          | 25          | 25          | 150                        |                                                    |
| 3                                  | 8.1            | Review the results of population-specific management plans, monitoring, survey efforts, and research at five-year intervals to determine success of recovery efforts.                                              | Every 5 years    | USFWS                                                                                                          |                                  |            |             |             |             |             |                            | Expenditures covered under existing program costs. |

| IMPLEMENTATION SCHEDULE            |                |                                                                    |                  |                                                                                 |                                  |            |             |             |             |             |                            |                                                    |
|------------------------------------|----------------|--------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------|----------------------------------|------------|-------------|-------------|-------------|-------------|----------------------------|----------------------------------------------------|
| Eastern Indigo Snake Recovery Plan |                |                                                                    |                  |                                                                                 | U.S. Fish and Wildlife Service   |            |             |             |             |             |                            |                                                    |
| TASK<br>PRIORITY                   | TASK<br>NUMBER | TASK<br>DESCRIPTION                                                | TASK<br>DURATION | RESPONSIBLE<br>PARTIES                                                          | COST ESTIMATES (\$K) (YR = Year) |            |             |             |             |             |                            | COMMENTS                                           |
|                                    |                |                                                                    |                  |                                                                                 | YR<br>1-5                        | YR<br>6-10 | YR<br>11-15 | YR<br>16-20 | YR<br>21-25 | YR<br>26-30 | Total<br>Recovery<br>Costs |                                                    |
| 3                                  | 8.2            | Develop a Conservation Action Plan to facilitate recovery efforts. | Continuous       | ADCNR<br>DOD<br>FWC<br>GADNR<br>PRIVATE<br>TOS<br>TNC<br>USFS<br>USFWS<br>USNPS |                                  |            |             |             |             |             |                            | Expenditures covered under existing program costs. |

**Estimated costs of recovery:** The total recovery costs to ultimately delist the eastern indigo snake is approximately \$8,995,000. Some costs for recovery actions are not determinable at this time (e.g., land protection); therefore, the total cost for recovery will be higher than this estimate.

## APPENDIX A: Conservation Focus Areas

Sixteen Conservation Focus Areas (Figure A1, Table A1), distributed throughout portions of the historic and current range of the eastern indigo snake were identified, to provide our partners with a potential conservation scenario to consider to implement recovery efforts. Populations within these areas, if protected and managed for eastern indigo snakes under this scenario, could improve the status of the species. The areas were chosen because they contain potentially viable populations or because they will contribute to the connectivity of occupied eastern indigo snake habitat and thus increase dispersal between populations and improve opportunities for new population establishment. Preservation and enhancement of habitat within each focus area is important to maintain and expand the distribution of eastern indigo snake populations range-wide. Conservation Focus Areas in the historic range represent important elements of the species' historic distribution and were selected to prevent further range collapse. Unoccupied areas may require varying degrees of rehabilitation (e.g., prescribed fire, gopher tortoise translocations) to restore habitat suitability prior to future recolonization or reestablishment efforts. These potential areas would require long-term protection and management so that existing and newly-established populations achieve and maintain viability.

Conservation Focus Areas were selected based on a review of the historical/current distribution and habitat requirements of the species. Data were incorporated from a review of the current literature, primarily Enge *et al.* (2013); comments provided by eastern indigo snake experts; and an eastern indigo snake habitat model (Service 2019). The primary factors used in delineating boundaries of Conservation Focus Areas within specific physiographic provinces were presence of: (1) intact, unfragmented (by major roads or river systems), naturally-functioning habitat representative of that area's physiographic province that meet the medium or higher threshold for habitat fragmentation (25% of habitat is >20K acres patch size; or 50% is >10K acres patch size; or 75% >5K acres patch size ); (2) areas that in their totality, support genetic and ecological integrity of the species by including areas throughout the historical and current range of the eastern indigo snake and in both the Gulf Coastal Plain and Atlantic Coastal Plain; (3) areas that contain multiple, large acreages (greater than 2,500 ac (1,000 ha)) of conservation land such as public lands or property with conservation easements capable of adequate management (e.g., prescribed fire, wildlife corridors); and (4) diverse habitat types (e.g., scrub, sandhills, riverine sand ridges, etc.) as identified by our eastern indigo snake habitat model (Service 2019).

Physiographic provinces were used as described by Brooks (1981) for Florida and Wharton (1978) for Georgia. A discussion of the habitat types used by eastern indigo snakes in these physiographic provinces is provided below in the discussion of each individual Conservation Focus Area. Conservation Focus Areas were given names that would be identifiable to the general public by using a geographic area name or, as in the case of Fort Stewart and



Okefenokee, the name of a major Federal landholding. Conservation Focus Areas may include entire watersheds and thus are composed of both public and private lands.

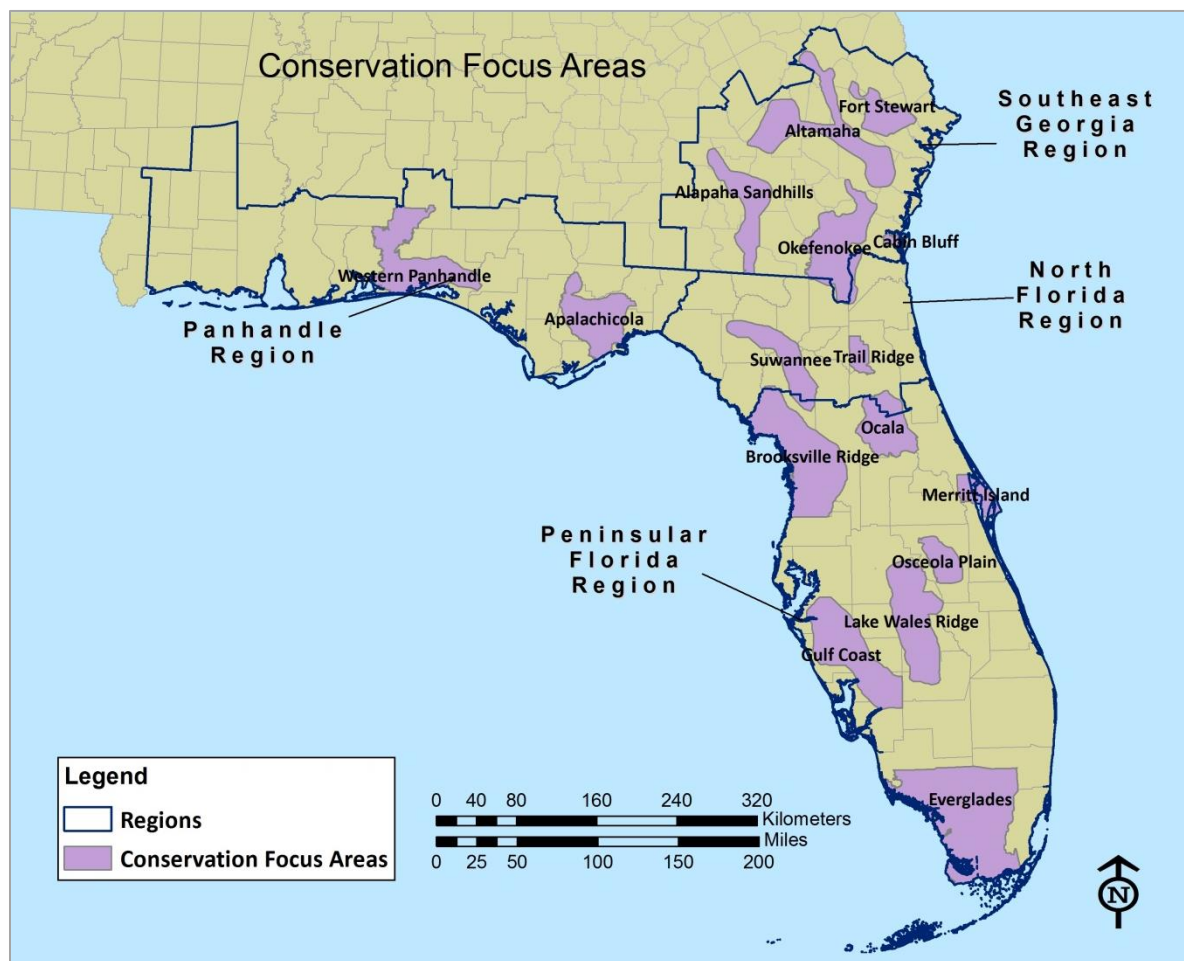


Figure A1: Eastern indigo snake Conservation Focus Areas (CFA).

## CONSERVATION FOCUS AREAS

### PANHANDLE

#### ***Western Panhandle***

The Western Panhandle Conservation Focus Area includes parts of Covington and Escambia counties in Alabama, and parts of Okaloosa, Santa Rosa, and Walton counties in Florida. Most of this Conservation Focus Area lies within the Western Highlands Physiographic Province, while the more southerly portions closer to the Gulf Coast are within the Coastal Lowlands. This area, close to the western margin of the species' range, includes large and well-managed (e.g. regular prescribed fire) public lands both in Alabama and Florida (Conecuh National Forest, Blackwater River State Forest, Choctawhatchee River Wildlife Management Area (WMA), Eglin Air Force Base); and a privately-owned nature preserve dedicated to the preservation of native biodiversity (Nokuse Plantation). It contains approximately 845,607 ac (342,205 ha) of potential eastern indigo snake habitat. The most recent verifiable eastern indigo snake record for the region was at Eglin Air Force Base in 1999; a credible (but not verified by photo or specimen) eastern indigo snake sighting was reported from close to the base boundary in 2011 (Enge *et al.* 2013). The decline of eastern indigo snakes in this region may have resulted from a dramatic decline in gopher tortoise populations, going back to the mid 1900's and coinciding with a period of heavy human predation on tortoises. Currently, an eastern indigo snake reintroduction effort is underway on the Conecuh National Forest, Alabama (Stiles *et al.* 2013). In this region, eastern indigo snakes require tortoise burrows for cool-season shelter sites and other aspects of their ecology.

#### ***Apalachicola National Forest and Vicinity***

The Apalachicola National Forest and Vicinity Conservation Focus Area occupies parts of Franklin, Gadsen, Leon, Liberty, and Wakulla counties in Florida. The Apalachicola National Forest (ANF) is located almost entirely within the Delta Plain and Coastal Strip physiographic regions, however the northeastern section, a large block of xeric sandhill (called the Munson Sandhills), is part of the Paleodelta Relics region (also known as the Woodville Karst Plain). North of the ANF an extensive sand ridge that is a part of the Quincy Hills physiographic region occurs on the east side of, and parallel to, the Apalachicola River in Liberty County. Apalachicola Bluffs and Ravines Preserve (owned by The Nature Conservancy) is located on this sand ridge, is actively managed for longleaf pine-wiregrass, and supports a gopher tortoise population. The Munson Sandhills and Apalachicola Bluffs and Ravines supported eastern indigo snake populations into the late 1980s-to-mid-1990s (Enge *et al.* 2013). Much of the western half of the ANF is too poorly-drained (i.e., mesic savannas and flatwoods, swamps) to support eastern indigo snakes, however this Conservation Focus Area contains 424,274 ac (171,698 ha) of potential eastern indigo snake habitat. In this part of their range, eastern indigo snakes require tortoise burrows excavated in well-drained xeric sands for cool-season shelter sites and other aspects of their ecology. If snake reintroductions are attempted in the Florida

panhandle within the historic range of the species, the Munson Sandhills and Apalachicola River sandhills will be likely areas to consider for the effort.

## **NORTH FLORIDA**

### ***Suwannee River***

The Suwannee River Conservation Focus Area includes portions of Alachua, Columbia Gilchrist, Lafayette, Levy, and Suwannee counties in Florida. This Conservation Area is located within the Northern Peninsula Plains, Suwannee River Valley and Newberry Sand Hills physiographic provinces and includes a portion of the Brooksville Ridge. The northern part of this area includes significant xeric sandhill habitats along the Suwannee River in Suwannee and Lafayette counties. The southern portion encompasses the northern extent of the Brooksville Ridge in Levy County. Approximately 406,732 ac (164,599 ha) of potential eastern indigo snake habitat occurs in this Conservation Focus Area. There are recent eastern indigo snake records for the rolling sandhills of Goethe State Forest, Watermelon Pond Wildlife and Environmental Area, and Ashton Biological Preserve in southwestern Alachua County; Troy Springs Conservation Area; Lafayette Blue Springs State Park in Levy County; Ichetucknee Springs State Park and Little River Conservation Area in Suwannee County; and Twin Rivers State Forest in Madison County. Habitat management of longleaf pine–wiregrass communities is ongoing at conservation tracts throughout this Conservation Focus Area. In this region, eastern indigo snakes require gopher tortoise burrows excavated in well-drained xeric sands for cool-season shelter and other aspects of their ecology.

### ***Trail Ridge***

The Trail Ridge Conservation Focus Area occurs in portions of Clay and Putnam counties, Florida. Trail Ridge is the largest of several long, low north-trending ridges in central Florida and is among the most distinctive landforms in an area of otherwise low topographic relief. The ridges are complexes of sand dunes formed during the Pleistocene and contain 110,031 ac (44,528 ha) of potential eastern indigo snake habitat. The Trail Ridge Conservation Focus Area is composed of portions of three physiographic regions: Duval Upland, Interlachen Sand Hills and Okefenokee Upland. In this Conservation Focus Area, eastern indigo snakes are thought to require gopher tortoise burrows excavated in well-drained xeric sands for cool-season shelter and other aspects of their ecology. Conservation lands in this region known to support eastern indigo snake populations include Camp Blanding Joint Training Center, Belmore State Forest, Etoniah Creek State Forest, and Gold Head Branch State Park.

## **PENINSULAR FLORIDA**

### ***Brooksville Ridge and Vicinity***

The Brooksville Ridge and Vicinity Conservation Focus Area includes all of Citrus County and portions of Gilchrist, Hernando, Levy, Marion, and Sumter counties, Florida. It is situated within 10 different physiographic regions and encompasses 589,489 ac (238,558 ha) of potential

eastern indigo snake habitat. The Brooksville Ridge, an ancient, linear dune line that extends from Levy County to southern Hernando County, is characterized by high-quality tracts of longleaf pine sandhills. Elevations along the ridge range from 70 to 300 ft (230 to 984 m) above sea level. This region is a recognized stronghold for the species in Florida (Enge *et al.* 2013). Although at this latitude eastern indigo snakes do not absolutely require gopher tortoise burrows, many indigo populations in this region are associated with xeric sandhills and large tortoise populations, and at these sites it is likely that they exhibit frequent use of tortoise burrows. Other habitats utilized by snakes in this region include scrubby and mesic pine flatwoods, hydric hammocks, and depressional wetlands. Conservation lands within this Conservation Focus Area with recent eastern indigo snake records include Marjorie Carr Cross Florida Greenway, Chassahowitzka National Wildlife Refuge, Chassahowitzka WMA, Ross Prairie State Forest, Goethe State Forest, Crystal River State Park, Weekiwachee Preserve, Lake Panasoffkee WMA, Half Moon WMA, Halpata Tastanaki Preserve, Annutteliga Hammock (a conservation land administered by the Southwest Florida Water Management District), Rainbow Springs State Park, and six different tracts comprising the Withlacoochee State Forest.

### ***Gulf Coast***

The Gulf Coast Conservation Focus Area occupies portions of Charlotte, DeSoto, Hardee, Hillsborough, Lee, Manatee, and Sarasota counties, Florida. It is located primarily within the DeSoto Slope physiographic region, but also occurs within a portion of the Bone Valley Uplands region. The area is composed of a mix of dry prairie, pinelands, freshwater marsh, wet prairie, and hardwood swamp. Eastern indigo snakes do not depend on gopher tortoise burrows in this area and snake populations occur in various habitats. However, it's likely that tortoise burrows are used where the species overlap. A significant portion of the natural habitat has been converted to pasture and cropland, however approximately 773,207 ac (312,906 ha) of this Conservation Focus Area represent potential eastern indigo snake habitat. Conservation lands in the region with potential habitat and recent records for eastern indigo snakes include Babcock Ranch Preserve, Myakka River State Park, and Duette Preserve. Babcock-Webb WMA also has potential habitat for the species.

### ***Everglades***

The Everglades Conservation Focus Area occurs in portions of Broward, Collier, Monroe, and Miami-Dade counties, Florida. This Conservation Focus Area is within the Big Cypress Swamp, Everglades, Southern Atlantic Coastal Strip, and Ten Thousand Islands physiographic regions. It is located in southernmost peninsular Florida and contains 657,004 ac (265,880 ha) of potential eastern indigo snake habitat. In this area, eastern indigo snakes are locally distributed and uncommon, inhabiting pine rocklands, hardwood hammocks, wetland margins, mangroves, and disturbed habitats. Eastern indigo snakes do not depend on gopher tortoise burrows in this area (in fact, natural tortoise populations are absent from most of this predominantly wetland region). Conservation lands in this region known to support eastern indigo snake populations include

Everglades National Park, Big Cypress National Preserve, Rookery Bay National Estuarine Research Preserve, and Fakahatchee Strand Preserve State Park.

### ***Ocala***

The Ocala Conservation Focus Area occurs in portions of Lake, Marion, Putnam, and Volusia counties, Florida. It is situated within portions of Crescent City-Deland Ridge, Lynne Karst, Ocala Scrub, and St. John's Offset Physiographic regions, lies between the Ocklawaha and St. Johns Rivers in central Florida and includes the Ocala National Forest where eastern indigo snakes have been documented in recent surveys (Enge *et al.* 2013). This Conservation Focus Area includes a significant part of the Big Scrub, a notable ecological area that supports many scrub endemic species. Uplands of approximately 445,997 ac (180,489 ha) of potential eastern indigo snake habitat include oak scrub, sand pine scrub, longleaf pine sandhills, xeric hammocks, and some mesic pine flatwoods. This area supports a very large gopher tortoise population (over 10,000+ individuals) and uplands are actively managed using prescribed fire. Eastern indigo snakes are widespread in this region but do not appear to be especially common. It is not known to what extent the eastern indigo snake depends on gopher tortoise burrows in this area, but it's likely that tortoise burrow use is common where the species overlap.

### ***Osceola Plain***

The Osceola Plain Conservation Focus Area occurs in Osceola County, Florida. It is part of the Holopaw-Indian Town Ridges and Swales and Kissimmee Valley physiographic province, a region of palmetto prairie and scrubby flatwoods habitats. The Conservation Focus Area contains approximately 238,384 ac (96,470 ha) of potential eastern indigo snake habitat. Eastern indigo snakes do not depend on gopher tortoise burrows in this area, but it's likely that tortoise burrow use is common where the species overlap. Conservation lands in this region with recent eastern indigo snake records include Bull Creek Wildlife Management Area, Three Lakes Wildlife Management Area, and Triple N Ranch Wildlife Management Area.

### ***Lake Wales Ridge***

The Lake Wales Ridge Conservation Focus Area occurs in Glades, Hardee, Highlands, and Polk counties, Florida. This south-central Florida Conservation Focus Area is centered on an ancient dune system which runs (north-to-south) for about 150 mi (240 km) and includes Lake Wales Ridge, Carlton Ranch Ridge, and Bombing Range Ridge physiographic regions. Intact habitats on the Lake Wales Ridge itself are predominantly scrub (oak scrub, sand pine scrub) and scrubby flatwoods, with lesser areas of sandhill habitat. Although at this latitude eastern indigo snakes do not absolutely require gopher tortoise burrows, many snake populations in this region are associated with xeric sandhills and large tortoise populations, and at these sites snakes exhibit frequent use of tortoise burrows (Layne and Steiner 1996, Bauder 2018). This region of approximately 645,361 ac (261,168 ha) of eastern indigo snake potential habitat is recognized as a significant population stronghold, despite historic habitat loss and fragmentation. Conservation

lands eastern indigo snake populations in this Conservation Focus Area include the Avon Park Bombing Range, Lake Wales Ridge Wildlife and Environmental Area, Lake Wales Ridge State Forest, Highlands Hammock State Park, and Archbold Biological Station.

### ***Merritt Island and Vicinity***

The Merritt Island and Vicinity Conservation Focus Area occurs in Brevard County, Florida. This Conservation Focus Area, along the Atlantic Coast of central Florida, includes Merritt Island, as well as inland habitats located to the west, and on both sides of Interstate 95, in Brevard County. Physiographic regions within this area include Cape Canaveral, Central Atlantic Coastal Strip, and St. Johns Wet Prairie. Conservation lands supporting eastern indigo snake populations include Merritt Island National Wildlife Refuge, Seminole Ranch Conservation Area, Buck Lake Conservation Area, Salt Lake Wildlife Management Area, Fox Lake Sanctuary, and Cape Canaveral National Seashore. Although this Conservation Focus Area encompasses brackish estuaries and marshes, the remaining habitats consisting of approximately 132,709 ac (53,706 ha) of coastal dunes, oak scrubs, pine flatwoods, oak hammocks, cabbage palm hammocks, and swamps are considered potential eastern indigo snake habitat. Eastern indigo snakes in this region are not dependent on the presence of tortoise burrows and use a wide variety of refuge types including debris piles, small mammal burrows and armadillo burrows. The eastern indigo snake population in this region has been well-studied including research using radio-telemetry (Breininger *et al.* 2004, 2011, 2012).

## **SOUTHEAST GEORGIA**

### ***Fort Stewart***

The Fort Stewart Conservation Focus Area occurs in Candler, Bryan, Bulloch, Evans, Liberty, Long, and Tattnall counties, Georgia. It is located primarily within the Sea Island Flatwoods physiographic province of southern Georgia and includes all of the Fort Stewart Military Installation. This area includes extensive xeric sand ridge habitats adjacent to the Canoochee River and xeric sandhills associated with Beard's Creek, an Altamaha River tributary. Habitats within this Conservation Focus Area include fire-managed longleaf pine sandhills that support large sizeable tortoise populations, mesic pine flatwoods, blackwater creek swamps and isolated depressional wetlands. Approximately 260,253 ac (105,432 ha) of potential eastern indigo snake habitat occurs within this Conservation Focus Area. The eastern indigo snake population on the Fort Stewart Military Installation has been monitored via mark-recapture methods for 15 years (1999-2014) (Stevenson *et al.* 2009, Hyslop *et al.* 2012) and was the site of a recent radio-telemetry study examining home range and habitat use (Hyslop 2007). There are numerous recent eastern indigo snake records for this area. Eastern indigo snakes in this region require gopher tortoise burrows excavated in well-drained xeric sands for cool-season shelter and other aspects of their ecology.

### ***Altamaha River Sandhills***

The Altamaha River Sandhills Conservation Focus Area occurs in Appling, Candler, Coffee, Emanuel, Glynn, Jeff Davis, Long, McIntosh, Montgomery, Tattnall, Telfair, Toombs, Wayne, and Wheeler counties, Georgia. It is located primarily within the Tifton Uplands with more southerly portions within the Sea Island Flatwoods physiographic province. It includes eastern indigo snake and gopher tortoise habitats within the Altamaha River Drainage from the lower Ocmulgee River and lower Oconee River (and their perennial tributaries) southeasterly and downstream along the Altamaha River to close to the coast. Approximately 620,253 ac (251,008 ha) of potential eastern indigo snake habitat occurs within this Conservation Focus Area. Because of the widespread distribution of the eastern indigo snake and local robust populations, this region has long been recognized as a population stronghold for the species in Georgia. This Conservation Focus Area includes some xeric sand ridge habitats that, historically, have been fire-suppressed or planted for commercial forestry; active management efforts are currently underway to restore these sites to longleaf pine – wiregrass habitats (e.g., Long and McIntosh counties). Eastern indigo snakes in this region require gopher tortoise burrows excavated in well-drained xeric sands for cool-season shelter and other aspects of the snakes' ecology. There are numerous recent eastern indigo snake records for this area, and substantial acreage of public and conservation lands within this Conservation Area which include the Griffin Ridge Wildlife Management Area, Orianne Indigo Snake Preserve, Sansavilla Wildlife Management Area, and Townsend Wildlife Management Area. Even so, acquisition and/or protection of additional eastern indigo snake habitat is needed, especially along the Ochopee River and Little Ocmulgee River.

### ***Alapaha River Sandhills***

The Alapaha River Sandhills Conservation Focus Area occurs in Berrien, Coffee, Echols, Irwin, Lanier, Lowndes, and Turner counties, Georgia. It is located within the Tifton Uplands and Okefenokee Plains physiographic provinces of southern Georgia. This Conservation Focus Area includes vast areas of xeric sand ridge habitats, some of which are intact and in good condition with large numbers of gopher tortoises, adjacent to the Alapaha River. It also includes sandhills within the upper Satilla River Drainage along 17-Mile River. Approximately 283,837 ac (114,865 ha) of this Conservation Focus Area is considered potential eastern indigo snake habitat. Eastern indigo snakes in this region require gopher tortoise burrows excavated in well-drained xeric sands for cool-season shelter and other aspects of the snakes' ecology. There are numerous recent eastern indigo snake records for the Alapaha River Sandhills although public conservation lands within this Conservation Focus Area are limited to Alapaha River Wildlife Management Area, a Georgia Forestry Commission Conservation Easement in Berrien County, Grand Bay Wildlife Management Area, and Moody Air Force Base. Acquisition and/or protection of additional eastern indigo snake habitat are needed.



### ***Cabin Bluff***

This small Recovery Area is located entirely within Camden County and extends to the Atlantic Coast (Sea Islands Coastal Marsh and Sea Island Flatwoods physiographic provinces). Habitats here include a matrix of sandy uplands, pine flatwoods, wetlands and coastal marshes between the lower Satilla River and the Crooked River. Approximately 24,663 ac (9,981 ha) of this Conservation Focus Area is considered potential eastern indigo snake habitat. The region supports a large gopher tortoise population and is one of the few sites in Georgia where eastern indigo snakes occur in coastal habitats. Eastern indigo snakes in this region require gopher tortoise burrows excavated in well-drained xeric sands for cool-season shelter and other aspects of the snakes' ecology. Public conservation lands are very limited to Crooked River State Park although the nearby Kings Bay Navy Base may offer suitable habitat within this Conservation Focus Area. Acquisition and/or protection of additional eastern indigo snake habitat are needed.

### ***Okefenokee and Vicinity***

The Okefenokee and Vicinity Conservation Focus Area occurs in Brantley, Camden, Charlton, Clinch, Glynn, Ware, and Wayne counties, Georgia; and a small area of Nassau County, Florida. It is located mostly within the Okefenokee Swamp and Okefenokee Plains physiographic provinces, but also includes part of the Bacon Terraces. This area includes all of the Okefenokee National Wildlife Refuge (ONWR) and sandy uplands on the east side of the refuge associated with Trail Ridge; and areas of sandhill habitats north of ONWR and within the Satilla River and St. Mary's River Drainages. Recent field work has provided data documenting eastern indigo snakes from the east side of ONWR (Enge *et.al.* 2013), however, eastern indigo snakes are not currently known to inhabit any of the pine islands within the swamp interior, or any refuge lands on the west or north sides of the swamp. This Conservation Focus Area consists of approximately 351,861ac (142,395 ha) of potential eastern indigo snake habitat. Eastern indigo snakes in this region require gopher tortoise burrows excavated in well-drained xeric sands for cool-season shelter and other aspects of the snakes' ecology. Outside of ONWR, there is very limited acreage of public and conservation lands within this Conservation Focus Area, and acquisition and/or protection of additional eastern indigo snake habitat is needed, especially within the Satilla River Drainage.



**Table A1.** Eastern Indigo Snake Conservation Focus Areas. Conservation Areas which contain > 2,500 ac (1,000 ha) of appropriate habitat for the species are listed. X = Recent records of the species (since 2001), X\* indicate sites where eastern indigo snakes are being repatriated.

| CONSERVATION FOCUS AREA                                 | Recent Eastern Indigo Snake Records | Total Acres (Hectares)  |
|---------------------------------------------------------|-------------------------------------|-------------------------|
| <b>PANHANDLE</b>                                        |                                     |                         |
| <b><i>Western Panhandle</i></b>                         |                                     |                         |
| Conecuh National Forest                                 | X*                                  | 83,001 ac (33,590 ha)   |
| Blackwater River State Forest                           |                                     | 189,590 ac (76,726 ha)  |
| Eglin Air Force Base                                    |                                     | 463,439 ac (187,551 ha) |
| Nokuse Plantation                                       |                                     | 51,000 ac (20,639 ha)   |
| Choctawhatchee River Wildlife Management Area           |                                     | 57,000 ac (23,068 ha)   |
|                                                         |                                     |                         |
| <b><i>Apalachicola National Forest and Vicinity</i></b> |                                     |                         |
| Apalachicola National Forest                            |                                     | 569,790 ac (230,591 ha) |
| Apalachicola Bluffs and Ravines Preserve                | X*                                  | 6,247 ac (2,528 ha)     |
|                                                         |                                     |                         |
| <b>NORTH FLORIDA</b>                                    |                                     |                         |
| <b><i>Suwannee River</i></b>                            |                                     |                         |
| Goethe State Forest                                     | X                                   | 53,019 ac (21,456 ha)   |
| Watermelon Pond Wildlife and Environmental Area         | X                                   | 4,231 ac (1,712 ha)     |
|                                                         |                                     |                         |
| <b><i>Trail Ridge</i></b>                               |                                     |                         |
| Camp Blanding Joint Training Center                     | X                                   | 73,075 ac (29,573 ha)   |
| Belmore State Forest                                    | X                                   | 12,264 ac (4,963 ha)    |
| Etoniah Creek State Forest                              | X                                   | 8,678 ac (3,512 ha)     |
|                                                         |                                     |                         |
| <b>PENINSULAR FLORIDA</b>                               |                                     |                         |
| <b><i>Brooksville Ridge and Vicinity</i></b>            |                                     |                         |
| Marjorie Carr Cross Florida Greenway                    | X                                   | 71,269 ac (28,841 ha)   |
| Chassahowitzka National Wildlife Refuge                 | X                                   | 30,843 ac (12,482 ha)   |
| Chassahowitzka Wildlife Management Area                 | X                                   | 33,917 ac (13,726 ha)   |
| Ross Prairie State Forest                               | X                                   | 3,546 ac (1,435 ha)     |
| Goethe State Forest                                     | X                                   | 48,441 ac (19,604 ha)   |
| Crystal River State Park                                | X                                   | 27,433 ac (11,102 ha)   |
| Weekiwachee Preserve                                    | X                                   | 11,199 ac (4,532 ha)    |
| Lake Pansofftkee Wildlife Management Area               | X                                   | 10,323 ac (4,177 ha)    |
| Half Moon Wildlife Management Area                      | X                                   | 9,650 ac (3,905 ha)     |
| Halpata Tastanaki Preserve                              | X                                   | 7,892 ac (3,194 ha)     |
| Withlacoochee State Forest                              | X                                   | 138,455 ac (56,032 ha)  |

| CONSERVATION FOCUS AREA                          | Recent Eastern Indigo Snake Records | Total Acres (Hectares)  |
|--------------------------------------------------|-------------------------------------|-------------------------|
| <b><i>Ocala</i></b>                              |                                     |                         |
| Ocala National Forest                            | X                                   | 383,563 ac (155,226 ha) |
|                                                  |                                     |                         |
| <b><i>Merritt Island and Vicinity</i></b>        |                                     |                         |
| Merritt Island National Wildlife Refuge          | X                                   | 131,114 ac (53,061 ha)  |
| Seminole Ranch Conservation Area                 | X                                   | 29,497 ac (11,937 ha)   |
| Buck Lake Conservation Area                      | X                                   | 9,589 ac (3,880 ha)     |
| Salt Lake Wildlife Management Area               | X                                   | 5,041 ac (2,040 ha)     |
| Fox Lake Sanctuary                               | X                                   | 3,048 ac (1,233 ha)     |
| Canaveral National Seashore                      | X                                   | 16,242 ac (6,573 ha)    |
|                                                  |                                     |                         |
| <b><i>Gulf Coast</i></b>                         |                                     |                         |
| Babcock Ranch Preserve                           | X                                   | 73,239 ac (29,638 ha)   |
| Babcock-Webb Wildlife Management Area            | X                                   | 67,570 ac (27,345 ha)   |
| Myakka River State Park                          | X                                   | 37,198 ac (15,053 ha)   |
| Duette Preserve                                  | X                                   | 20,269 ac (8,202 ha)    |
|                                                  |                                     |                         |
| <b><i>Osceola Plain</i></b>                      |                                     |                         |
| Three Lakes Wildlife Management Area             | X                                   | 61,834 ac (25,024 ha)   |
| Bull Creek Wildlife Management Area              | X                                   | 23,495 ac (9,508 ha)    |
| Triple N Ranch Wildlife Management Area          | X                                   | 15,389 ac (6,228 ha)    |
|                                                  |                                     |                         |
| <b><i>Lake Wales Ridge</i></b>                   |                                     |                         |
| Avon Park Bombing Range                          | X                                   | 106,097 ac (42,937 ha)  |
| Lake Wales Ridge Wildlife and Environmental Area | X                                   | 18,461 ac (7,471 ha)    |
| Lake Wales Ridge State Forest                    | X                                   | 22,113 ac (8,949 ha)    |
| Highlands Hammock State Park                     | X                                   | 8,139 ac (3,294 ha)     |
| Archbold Biological Station                      | X                                   | 5,239 ac (2,120 ha)     |
|                                                  |                                     |                         |
| <b><i>Everglades</i></b>                         |                                     |                         |
| Everglades National Park                         | X                                   | 758,891 ac (307,119 ha) |
| Big Cypress National Preserve                    | X                                   | 728,982 ac (295,015 ha) |
| Rookery Bay National Estuarine Research Preserve | X                                   | 110,557 ac (44,742 ha)  |
| Fakahatchee Strand Preserve State Park           | X                                   | 78,379 ac (31,719 ha)   |
|                                                  |                                     |                         |
| <b>GEORGIA</b>                                   |                                     |                         |
| <b><i>Fort Stewart</i></b>                       |                                     |                         |
| Fort Stewart Military Installation               | X                                   | 279,234 ac (113,000 ha) |
|                                                  |                                     |                         |
|                                                  |                                     |                         |

| CONSERVATION FOCUS AREA                                           | Recent Eastern Indigo Snake Records | Total Acres (Hectares)  |
|-------------------------------------------------------------------|-------------------------------------|-------------------------|
| <b><i>Altamaha River Sandhills</i></b>                            |                                     |                         |
| Alligator Creek Wildlife Management Area                          | X                                   | 3,088 ac (1,250 ha)     |
| Flat Tub Wildlife Management Area                                 | X                                   | 3,514 ac (1,422 ha)     |
| Griffin Ridge Wildlife Management Area                            | X                                   | 5,599 ac (2,266 ha)     |
| Horse Creek Wildlife Management Area                              | X                                   | 8,100 ac (3,278 ha)     |
| Long County Georgia Department of Transportation Mitigation Tract | X                                   | 7,215 ac (2,920 ha)     |
| Moody Forest Natural Area Preserve                                | X                                   | 6,291 ac (2,546 ha)     |
| Ochoopee Dunes Natural Area                                       |                                     | 3,153 ac (1,276 ha)     |
| Orianne Indigo Snake Preserve                                     | X                                   | 2,501 ac (1,012 ha)     |
| Penholoway Swamp Wildlife Management Area                         | X                                   | 4,270 ac (1,728 ha)     |
| Sansavilla Wildlife Management Area                               | X                                   | 19,598 ac (7,931 ha)    |
| Townsend Bombing Range-Buffer Easement                            | X                                   | 11,129 ac (4,504 ha)    |
| Townsend Wildlife Management Area                                 | X                                   | 25,100 ac (10,158 ha)   |
|                                                                   |                                     |                         |
| <b><i>Alapaha River Sandhills</i></b>                             |                                     |                         |
| Alapaha River Wildlife Management Area                            | X                                   | 6,870 ac (2,780 ha)     |
| Georgia Forestry Commission Conservation Easement                 | X                                   | 5,041 ac (2,040 ha)     |
| Grand Bay Wildlife Management Area                                | X                                   | 8,698 ac (3,520 ha)     |
| Moody Air Force Base                                              |                                     | 11,401 ac (4,614 ha)    |
|                                                                   |                                     |                         |
| <b><i>Okefenokee and Vicinity</i></b>                             |                                     |                         |
| Okefenokee National Wildlife Refuge                               | X                                   | 401,982 ac (162,680 ha) |
|                                                                   |                                     |                         |
| <b><i>Cabin Bluff</i></b>                                         |                                     |                         |
| Kings Bay Navy Base                                               | X                                   | 14,462 ac (5,853 ha)    |
| Crooked River State Park (adjacent to Kings Bay)                  | X                                   | 515 ac (208 ha)         |

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