Visual Encounter Survey Protocol for the Eastern Indigo Snake (*Drymarchon couperi*) in Georgia

Purpose and Scope

The purpose of this Eastern indigo snake (*Drymarchon couperi*) survey protocol is to provide guidance to project proponents and improve the review of permit applications and proposed land disturbance activities for potential effects on the federally threatened Eastern indigo snake, in accordance with Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.). The survey protocol is applicable to the U.S. Fish and Wildlife Service (USFWS) Georgia Ecological Services Field Office (GAES) geographic area of responsibility, which includes the entire range of the Eastern indigo snake in Georgia.

Use of this visual encounter survey protocol (Protocol) is recommended for project proponents or their designees to evaluate the possible presence of the Eastern indigo snake at a proposed project site. The results of the Protocol can be used by Federal and non-Federal entities in evaluating permit applications and proposed activities for compliance with the ESA. The GAES encourages the use of this Protocol by any project proponent, and Federal and non-Federal permitting entities in situations where habitats that may support Eastern indigo snakes will be affected. This Protocol may not be best suited for some project types (e.g., linear projects). *If any other survey method is proposed for the Eastern indigo snake the USFWS should be consulted*.

This Protocol does NOT authorize the handling or collection of Eastern indigo snakes. Therefore, the USFWS does not intend to issue Section 10 (a)(1) (A) scientific enhancement and collecting permits for the capture, handling, or relocating of Eastern indigo snakes in conjunction with the implementation of this Protocol.

If implemented appropriately, this Protocol is not expected to pose a risk of mortality or harassment to Eastern indigo snakes; therefore, a federal permit is not required. However, a **Georgia Department of Natural Resources (GADNR) scientific collection permit is required to scope Gopher tortoise (*Gopherus polyphemus*) burrows**. Additional information on applying for state permits can be found at https://gadnrle.org/special-permits.

This Protocol explains visual encounter survey methodology that includes pedestrian transect surveys and inspection of above-ground and underground refugia commonly used by Eastern indigo snakes. An Eastern indigo snake survey conducted according to this Protocol is an attempt to determine presence of the species within the project boundary (or area of interest) of a proposed project site. Confirmation of Eastern indigo snake(s) presence during the project's planning stage provides project proponents an early opportunity to develop minimization and/or compensation measures and to consult with the USFWS. Failure to detect Eastern indigo snakes does not confirm their absence. However, even negative survey findings will be informative for

coordination and consultation with the USFWS. This Protocol represents the best available and recommended techniques for surveying for the Eastern indigo snake in a manner which does not include handling, trapping, or potentially injuring the snake. This Protocol will work best in xeric upland habitats occupied by gopher tortoises.

We recommend this Protocol as a measure to help the USFWS (or lead federal agency) obtain necessary information to make informed regulatory decisions relative to the recovery and management of this federally threatened species. It is the intent of the USFWS to recommend this protocol until such a time that better survey methodologies are available for project proponents.

Habitat (excerpt from USFWS 2019)

The Eastern indigo snake occurs in a wide range of upland and lowland habitat types throughout the species' range, including mesic pine flatwoods, scrubby flatwoods, longleaf pine sandhills, oak scrub, sand pine scrub, dry prairie, tropical hardwood hammocks, freshwater and saltwater marshes and swamps, coastal dunes, and some human-altered habitats (USFWS 1982, Moler 1992, Stevenson et al. 2008, Hyslop et al. 2009, Enge et al. 2013). They may move seasonally between upland and lowland habitats, especially in northern portions of their range (i.e., Georgia and northern Florida). However, across its range, Eastern indigo snakes exhibit a strong preference year-round for upland habitat types (Hyslop et al. 2014, Bauder et al. 2018).

Throughout their range, Eastern indigo snakes may also use underground shelter sites for shelter, breeding, feeding, and nesting (Speake et al. 1978, Stevenson et al. 2003, Hyslop et al. 2009, Stevenson et al. 2010). In the northern part of their range (i.e., Georgia and northern Florida), Eastern indigo snakes depend on Gopher tortoise burrows to protect against the cold in the winter. In summer, Eastern indigo snakes use burrows as protection from heat and dry conditions since they have been shown to be susceptible to desiccation (Bogert and Cowles 1947). Reliance on xeric sandhill habitats throughout the northern portion of the Eastern indigo snake's range in Georgia and northern Florida is due to the dependence on Gopher tortoise burrows for shelter during winter (Stevenson et al. 2003 and 2009, Hyslop et al. 2009, Bauder et al. 2017). Additionally, these sandhill habitats also serve as breeding habitat during the autumn and winter months, October through February. Few nest sites have been observed, but they have been found in open-canopied sandhill habitats associated with Gopher tortoise burrows (Stevenson et al. 2021). Hyslop (2009) found females using upland sandhills in early spring, after males had mostly dispersed to lowland habitats, specifically using a higher proportion of abandoned Gopher tortoise burrows during what was assumed to be just prior to nesting. However, presence of Gopher tortoise burrows alone is not a sufficient predictor of suitable overwintering habitat for Eastern indigo snakes (Bauder et al. 2017). Eastern indigo snakes use both active and inactive Gopher tortoise burrows. In Georgia, Eastern indigo snakes have been documented to have strong winter site fidelity, returning to the same sandhills and sometimes the same burrows over

multiple winters (Stevenson et al. 2003, Hyslop et al. 2007, Hyslop et al. 2009). Eastern indigo snakes may also take shelter in hollowed root channels, hollow logs, stump holes, or the burrows of rodents, armadillo (*Dasypus novemcinctus*), or land crabs (*Cardisoma guanhumi*) (Lawler 1977, Moler 1985, Layne and Steiner 1996, Hyslop 2007, Hyslop et al. 2009).

Survey Protocol

This Protocol is intended to locate Eastern indigo snakes above-ground and to identify potential refugia for subsequent inspection to locate the species underground. The survey area (or area of interest) should include at minimum the project boundary, however, surveying adjacent habitat if possible, may provide a more comprehensive evaluation. Underground refugia commonly used by this species include active and inactive burrows excavated by Gopher tortoises or other species, natural ground holes (e.g., wood, rock, naturally forming on slopes), and hollows at the base of trees. Above-ground refugia includes shrub thickets, thick grasses, and saw palmetto clumps (*Serenoa repens*).

Survey Period

- In the northern part of the species' range (Georgia and northern Florida), Eastern indigo snake home ranges vary extensively on a seasonal basis ranging less than 25 acres (10 hectares) in the winter and up to 3,700 acres (1,500 hectares) in spring through autumn when more diverse habitats are occupied (USFWS 2019 and references therein). Thus, it is relevant for surveyors to note that Eastern indigo snakes are more likely to be observed during winter month surveys when the snakes' ranges are more condensed, rather than during the warm seasons when their movement activity and ranges are increased.
- Eastern indigo snake surveys should be conducted November through March when snakes are exhibiting regular use of Gopher tortoise burrow refugia and their daily movements, on average, are limited (Stevenson et al. 2003; Bauder et al. 2017). Best survey months are December through February due to annual variation in fall and spring weather patterns.
- Eastern indigo snake surveys should be conducted when temperatures are between 50°F (10°C) and 70°F (12.7°C to 21.1°C) (Bauder et al. 2017, Stevenson, pers. obs.).
- On sunny days, surveys can occur from 0900 to 1600 (9AM to 4PM), with the optimal search period from 1200 to 1600 (12PM to 4PM) on colder or overcast days. On overcast days, it may take longer to reach optimal temperatures.

Methodology

The Protocol's methodology consists of three components:

1. Visual encounter surveys along transects to locate snakes and identify above-ground and underground refugia in the survey area.
2. Inspection of above-ground refugia.
3. Inspection of underground refugia.

The surveyor should always carry a camera to photo-document any snake sightings and use a Global Positioning System (GPS) unit to document the location. If a GPS unit is not available, a notebook entry with location and site characteristics should be utilized. Locating Eastern indigo snakes involves walking along transects previously established on a map or graphic representation of the project parcel. These transects should be appropriately spaced (see below) to ensure that all areas inside of the survey area are inspected as described below.

Transects

Visual encounter surveys should be conducted along transects to increase the detectability of potential refugia not previously noted and the chance of observing a snake that is active or basking on the surface.

- A minimum of five (5) survey days conducted when daytime temperatures are above 50°F and not raining, including a minimum of three (3) nonconsecutive survey days. Surveys can be conducted by one or multiple surveyors depending on the size of the impact area. *A survey day is the amount of time required to review the entire survey area once.* Therefore, the entire impact area needs to be reviewed a minimum of **5 times which may result in more than 5 days** for larger impact areas. Should any Eastern indigo snakes be located after the completion of at least one survey day; then the surveyor may discontinue the survey for the remaining days of the recommended 5 days since presence has been established.
- Since Eastern indigo snake activity can vary among years and detection of individuals is challenging, annual winter surveys until the project is "breaks ground" are preferred on projects containing high-quality habitat.
- While Eastern indigo snakes are commonly associated with Gopher tortoises, the relationship is not exclusive; surveys within all suitable winter habitat should be conducted before it is determined that the species is not detected in the area of interest.
- Surveys should be conducted throughout all previously identified suitable habitat within the project boundary.
- Transects may be conducted by more than one person and should be conducted at a maximum width of about 30 feet (9 meters). If the vegetation density is thicker, transect width should be narrower. The goal is for each surveyor to be able to fully scan the ground surface between the adjacent transects.
- Where possible, surveys should be facilitated by using a GPS unit to track the survey paths and ensure sufficient coverage of the habitat.

Inspection of Eastern Indigo Snake Above-ground Refugia

Previously identified above-ground refugia in the project area should be inspected **in a non-destructive manner.** Above-ground refugia include shrubs, brush piles, trash piles, abandoned structures, rock piles, and other similar formations likely to serve as Eastern indigo snake

refugia. Inspection of above-ground refugia includes inspecting trash piles and lifting and moving parts of structures on the ground (large cover objects such as plywood, tin, or car pieces) to locate Eastern indigo snakes in hiding. After inspections, refugia should be restored to a condition (placement and object integrity) like it was found. Note: if a snake is observed, do NOT place objects on top of the snake.

Inspection of Eastern Indigo Snake Underground Refugia

For this Protocol, the inspection of underground refugia involves the visual inspection of Gopher tortoise burrows, burrows excavated by other species, and other holes in the ground. Scoping a burrow or refugia with a camera can help with detection, but camera scoping does not always detect Eastern indigo snakes when they are present. NOTE: **Scoping of a Gopher tortoise burrow requires a permit from the State of Georgia.**

Caution should be applied when placing hands, head, or feet on the ground near the entrance to Gopher tortoise burrows as Eastern diamondback rattlesnakes (*Crotalus adamanteus*) are frequent commensals in the burrows. Pigmy rattlesnakes (*Sistrurus miliarius*), Fire ants (*Solenopsis invicta*), Black widow spiders (*Latrodectus mactans*), and various wasp and stinging insect species may also be present.

Inspection of underground refugia (burrows) may be conducted at the same time as transects. Marking burrows with flagging and/or GPS coordinates may facilitate future survey efforts.

- Surveyors shall approach refugia slowly so as not to encourage snakes in the area to flee prior to identification being made.
- More intensive searches should be conducted within a 30-foot (9-meter) radius of refugium entrance (Gopher tortoise burrows and other burrows) for snakes, shed skins, and tracks.
- Eastern indigo snake shed skins are commonly found on the ground near tortoise burrows, especially during the winter months (See: **Image 1.**). The shed skins may persist for weeks to months. Surveyors should look for intact or partial sheds close to downed logs, in saw palmetto clumps, and on the ground within 16 to 30 feet (5 to 10 meters) of burrows. Shed skins can be confused easily with several other species of sympatric snake species; therefore, consulting an expert to confirm identification is recommended. A GPS point should be recorded, and high-quality photographs should be submitted to USFWS, GADNR, or another Eastern indigo snake species expert for identification. Photographs for shed skins should include: 1) the overall skin in situ, 2) clear close-up of dorsal scales, and 3) close up of ventral scales. Details of the communication and identification should be included in the survey report. Shed skins should not be removed from the site and should left in place where it was discovered.
- Since juvenile Gopher tortoises tend to place burrows under vegetation around the margins of open areas (e.g., wiregrass clumps, palmetto fronds, cactus—See: **Image 2.**),

using a snake hook or stick to lift vegetation gently, increases detectability of shed skins under vegetation.

- A mirror or flashlight can be used to illuminate the upper portion of a burrow. Thoroughly scan the ground surface before kneeling down or placing your hands on the ground. Do not extend head or hands into burrows.
- Monitor for snake slides (tracks) that may be evident in loose sand at the openings of burrows (See: **Image 3.**). Tracks can also be observed commonly in burrows as snakes often push sand into mounds when exiting the burrow.
- **All** Gopher tortoise burrows (active, inactive, and abandoned) and other burrows that are greater than about 2 feet (0.5 meters) in length should be scoped. Scoping may reveal Eastern indigo snakes and other commensal species of interest (See: **Image 4.**). The burrow can be probed with a stick to determine if it is of a length that warrants scoping with a camera.
- Surveyors should take caution as to not stand on top of burrows (ground above the burrow and behind the opening) during scoping procedures due to risk of collapse. Therefore, burrows should be scoped with the surveyor positioned on the apron.
- Burrow scopes can be different lengths and include camera sizes suited for both juvenile and adult burrows.
- The burrow scope should be flexible so that it can be maneuvered until the back of the burrow is reached, or the scope cannot go farther (e.g., if the burrow takes a sharp turn that cannot be negotiated) (See: **Image 5**). Note: contact GADNR for additional information regarding proper burrow scopes.
- Care should be taken while scoping to examine the entire width of the burrow chamber to not miss side channels or other places where Eastern indigo snakes might be hiding.

Equipment Disinfection Protocol

Due to a concern regarding the transmission of highly contagious diseases, such as upper respiratory tract disease (URTD) and snake fungal disease (SFD), all organic debris and soils shall be wiped from the burrow camera and scopes shall be disinfected between sites. A 1:10 (10%) dilution of 5% household bleach is recommended for disinfection of URTD (ADCNR 2017, GADNR 2023) and has also been shown effective against SFD (Rzadkowska et al. 2016). The disinfectant should remain in contact with the equipment for a minimum of 2 minutes. Solutions should be stored in dark bins or in opaque bottles and should be made fresh regularly (e.g., weekly, depending on storage conditions). Bleach should be purchased in small bottles or dispensed into small bottles to minimize deterioration from opening/closing the lid (ADCNR 2017).

Image 1. Eastern indigo snake shed skin Photo: Dirk Stevenson

Image 2. A hatchling Gopher tortoise burrow under a cactus. Photo: Lance Paden

Image 3. Fresh Eastern indigo snake slide (track) in loose sand at burrow opening. Photo: USFWS

Image 4. Eastern indigo snake as seen on a burrow camera scope. Photo: Dirk Stevenson

Image 5. Example of adult Gopher tortoise burrow camera system.

References

Alabama Department of Conservation and Natural Resources (ADCNR). 2016. Gopher Tortoise Handling, Equipment Disinfection Protocol. Division of Wildlife and Freshwater Fisheries.

Bauder, J.M., D.J. Stevenson, C.S. Sutherland, and C.L. Jenkins. 2017. Occupancy of potential overwintering habitat on protected lands by two imperiled snake species in the coastal plain of the southeastern United States. Journal of Herpetology 51:73-88.

Bauder, J.M., Breininger, D.R., M.R. Bolt, R. Breininger, M.L. Legare, C.L. Jenkins, B.B. Rothermel, and K. McGarigal. 2018. Multi-level, multi-scale habitat selection by a wide-ranging, federally threatened snake. Landscape Ecology 33:743-763.

Enge, K.M., D. J. Stevenson, M.J. Elliott, and J.M. Bauder. 2013. The historical and current distribution of the eastern indigo snake *(Drymarchon couperi)*. Herpetological Conservation and Biology 8:288−307.

Bogert, C.M., and R.B. Cowles. 1947. Results of the Archbold expeditions. No. 58. Moisture loss in relation to habitat selection in some Floridian reptiles. American Museum Novitates 1358:1-55.

Enge, K.M., D. J. Stevenson, M.J. Elliott, and J.M. Bauder. 2013. The historical and current distribution of the eastern indigo snake *(Drymarchon couperi)*. Herpetological Conservation and Biology 8:288−307.

GADNR 2023. Georgia DNR Wildlife Resources Division Sanitation Protocol for Surveying and Handling Gopher Tortoises. Version 1. Feb 2023. 2p.

Hyslop, N.L. 2007. Movements, habitat use, and survival of the threatened eastern indigo snake (*Drymarchon couperi*) in Georgia. PhD dissertation, University of Georgia, Athens, Georgia.

Hyslop, N.L., R.J. Cooper, and J.M. Meyers. 2009. Seasonal shifts in shelter and microhabitat use of *Drymarchon couperi* (Eastern Indigo Snake) in Georgia. Copeia 2009:458–464.

Hyslop, N.L., J.M. Meyers, R.J. Cooper, and D.J. Stevenson. 2014. Effects of body size and sex of *Drymarchon couperi* (eastern indigo snake) on habitat use, movements, and home range size in Georgia. Journal of Wildlife Management 78:101-111.

Layne, J.N., and T.M. Steiner. 1996. Eastern indigo snake (*Drymarchon corais couperi*): summary of research conducted on Archbold Biological Station. Report prepared under Order 43910-6-0134 to the U.S. Fish and Wildlife Service; Jackson, Mississippi.

Lawler, H.E. 1977. The status of *Drymarchon corais couperi* (Holbrook), the eastern indigo snake, in the southeastern U.S.A. Herpetological Review 8:76-79.

Moler, P.E. 1985. Home range and seasonal activity of the eastern indigo snake, *Drymarchon corais couperi*, in northern Florida. Final performance report, Study E-1-06, III-A-5. Florida Game and Fresh Water Fish Commission; Tallahassee, Florida.

Moler, P.E. 1992. Eastern indigo snake. Pgs. 181-186 *in* P.E. Moler, ed. Rare and endangered biota of Florida, volume III, Amphibians and Reptiles. University Press of Florida, Gainesville, Florida.

Rzadkowska, M., M. C. Allender, M. O'Dell, and C. Maddox. 2016. Evaluation of common disinfectants effective against *Ophidiomyces ophiodiicola*, the causative agent of Snake Fungal Disease. Journal of Wildlife Diseases 52:759-762.

Speake, D.W., J.A. McGlincy, and T.R. Colvin. 1978. Ecology and management of the eastern indigo snake in Georgia: A progress report. Pgs. 64-73 *in* R.R. Odum and L. Landers, eds. Proceedings of rare and endangered wildlife symposium, Georgia Department of Natural Resources, Game and Fish Division, Technical Bulletin WL 4.

Stevenson, D.J., K.J. Dyer, and B.A. Willis-Stevenson. 2003. Survey and monitoring of the eastern indigo snake in Georgia. Southeastern Naturalist 2:393-408.

Stevenson, D.J., R.A. Moulis, and N.L. Hyslop. 2008. Eastern indigo snake (*Drymarchon couperi*. Pgs. 339-341 *in* J.B. Jensen, C.D. Camp, W. Gibbons, and M.J. Elliott, eds. Amphibians and reptiles of Georgia. University of Georgia Press, Athens, Georgia.

Stevenson, D.J., K.M. Enge, L. D. Carlile, K.J. Dyer, T.M. Norton, N.L. Hyslop, and R.A. Kiltie. 2009. An eastern indigo snake (*Drymarchon couperi*) mark-recapture study in southeastern Georgia. Herpetological Conservation and Biology 4:30-42.

Stevenson, D.J., K.R. Ravenscroft, R.T. Zappalorti, D.D. Ravenscroft, S.W. Weigley, and C.L. Jenkins. 2010. Using a wildlife detector dog for locating eastern indigo snakes (*Drymarchon couperi*). Herpetological Review 41:437-442.

Stevenson, D.J., N.L. Hyslop, C. Layton, J. Godlewski, and F.H. Snow. 2021. Nesting sites of the eastern indigo snake (*Drymarchon couperi*) in Georgia. Southeastern Naturalist 20:345–352.

U.S. Fish and Wildlife Service (USFWS). 1982. Eastern indigo snake recovery plan. Atlanta, GA. 23 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Species status assessment report for the eastern indigo snake (*Drymarchon couperi*). Version 1.1, July, 2019. Atlanta, Georgia.