2025
Eastern Tiger Salamander Conservation Plan

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Eastern tiger salamander (Westmoreland County) – DWR Dane Conley

VIRGINIA DWR
DEPARTMENT OF
WILDLIFE RESOURCES
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2025
Eastern Tiger Salamander
Conservation Plan

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I. Acknowledgements

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Eastern tiger salamander (York County) – DWR J.D. Kleopfer

II. Executive Summary

Current Species Status: The eastern tiger salamander (*Ambystoma tigrinum*) is designated as State Endangered under Virginia's Endangered Species Act and is a Tier IIa Species of Greatest Conservation Need (SGCN) in Virginia's 2015 Wildlife Action Plan (WAP) and is proposed for elevation to a Tier Ia SGCN in the 2025 WAP revision. This ranking indicates it faces an extremely high risk of extirpation, and that managers have identified "on the ground" species or habitat management strategies expected to benefit the species; at least some of which can be implemented with existing resources and are expected to have a reasonable chance of improving the species' conservation status.

In Virginia, there are two unique lineages of eastern tiger salamander, the Ridge and Valley lineage and the Coastal Plain lineage (see Distribution for additional information). The Ridge and Valley population occurs almost entirely on protected lands in Augusta County, while the Coastal Plain population occurs exclusively on unprotected lands in Westmoreland, Mathews, York, and Isle of Wight counties. Because of the genetic distinction between the two populations and the difference in occupied habitat protection, the conservation goals for these two populations also are disparate.

Conservation Goals: 1) protect all known breeding locations by working with private and public landowners to monitor and manage these sites appropriately, 2) acquire private lands known to have breeding sites, 3) establish new populations via translocation efforts within protected areas, 4) when appropriate, create new breeding sites for translocation, 5) continue surveying for new breeding sites, and 6) continue coordinating regional conservation efforts through Northeast Partners in Amphibian and Reptile Conservation (NEPARC) and the associated Northeast Tiger Salamander Working Group (NETSWG).

Eastern tiger salamanders (Isle of Wight County) – DWR J.D. Kleopfer

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I. INTRODUCTION

A. General Species Overview

The eastern tiger salamander (*Ambystoma tigrinum*) is a large subterranean ambystomatid that inhabits forested habitats associated with temporary and permanent ponds without fish predators. It is relatively abundant in the midwestern and southwestern portions of its natural range but has declined substantially in the eastern U.S. largely because of the loss of suitable wetland habitats.

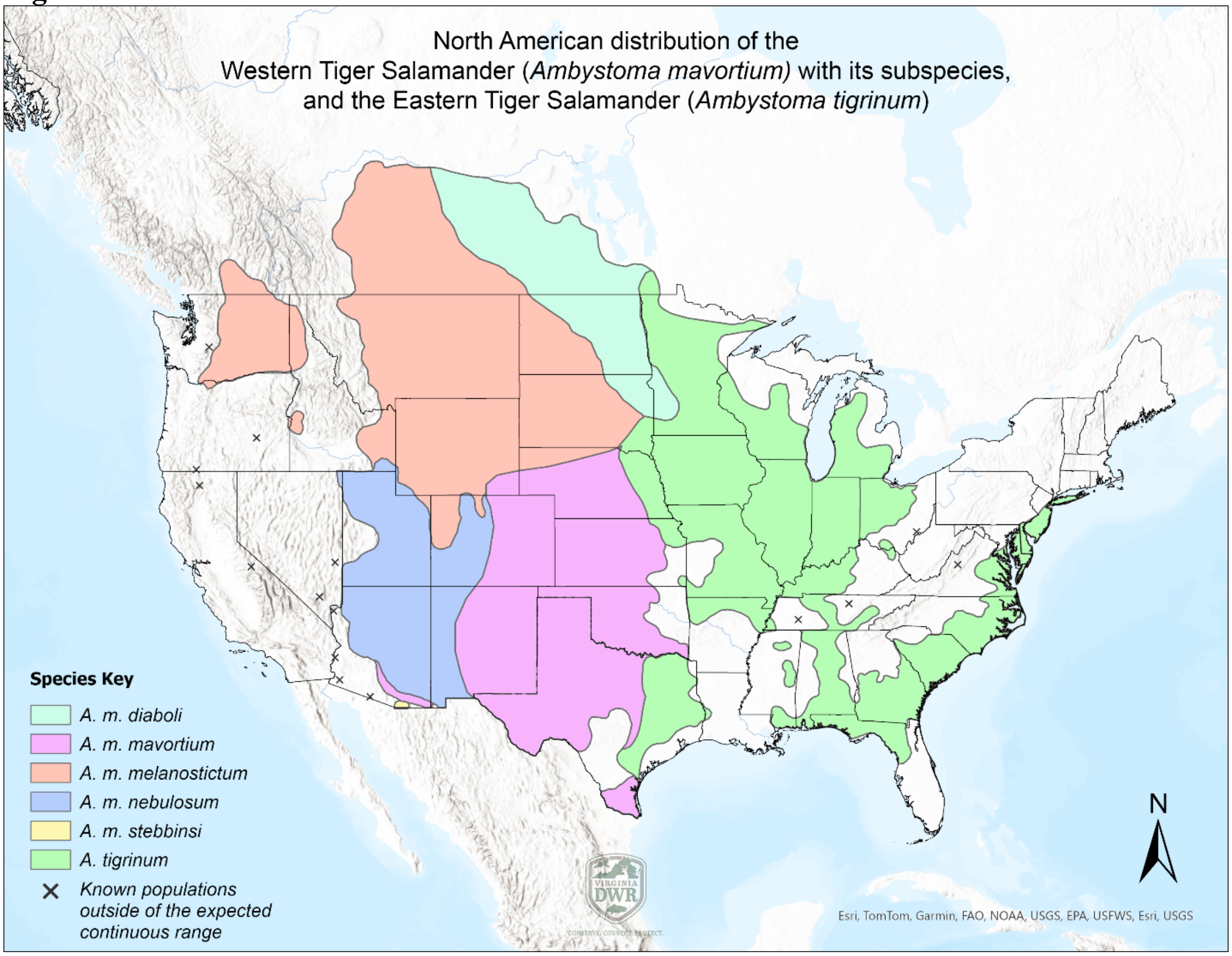
Adult tiger salamanders typically experience high survivorship; mate and lay eggs in successive years; lay only one clutch of eggs per year in egg masses attached to twigs or grass stems in water; and occupy underground retreats in the surrounding hardwood forest at all times of the year outside of the breeding season (January-mid March). Estimated population sizes in the eastern portion of its range are small, and the only one located in Virginia that has been studied to date has apparently fewer than 70 individuals. Eggs and larvae experience low survivorship, with high mortality at all stages; few of the eggs produced result in metamorphs. Egg and larval mortality results from a variety of vertebrate and invertebrate predators and from ponds drying before metamorphosis can take place. The early life history of eastern tiger salamanders is dynamic and unpredictable. Persistence of small populations is maintained only by the ability of adults to reproduce in successive years so that the population can tolerate years without recruitment of new adults. The combination of quality breeding ponds and the surrounding forested habitat is essential for the maintenance and continued existence of eastern tiger salamanders in Virginia.

B. Taxonomy

This species was originally described as *Salamandra tigrina* by Green (1825) from a specimen collected in New Jersey. Baird (1849) first used the generic name *Ambystoma* for this species. Agassiz (1849) first used the emended spelling of the genus (*Ambystoma*) but was followed only by Cope (1889) and few others. The currently used generic spelling and species names were established by Dunn (1940).

Shaffer and McKnight (1996) provided molecular phylogenetic data indicating that the eastern and western tiger salamanders should be regarded as distinct species and treated the western forms as subspecies of *Ambystoma mavortium*. The eastern tiger salamander (*Ambystoma tigrinum*) ranges along the east coast of the United States from southern New York to northern Florida, west from Ohio to Minnesota and southward through eastern Texas to the Gulf of Mexico (Figure 1). There are no recognized subspecies of the eastern tiger salamander. However, the western tiger salamander (*Ambystoma mavortium*) is comprised of five subspecies (Figure 1). Lannoo (2005) includes *A. mavortium* in *A. tigrinum* (Crother 2017). Johnson et al. (2011) also implied that *A. mavortium* is a synonym of *A. tigrinum*.

Figure 1.



C. Description

The eastern tiger salamander is one of the largest terrestrial salamanders in the world, reaching a maximum total length of 330 mm (Powell et al. 2016). The largest measured in Virginia was 232 mm total length and 114.0 mm snout to vent length (SVL = body length measured from tip of snout to posterior margin of cloacal opening). The SVL of adults ranges from 80-114 mm, and total length ranges from 141-232 mm. The ratio of the tail to total length is 0.39-0.51. Adults weigh 13-38 grams. Adults are robust with broad, depressed heads and widely separated eyes. There are four toes on the forelimbs and five on the substantially larger hindlimbs. The toes are lance-shaped and pointed. The tail is long and laterally compressed. Adults are dark brown to dull black in background color with irregularly spaced and shaped yellow to olive dorsal blotches. The blotches extend laterally and blend into the yellowish venter. The dorsal markings continue from the head onto the tail; the blotches sometimes form bars across the dorsum.

The larvae are usually dark with a pale yellow to whitish venter. The muscular portion of the tail is dark with indistinct mottling. A dorsolateral row of light spots, one per costal fold, is prominent. Two characters separate the larvae of this species from other ambystomatids. The dorsal fin originates slightly posterior to the forelegs, and the toes are wedged-shaped.

D. Distribution

The eastern tiger salamander is the most widespread salamander species in North America (Lannoo, 2005). U.S. state distribution includes Alabama, Arkansas, Delaware, Florida, Georgia, Iowa, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Missouri, Mississippi, North Carolina, North Dakota, Nebraska, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, and Wisconsin (AmphibiaWeb, 2023).

The first eastern tiger salamander known from the Commonwealth was a specimen in the Smithsonian Institution's National Museum of Natural History (1874 USNM 9273). Two egg masses apparently of this species were found on 23 March 1973 in Jones Pond, Hanover County (10 miles west of Ashland) by Funderberg et al. (1974). The identity of the eggs was confirmed by David S. Lee (a Maryland biologist having experience with tiger salamanders) and subsequently deposited in the Natural History Society of Maryland. Tirrell (1974) and Funderburg et al. (1974) each reported that two tiger salamanders had been found in a suburban garden under a tomato plant in Tabb, York County, on 13 October 1973. On 21 May 1993, two adults turned up in the backyard garden of a resident of York County (Mitchell, 1994). One of these salamanders was presented to the Peninsula Nature and Science Center (now the Virginia Living Museum) in Newport News, but it later died and is currently catalogued in the Virginia Museum of Natural History's herpetological collection (VMNH 6654).

Three additional observations were made between 1986 and 1992 in Augusta County, Isle of Wight County, and Mathews County. In 1990, Buhlmann and Hoffman reported the first records for the Ridge and Valley Physiographic Province, approximately 161 km outside the then presumed range of tiger salamanders in Virginia. The Mathews County observation was reported by Pague and Buhlmann in 1991, but no breeding site has been identified. John (J.D.) Kleopfer with the Virginia Department of Wildlife Resources discovered breeding sites in Westmoreland and York counties in 2017 and 2020, respectfully.

A newly morphed subadult showing the remnants of its external gills. Photo was taken on 6 June 2009.
DWR – J.D. Kleopfer

In Virginia, there are two distinct lineages: one occurring in the Ridge and Valley (Augusta County) and the other in the Coastal Plain (Figure 2). The coastal lineage has remained isolated from the montane populations for at least the past 400,000 to one million years (Church et al. 2003). In the Coastal Plain, breeding sites have been identified in Isle of Wight, York, and Westmoreland counties, all of which occur entirely on privately-owned lands. An historic record exists for Mathews County, but no additional information exists in the Virginia Fish and Wildlife Information Service (VA FWIS) SppObs (Species Observations), and a breeding site was never identified.

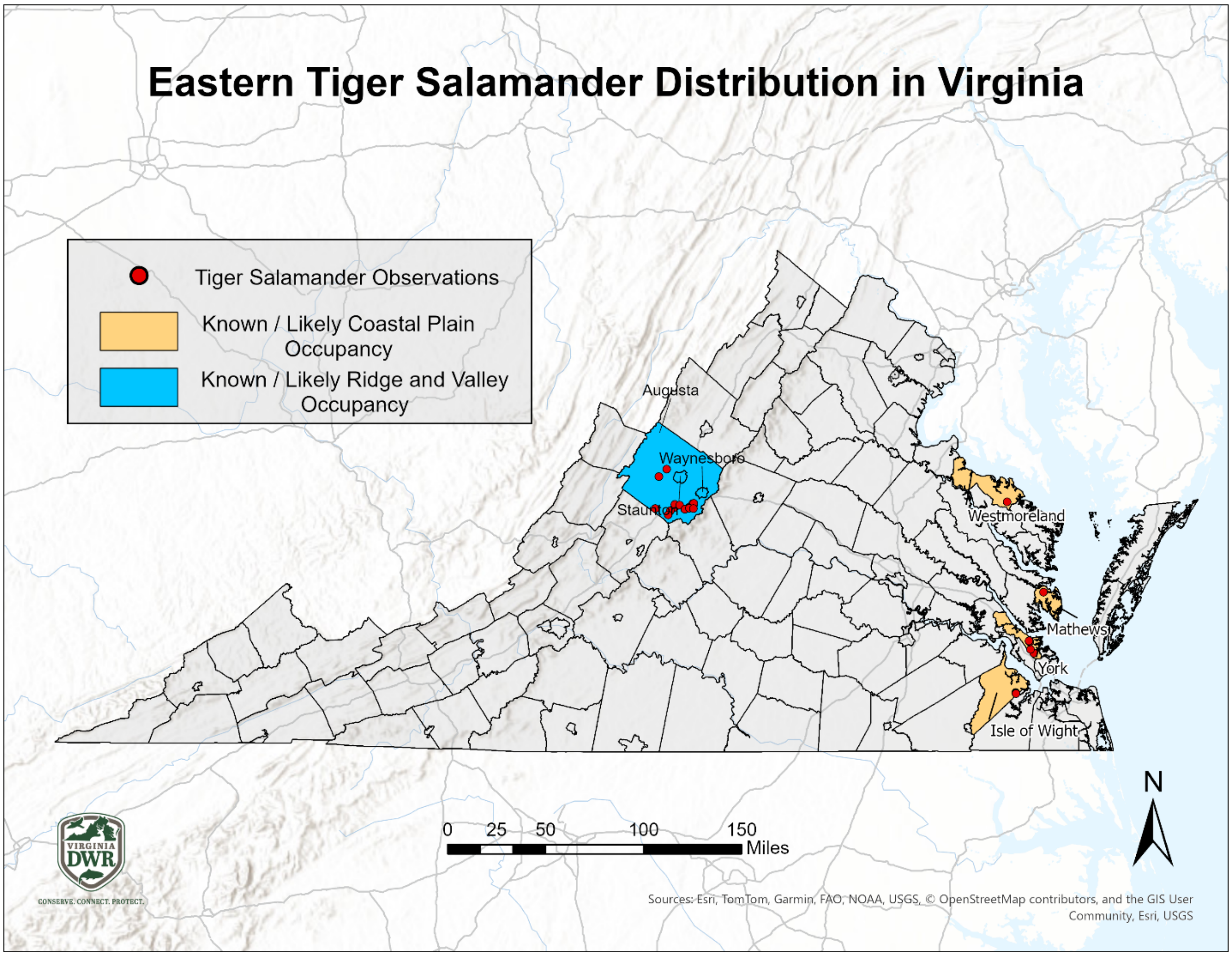


Figure 2. County distribution of eastern tiger salamanders in Virginia showing the Ridge and Valley (blue) and Coastal Plain (yellow) populations.

Ridge and Valley Population

Augusta County:

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Coastal Plain Population

York County:

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Westmoreland County:

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Isle of Wight County:

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E. Life History:

1. Body size and Sexual Dimorphism

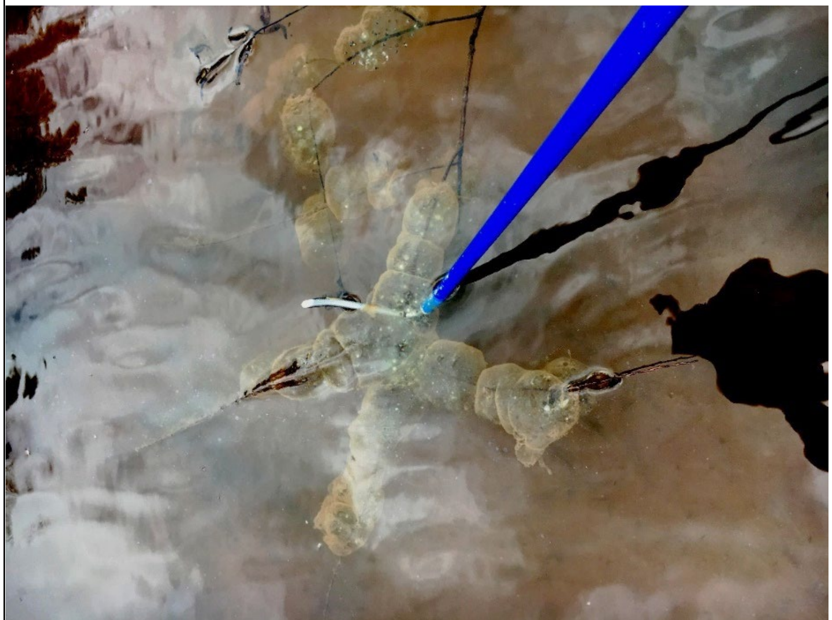
Adult males (85-114 mm SVL, 159-232 mm total length) reach larger sizes than adult females (80-107 mm SVL, 141-195 mm total length) (Buhlmann and Mitchell, 2000). Body mass is greater in adult males (14-38 grams) than in adult, nongravid females (12-28 grams) (Buhlmann and Mitchell, 2000). During the breeding season, adult males possess distinctly swollen cloacal lips, whereas females do not have swollen cloaca.

2. Reproduction, Growth, and Development

In Virginia, adults have been documented first entering breeding ponds during January through mid-March, depending on the weather. Males arrive before females and lay a series of spermatophores. Females arrive several days later and tend to spend less time in breeding ponds than males. A successful courtship ends with the female picking up one or more spermatophores in her cloaca. Egg laying follows with the female attaching her loose egg masses on twigs and grass stems under water. Egg masses were first found between 20 January through 12 March over a four-year period (1988-1992), and eggs numbered 4-81 per mass (Buhlmann and Mitchell, 2000). Egg masses were found in a pond on the eastern shore of Maryland from 22 December through 15 January (Stine, 1984). Total clutch size in Maryland was 344-394 (Stine, 1984); one female from Virginia contained 328 eggs (Buhlmann and Mitchell, 2000).

Depending on water temperature, embryos develop within the eggs and hatching occurs several days to weeks after being deposited. Larvae develop in the pond and metamorphose June - July. The larval period has been estimated to be 75-205 days in Maryland, New Jersey, and New York (Bishop, 1941; Hassinger et al., 1970; Stine, 1984). The length of the larval period depends on factors such as water temperature, timing of drying of the pond, and density of larvae in the pond. Larval density has not been high in any known Virginia ponds, so the first two factors, combined possibly with prey availability, determine actual time of metamorphosis and pond emergence. Metamorphic individuals in Virginia reach snout-vent lengths of 51-65+ mm (Buhlmann and Mitchell, 2000).

Growth rates of metamorphs, juveniles, and adults are unknown in Virginia populations. In Maryland, adults recaptured after 306-332 days grew 11-41 mm in total length (Stine, 1984). Unfortunately, we cannot determine if growth was in body size or in tail length. Females apparently reach maturity in 4-7 years, whereas males reach maturity in 1-5 years (Shoop, pers. comm., in Stine, 1984). Differences in age at maturity affects the population sex ratio, adult survivorship, variation in progeny production, and the population's genetic structure (e.g., amount of inbreeding, genetic drift). Zappalorti (2018) found they reach sexual maturity at 2-3 years of age, when they return to the same breeding pond from which they metamorphosed. The effective population size (actual number and age of reproductive adults) is a result of all these interacting factors.



Tiger salamander egg masses (left) are "looser" and less organized than spotted salamander (*Ambystoma maculatum*) egg masses (right). DWR J.D. Kleopfer

Late-stage tiger salamander larvae – Scott Bolick

Subadult tiger salamanders. Photo was taken on 20 July 2024- DWR J.D. Kleopfer

3. Feeding, Predators, and Sources of Mortality

The natural prey of adults in the eastern part of the range is not well known. Bishop (1941 and references therein) report insects, worms, young field mice, cricket frogs, caterpillars, small fishes, tadpoles, and ground beef. The natural prey of larvae in Delaware included cladocerans, ostracods, copepods, malacosterans, insects (Ephemeroptera, Odonata, Hemiptera, Trichoptera, Coleoptera, Diptera), gastropods, and unidentified bivalves (Arndt, 1989). Larvae are known to consume most aquatic organisms that are small enough to swallow. The prey of Virginia tiger salamanders (adults or larvae) is unknown.

Red-spotted newts (*Notophthalmus viridescens*), predaceous diving beetles, and caddisfly larvae have been observed feeding on tiger salamander eggs (Stine, 1984). Small tiger salamander larvae are eaten by larger marbled salamander (*Ambystoma opacum*) larvae, although when the tiger salamander larvae reach the later stages of growth, the roles reverse. Aquatic predators may also include snapping turtles (*Chelydra serpentina*), painted turtles (*Chrysemys picta*), and wading birds, all of which occur in known breeding sites in Virginia. Terrestrial predators may include raccoons (*Procyon lotor*), and owls.

In addition to natural predators, other sources of mortality include collection of adults and larvae for bait and the pet trade, disease, water pollution (e.g., oil, pesticides), and pond drying before completion of the larval period.

4. Population Ecology and Survivorship

The size of the populations in the known breeding sites in Virginia is unknown. The largest number of egg masses were found in one temporary pond in the Augusta County site in 1992, yielding 1657+ eggs (Buhlmann and Mitchell, unpublished). If females lay 300-350 eggs per clutch and only one clutch is produced in a breeding season, then only 5-6 females are present in this local population. If the average sex ratio of males to females of Maryland populations (1.7) also pertains to this Virginia population, then only 9-10 adult males are present. The Augusta County site contains several ponds used by tiger salamanders. A total of 33 individual adult males and 23 individual adult females have been recorded over a five-year period (Buhlmann and Mitchell, unpublished). On the eastern shore of Maryland, estimated population sizes of adults and juveniles ranged from 6 to 217 and averaged 67 (Stine, 1984). For a more in-depth discussion of the population ecology of the Ridge and Valley population see Church's 2004 doctoral dissertation.

Adult survivorship is unknown but is expected to be substantially higher than that for larvae and metamorphs because adults have been recaptured in successive years (Stine, 1984; Buhlmann and Mitchell, unpublished). Larval survivorship is highly variable as evidenced by the number surviving to metamorphosis in temporary ponds in South Carolina, estimated to be 0-23.7 per female depending on the year (Semlitsch, 1983c). Stine (1984) in Maryland and Anderson et al. (1971) in New Jersey determined that larval survivorship typified a Type III or hyperbolic survivorship curve (Pianka, 1983). Few larvae survive to metamorphosis.

5. Habitat Requirements

Tiger salamanders need two types of habitats to survive: 1) fish-free ponds for breeding and 2) moist earth for burrowing. In North Carolina, they favor upland areas with sandy soils and sandhills or flatwoods vegetation. Thriving, robust populations are typically found within pine savanna forests, which are often actively managed using prescribed fire. Except for the Westmoreland County site, all known breeding ponds in Virginia are wholly or partially surrounded by deciduous hardwood or mixed hardwood/pine forests and are natural depressions or sinkhole ponds. However, this is most likely the result of suppressed land disturbance (i.e., fire) resulting in a transition from an open to closed canopy forest type. The Westmoreland County site is an old mill pond (>50 years old) which the water level is maintained through an aging earthen dam. No naturally occurring breeding site has been identified in the area. As such, it was most likely obliterated by historic land use.

Arndt (1989) found that out of 12 ponds in Delaware containing tiger salamanders, 5 were natural and 7 were man-made. The former were natural bays and the latter were borrow pits. All 12 ponds were entirely or partially surrounded by mature mixed hardwood forest. Stine (1984) also found tiger salamanders in natural and man-made ponds.

6. Movement and Dispersal

Movement and dispersal of tiger salamanders can vary depending on location and environmental factors. Petranka (1998) gave perhaps the best general discussion of mating migrations, noting that the timing of late winter to early spring mating migrations varies according to weather, with mating migrations occurring earlier at lower elevations and latitudes and later at higher elevations and latitudes. Coastal populations tend to breed earlier than inland populations. Buhlmann and Mitchell (2000) stated that eastern tiger salamanders enter breeding ponds in Virginia in January to mid-March.

The presence of suitable forest habitat is crucial to the survival of tiger salamander populations, as adults spend most of their lives underground in this habitat. Tiger salamanders construct their own burrows (Semlitsch, 1983a). The underground tunnel of one male in South Carolina was 12 centimeters underground and 28 millimeters in diameter (Semlitsch, 1983b). Semlitsch also found that the adult male moved 162 meters away from the breeding pond where he spent periods of inactivity underground. In New York, Madison and Farrand (1998) found that individuals dispersed an average distance of 60m with a maximum distance of 286m and that most resident salamanders moved no more than 150 m from the breeding pond. One of the most extensive investigations into the movement of tiger salamanders was also conducted in Long Island, New York (Titus et al. 2014). Juveniles were found to move further than adult males and females with maximum dispersal range of 282 meters. In Georgia, Steen et. al (2006) found salamanders moved a maximum distance of 255 m from the wetland of origin and found refugia both within forested land and wildlife food plots. In Virginia, a gravid (pregnant) female salamander was observed 265m from a known breeding site (Kleopfer, 2024). Such movements indicate that the forested habitat surrounding breeding ponds must have a radius of 250-300 meters to meet the terrestrial requirements of this species and that dispersals beyond 300m are unlikely.

F. Limiting Factors and Causes of Population Decline:

The primary limiting factor to eastern tiger salamander populations is the number of suitable breeding ponds. Declines in the number of temporary ponds in the Coastal Plain are due to drainage and alteration for agricultural land, forestry operations, and urban developments. Populations also decline because the forested habitat surrounding temporary ponds is also lost to agriculture, forestry, and urban projects. Thus, the primary cause of the decline of eastern tiger salamanders in Virginia is habitat loss.

Other important causes of population decline include stocking of ponds with fish, pollution (such as acid rain, fertilizers, and pesticides), collecting adults for the pet trade, and invasion of certain plants like the button bush (*Cephalanthus occidentalis*) that reduces the amount of open water (Stine, 1984), and gradual filling of the ponds. Although it was not shown to cause mortality, ranaviral infections have been documented for this species in Tennessee (Hoverman et al. 2012)

The effects of small population size cannot be overlooked. Small populations with few breeding adults can be seriously affected by small changes in sex ratio, survivorship of adults, disease, genetic problems, and environmental disasters. Removal of one adult from a small population by a predator can produce drastic changes in population structure. Thus, the simple reduction of a once large population into one or more small ones can contribute to population decline.

G. Conservation Strategy Framework

The primary objective of this Conservation Plan is to prevent the extinction of the eastern tiger salamander in the Coastal Plain region of Virginia through the protection of extant populations and the establishment of new populations on protected lands. To this end, the protection of the habitats of all known breeding populations should be the highest priority. The secondary objective is to recover the species to an extent that reclassifying of this species from Endangered to Threatened is appropriate. This can be met only after the primary objective is met. To meet these objectives the following must be attained: (1) immediate protection of known breeding sites, (2) regular monitoring of known breeding sites for trends in population structure and size, and for changes in physical characteristics of the habitat, and (3) distributional surveys throughout the Coastal Plain region of the Commonwealth deemed suitable so that all populations can be identified.

1. Protection of known breeding sites
    - 1.1 Contact landowners
2. Monitoring of known breeding sites
    - 2.1 Salamander populations
3. Determine the distribution
    - 3.1 Distributional survey
4. Determine the ecology and life history
    - 4.1 Ecology
    - 4.2 Life history characteristics
5. Develop landowner support for species protection
6. Translocation

H. Conservation Outline Narrative

1. Protection of known breeding sites

There are three currently known breeding sites in the Coastal Plain, all of which occur on privately owned lands. The first priority in protecting this endangered species is to protect these breeding sites.

1.1 Contact landowners

All landowners around known Coastal Plain sites must be identified. Each should be contacted in the best possible manner to ensure cooperation. Landowners should be made aware of the sensitivity of the breeding site and the buffer area needed to maintain the population. They should be made aware of the conservation options available, from selling their land to the Commonwealth of Virginia to establishing conservation easements. All efforts should be made by DWR and other conservation organizations to ensure the protection of these sites.

2. Monitoring of known breeding sites

Each known breeding site should be regularly monitored in two ways, population size; and dynamics and changes in the habitat.

2.1 Salamander populations

Tiger salamander populations are never large, as indicated above. Small populations are known to fluctuate because of random events, such as removal of one to a few breeding adults by predators, which, in turn, affect the effective sex ratio and may cause important changes in population structure. Because populations fluctuate through time, the size of tiger salamander populations should be determined once per year or at least on a 3-year cycle so that trends can be detected early. Population studies should include a mark-recapture (Passive Integrated Transponder tags) program on adults and annual counts of egg masses and larvae in each known breeding pond. The use of pattern recognition is also a possibility as markings of adults change very little after an animal reaches maturity (Church 2004).

3. Determine the distribution

The true distribution of the eastern tiger salamander in Virginia is not known. Additional surveys need to be undertaken so that all breeding sites can be mapped and monitored.

3.1 Distributional surveys

Surveys should be carried out systematically, possibly county by county. DWR personnel, including Conservation Police Officers and District Biologists, should be employed to help gain access to private lands. GPS coordinates for all breeding sites should be submitted to the VA FWIS SppObs. Environmental DNA (eDNA) may be the most cost-efficient and expeditious method to survey a large number of sites over a broad area.

4. Determine the ecology and life history

Little is known of eastern tiger salamanders in Virginia. A concerted effort is needed to obtain basic ecological and life history parameters of each population known.

4.1 Ecology

Ecological information needed for management purposes includes phenological patterns, predators, prey, migration routes, home range, use of surrounding forested habitat, etc.

4.2 Life history characteristics

Life history information needed for management purposes includes size and age at maturity, survivorship of all age classes, growth patterns of larvae, metamorphs, and adults, relationship of clutch size to parental body size, and clutch frequency.

A database should be developed for each breeding site and should contain all pertinent habitat, land ownership, salamander population, ecology, and life history information. Each breeding site could then be evaluated on a regular basis for changes in any aspect of the above parameters. A management profile could include:

a. site number and location on the appropriate topographic map
b. description of the pond within the landscape, including the surrounding forest habitat
d. name, address, and phone numbers of all appropriate landowners
e. a photograph of the site
f. all available of historical and current information on population levels
g. results of annual or periodic monitoring surveys
h. data files on ecological and life history parameters of the population
i. habitat maintenance, enhancement, and/or restoration
k. records of incidences of predation or other natural disturbances
l. records of incidences of vandalism and other unnatural disturbances

5. Develop landowner support for habitat protection

Landowners should be informed of the value of tiger salamanders as part of Virginia's natural heritage. They should receive special instructions on how they can protect and prevent the loss and alteration of the aquatic and terrestrial habitats. Acknowledging the fact that landownership can change, this should be viewed only as a temporary solution. More protective and permanent measures, such as conservation easements and land acquisition by conservation organization, should be the primary goal for any breeding site.

6. Translocation

One management tool that should be considered in enhancing the future of the eastern tiger salamanders in Virginia is translocating individuals to establish new populations within protected areas (i.e. Wildlife Management Areas, Natural Area Preserves, etc.) where the management is conducive for tiger salamanders to thrive.

Translocation is the human-mediated movement of living organisms from one area into another (IUCN 2013). The specific reasons for translocating a species vary greatly but can be generally grouped into one of the following: conservation, research, or human–wildlife conflict. For amphibians, a vast majority of translocations are carried out for conservation reasons (Germano and Bishop, 2009). Animal translocations for conservation reasons are conducted either to reintroduce species to sites that were occupied in the past, to introduce species to new sites, or to increase population numbers where the species is already present. This strategy can help to rescue populations from threats such as development, maintain or restore a species' historical range, or increase the total number of viable populations to safeguard against loss of other populations (Ficetola and De Bernardi 2005).

Trenham and Marsh (2002) contended that translocation might be the best option for preserving amphibians in highly disturbed landscapes where dispersal barriers such as roads and development would prevent movement and natural colonization. In addition, several life history traits make amphibians good candidates for captive-release programs, including high fecundity and lack of parental care (Bloxam and Tonge 1995). For tiger salamanders and other aquatic-breeding amphibians, it may be preferable to move eggs or animals in early larval stages due to the large numbers available, which aids in ease of collection and maximizes genetic diversity (Semlitsch 2002). Translocation has already been proven to be a successful technique in establishing new populations of tiger salamanders in created wetlands (Zappalorti 2018).

Our knowledge on the impacts of reintroduction and translocation projects on the native flora and fauna is limited. The spatial and temporal competition for resources between species is always a concern. When animals are translocated, they can face competition with native species already inhabiting that area, potentially impacting the survival and population dynamics of both the introduced and resident species, as they may compete for the same food, shelter, or mates, potentially leading to resource scarcity and altered ecosystem balance (Schroeder and Stewart 2022). DWR will monitor the introduced and native amphibian populations to detect potential negative impacts. Fortunately, many of the native amphibians at Big Woods Wildlife Management Area and Piney Grove Preserve are sympatric with native tiger salamanders in Virginia as well as other sites throughout their southeastern coastal range (Appendix 1).

Amphibians known to breed at tiger salamander sites in Virginia: Mabee's salamander (*Ambystoma mabeei*), spotted salamander (*Ambystoma maculatum*), marbled salamander (*Ambystoma opacum*), red-spotted newt (*Notophthalmus viridescens*), barking treefrog (*Hyla gratiosa*), Cope's gray treefrog (*Hyla chrysoscelis*), southern leopard frog (*Lithobates sphenocephalus*), green frog (*Lithobates clamitans*), and cricket frog (*Acris spp.*). There are most likely other amphibians that breed at these sites, but which have not been confirmed.

IV. Literature Cited:

AmphibiaWeb. 2023. <https://amphibiaweb.org> University of California, Berkeley, CA, USA. Accessed 21 Dec 2023.

Anderson, J.D., D.D. Hassinger, and G.H. Dalrymple. 1971. Natural mortality of eggs and larvae of *Ambystoma t. tigrinum*. Ecology 52:1107-1112.

Arndt, R.G. 1989. Notes on the natural history and status of the tiger salamander, *Ambystoma tigrinum*, in Delaware. Bulletin of the Maryland Herpetological Society 25:1-21.

Bishop, S.C. 1941. The Salamanders of New York. State University of New York, Albany, NY. 365 pp.

Bloxam, Q. C., and S. J. Tonge. 1995. Amphibians: suitable candidates for breeding-release programmes. Biodiversity and Conservation 4:636–644.

Buhlmann, K.A., and R.L. Hoffman. 1990. Geographic distribution: *Ambystoma tigrinum tigrinum*. Herpetological Review 21:36.

Buhlmann, K. A., and J. C. Mitchell. 2000. Age of adult eastern tiger salamanders (*Ambystoma tigrinum tigrinum*) in a Virginia sinkhole pond complex: implications for conservation. Journal of the Elisha Mitchell Scientific Society 116: 239–244.

Church, S. A., J. M. Kraus, J. C. Mitchell, D. R. Church, and D. R. Taylor. 2003. Evidence for multiple Pleistocene refugia in the postglacial expansion of the eastern tiger salamander, *Ambystoma tigrinum tigrinum*. Evolution 57:372-383.

Church, D. R. 2004. Population Ecology of *Ambystoma tigrinum* (Caudata, Ambystomatidae) and Occupancy Dynamics in an Appalachian Pond-breeding Amphibian Assemblage. Doctoral dissertation, University of Virginia.

Conant, R., and J.T. Collins. 1991. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, MA.

COSEWIC. 2012. COSEWIC assessment and status report on the Western Tiger Salamander Ambystoma mavortium in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xv + 63 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Crother, B. I. (editor). 2017. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. 8th edition. SSAR Herpetological Circular 43:1-104. [Updates in SSAR North American Species Names Database at: https://ssarherps.org/cndb]

Ficetola G.F. & De Bernardi F. (2005) Supplementation or in situ conservation? Evidence of local adaptation in the Italian agile frog *Rana latastei* and consequences for the management of populations. Animal Conservation 8:33-40.

Funderburg, J.B., C.H. Hotchkiss, and P. Hertl. 1974. First records of the eastern tiger salamander, *Ambystoma tigrinum tigrinum* Green, in Virginia. Bulletin of the Maryland Herpetological Society 10:57-58.

Germano J.M. & Bishop P.J. (2009) Suitability of amphibians and reptiles for translocation. Conservation Biology 23:7-15.

Harper, E.B., T.A.G. Rittenhouse, and R.D. Semlitsch. 2008. Demographic consequences of terrestrial habitat loss for pool-breeding amphibians: predicting extinction risks associated with inadequate size of buffer zones. Conservation Biology 22:1205–1215.

Harris, H.S., Jr. 1975. Distributional survey (Amphibia/Reptilia): Maryland and the District of Columbia. Bulletin of the Maryland Herpetological Society. 11:73-167.

Hassinger, D. D., Anderson, J. D., and G. H. Dalrymple. 1970. The early life history and ecology of *Ambystoma tigrinum* and *Ambystoma opacum* in New Jersey. Am. Midl. Nat. 84:474-495.

Hoverman, J. T., Gray, M. J., Miller, D. L., & Haislip, N. A. (2012). Widespread occurrence of ranavirus in pond-breeding amphibian populations. *EcoHealth*, *9*, 36-48.

IUCN/SSC. 2013. IUCN Guidelines for Reintroductions and Other Conservation Translocations. viiii + 57 pp. Available from http://www.issg.org/pdf/publications/translocationGuidelines-2012.pdf.

Johnson, J. R., R. C. Thomson, S. J. Micheletti, and H. B. Shaffer. 2011. The origin of tiger salamander (*Ambystoma tigrinum*) populations in California, Oregon, and Nevada: introductions or relicts? Conservation Genetics 12:355-370.

Kleopfer, J.D. 2017. *Ambystoma tigrinum tigrinum* (Eastern Tiger Salamander), Field Note. Catesbeiana 37(1):43.

Kleopfer, J.D. 2023. *Ambytoma tigrinum* dispersal, Field Note. Catesbeiana 43(2):129-130.

Lannoo, M.J. (ed.). 2005. Amphibian Declines. The Conservation Status of United States Species. University of California Press, Berkeley.

Madison, D. M., and L. Farrand, III. 1998. Habitat use during breeding and emigration in radio-implanted tiger salamanders, *Ambystoma tigrinum*. Copeia 1998:402-410.

Mitchell, J.C. 1994. Eastern Tiger Salamander (Ambystoma tigrinum tigrinum) Rediscovered in York County, Virginia. *Banisteria,* Number 4:30-31.

Pague, C.A., and K.A. Buhlmann. 1991. Eastern tiger salamander, *Ambystoma tigrinum tigrinum* (Green). pp. 431-433 In K. Terwilliger (Coordinator), Virginia's Endangered Species. McDonald and Woodward Publ. Co., Blacksburg, VA.

Petranka, J. W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D. C.

Pianka, E.R. 1983. Evolutionary Ecology. Harper and Row Publishers, Inc., New York, NY.

Powell, R., R. Conant, and J.T. Collins. 2016. Peterson Field Guide to Reptiles and Amphibians of Eastern and Central North America. 4the ed., Houghton Mifflin Harcourt, Boston.

Schroeder, C., and K. Stewart. 2022. Unintended consequences of species translocations: changes in distribution and habitat selection of mule deer following introduction of elk. California Fish and Wildlife Journal 108:e16.

Semlitsch, R.D. 1983a. Burrowing ability and behavior of salamanders of the genus *Ambystoma*. Canadian Journal of Zoology 61:616-620.

Semlitsch, R.D. 1983b. Terrestrial movements of an eastern tiger salamander, *Ambystoma tigrinum*. Herpetological Review 14:112-113.

Semlitsch, R.D. 1983c. Structure and dynamics of two breeding populations of the eastern tiger salamander, *Ambystoma tigrinum*. Copeia 1983:608-616.

Semlitsch, R. 2002. Critical elements for biological based recovery plans of aquatic-breeding amphibians. Conservation Biology 16:619–629.

Shaffer, H. B., and M. L. McKnight. 1996. The polytypic species revisited: genetic differentiation and molecular phylogenetics of the tiger salamander *Ambystoma tigrinum* (Amphibia: Caudata) complex. Evolution 50:417-433.

Steen, D.A.; Smith, L.L.; Miller, G.J.; Sterrett, S.C. 2006 Post-breeding terrestrial movements of *Ambystoma tigrinum* (eastern tiger salamander). Southeast. Nat. 5:285–288.

Stine, C. J. 1984. The Life History and Status of the Eastern Tiger Salamander, *Ambystoma tigrinum*. Bulletin of the Maryland Herpetological Society. Vol. 20 No. 3.

Tirrell, P.B. 1974. Tiger salamander found in York County, Virginia. Virginia Herpetological Society Bulletin 74:1.

Titus, V.; Madison, D.; Green, T. 2014. The Importance of Maintaining Upland Forest Habitat Surrounding Salamander Breeding Ponds: Case Study of the Eastern Tiger Salamander in New York, USA. Forests 5:3070-3086.

Trenham, P. C., and D. M. Marsh. 2002. Amphibian translocation programs: reply to Seigel and Dodd. Conservation Biology 16:555–556.

Zappalorti, R.T. 2018. Experimental Translocation of the Eastern Tiger Salamander in New Jersey: A Conservation Success Story. Unpublished report submitted to the NJDEP. 21 pp.

V. Project Proposal:

Translocating Eastern Tiger Salamander Larvae from the Sandhills Game Lands of North Carolina to the Big Woods Wildlife Management Area in Virginia.

Partners: Virginia Department of Wildlife Resources (DWR), The Nature Conservancy (TNC), North Carolina Wildlife Resources Commission (NCWRC) and the North Carolina Zoo (NCZ)

Purpose: To establish a reproducing population of eastern tiger salamanders within the Big Woods Wildlife Management Area (BWWMA) in Sussex County, Virginia from larvae sourced from the Sandhills region of North Carolina. Due to the relatively small population sizes, sourcing stock from Virginia is not feasible.

Need: Considering the uncertain future of breeding sites on private property and that the York County site is surrounded by urban development, the long-term conservation of tiger salamanders in the Coastal Plain of Virginia is tenuous at best without the establishment of new populations on protected properties that are suitably managed for tiger salamanders. If successful, the BWWMA location may also function as a source population for future translocation efforts. Because the TNC Piney Grove Preserve (PGP) is directly adjacent to the BWWMA and contains suitable breeding habitat, dispersal onto this property is a possibility. There is also the potential for translocating larvae to the PGP at some point. However, direct release onto PGP is not critical to the success of this project.

Metrics of Success: In our professional opinion, success is evidence of a reproducing population (e.g., egg masses) or adults returning to breeding sites within 5 years of the initial release of larvae. By years 6 & 7, we would expect evidence of a reproductive population. These metrics of success assume that environmental conditions will be suitable for reproduction. As we have previously observed, reproduction may not occur or be very limited during unusually dry winters.

Genetics: Genetics is always a concern when translocating animals from one area to another. Church et al. (2003) showed that post-Pleistocene emigrants from the Mid-Atlantic populations swept northward, colonizing the previously glaciated regions of the Northeast. Thus, tiger salamanders from the Carolinas are genetically alike to those found throughout the Northeast.

Disease: Visual monitoring for signs of disease will be conducted by NCZ staff throughout the captive rearing process. Eggs/larvae are observed and cared for daily. Any larvae or metamorphs, which appear to be diseased, distressed, or behaving unnaturally are removed and euthanized by NCZ veterinary staff, following American Veterinary Medical Association guidelines. If there is concern that disease is present in any individual, hose individuals are swabbed and/or preserved and sent to the appropriate lab for testing (Bd, Ranavirus, Dermomycoides, etc.), or evaluated by the zoo's pathologist. This is the same procedure for deceased metamorphs, however, zoo veterinarians may conduct a gross necropsy, depending on the size. Any diseases or other concerns would be reported to the appropriate agency managing the species/project to evaluate next steps. During the husbandry process, all staff will wear gloves and use assigned tools for the specific project. Husbandry staff will work with any other amphibians prior to caring for conservation program species, unless, they have washed appropriately and changed clothing and footwear.

Budget: Except for DWR staff time and the use of a vehicle, there have been no identified direct expenses associated with this project. NCWRC and the NCZ have generously provided their services *in kind*.

Timeline and Methods: It has been shown that tiger salamanders take 2-3 years from hatching for larvae to reach sexual maturity (Buhlmann and Mitchell 2000; Semlitch 1983). As such, we hope to observe evidence of reproduction at the release site 3-5 years after the first release.

Winter Year 1 (2025-2026) – NCWRC will collect egg masses and transport them to the NCZ for headstarting. Target number of larvae is 300-500 larvae. This number is dependent on the size and condition of the larvae and capacity of the NCZ.

Spring Year 1 (2026) – DWR staff coordinate with their NC partners to transport and release 300-500 larvae at BWWMA.

Winter Year 2 (2026-2027) – NCWRC will again collect egg masses and transport them to the NCZ

Spring Year 2 (2027) – DWR staff coordinate with their NC partners to transport and release larvae at BWWMA.

Winter Year 3 (2027-2028) – NCWRC will again harvest egg masses from the donor site(s) and transport them to the NCZ. DWR will begin conducting egg mass surveys at BWWMA.

Spring Year 3 (2028) – DWR staff coordinate with their NC partners to transport and release larvae at BWWMA.

Winter Year 4 (2028-2029) – DWR staff will survey for adults and conduct egg mass counts.

Spring Year 4 (2029) – DWR and their conservation partners will evaluate the success of the program and evaluate whether to continue augmenting the *recipient* site.

Winter Year 5 (2029-2030) – DWR staff will survey for adults and egg mass counts at the recipient site and nearby ponds.

Spring Year 5 (2030) – DWR and their conservation partners will evaluate the success of the program and evaluate whether to continue augmenting the *recipient* site.

Winter Years 6 & 7 (2030-2031 & 2031-2032) – DWR staff will survey for adults and egg masses.

VI. Regulatory Considerations:

Wildlife, Inland Fisheries and Boating
Chapter 1. Administration of Wildlife Resources.
Article 1. General Provisions.

§ 29.1-103. Powers and duties of the Board.
The Board is responsible for carrying out the purposes and provisions of this title and is authorized to:

6. Acquire and introduce any new species of game birds, game animals, or fish on the lands and within the waters of the Commonwealth, with the authorization and cooperation of the local government for the locality where the introduction occurs.

Under §29.1-563, this population will be designated as "experimental". "*Experimental population" means any population of an endangered or threatened species of fish or wildlife, excluding those species appearing on the federal list specified in § 29.1-564, that is (i) established through deliberate introduction by humans; (ii) designated by regulation of the Board; and (iii) explicitly delineated in a conservation plan*. The Big Woods WMA and Piney Grove Preserve have been identified as the boundaries for this experimental population (Figure 4 and Figure 5).

The stains on these tree trunks demonstrate how much water levels can fluctuate at breeding sites.
DWR J.D. Kleopfer

A. Maximum Dispersal Buffer:
Movement onto private land is not a concern as the maximum dispersal range of this species is less than 300 meters with most individuals moving an average distance of 60 meters from their breeding site. For project planning purposes, we designated a 300-meter Maximum Dispersal Buffer (MDB), which will be entirely contained within the BWWMA and PGP. Nearest private land is approximately three times the distance of the MDB (Figures 4 and 5).

Figure 4:

Map Intentionally Omitted Due to the Confidential Nature of the Information

Figure 5:

Map Intentionally Omitted Due to the Confidential Nature of the Information

Appendix 1.

Amphibians known to occur and/or breed at 17 Frog Pond (donor site) in the Sandhills Game Lands of North Carolina

<u>Salamanders</u>
Siren intermedia Lesser Siren
Notophthalmus viridescens dorsalis Broken-striped Newt

<u>Frogs</u>
Plethodon chlorobryonis Atlantic Coast Slimy Salamander
Scaphiopus holbrookii Eastern Spadefoot
Bufo fowleri Fowler's Toad
Bufo quercicus Oak Toad
Bufo terrestris Southern Toad
Acris gryllus Southern Cricket Frog
Hyla andersonii Pine Barrens Treefrog
Hyla chrysoscelis Cope's Gray Treefrog
Hyla femoralis Pine Woods Treefrog
Hyla gratiosa Barking Treefrog
Pseudacris crucifer Spring Peeper
Pseudacris ornata Ornate Chorus Frog
Gastrophryne carolinensis Eastern Narrow-mouthed Toad
Rana capito Carolina Gopher Frog
Rana catesbeiana American Bullfrog
Rana clamitans Green Frog
Rana sphenocephala Southern Leopard Frog
Rana virgatipes Carpenter Frog

Amphibians of Big Woods/Piney Grove and surrounding 5-mile area

<u>Salamanders</u>
Ambystoma mabeei Mabee's Salamander
Ambystoma maculatum Spotted Salamander
Ambystoma opacum Marbled Salamander
Amphiuma means Two-toed Amphiuma
Desmognathus auriculatus Holbrook's Southern Dusky Salamander
Eurycea cirrigera Southern Two-lined Salamander
Hemidactylium scutatum – Four-toed Salamander
Notophthalmus viridescens viridescens Red-spotted Newt
Plethodon chlorobryonis Atlantic Coast Slimy Salamander
Pseudotriton montanus Mud Salamander
Pseudotriton ruber Red Salamander
Stereochilus marginatus Many-lined Salamander
Necturus punctatus Dwarf Waterdog

Frogs

Scaphiopus holbrookii Eastern Spadefoot
Anaxyrus americanus American Toad
Anaxyrus fowleri Fowler's Toad
Anaxyrus quercicus Oak Toad
Anaxyrus terrestris Southern Toad
Acris crepitans Eastern Cricket Frog
Acris gryllus Southern Cricket Frog
Hyla cinerea Green Treefrog
Hyla chrysoscelis Cope's Gray Treefrog
Hyla femoralis Pine Woods Treefrog
Hyla gratiosa Barking Treefrog
Hyla squirrella Squirrel Treefrog
Lithobates kauffeldi Mid-Atlantic Coast Leopard Frog
Lithobates palustris Pickerel Frog
Lithobates catesbeiana American Bullfrog
Lithobates clamitans Green Frog
Lithobates sphenocephala Southern Leopard Frog
Lithobates virgatipes Carpenter Frog
Pseudacris brimleyi Brimley's Chorus Frog
Pseudacris crucifer Spring Peeper
Pseudacris feriarum Upland Chorus Frog
Pseudacris nigrita Southern Chorus Frog
Pseudacris ocularis Little Grass Frog
Gastrophryne carolinensis Eastern Narrow-mouthed Toad