Experimental Translocation of the Eastern Tiger Salamander in New Jersey: A Conservation Success Story

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Experimental Translocation of the Eastern Tiger Salamander in New Jersey: A Conservation Success Story

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to

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By

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Introduction

Amphibian declines has been an ongoing concern in the scientific community (Lannoo, 2005). Historically, the eastern tiger salamander’s (*Ambystoma tigrinum*), range originally encompassed 8 different counties in southern New Jersey. In 2018, tiger salamanders are now restricted to only 3 southern New Jersey counties (e.g., Cape May, Cumberland and Salem). Within these three counties the remaining populations are known to successfully breed at approximately 13 suitable wetland locations. Currently, eastern tiger salamanders breed almost exclusively in human-made ponds that fill with ground water and rain water. These breeding sites are usually sand and gravel extraction borrow pits. Most of the known tiger salamander breeding ponds are on private property. However, suitability of borrow pits for salamander breeding is sometimes degraded from illegal dumping by homeowners, landscapers, and building contractors. Sometimes they dump industrial waste and chemical compounds into the burrow pits which not only pollutes the ground water, but eventually kills a host of amphibian and invertebrate species that traditionally breed there. Some burrow pits are used by breeding amphibians even if they are still being mined for sand and gravel.

Because of these ongoing disturbances that cause adverse environmental impacts to the amphibians and their breeding ponds, an experimental translocation and management plan was devised by the NJDEP’s, Endangered and Nongame Species Program personal that was based upon recommendations from the late James D. Anderson of Rutgers University (1976), and Herpetological Associates, Inc. (1980). In order to mitigate these disturbances an experimental human made breeding pond was proposed at one or more NJDEP, Division of Fish and Wildlife Management Areas (WMA), in southern New Jersey.

The following best management practices or protocol was used and considered in the selection of the translocation sites (Anderson, 1976; Anderson, Galandak and Howthorne, 1978; Zappalorti and Johnson, 1980; Frier and Zappalorti, 1983):

1). The experimental breeding pond should only be constructed on permanently protected NJDEP state land.

2). The selected site should be at least 500-acres in size to provide enough buffer areas and terrestrial habitat for the adult salamander population.

3). The selected site should have suitable sandy, loamy soils for easy burrowing.

4). The recipient site should have a large tract of oak and pine forest that could be used as summer home range for the salamander population.

5). The proposed construction site for the experimental pond should have a clay or hardpan gravel soil horizon that would be capable of holding ground and rain water long enough (at least 4 to 5 months), to allow successful amphibian metamorphosis, and yet still serve as a vernal pond.
One of the most important factors of the experiment was to mimic a natural vernal pond, which was no easy task. The New York State Department of Environmental Conservation (NYS-DEC), has sponsored several management action plans for tiger salamander on Long Island, New York over the past 30-years. Actions that were implemented included: transplanting egg masses, establishing roadway crossings, creating artificial ponds, creating salamander preserves, conducting radio-telemetry studies, designating Class 1 wetlands, and establishing buffer zones (Levy 2001; NYS-DEC 2010a). Despite much of the occupied habitat occurring on various state and federal jurisdictions, none of the above management actions have been successful at halting the precipitous decline of the population at the statewide scale (Corser 2010).

Other salamander translocation efforts in Long Island, New York have used rubber pond liners with some success (NYS-DEC, 2010b), but over time the liners can crack or be punctured thus reducing their value by not holding enough water. Because of that potential problem, the NJDEP chose a different approach by seeking to build a vernal pond that had a natural clay or hardpan bottom (Anderson, 1976; Zappalorti and Johnson, 1980; Frier and Zappalorti, 1983). Table 1, lists all the amphibians species known to use vernal ponds in New Jersey.
Greenwood Forest WMA, in Ocean County was initially chosen for constructing an experimental amphibian breeding pond. An effort was made to select a site based upon soil types and forest types surrounding the proposed vernal pond. However, after the pond was constructed it was learned that the substrate was too porous and could not hold water long enough for successful amphibian metamorphosis. That site in Greenwood Forest WMA was abandoned and Higbee Beach WMA, in Cape May County was chosen, which is located at the southern tip of New Jersey. This Cape May site had all the structural habitat features listed above (Anderson, 1976; Zappalorti and Johnson, 1980; Frier and Zappalorti, 1983; Mitchell, Breisch and Buhlmann, 2006).

**Breeding Habits and Natural History of Tiger Salamanders**

Amphibians in general and tiger salamanders in particular are declining for a variety of reason (Pechmann et al., 1991). The eastern tiger salamander is a member of a group known as “mole salamanders.” They typically breed on rainy nights in winter form November through February in southern New Jersey. During rainstorms, migrating adults sometimes traverse snow or ice to reach the open water of their annual breeding pond. Some adult tigers may remain in the breeding pond for days or weeks until they successfully breed. The male tiger salamanders seek receptive females in the pond and swim around them waving their tails and rubbing against them. Fertilization is external. During the elaborate underwater courtship, adult female tiger salamanders pick up small, gelatinous spermatophore packets on their vent that were deposited by males (Hassinger, Anderson and Dalrymple, 1970; Anderson, Galandak and Howthorne, 1978).

Females lay and attach their egg clusters to aquatic vegetation, plant stems or sticks in the pond. An egg mass may contain 25 to 75 individual round eggs (average compliment is 50). The eggs take about two weeks to hatch depending upon water temperature and lack of ice on the pond surface. Back in 1989 at a Cape May borrow pond, HA has observed tiger salamander eggs hatching on New Year’s day (Zappalorti, personal observation).
Table 1. List of New Jersey Obligate and Facultative Vernal Pool Breeding Amphibians, their Threatened and Endangered Status, and Common Names.

<table>
<thead>
<tr>
<th>Obligate Species</th>
<th>Scientific Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easter tiger salamander</td>
<td>Ambystoma tigrinum</td>
<td>Endangered</td>
</tr>
<tr>
<td>Marbled salamander</td>
<td>Ambystoma Opacum</td>
<td>Special Concern</td>
</tr>
<tr>
<td>Spotted salamander</td>
<td>Ambystoma maculatum</td>
<td>Stable</td>
</tr>
<tr>
<td>Jefferson salamander</td>
<td>Ambystoma jeffersonianum</td>
<td>Special Concern</td>
</tr>
<tr>
<td>Blue-spotted salamander</td>
<td>Ambystoma laterale</td>
<td>Endangered</td>
</tr>
<tr>
<td>Eastern spadefoot toad</td>
<td>Scaphiopus holbrookii</td>
<td>Special Concern</td>
</tr>
<tr>
<td>Wood frog</td>
<td>Lithobates sylvatica</td>
<td>Stable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Facultative Species</th>
<th>Scientific Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four-toed salamander</td>
<td>Hemidactylium scutatum</td>
<td>Stable</td>
</tr>
<tr>
<td>Long-tailed salamander</td>
<td>Eurycea l. longicauda</td>
<td>Threatened</td>
</tr>
<tr>
<td>Northern spring peeper</td>
<td>Pseudacris crucifer</td>
<td>Stable</td>
</tr>
<tr>
<td>New Jersey chorus frog</td>
<td>Pseudacris triseriata kalmii</td>
<td>Stable</td>
</tr>
<tr>
<td>Upland chorus frog</td>
<td>Pseudacris triseriata ferarium</td>
<td>Stable</td>
</tr>
<tr>
<td>Northern cricket frog</td>
<td>Acris crepitans</td>
<td>Special Concern</td>
</tr>
<tr>
<td>Northern gray treefrog</td>
<td>Hyla versicolor</td>
<td>Stable</td>
</tr>
<tr>
<td>Southern gray treefrog</td>
<td>Hyla chrysoscelis</td>
<td>Endangered</td>
</tr>
<tr>
<td>Pine Barrens treefrog</td>
<td>Hyla andersonii</td>
<td>Threatened</td>
</tr>
<tr>
<td>Carpenter frog</td>
<td>Lithobates virgatipes</td>
<td>Special Concern</td>
</tr>
<tr>
<td>Southern leopard frog</td>
<td>Lithobates utricularia</td>
<td>Stable</td>
</tr>
<tr>
<td>Pickerel frog</td>
<td>Lithobates palustris</td>
<td>Stable</td>
</tr>
<tr>
<td>Green frog</td>
<td>Lithobates clamitans melanota</td>
<td>Stable</td>
</tr>
<tr>
<td>Bullfrog</td>
<td>Lithobates catesbeiana</td>
<td>Stable</td>
</tr>
<tr>
<td>Fowlers toad</td>
<td>Anaxyrus fowleri</td>
<td>Stable</td>
</tr>
</tbody>
</table>
Tiger salamander larvae are voracious feeders which enables them to grow quickly (see Figures 4 and 5), and may become the top predator in the breeding pond. In a stomach content study conducted in Maryland, larval tiger salamanders preyed upon 1,259 identifiable food organisms found in 42 larvae (Lee, 2006). The larvae were feeding primarily on aquatic, bottom-dwelling insects and crustaceans. They occasionally eat the small tadpoles of spring peepers, chorus frogs and cricket frogs. They are not specialized feeders, but are more opportunistic with a variable prey base. Larval tiger salamanders feed on a variety of small aquatic life forms, such as fairy shrimp and other insect larvae. Some tiger salamander larvae may become cannibalistic and eat smaller members of the aquatic population in the breeding pond (Anderson, Galandak and Howthorne, 1978; Hassinger, Anderson and Dalrymple, 1970; Lee and Franz, 1974).

After reproduction activities are completed, the adults migrate back to their terrestrial habitat and return to subterranean burrows in the surrounding coniferous or hardwood forests. Summer habitat may be near their breeding pond, but some individuals may migrate several hundred feet to upland burrows where they remain hidden in their tunnels until the following winter. After 4 or 5 months in the breeding pond, the larval tiger salamanders metamorphose into air breathing sub-adults (Noble and Brady, 1933; Bishop, 1947). Typically they migrate away from the breeding pond at night or on rainy days to their upland habitat where they seek and establish their summer burrow system (Hoffmann, 2003). However, they do not reach sexual maturity until they are 2 or 3-years of age, when they return to the same breeding pond from which they metamorphosed (Wilbur and Collins, 1973). Most mole salamanders have a strong fidelity to their natal breeding pond (Bishop, 1947; Lee, 1975). Tiger salamanders are capable of living from 13 to 25-years or more in their natural habitat.
Methods Used for the Experimental Translocation

In December 1981, an experimental tiger salamander breeding pond was excavated at Higbee Beach Wildlife Management Area following the design of Anderson (1976), and Herpetological Associates (Frier and Zappalorti, 1982). The pond measured 100-feet across by 300-feet long and had a gradual sloping bottom from its shallow edges of 6-inches to the center at 3-feet. The center of the pond also had a 2-feet wide 4-feet deep ditch that ran across its entire bottom, which was the deepest point. This was a safety trench in case the pond prematurely dried up due to lack of rain. It would allow the larvae a reservoir of water to sustain them until metamorphosis (Zappalorti and Johnson, 1981). The construction of the breeding pond conformed to the dimensions recommended in the management plan (Frier and Zappalorti, 1982). After construction the pond was allowed to fill naturally with rain and ground water over winter. The midline ditch, designed to hold water in case of drought during the salamander's developmental period filled within 3-days after excavation, and the entire pond filled within 3-weeks afterwards with the help of seasonal rains. As designed, the pond dries up by late summer thus limiting predatory fish from becoming residents. It should be noted that there was about 500-acres of oak-pine forest and 35-acres of old field habitat surrounding the experimental pond which served as a buffer and summer foraging areas for the salamanders (Semlitsch and Bodie, 2003; Steen, et al., 2006).
In March 1982, approximately 20 tiger salamander egg masses (~1,000 eggs), were collected by dip net from unprotected privately owned ponds in Cape May and Cumberland Counties (Figure 6). These ponds were vulnerable to adverse impacts and pollution from illegal dumping. The eggs were transported in five-gallon buckets containing pond water (Figure 7). We also collected various aquatic vegetation that was planted in the recipient pond bottom along with some tree branches and stumps which would provide underwater shelter for the salamander larvae (Noble and Brady, 1933; Douglas and Monroe, 1981).

Additionally, we also collected the larvae of marbled salamanders (*Ambystoma opacum*), the string-like eggs of Fowler's toads (*Anaxyrus fowleri*), egg masses of leopard frogs (*Lithobates utricularia*), and tadpoles of New Jersey chorus frogs (*Pseudacris triseriata kalmii*) and spring peepers (*Pseudacris crucifer*). These amphibians were translocated to the experimental pond as well as a potential food source in the future. Extreme care was taken to avoid introducing fish predators into the experimental vernal pond. It should be noted that there was an existing freshwater pond within 600-feet from the experimental salamander breeding pond that had a sandy, clay bottom which gave us confidence that the selected site had the correct soil type (Figure 6).
Results of Translocation Efforts

Periodic monitoring (one or two week intervals), of the experimental breeding pond was done by visual surveys and dip-netting. After two weeks all the trans-located egg masses had hatched as evidenced by free swimming salamander larvae and tadpoles. Likewise, by the end of June and early July 1982, the tiger salamander larvae had metamorphosed successfully. ENSP staff conducted field observations using a drift fence with pitfall traps around the experimental pond. These observations indicated that approximately 400 of the metamorphed tiger salamanders were caught in the pitfall buckets. They were marked by branding and released away from the drift fence. The juvenile salamanders migrated away from the breeding pond in June and July of 1982. As a follow-up to enhance the translocated population in February and March of 1983, another transfer of 20 tiger salamander egg masses (~1,000 eggs) was accomplished (Figure 7). Similar to the events of 1982, the eggs hatched and larvae metamorphosed by mid-July of 1983. Ongoing monitoring in the winter of 1984 resulted in observing adult individuals of the 1982 cohort who reached sexual maturity after two years living in underground burrows on the forest floor (Figure 8). These translocated tiger salamanders subsequently reached adulthood and returned to the artificial pond to breed as evidenced by the presence of 10 fertile egg masses observed during the winter of 1984 - 1985 by NJDEP staff (Dave Golden, ENSP, personal communication).
Figure 7. A 5-gallon bucket containing 10 tiger salamander egg masses along with some aquatic vegetation. The eggs were collected at unprotected breeding sites and transported the same day to the experimental breeding pond in Cape May.

Figure 8. A female Tiger Salamander leaving the pond after breeding.
Follow-up Monitoring to Measure Success

Periodic follow-up winter egg-count surveys were conducted by HA and Endangered and Nongame Species Program personal. Monitoring during the 1990's era, and again between 2000 - 2005 has shown the continued presence of eggs and/or larval of tiger salamanders in this artificially created breeding pond. One unforseen problem that has gradually occurred over the years was the invasion of the plant *Phragmites australis*. Although the *Phragmites* has choked the open water in the pond, it has not deterred the salamanders from returning and breeding in it.

Biologists with the NJDEP and HA have monitored the use of this pond by tiger salamanders over the past 36-years. Every time a winter egg-count survey was conducted, egg masses, salamander larvae, and/or adult tiger salamanders have been seen in the pond. Adult females now attach their egg masses to the stems of the *Phragmites*. This experiment has been especially rewarding because over the years the trans-located salamanders continue to breed, lay eggs, and metamorphose. Ongoing observations have shown that a population of tiger salamanders has been established at Higbee Beach WMA. More important, it demonstrates the value of this conservation management technique. This method could work with other members of the “mole salamander” family (*Ambystoma spp.*). Likewise, rare frog species could also benefit from experimental translocation to suitable ponds by carefully moving their egg masses to a recipient vernal pond site.

*Figure 9.* A front view of a larval Tiger Salamander. Notice the large external gills.
Importance of Breeding Pond Buffers and Terrestrial Habitat

Many studies have been conducted on the appropriate size of protective buffer zones around salamander breeding ponds (Semlitsch, 1998). Semlitsch and Bodie (2003), summarized the results of 40 papers describing the biologically relevant core habitats that surround amphibian breeding ponds. They concluded that the size of the core upland or terrestrial habitat required to protect adult salamanders and other frogs and toads was a radius of 521 to 951-feet from the breeding pond. Additionally, a protective buffer of 150-feet should be added to ensure that there is enough terrestrial habitat available for the long-term protection of the amphibian populations (Scott, et. al., 2013).

In New Jersey, the wetland protection law requires only a 150-feet buffer if rare species are present. However, the New Jersey Pinelands Commission has expanded buffer zones to 300-feet at known areas that have endangered or threatened wildlife species using the wetland habitat. The best management practices are to protect large inter-connected wildlife corridors between seasonal wetlands and upland forests (e.g., containing vernal ponds). If paved roads are near amphibian breeding ponds or pass through the upland habitat, barriers and under road tunnels should be considered to keep salamanders, frogs and toads off the roads (Woltz, et. al., 2008). Every year, hundreds of amphibians are killed by passing motor vehicles as they attempt to migrate across paved or gravel roads to their ancestral breeding ponds (Pechmann, et. al., 1991; Clevenger, et. al., 2001).

Figure 10. A pair of Tiger Salamanders migrating towards their breeding pond.
Summary and Recommendations

One potential problem that was unforeseen and not thought of back in 1981 when this conservation project was designed and planned, is the possibility of sea level raise in lower Cape May County. In the future, portions of Higbee Beach WMA may suffer from salt water intrusion, thus making the breeding pond and surrounding forested habitat unsuitable for tiger salamanders and other wildlife. Actions should be taken to establish tiger salamander “assurance colonies” from the Higbee Beach population.

To that end, HA recommends that the NJDEP select other WMA’s within the historic known range of the tiger salamander in New Jersey (e.g., Atlantic, Burlington, or Ocean Counties), and replicate this experiment. In other words, find suitable natural vernal ponds which currently lack tiger salamanders and initiate a conservation program by trans-locating egg masses to selected sites for repatriation. If suitable vernal ponds cannot be found, then the NJDEP should create some ponds following the protocol cited above in this report. Since the Higbee Beach WMA tiger salamander translocation was successful in the past, if the same protocol was used again then there is a high probability that it could be repeated (Anderson, 1976).

Every effort should be made to establish several tiger salamander “assurance colonies” on NJDEP Wildlife Management Areas. HA is ready, willing and able to assist with this experimental conservation program should the Endangered and Nongame Species Program and Bureau of Land Management (NJDEP), decide to implement a tiger salamander repatriation project within its known historic range in New Jersey.

Figure 11. An adult female Eastern Tiger Salamander migrating towards its breeding pond.


New York State Department of Environmental Conservation. 1985. Checklist of the amphibians, reptiles, birds, and mammals of New York State, including their protective status. Nongame Unit. Wildlife Resources Center. Delmar, NY.


Stone, J., 1992. Vernal pools in Massachusetts: Aerial photographic identification, biological and physiographic characteristics, and state certification criteria. MS Thesis, University of Massachusetts, Amherst, MA.


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Figure 12. Tiger Salamander.