# Distribution and localization of the Eastern Tiger Salamander (*Ambystoma tigrinum tigrinum*) egg masses in vernal pools at Brookhaven National Laboratory

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## Abstract

The tiger salamander, a New York State endangered species, is locally abundant in parts of eastern Long Island. Eastern Long Island is composed of sandy Pine Barren areas with ideal vernal pools for breeding and life activities for amphibians. These areas are found in abundance at Brookhaven National Laboratory where the eastern tiger salamander population is conserved in natural ponds and man-made depressions filled with water. During winter-spring 2004, egg masses were found at several vernal pools. To confirm use of vernal pools by salamanders, egg mass data was recollected during the months of February through April 2004 in 18 different vernal pools around the laboratory; considering the relationship between the kind of pond, amount of egg masses, height of egg mass deposited above pond bottom on twig or weed stems, and water temperature. For the purpose of improving breeding season success in some ponds, artificial deposition sites were installed, which resulted in positive use in some ponds. This study quantifies the distribution and localization of egg masses and the amount of eggs found in each pond showing a range between the bioconcentration in each pond and ideal conditions for tiger salamander breeding activity.

## Introduction

The knowledge of the breeding and the movement patterns of animal species are particularly fundamental in understanding the distribution, localization, and ecology of life cycles in amphibians, which develop between water and dry land. One such example is the Eastern Tiger Salamander, *Ambystoma tigrinum trigrinum*, which is one of the largest terrestrial salamanders (genus *Ambystoma*) in United States. This species, spends most of its life underground, but emerges from its burrow in late winter and early spring , to migrate at night, usually during rain periods, to the breeding ponds (Semlitsch, 1983). After a brief courtship, the females attach egg masses containing 25-50 eggs per mass to twigs or stems under water, in both temporary and permanent pools within the Central Pine Barrens of Long Island (Madison and Farrand III, 1998).

About four weeks after, oviposition eggs hatch. Larvae remain in the ponds until late July or early August; after which they transform into air-breathing sub-adults measuring between ten to twelve centimeter in length. The new metamorphs leave the ponds at night during periods of precipitation to begin their underground existence. Four to five years later, they reach sexual maturity and may live for 12-15 years, primarily feeding on earthworms, insects and mollusks, as well as occasional frogs or baby mice.

Long Island, New York boasts a fragile ecosystem, where numerous natural communities and countless species are found in particular habitats. Furthermore, Long Island is located on the northeastern edge of the tiger salamander range, and most of the known breeding colonies occur in and around the Central Pine Barrens. This ecosystem is commonly associated with breeding and distribution of the tiger salamanders on Long Island. (Green, D.M. and R.W. Campbell.1992) Reproduction was probably never high in

this area until the beginning of the uncontrolled human population growth and environmental alteration (Ash A, 1997). In 1983, Tiger Salamanders were listed, as State-endangered species as a result of the different anthropogenic influences, like urban sprawl and other development throughout Long Island. Development led to the loss of many types of habitat including, woodlands with sandy soils, moist meadows, and the burrows of mammals and invertebrates (the salamander's habitat) associated with these habitats. Other factors such as the loss of wetlands, introduction of predatory fish such as bluegill sunfish (*Lepomis macrochirus*) (Madison and Farrand III, 1998), and expansion of bullfrog populations can also threaten annual reproduction.

In view of this situation we investigated the distribution and localization of egg masses in some of the vernal pools at the Brookhaven National Laboratory and obtained the average number of eggs in each mass. In addition we compared the localization of eggs masses deposited on artificial substrates (sticks) and natural branches at five different ponds. We hypothesized that average egg masses would be distributed evenly around the vernal pools' edge, laid along the middle parts of twigs, and under an open canopy, particularly in man-made ponds that are depressions filled with water adjacent to forested areas.

## Materials and Methods

### Study Area

The study was conducted at Brookhaven National Laboratory, which is located in a section of the Pitch Pine/Oak forest region of the coastal Plain of Long Island, New York. The Laboratory consists roughly of five percent of the 404.7 sq-km Pine Barrens

on Long Island. Many vernal pools are found at BNL, where the presences of tiger salamander egg masses are deposited annually between late winter/early spring (January-April). This survey was conducted in five different vernal pools at the Laboratory: TS-W6b, TS-W6a1, TS-A7a (MMa), TS-A6b and TS-2.

**Eastern Tiger Salamander (*Ambystoma tigrinum trigrinum)* Description**

The Eastern Tiger Salamander is one of the largest terrestrial salamanders in North America. Terrestrial adults can reach 33-35 cm in total body length and are stout-bodied animals with conspicuously broad heads and relatively small eyes (Smith 1949). The species coloration and patterning is generally light yellow, brown, or yellowish green with crossbands or blotches on a dark brown or black background. The only other salamander with which it might be confused is the smaller spotter salamander (*Ambystoma maculatum*) that has two rows of regular yellow-orange spots parallel down the dorsum, as distinct from the irregular distributed spots of the tiger salamander

**Ponds Data**

At each vernal pool (TS-W6b, TS-W6a1, TS-A7a (MMa), TS-Ab, TS-2) data was taken using a Kestrel 4000 handheld weather station and water quality data was taken with a YSI Environmental Monitoring meter, model 650 MDS. Measurements were taken for water and air temperature, conductivity, dissolved oxygen, pH, turbidity, relative humidity and wind speed. Also taken were observations on canopy cover, maximum water depth, percent cover of herbs, precipitation, and cloud cover. At the same time, each vernal pool was surveyed for egg masses around the edges and along the middle.

When egg masses were discovered, five randomly selected egg masses. Each egg mass was counted while carefully handling and observing the locality depth of the egg masses.

## Results

During late winter/early spring (January-April) 118 eggs masses were recorded from five different ponds with an average of 32 eggs per mass in ponds with an average water temperature of 15$^{o}$C (Table 1). The total number of eggs in the five egg masses from TS-W6a1 and TS-A7a were221 and 157 eggs respectively, much higher in comparison to the others three ponds investigated. The amount of eggs fluctuated within a range of 14 to 52 eggs per mass except at TS-W6b, where an egg mass containing 87 eggs was found in the beginning of January. Egg masses were found roughly 50 to 70 cm from the pond edge, attached to twigs or stems under water approximately 20 to 30 cm, midway between the pond bottom and the surface of the water. The meteorological and water quality data indicate in significant findings because the dissolve oxygen (DO) was low (1-10mg/l) a common characteristic of vernal pools. These low levels of DO were positively associated with increasing abundance of egg masses through the season. This occurred particularly in TS-A7a and TS-W6a1 where egg mass abundance increases while that DO decreases in each pond (Fig 1). Water and air temperatures were variable during the winter and spring, fluctuating from 7 $^{o}$C to 26 $^{o}$C and 14 $^{o}$C and 20 $^{o}$C, respectively. During the period surveyed, the precipitation fell sometimes as snow altered the water temperatures stabilizing slowly. This precipitation increased the salamander breeding drastically. However, pH remained stable all the time (Fig 2).

The natural conditions that were found in ponds were fundamentally shallow water with open canopies surrounded with coniferous vegetation and exposed areas. The pond edge fauna was composed of particular organisms like frogs (Bullfrog, Wood Frog and Spring Peeper), mice, raccoons, snakes, turtles, invertebrates, and other salamanders. For the most part, the vernal pools are unsuitable for any fish and the ground is sandy and moist.

## Discussion

Faced with the loss of many wetlands, introduction of predatory fish and the sudden development of Long Island (Madisson and Farrand III, 1998), the Tiger Salamander must be conserved in the Long Island Pine Barrens. The ideal habitat for this species is man-made or natural vernal pool surrounded by Pine Barrens and free of breeding populations of fish. These conditions occur at Brookhaven National Laboratory, which contains a great concentration of coniferous forest around ponds that have soil rich in moisture and places prone to flooding that benefit Tiger Salamander breeding.

This study supports the conclusion that vernal pools are good habitat for the salamander because they have low dissolve oxygen (DO), which is prejudicial against fish reproduction. Fish typically need more than 5mg/L DO for survival, because they consume oxygen from the water, however amphibians like the salamander, carry out life activities without much oxygen, between 1mg/L to 10mg/L. This is significant because when DO is low, it keeps fish out of the pond and increases the egg abundance during the breeding season. The increased egg mass abundance can be observed around the margins of ponds, in shallow water, close to the edge, specifically in the middle of the branches

and sticks, approximately 20 to 30cm from the bottom of the vernal pool. This placement may be occurring because the egg masses need solar warming for their development.

This study also provided data on the number of eggs found in each egg mass in the vernal pools. This averaged 32 eggs per mass and ranged between 15 and 40 eggs. In addition, each vernal pool can have from 5 to 63 egg masses depending on DO and pH (Figure 1 and 2), which could be change until a pH les than 4 because some vernal pool organisms can tolerance high acidity.(Bennett, 2002)

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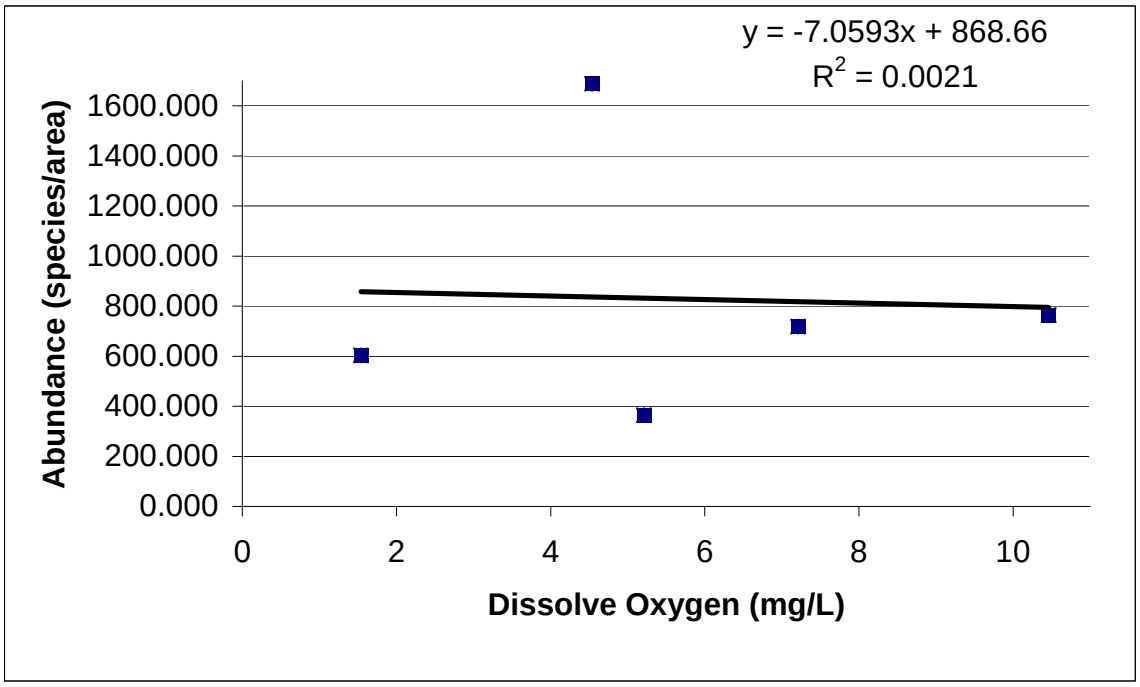


Fig. 1 Abundance species/area vs. Dissolve Oxygen. (mg/L). Data was taken during late winter/early spring. (January to April)

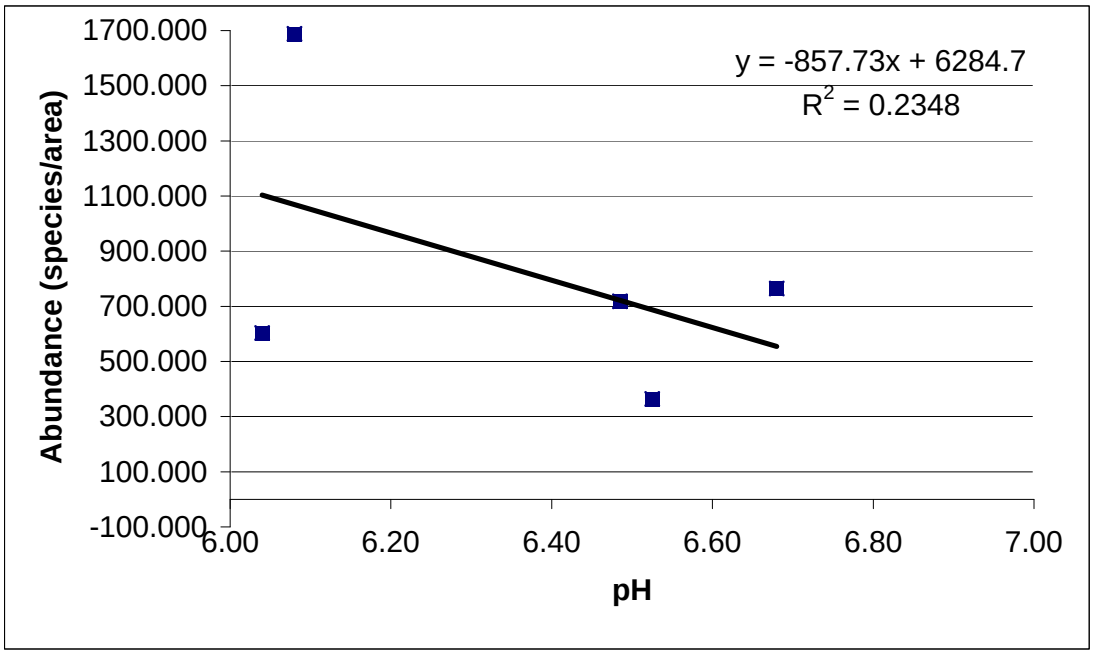


Fig 2. Abundance species/area vs. pH. Data was taken during late winter/early spring, (January to April)

**Tiger Salamander - Eggs Masses**

| Pond | 1 | 2 | 3 | 4 | 5 | Total (EM) | Mean (EM) | Eggs Masses | Water Temp $^{O}$C mean |
|---|---|---|---|---|---|---|---|---|---|
| **TS-W6a1** | 45 | 40 | 43 | 53 | 40 | 221 | 44.2 | 5 | 15 |
| **MMa - TS-A7a** | 34 | 30 | 22 | 35 | 36 | 157 | 31.4 | 29 | 26 |
| **TSW6b** | 16 | 17 | 30 | 20 | 87 | 170 | 34.0 | 63 | 8 |
| **TS-2** | 52 | 26 | 26 | 28 | 26 | 158 | 31.6 | 8 | 13 |
| **TS-6Ab** | 20 | 16 | 30 | 24 | 14 | 104 | 20.8 | 13 | 14 |
| | | | | | **Total** | 810 | 162 | 118 | 76 |
| | | | | | **Average** | 162 | 32.4 | 23.6 | 15.2 |

Table 1. Eggs masses localization in five different vernal pools at Brookhaven National Laboratory