Tiger Salamander (*Ambystoma tigrinum tigrinum)* Emergence

in Natural and Man-Made Ponds

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Abstract:

Although listed as Endangered in the state of New York, the eastern tiger salamander (*Ambystoma tigrinum tigrinum*) is abundant at Brookhaven National Laboratory. The purpose of this study was to compare the emergence of metamorphic salamanders from man-made and natural wetlands in order to develop better management strategies for the species. Drift fence arrays with pitfall traps were installed around two vernal pools, one man-made and one natural. Fences were checked in the morning and metamorphs were measured and released. Emergence from the man-made pond began 17 days before that of the natural pond. There is evidence that the larvae in the man-made pond are influenced by overcrowding. Data from these ponds continues to be collected for further study.

Introduction:

Though they are common throughout most of the United States, eastern tiger salamanders (*Ambystoma tigrinum tigrinum*) are listed as Endangered in New

York. While urban sprawl and development spreads over their home range, some eastern tigers salamanders have been reported to be breeding in artificial wetlands, such as road side drainage ditches and retention ponds. This study addresses the question of how an artificial wetland compares to a naturally occurring wetland in productivity of metamorphic salamanders. Variables between the man made and natural wetlands include a lack of canopy over the man made wetlands and the presence of cleared areas around the pool.

In a Pennsylvania survey comparing herp diversity in a power line right of way to that of nearby forest by Yahner, et al. (2001), Jefferson salamanders (*Ambystoma jeffersoniamum*) were found to be more abundant in the right of way, and thus open areas. In contrast, DeMaynadier and Hunter (1999) report that spotted salamanders (*Ambystoma maculatum*) were more abundant in heavily wooded areas than in recent clear-cut areas. Both of these species are closely related to tiger salamanders, and may behave similarly.

Here at Brookhaven National Laboratory, eastern tiger salamanders are relatively abundant as compared to the rest of Long Island. Over 15 wetlands on the lab ground have been identified as breeding pools; some of them natural and some of them man made. Using drift fence surveys, metamorphs were sampled from selected ponds.

The salamanders were identified by species, weighed, and measured from snout to vent. Those emerging from a natural pond with a tree canopy and surrounded by woodland were compared to those emerging from a man made pond with no canopy surrounded by grass and lightly forested areas on one side and an open road on the other.

Methods:

Tiger Salamanders (*Ambystoma tigrinum tigrinum)*:

The eastern tiger salamander (Ambystoma tigrinum tigrinum) is one of the largest terrestrial salamanders in the United States, with adults ranging from 18 to 21 cm in total body length (Conant, 1998). The subspecies that exists in New York is a gray to brown color with irregular olive green blotches covering its body. Like most Ambystomatids, the tiger salamander is known to breed in the spring in temporary ponds, where its larvae are one of the top predators. As the pool dries, the larvae finish growing their limbs, absorb their external gills, and develop lungs before emerging onto dry land. The metamorphs, like the adults, are most active at night, and seek out small mammal holes for refuge.

Pond-7:

Pond 7 was originally a lowland and was converted to a recharge basin for storm water from a warehouse area. Since then it has become vegetated with sedge, rushes, and swamp grass. It is surrounded immediately by field, and then by forest. A patch of high bush blueberry *(Vaccinium corymbosum*) borders the northwest corner of the pond, and cat brier (Smilax) lies to the pond's west. A closed paved road lies to its south, and at high water level the road itself is flooded and becomes part of the pond. A riffraff inlet flows into the pond on its northern side. Pond 7 is about two meters deep, and measures 1010 square meter.

The pond fills in late fall/early winter and dries in late summer. Since there is no tree canopy, the pond is completely exposed to the sun, and so its warm water is rich with algae. Snails (Gastropoda), dragonflies and damselflies(Odonata), green frogs (*Rana clamitans melanota*), eastern spadefoot toads (*Scaphiopus holbrookii holbrookii*), and water boatmen (Corixidae) are frequently found in the pond.

Pond-6:

Pond 6 is a classic natural vernal pool. The pond fills in the early winter, covers 2613 square meters, and is two meters deep. The surrounded upland consists of mixed oak and pitch pine, with low bush blueberry (*Vaccinium angustifolium*) covering much of the forest floor. High bush blueberry (*Vaccinium corymbosum*) resides on much of the pool's border, and swamp grass is thick within the pool, which forms a field when it dries in late fall. The pond is abundant in marble salamander larvae (*Ambystoma opacum)*, wood frogs (*Rana sylvatica),*eastern spotted newts (*Noyopthalmus viridescens*) dragonflies and damselflies (Odonata), and water boatmen (Corixidae).

Drift fences:

Four segments of drift fences were set up at both ponds, at the northwest, northeast, southwest, and southeast corner. A central fifteen liter bucket was first planted in the ground, so that its opening was even with the ground. Two troughs were dug on either side of the central bucket, each making a twenty degree angle with the water, forming a "V." Two pieces of aluminum flashing were cut to into rectangles measuring three meters by half a meter, and were buried about fifteen cm down as the troughs were filled in around them. Wooden stacks supported these walls. At the end of each piece of flashing, another bucket was buried even with the ground.

To help prevent predation, wooden legs were glued the top of the lid of each bucket. When the bucket lid was flipped upside-down it formed a table which rose about three centimeters off the ground, allowing salamanders to past under it into the buckets, but blocking them from view of predators. Bricks were placed on top of each lid to weigh it down as an added deterrent to predators. Two 12.7 cm lengths of PVC pipe, 3.81cm in diameter, were placed on the bottom of each bucket as a refuge for the salamanders. When these methods failed to prevent predation, hardware cloth was cut to fit over the top of each bucket. A hole was drilled at each corner of the bucket, and the mesh was attached to the bucket using copper wire.

Data Collection:

The drift fences were checked every morning, starting at 8:00 am, at which time snout vent length each salamander was measured, weighed, and water temperature is recorded. A layer of mud was allowed at the bottom of each bucket so that the salamanders could hide and avoid beetles. After being measured, the salamanders were released separately so as not to attract predators. They were let go away from the fence in tall grass or bushes where they could easily crawl out of sight.

On days where the fence was not monitored, the lids were flipped so that the legs were in the air, and acted as normal lids to prevent salamanders from entering the buckets.

Results:

To date (August 12, 2003) an even 300 Tiger Salamander metamorphs were recorded from Pond-7. These salamanders started emerging on July 16, 2003, when one salamander was found in the south-east drift fence. The number of salamanders caught over the 25-day survey period varied from day to day. Emergence was substantial on July 23 and 24, and August 8 with 37, 40, and 49 salamanders caught, respectively, and peaked on August 1 with 125 individuals. During emergence, the average number of salamanders per day was 12, but if the peak days are removed from the pool the average drops to 2.33 salamanders per day. On 9 of these days, no salamanders were caught.

Only 11 salamanders have emerged form Pond-6. On August 1, the first eastern tiger salamander from this pond's fences was found. Six days later, on August 7, the second salamander was observed, followed by one more on August 8, two on August 8, and three more on both August 11, and 12.

More salamanders emerged on rainy nights than clear nights. 1.17, .79, 1.17, and 3.23 cm of rain fell on July 23 and 24, and August 1 and 8, (the nights when emergence from Pond-7 was greatest, two of Pond-6's five days of emergence thus far) respectively. A total of 8.61 cm of rain fell during the survey, with an average of .34 cmper night (n=25). If these four previously mentioned nights are removed, the total precipitation falls to .89 cm, and the average becomes .04 cm per night (n=25).

The mean size of the 11 salamanders that emerged from Pond-6 was 65.57 mm from snout to vent (SVL), and the mean weight was 10.55 g. The 300 salamanders from Pond-7 average smaller in length and weight, measuring 64.02 mm and 8.87 g. Pond-7 also produced five large metamorphs, with average SVL of 88.82 mm and weight of 32.4 g. These averages are 1.39 times as large and 3.63 times as heavy as the means of the total population.

. On average, Pond-7 was 3.43 ºC warmer than Pond-6. The average temperature of Pond-6 was 21.72 ºC, and ranged from 18.5 ºC to 24 ºC. The average temperature of Pond-7 was 25.26 ºC, and ranged from 21 ºC to 28.5 ºC.

Discussion:

The results to date indicate that the emergence of eastern tiger salamander metamorphs from Pond-6 is incomplete, while the emergence from Pond -7 is near its end. One explanation for this delayed emergence from Pond-6 may be that water in this natural pool is cooler than the water in the man-made pool. This is probably caused by the presence of a canopy around Pond-6, and the absence of a tree canopy to block sunlight from hitting the water in Pond-7. Tiger salamanders, like other amphibians, are exotherms and gather heat from their surroundings. Thus, the warmer the surroundings the more energy they take in, leading to faster metabolisms and development.

Another possible explanation for the difference in time of emergence between the two ponds is that salamanders from Pond-7 "choose" to leave early. Amphibian larvae in general tend to postpone metamorphosis and instead remain longer as larvae to increase body size at metamorphosis. Raymond, et al., found that *Ambystoma talpoideum* are benefited by emerging at a larger size in terms of higher survival and younger age at first reproduction (1988). Raymond and Henry found that populations of *Ambystoma maculatum* delay metamorphosis until the pond dries, maximizing their larval period (1988). It would seem that larvae of the eastern tiger salamander populations considered here would choose to remain in these pools longer, to maximize their larvae growth period as well, as neither of these ponds have substantially dried. It is possible that the larvae from Pond-7 are under some sort of stress that outweighs the advantages of remaining in the pool longer.

One source of such stress could be overcrowding in Pond-7. Van Nuskirk (1991) describes that high density populations of *Ambystoma laterale* leads to lower survival rates of the larvae as well as smaller metamorphs. His study indicates that the survival of the larvae is decreased not from predation or lack of food, but rather from aggressive interactions within the species.

Thus, it is possible that the difference in timing of the emergence of these two populations of eastern tiger salamanders is due to an early emergence caused by overcrowding in Pond-7. This theory is supported by the presence of abnormally large metamorphs emerging from this pond. The eastern tiger salamander is known to have cannibalistic morphs, where larvae change their physiology to gain ability to eat their cohorts (Petranka, 1998). Cannibals are described as having "disproportionately large heads, wide mouths, and elongate teeth" and are stimulated by larval density (Duellman,1986). The five observed large eastern tiger metamorphs may be cannibals caused by overcrowding, and thus evidence that the population of larvae is stressed.

The strong correlation between rain and emergence can be explained by basic principles behind amphibian biology. Since amphibians loose moisture easily through their skin, emergence on rainy nights may reduce the risk of the metamorph drying out before they can find shelter on land. Trenham et al., (2000) state that "it seems clear that rainfall is a key trigger for many life-history activities" of ambystomatid salamanders. It has also been documented that although migration of *Ambystoma maculatum* is occurred only during nocturnal rainfall, the amount of migration is not directly correlated to how much rain falls (Sexton, et al. 1990). This also seems to be the case with eastern tiger salamander emergence. (Figure 1)

In conclusion, the metamorphs from Pond-7, the man-made pond began emergence 17 days before the metamorphs of the natural pond Pond-6. This time difference may be due to different water temperatureS of the ponds affecting the speed of development. It may also be due to overcrowding at Pond-7, as evidenced by the possible cannibals. No cannibals have been reported from Pond-6, but the metamorphs at this pond have only begun to trickle into the uplands and so it is likely that cannibals, if they exist in this pond, have not yet been discovered. It also appears that emergence in both pnods is clearly correlated to nights with precipitation. Data from these ponds continues to be collected for further study.

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Figures:

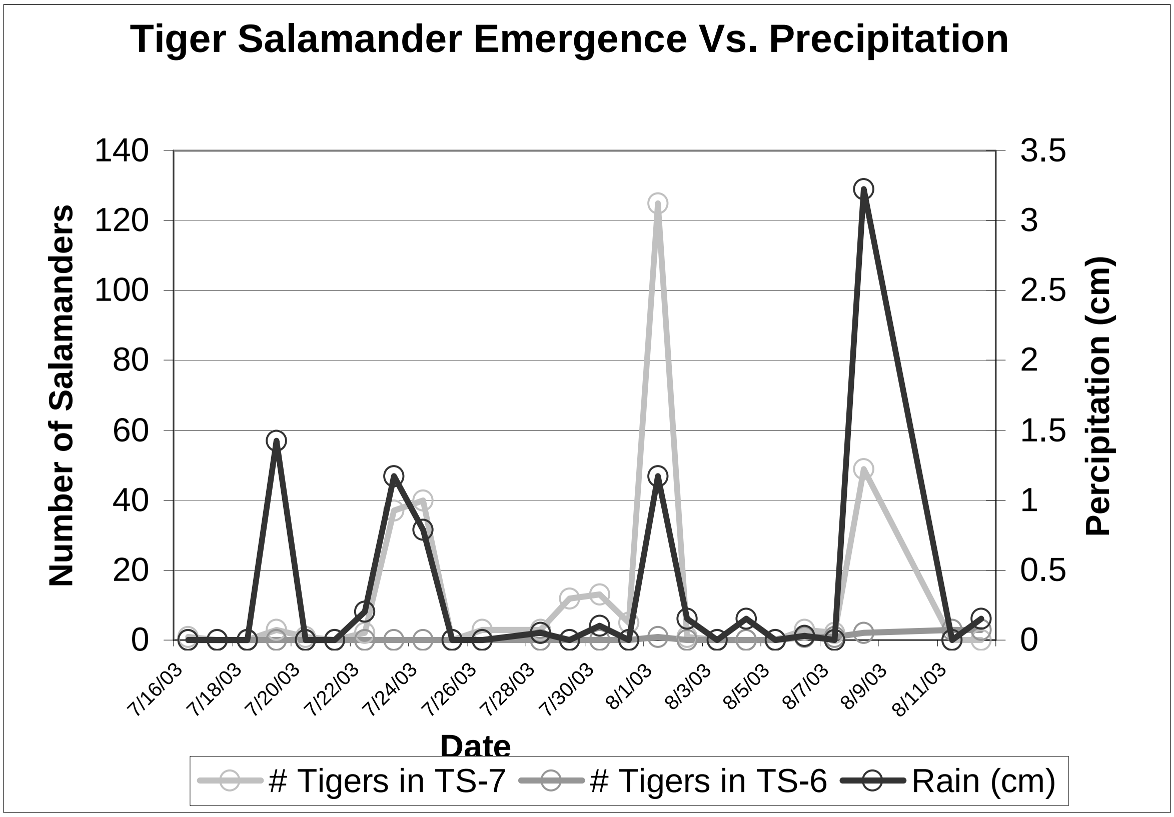

Figure one