Amphibian Species Richness and Abundance at Brookhaven National Laboratory

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An adult green frog

A juvenile Fowler's Toad

ABSTRACT

Brookhaven National Laboratory (BNL) is located in the Central Pine Barrens on Long Island. The Central Pine Barrens offer a unique environment that is inhabited by many species of amphibians. Because amphibians are excellent indicators of the health of an ecosystem, measurements of species richness and abundance can provide vital information regarding ecosystem stability. In order to obtain this information, drift fences were placed at three distinct vernal pools on BNL property: a human-made pool (DF-3), a natural pool (DF-2), and a human-altered pool (DF-1). *Rana clamitans melanota* metamorphs, *Rana catesbeiana* metamorphs, *Rana sylvatica* adults, *Ambystoma tigrinum* metamorphs and adults, *Bufo woodhousei fowleri* metamorphs and adults, and *Pseudacris crucifer* adults were captured at DF-1. *Rana clamitans melanota* metamorphs, *Rana sylvatica* metamorphs and adults, *Ambystoma opacum* metamorphs and adults, *Ambystoma tigrinum* metamorphs and adults, *Notophthalmus viridescens* metamorphs and adults, and *Scaphiopus holbrooki holbrooki* metamorphs were captured at DF-2. *Rana clamitan melanota* metamorphs and adults, *Ambystoma tigrinum* metamorphs and adults, a *Bufo woodhousei fowleri* adult, a *Hyla versicolor* adult, *Notophthalmus viridescens* adults, *Plethodon cinereus* adults, *Pseudacris crucifer* adults, *Rana sylvatica* metamorphs and adults, and a *Scaphiopus holbrooki holbrooki* metamorph were captured at DF-2. Data collected implementing drift fences at BNL suggests that there are viable populations of many species of amphibians on site. There seems to be a viable population of *Ambystoma tigrinum* on site, although the species is considered endangered in New York State. The success of amphibians at Brookhaven National Lab contrasts with the dwindling numbers of amphibians globally. While many amphibian habitats in the country have been destroyed due to development, a large portion of BNL property remains undeveloped and safe from commercial development.

INTRODUCTION

Biologists first began to document amphibian population declines over half a century ago, and by the 1970's this problem began to receive global attention. These declines received much attention throughout the scientific community due to the biological indicating potential of amphibian populations. Proposed hypotheses explicating possible causes of the declines were not widely accepted, originally. Although there was an apparent amphibian population decline scientists suggested that these fluctuations could be the result of natural cycles. Populations of amphibians could experience many years of slow population decline with few metamorph recruitments, followed by a year with a major metamorph recruitment, which in effect would cancel any population decline. A population that cycles in this way would give a false appearance of a population decline, even if in actuality the population was stable.

It was also suggested, that due to sampling error, far less amphibians were being counted than were actually present at sampling sites. Most captured amphibians used in population estimates were either metamorphs leaving breeding areas or adults heading to and from breeding areas. Because all amphibians in a given population do not breed every year, sampling techniques exploiting breeding areas will theoretically result in a significantly lower population-size estimate.

Even accepting that some populations of amphibians were in fact decreasing, many scientists were not quick to subscribe to the belief that environmental stress due to human activities was responsible for these decreases. Because local extinctions are a natural phenomenon, and because all species eventually go extinct, a greater wealth of data was needed to make the final judgment concerning the state of the class Amphibia.

Long-term studies of amphibian populations are not common. In order to separate natural population fluctuations from the hypothesized world-wide decline and access the probable causes of these declines, if found to actually exist, long term studies of amphibian populations were suggested. It was recommended that these studies encompass at least one complete turnover of the species being studied. This period should extend throughout the life cycle of the first generation of metamorphs captured. Also, when possible, captured individuals should be marked in some fashion to allow for longevity and survivorship measurements. To adjust population studies for the existence of metapopulations it was suggested that studies involve more than one location.

In the summer of 2003 an amphibian monitoring system was initiated at BNL. BNL represents a prime facility for the study of amphibian populations. There is a plethora of amphibian populations on site including populations of *Ambystoma tigrinum tigrinum*, which are currently considered endangered in New York State. Analysis of the data collected over the past year provides valuable insight into species richness, species abundance, and population activities, and also allows for comparison of specific time periods between the two summers that the monitoring systems have been operational.

MATERIALS AND METHODS

Starting in the summer of 2003 amphibian monitoring systems were initiated at DF-1 and DF-2 and in the spring of 2004 a third monitoring project was started at DF-3. DF-1, a human-altered pool, is surrounded by grass, which is routinely mowed on the southern most side, but left in a natural state surrounding the rest of the pool. This pool has approximately 0.0% herbaceous cover with approximately 5.0% canopy cover. The maximum depth of this pool is approximately 1.5 meters.

DF-2, a natural pool, is in a densely wooded area. This pool has approximately 100.0% herbaceous cover with approximately 50.0% canopy cover. The maximum depth of DF-2 is approximately 1.0 meter.

DF-3, a human-made pool, is located in a sandy, arid environment. This pool has approximately 0.0% herbaceous cover and 0.0% canopy cover. The maximum depth of this pool is approximately 2.0 meters.

During the study period the buckets at the three vernal pools were checked daily. When these buckets could not be checked, they were closed to prevent retention of animals for extended periods of time. All amphibians captured in the buckets were weighed on an Acculab GSI-200 digital scale and snout vent lengths (SVL) were taken using digital calipers. Weights were recorded in grams (g) and snout vent lengths were recorded in millimeters (mm). All tiger salamanders, because their relatively large size allowed for easy manipulation, were toe clipped for future identification and population estimates. Other large amphibians were also toe clipped, but the small size of most amphibians captured prevented accurate toe clipping. After all information was recorded for a specimen, the specimen was released away from the drift fencing to prevent repeated captures, which could skew results.

Daily, during each site visit, air temperature, wind speed, and relative humidity readings were taken using a Kestrel 4000 personal weather station. Air temperature was recorded in centigrade (C) and wind speed was recorded in miles per hour (mph). Using a thermometer, water temperature was taken during each site visit. Water temperature was recorded in centigrade. Along with recording the time of each daily visit, percent cloud coverage was estimated and recorded. The National Oceanic and Atmospheric Administration provided precipitation data used in this study.

Although most numbers presented in this research are raw data, some estimates of total emerging metamorphs and adults, during specific time periods, were made using a derived formula based on a ratio comparing actual drift fence coverage to the perimeter of each pool.

RESULTS

Species	Altered Pond (DF-1)			Natural Pond (DF-2)			Created Pond (DF-3)		
	Adult	Metamorph	Total	Adult	Metamorph	Total	Adult	Metamorph	Total
Ambystoma opacum	0	0	**0**	289	603	**892**	0	0	**0**
Ambystoma tigrinum tigrinum	40	465	**505**	8	24	**32**	3	8	**11**
Bufo woodhousei fowleri	8	176	**184**	0	1	**1**	1	0	**1**
Hemidactylium scutatum	0	0	**0**	1	0	**1**	0	0	**0**
Hyla versicolor	0	0	**0**	0	0	**0**	1	0	**1**
Notophthalmus viridescens	0	0	**0**	76	143	**219**	2	0	**2**
Plethodon cinereus	0	0	**0**	17	0	**17**	3	0	**3**
Pseudacris crucifer	13	0	**13**	0	0	**0**	5	0	**5**
Rana catesbeiana	0	32	**32**	0	0	**0**	0	0	**0**
Rana clamitans melanota	0	89	**89**	0	9	**9**	2	2	**4**
Rana sylvatica	2	0	**2**	20	28	**48**	7	9	**16**
Scaphiopus holbrooki holbrooki	0	2	**2**	0	112	**112**	0	1	**1**

Table 1. A compilation of all amphibian species captured at the three drift fences present at BNL.
DF-1: 07/09/03-07/31/04, DF-2: 06/27/03-07/31/04, DF-3: 03/04/04-07/31/04

Species	Altered Pond (DF-1)			Natural Pond (DF-2)		
	Adult	Metamorph	Total	Adult	Metamorph	Total
Ambystoma opacum	0	0	**0**	288	586	**874**
Ambystoma tigrinum tigrinum	40	443	**505**	8	20	**28**
Bufo woodhousei fowleri	8	159	**184**	0	1	**1**
Hemidactylium scutatum	0	0	**0**	1	0	**1**
Notophthalmus viridescens	0	0	**0**	51	143	**194**
Plethodon cinereus	0	0	**0**	16	0	**16**
Pseudacris crucifer	11	0	**11**	0	0	**0**
Rana catesbeiana	0	32	**32**	0	0	**0**
Rana clamitans melanota	0	83	**83**	0	9	**9**
Rana sylvatica	2	0	**2**	20	24	**44**
Scaphiopus holbrooki holbrooki	0	0	**0**	0	110	**110**
Date Ranges for Data	**07/09/03-07/08/04**			**06/27/03-06/26/04**		

Table 2. Annual productivity of two vernal pools located at BNL measured from the initiation of each monitoring system.

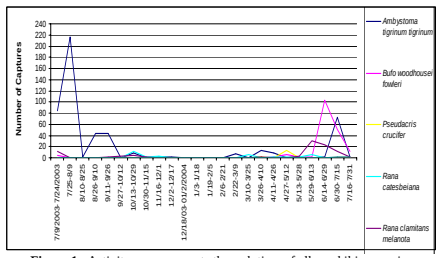

Figure 1. Activity measurements through time of all amphibian species captured at DF-1.

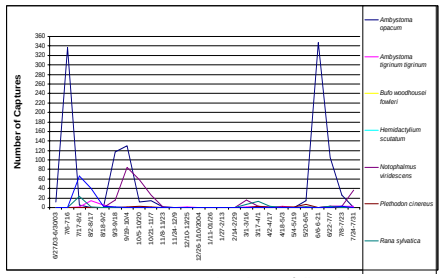

Figure 2. Activity measurements through time of all amphibian species captured at DF-2.

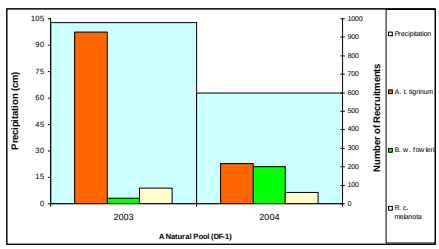

Figure 3. Compares the estimated number of amphibian recruitments during the same period, 07/09-07/31, in two separate years. Annual precipitation for both years, up to 07/31, is also provided for comparison.

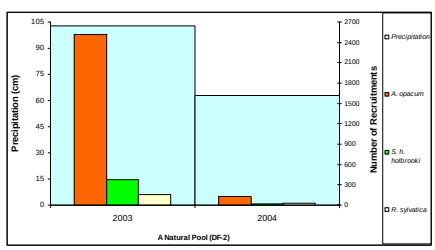

Figure 4. Compares the estimated number of amphibian recruitments during the same period, 06/30-07/31, in two separate years. Annual precipitation for both years, up to 07/31, is also provided for comparison.

DISCUSSION AND CONCLUSION

The substantial contrast between the 2003 and 2004 recruiting periods makes obvious the importance of long-term studies (see Figures 3 and 4). If we were to draw conclusions from these two periods, it would appear that in five out of six instances population sizes were plummeting. The considerable contrast between the 2003 and 2004 recruitment periods for the two salamander species, accepted by itself, seems to show definite population declines on site. Again, this suggests the importance of long-term studies to separate natural population fluctuations from true population declines.

One problem in drawing conclusions from this limited data set is that not all adult amphibians attempt to reproduce every year. Drought conditions prevailed during the 2002 amphibian-breeding season. There is believed to be a correlation between the amount of precipitation and the size of the breeding immigration populations. Many amphibians may have refused to breed during the 2002 drought conditions. During the 2003 breeding season, there was possibly a larger breeding immigration than in normal years. Many amphibians that would have bred during the 2002 season and the amphibians that would have waited until the 2003 season in any case may have all immigrated into vernal pools to breed. If this is the case, the 2004 recruitment period may actually reflect normal activity, with the 2003 period exhibiting an unusually high season of activity.

In another scenario, relating to the large fluctuations at DF-2, a shorter hydroperiod during the 2004 season may have resulted in a higher larval mortality rate. Unlike the 2003 season, by 07/31/04 DF-2 had almost completely dried. This shorter hydroperiod may have actually hastened development in *A. opacum*.

Figures 3 and 4 allow comparison of recruitment periods against the amount of precipitation for the years the periods fall in. Studies have found a correlation between precipitation and metamorph emergence. If this is the case, the lower activity during the 2004 recruitment period may be a result of less precipitation.

Many years of data will have to be acquired from the amphibian monitoring systems at BNL before any conclusions can be drawn about the state of the amphibian populations at the lab. Hopefully, with this study and other similar studies underway, scientists can discover the true causes of the world wide population declines in the class Amphibia.

An adult marbled salamander.

Red spotted newts, red eft stage.

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