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SALAMANDER POPULATION RESPONSE TO FOREST DISTURBANCE IN CENTRAL PENNSYLVANIA

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ABSTRACT

We compared the abundance of salamanders in mature and second growth forests to determine what effects, if any, forest disturbance has on salamander populations. Four different stream sites, two in mature forests and two in second growth forests, were chosen for comparison. Ten 1-m^2 areas were surveyed at each site. No salamanders were found at either of our mature forest sites, suggesting that some forest disturbance may create conditions that are favorable to salamanders. Significant salamander populations were found in both second growth forest sites. One possible explanation for this is that the streams in the mature forest sites were more acidic than those in the second growth forests.

Key words: Desmognathus ochrophaeus, *disturbance, forest*, Gyrinophilus porphyriticus, *populations, salamanders.*

INTRODUCTION

Chronic disturbance of forests can fragment ecosystems and severely disturb species composition, ecological function, and microclimate. These forest disturbances have caused problems in many parts of the world, with amphibians being particularly susceptible (Ash 1997). Clear cutting, an ecological disturbance, increases surface temperature and decreases surface moisture, two aspects that are critical to salamander survival (Herbeck and Larsen 1999). As a result, salamanders often find it difficult to colonize clear-cut areas because often the energy requirements needed to survive exceed energy intake (Herbeck and Larsen 1999).

In contrast, mature growth forests (over 120 years old) are ecologically stable, but possess acidic conditions that can limit amphibian distribution (Wyman and Hawksley-Lescault 1987). Levels of pH < 4 that are frequently found in mature growth forests can be lethal to salamanders (Wyman and Hawksley-Lescault 1987).

We compared population densities of stream-dwelling salamanders of four forests in central Pennsylvania (two mature and two second growth). We predicted that salamanders should be more common in the streams of mature forests than those of second growth forests because of the disturbance caused by clear-cutting and its adverse effects on stream ecosystems.

FIELD SITES

The mature forests were in Allan Seeger State Park and at the property of the Raystown Field Station of Juniata College. The Allen Seeger State Forest is perhaps the only true old growth forest left in

Pennsylvania. The pH of the stream running through Allen Seeger was 5.3 and the flow rate was 0.667 m/sec (March 25, 2003). The sugar maple forest at the Raystown Field Station has not been clearcut within the last 70 years, giving it mature forest status. The pH of the stream was 5.6 and the flow rate was 0.555 m/sec (March 26, 2003). Both of the mature forest sites were far from the disturbance of any major roads and major development. The Raystown Field Station site has a small area of lawn and several small buildings directly above the stream that we sampled.

The two second-growth forest sites were located at Petersburg Spring and Warm Spring. Petersburg Spring was in a second growth forest near a paved road and railroad tracks. The pH of the spring/stream was 6.8 and the flow rate was 0.575 m/sec (April 2, 2003). Warm Spring was located in a second growth forest near Cold Springs Road (Huntingdon). The pH of the spring/stream was 6.7 and the flow rate was 0.487 m/sec (April 22, 2003). Both of the second growth forest sites showed evidence of disturbance from roads, housing, and forest harvesting.

METHODS AND MATERIALS

The sampling procedure was kept consistent at all four locations. The temperature for sampling days was between 60-65^{o} F (March 25 to April 22, 2003). Similar areas of stream were selected at each site. These were areas of shallow water around the bank of the stream where the sample areas could be effectively assessed. At each site, ten closely spaced 1-m^2 plots were squared off to determine salamander density. Within each plot, every stick and stone was turned over in search for salamanders. When a salamander was found in a plot, the species of salamander was noted, along with its body length (tip of snout to tip of tail; ± 1 mm). The salamanders were released after the sampling was over to assure that there would be no recapture.

Flow rate was measured by how long it took an empty film canister to travel one meter. The pH of each site was also recorded using a Markson pH meter.

RESULTS

No salamanders were found in the mature forests of Alan Seeger State Park and the Raystown Field Station. At Petersburg Spring, salamanders were found with a density of 5.1/m^2, and a mean length of 56.6 mm (Table 1). At Warm Spring, salamanders were found with a density of 1.6/m^2, and a mean length of 40.85 mm (Table 2). Mountain Dusky (*Desmognathus ochrophaeus*) and northern spring salamanders (*Gyrinophilus porphyriticus*) were found at both sites..

Table 1. Number and body lengths of salamanders collected at Petersburg Spring.

Sample Area	Number of salamanders	Lengths of salamanders (mm)	Total Length	Mean Length
1	6	35, 34, 34, 86, 95, 36	320	53.33
2	9	32, 90, 35, 34, 135, 150, 84, 85, 35	680	75.56
3	4	35, 28, 36, 90	189	47.25
4	2	33, 36	69	34.5
5	5	130, 36, 87, 45, 32	330	66
6	6	35, 85, 32, 91, 33, 31	307	51.17
7	5	86, 34, 36, 132, 35	323	64.6
8	7	34, 34, 35, 90, 29, 86, 34	342	48.86
9	3	35, 87, 40	162	54

10	4	134, 85, 31, 34	284	71

Total: 51 Mean total length: 300.6 Total mean: 56.63
Mean: 5.1

Table 2. Number and body lengths of salamanders collected at Warm Spring.

Sample area	Number of salamanders	Lengths of salamanders (mm)	Total Length	Mean Length
1	2	40, 45	95	42.50
2	3	47, 52, 56	155	51.67
3	2	60, 58	118	59.00
4	0	0	0	0.00
5	1	42	42	42.00
6	1	57	57	57.00
7	2	53, 49	102	51.00
8	0	0	0	0.00
9	2	48, 52	100	50.00
10	3	43, 58, 65	166	55.33

Total: 16 Mean total length: 83.5 Total mean: 40.85
Mean: 1.6

DISCUSSION

We found salamanders in the disturbed forests, but not in the mature forests. This finding contradicts our original hypothesis, but may be considered as support for the intermediate disturbance hypothesis, or the idea that ecosystems with a moderate level of disturbance have the most biodiversity.

Evidence suggests that streams in second growth forests provide more favorable salamander habitat than those of mature forests. For example, the streams in the disturbed forest were less acidic than those in the mature forest, a factor we had not considered in our original hypothesis.

The soil of a deciduous forest will acidify as the forest matures. A study in Delaware County, New York revealed that acidic conditions may limit the distribution of salamanders and other amphibians (Wyman and Hawksley-Lescault 1987). One of the reasons for this was that low pH depresses sodium uptake and increases sodium loss in amphibian larvae, resulting in death when about 50 percent of the body's sodium content is lost.

Other studies like ours have yielded mixed results. According to Herbeck and Larsen (1999), regeneration cutting reduces microhabitats for salamanders, thus depleting their populations. On the other hand, according to Chazel and Niewiarowski (1998), clearcut habitats show no significant effects on individual traits, including survival, body size and whole body and egg nonpolar lipid content. These contrasting results can be linked by the work of Ash (1997), which has shown that salamanders gradually re-colonize clear cut openings over a period of 4-15 years.

Future research would benefit from examining sites more recently and extensively disturbed than those that we studied. Other factors, such as the presence of predators on salamanders, should also be assessed. Perhaps salamanders are more abundant in second growth forests than mature forests because the disturbance has reduced the numbers of their predators.

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