

Distribution, Abundance, and Contaminant Levels
In Redback Salamanders (*Plethodon cinereus*)
Along an Atmospheric Deposition Gradient
In Acadia National Park, Maine
1999 REPORT

Researchers

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Site

Acadia National Park
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Summary

In 1999, our objectives were to determine the distribution and abundance of terrestrial salamanders at sites throughout Acadia National Park. The sites were concurrently being assessed for sulfate flux in throughfall and lead content in surface soils by Drs. Kathie Weathers, Gary Lovett, and Steven Lindberg. In 2000, our objective was to measure metal and organochlorine levels in *Plethodon cinereus* at a subset of these sites representing an elevational gradient and/or extremes in sulfate flux in throughfall and/or lead deposition.

Three hundred (300) throughfall sampling stations were constructed and placed mid-summer of 1999 by Dr. Kathie Weathers' technicians Sam Simpkin, M.S. and Dave Lewis. Of these, twenty-three were surveyed for redback salamanders (*Plethodon cinereus*) by Dr. Sam Droege's and Dr. Robin Jung's technician Rebecca Chalmers. All of the sites could not be sampled because by the time the sampling stations were in place dry weather caused the salamanders to move deeper into the ground resulting in very few salamanders found under rocks and logs and research effort was therefore switched to other amphibian monitoring projects. The benefits of surveying 23 of the 300 throughfall stations were that some data on redback salamander relative abundance in Acadia National Park and the improvement of survey procedures so that they may be carried out more efficiently in another year. Correlations of salamander populations with atmospheric or soil data could not be made after this field season.

Introduction

Terrestrial salamanders live in close association with soils and are sensitive to soil pH levels (Wyman and Hawksley-Lescault 1992). Further, low soil pH can increase the bioavailability of aluminum to toxic levels for salamanders (Albers and Prouty 1987, Miller et al. 1992). Soil contaminants can both persist for long periods of time and be bioaccumulated in salamanders (Jordan 1975). Salamanders are exposed to contamination both through dermal contact (e.g. absorption of contaminated soil pore water) and dietary ingestion (e.g. soil arthropods).

Previous studies have shown the effects of point source pollution on salamanders:

Salamanders at sites closer to zinc smelters had increasingly greater metal concentrations (Storm et al. 1994) and organochlorines and their metabolites have been found in salamanders long after applications of these compounds (Dimond et al. 1968). We, however, were interested in determining whether the distribution and abundance of salamanders in Acadia National Park is influenced by general nonpoint atmospheric deposition patterns of acid deposition and contaminants. Also, we are interested in whether salamanders show higher bioaccumulation of metals and organochlorines when found in "hotspots" of deposition. Potential hotspots may be higher elevations, which have been shown to have greater wet, dry, "cold condensation," and cloud deposition (Lovett 1994, Blais et al. 1998).

Methods and Materials

Throughfall Research

The 300 throughfall stations were randomly located along 10 trail loops in Acadia National Park. The throughfall stations were located 50 feet off trail and marked by the trail with a piece of blue and white striped flagging. At the time of installation, the following data were recorded: GPS coordinates, slope, aspect, primary species of trees composing canopy, height of tree(s) directly above throughfall station and DBH of tree(s) directly above throughfall station.

Salamander Research

Diurnal searches under natural cover objects (rocks and logs) were conducted at randomly chosen sites: one trail loop was randomly chosen to be surveyed on a given day and then consecutive throughfall stations on that loop were surveyed. The searches consisted of turning over 50 or 100 cover objects within a 100 m radius of the throughfall sample locations. These salamander surveys were conducted by Rebecca Chalmers with occasional assistance from Elsa Alvear.

At each throughfall station survey, the date, time, and weather was recorded. Weather was described by taking soil and air temperature, recording days since the last rain, and recording the Beaufort wind code and sky code. Then each site was described in terms of vegetation, soil, cover objects, and salamanders.

The vegetation was described by using a densiometer to measure the % canopy cover of trees at the throughfall station. Four readings were taken at each of the four directions and the results were averaged. The species of the predominant canopy and understory tree were recorded.

The soil moisture and decay codes were recorded. If this project continues, soil pH and moisture would be tested in the lab. Leaf litter depth was measured. At each site, the moisture of soil underneath of objects was measured by approximately averaging the soil moisture code of five cover objects. Each of the 100 cover objects were recorded as either rock or woody.

Cover objects were only described if a salamander was found underneath. In that case, the following data was recorded: the ordinal number of the object (first, 100th); the object length, width, and height; and the soil moisture code under it. If the cover object was wood, the decay code and moisture code of cover object was recorded.

To search for salamanders, the nearest 100 cover objects were lifted and carefully replaced. Cover objects were wood or rock that appeared to be flush with the ground and were larger than either 4 cm by 4 cm or, if a long stick, 2 cm by 15 cm. All salamanders found were *Plethodon cinereus*. Their color morphology (red, lead, erythristic), any tail loss or regeneration,

and any abnormalities were recorded. I also measured their snout-vent length (SVL) and total length with the salamander in moist plastic zip bag.

Data

16 of the 26 sites were surveyed with the same, finalized, protocol . The total number of salamanders (*Plethodon cinereus*) was 26, of which 2 were found under rock and 24 under wood cover objects. The total number of rock cover objects was 190 and of wood cover objects was 1020.

The area needed in which to find 100 cover objects varied from about 75m² to 200m² per station. The time to do the entire search and data entry varied from 25-55 minutes, not including searching for the next station.

Salamanders were not collected for toxicology studies this field season because the primary research on atmospheric through-fall and on salamander abundance and distribution has not yet been completed.

Discussion

This study would be good to resume once the atmospheric throughfall data has been collected analyzed. The procedures are carefully laid out and ready to be used.

The search methodology used, cover object-constrained search, was chosen over the methodologies of either area- or time- constrained searches because: The cover object-constrained search appeared to sample the salamander abundance among diverse sites in a consistent manner. In dry weather terrestrial salamanders were primarily found under cover objects and not in the dry leaf litter. So, even with an area-constrained search the salamanders would only be found under cover objects. Hence, it seemed best to constrain the actual number of cover objects, especially since the number and density of cover objects varied greatly. An alternative would have been to statistically correct for the number of cover objects in the search, but this would only work if at least one salamander was found. Due to the dry weather and scarce cover objects, using a cover object-constrained search was the most reliable way to find one or more salamanders at each site.

Also, the cover object-constrained search was more efficient than an area-constrained search because so few salamanders were found in these woods, especially during droughts. Huge plots (at least 100 m²) would have to be laid out in order to consistently find at least one salamander using an area-constrained search. Also, laying out an accurate plot at each of 300 sites (which would probably be visited only once) would likely take too long for one field researcher to do in one field season.

Finally, the cover object-constrained search would be more consistently applied by different future researchers continuing this survey than would a time-constrained search. This is because it is easier to describe the specific type of cover object to lift, than it is to describe how "hard" to search in a time-constrained search.

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