Microhabitat selection by plethodontid salamanders at the Pierce Cedar Creek Institute

Final URGE Report to the Pierce Cedar Creek Institute

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Introduction

Salamanders are among the most numerous vertebrates in eastern deciduous forests (often outnumbering birds and small mammals) and they have numerous attributes that make them a preferred indicator of biodiversity and ecosystem integrity in forested and wetland habitats (Welsh and Droege, 2001). However, little is known about the ecology of salamanders, despite concerns that many populations are in decline (e.g., Frisbie and Wyman, 1992; Herbeck and Larsen, 1999). In Michigan, 10 species of salamanders are known to occur, but regional distributions of most of these species are not well known (Harding, 1997).

Researchers have long known that salamanders occur in cool, damp environments, such as in decaying wood or under leaf litter (Jaeger, 1978). However, microhabitat (small-scale) preference of salamanders is complicated by factors such as the distance to breeding sites, behavioral interactions among individuals, and subtle changes in the physical environment (Feder, 1983; Chen et al., 1999). Further, researchers have rarely described microhabitats of salamanders using actual measurements of parameters such as humidity and temperature (reviewed by Welsh and Droege, 2001). Assessments of microhabitat preference of salamanders have typically been limited to measuring conditions during opportunistic encounters with animals, even though true preferences may be more dependent on conditions over longer time-scales (Chen et al., 1999). We explored microhabitat selection of salamanders at the PCCI by assessing the presence of salamanders within small plots in relation to temperature and soil moisture. To do this, we observed the presence of salamanders under standardized Artificial Cover Objects (ACOs) comprising wood boards, and natural cover objects, such as fall logs. If cover objects represent cooler and wetter environments, we expected that salamanders would be more likely to be found under them than under adjacent objects of exposured locations. Our study also provided a means to determine the occurrence and relative abundance of various species of salamanders on the PCCI property.

Methods

To assess microhabitat preferences of salamanders, we established 180 Artificial Cover Objects (ACOs) in 20 arrays located at various locations around the PCCI property (Figure 1). Locations in seasonally-flooded, low-lying areas were selected using GIS maps and by walking through the property in April and May, 2005. We also assessed whether salamander eggs or larvae were present in ponds at the Institute. Within each array, we established nine ACOs – each of which was a 12” x 24” x 1” piece of untreated white pine. ACOs within each array were spaced in a 3 x 3 grid, with boards spaced 5 m apart (cf. Heyer et al., 1994). Since ACOs function best when allowed to weather, we placed them at the PCCI at the start of the field season. By the end of the summer, many boards were already beginning to rot and harbored fungi on their undersides.

For the first 10 weeks of the summer, we made weekely assessments of soil temperature and moisture within all arrays of ACOs. Specifically, soil temperature and humidity were recorded at 1-cm depths under, and immediately outside, of each ACO. For the last few weeks of the study, we used ibutton automatic recording devices to record ambient temperature and humidity under and immediately above 12 ACOs at hourly intervals. Although we occasionally sampled natural cover objects (e.g., logs, stumps) for the presence of salamanders, and captured many salamanders this way, we focus on our results for ACOs in this report since they represent a more consistent method of sampling salamanders over long time-scales (van Wieren, 2003) (data on captures from natural objects is available upon request and will be included in Sprague’s Honors Thesis at Albion College).

On occasions when a salamander was found under an ACO or natural cover object, we identified it to species-level, assessed the condition of the animal, and measured its size (snout-vent length). To account for the possibility of recapture, each salamander was marked using an elastomer dye injected under the skin of the animal. The dye is visible externally (even through pigmented skin) when viewed under blue light. This method has become popular for marking salamanders because it is less invasive than traditional marking methods and it leaves a long-lasting mark (Nauwelaerts et al., 2000; Pretzlaw et al., 2002). In analyzing our data, *t*-tests were used to compare pairs of means of data and logistic regression tests were used to compare likelihood of salamander observance in relation to environmental factors (temperature, humidity, moisture) and date of capture.

Results

Between 11 April and 15 July, 2005, we observed four species of salamanders inhabiting the PCCI property. Specifically, red-backed salamanders were observed on numerous occasions under logs and ACOs. On three occasions, we observed blue spotted salamanders under logs and woody debris. We also observed eggs of spotted salamanders at one location (a small pond near the northern limit of the PCCI property; Figure 1), and we caught four juvenile tiger salamanders under an ACOs near the same pond on the last sampling date of the season (these data are excluded herein because environmental conditions for this date have yet to be recovered from data-logging devices placed in the field). During our most intensive period of sampling (26 May - 15 July, 2005), we captured 14 different red-backed salamanders from ACOs at the PCCI. Based on 1123 pairs of measurements of soil temperature underneath versus adjacent to ACOs, there was a near-significant trend toward temperature being slightly lower under ACOs versus outside of them (mean ± SE temperature under ACOs = 15.4 ± 0.06; outside of ACOs = 15.7 ± 0.06; $t = 1.8$, $df = 2244$, $P = 0.06$). Overall, soil moisture did not differ underneath versus adjacent to ACOs (mean ± SE for both = 26.1 ± 0.8%; $t = 0.006$, $df = 2027$, $P = 0.95$).

Overall, we observed that the likelihood of catching salamanders under ACOs was not related to ambient air temperature, relative humidity, or soil moisture recorded under ACOs ($P > 0.05$ for all

Logistic X^2 tests). Further, soil temperature and moisture conditions under ACOs where salamanders were found did not differ significantly from conditions under other ACOs within those same arrays (recorded on the same dates) that did not have salamanders under them (using *t* – tests, all $P < 0.05$). Controlling for the number of arrays checked at various times of the summer (=sampling effort), the likelihood of capturing salamanders under ACOs did not vary in relation to date of capture (Logistic $X^2 = 0.31$, $df = 1$, $P = 0.58$).

Discussion

Although Artificial Cover Objects are generally viewed by researchers as representing shelters for salamanders from harsh environmental conditions (reviewed by van Wieren, 2003), we found that temperature and moisture differed little underneath of ACOs versus adjacent, exposed soils. Although soil temperatures tended to be slightly lower under ACOs than in adjacent areas, soil moisture did not differ. This result was surprising given previous suggestions that ACOs are expected to differ substantially in temperature and moisture than more exposed locations (e.g., Feder and Pough, 1975; Feder and Londos, 1984).

One explanation for a lack of a difference in environmental conditions under versus outside of ACOs was that there was very little rainfall during much of the time we monitored our arrays. As a result, differences soil moisture might have been minimal because conditions everywhere eventually reached a dry point. Under different conditions, it is possible that arrays could hold moisture for longer periods than exposured areas, thereby altering the microhabitats and adding complexity to the landscape. In fact, we observed that moisture levels were higher under ACOs immediately following rainy periods (meterological data remains to be fully assessed). Measurements of ACOs described herein were also made in the morning, when temperature differences might have been less variable than later in the day. In fact, our continuous measurements made under and on top of ACOs using the automated data-loggers suggest that temperature is, in fact, much more *variable* outside of ACOs than under them (thus, our weekly samples might have accurately capture mean conditions, but not variation around the mean, which could be more important to salamanders attempting to locate shelter). Furthermore, ACOs were unweathered when deployed, which may have resulted in less retention of moisture (Herbeck and Larsen, 1999). In fact, van Wieren (2003) found that ACOs similar to ours used in western Ontario did not attract high numbers of plethodontid salamanders under after nearly a year of use. Finally, sites we chose for placement of arrays likely represented high-quality sites for salamanders. As a result, the dense underbrush and closed canopy that were present may have already represented high-quality shelters. If this is true, we expect that ACOs might be more attractive to salamanders living in more disturbed environments than those observed in our study (e.g., logged forests; Herbeck and Larsen, 1999).

Long-term monitoring of ACOs would be helpful to assess whether they ultimately represent fundamentally different microhabitats than exposed locations and natural cover objects. With additional observation time, it appears that sufficiently-large sample sizes could be gathered to make comparisons of salamander population size and structure among locations at the PCCI and with populations of salamanders elsewhere in the Great Lakes area (e.g., van Wieren, 2003). The lack of a seasonal difference in capture rates of salamanders was also surprising given that other authors have found that salamanders are much more likely to be observed in spring and fall (e.g., van Wieren, 2003). A longer-term study might yield more variation in capture rates than observed in our study.

Our observation of salamander adults, juveniles, and eggs of four different species was not especially surprising given the diversity of habitat types and extensive wetlands on the PCCI property. By using GIS data available for the PCCI, we ultimately anticipate assessing the distribution of salamanders in relation to various landscape elements (roads, ponds, etc.). However, it is already clear that the PCCI property represents high-quality salamander habitat in that at least one species (red-backed salamander) was observed under ACOs in many arrays and under natural cover objects adjacent to arrays.

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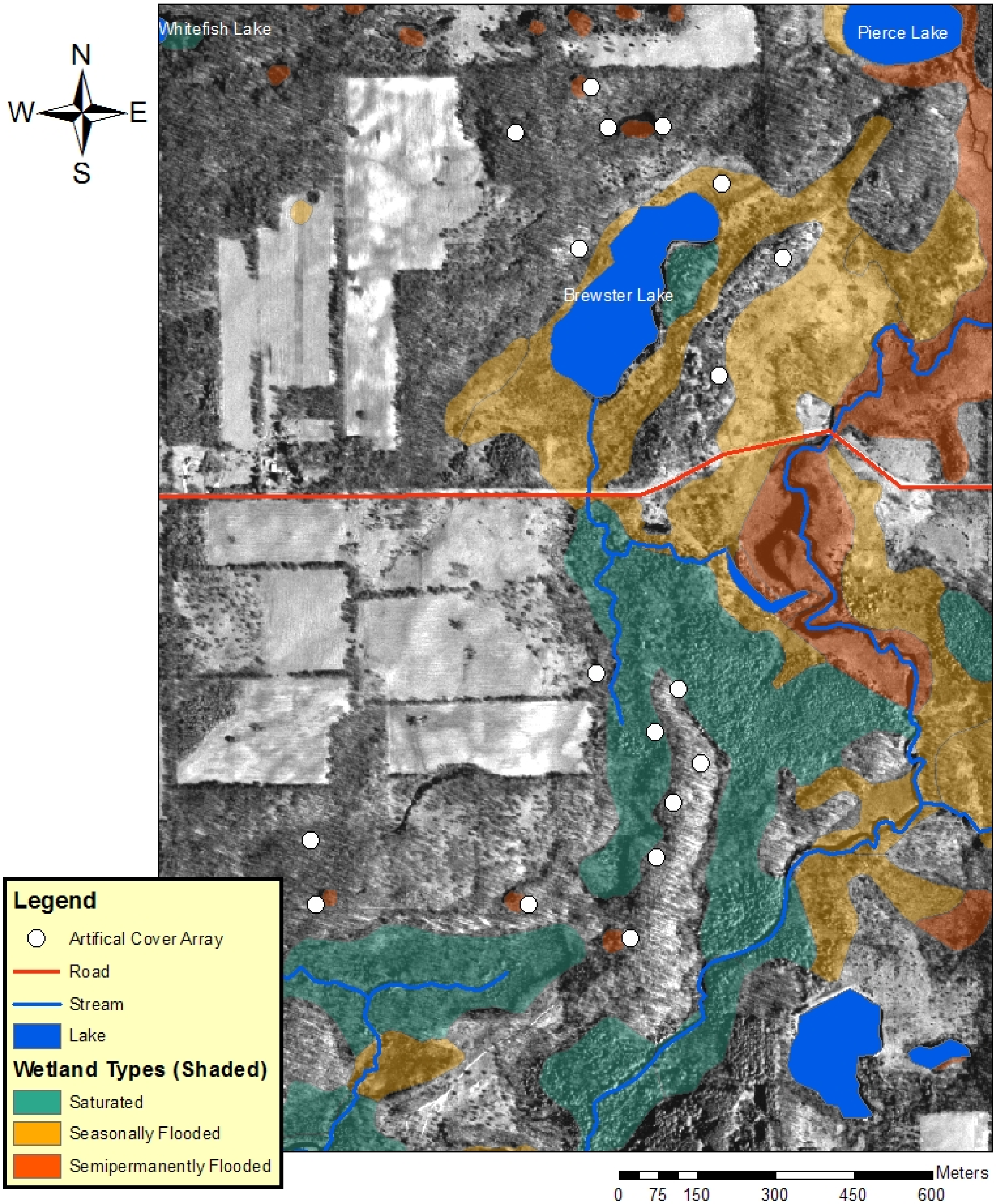

Figure 1. Study site at athe Pierce Cedar Creek Institute showing locations of arrays of Artifical Cover Objects. Wetland types are based on the National Wetlands Inventory data (background = 1998 orthophotograph).