Herpetological Review, 2003, 34(1), 39–42.

Comparative Effectiveness of Two Trapping Techniques for Surveying the Abundance and Diversity of Reptiles and Amphibians Along Drift Fence Arrays

CHRISTOPHER L. JENKINS[1]
KEVIN McGARIGAL
and
LLOYD R. GAMBLE
Department of Natural Resources Conservation, University of Massachusetts Amherst, Massachusetts 01003, USA

[1] *Current Address: Herpetology Laboratory, Department of Biological Sciences Idaho State University, Pocatello, Idaho 83209, USA*
e-mail: christolj@hotmail.com

In the northeastern United States, there are growing concerns about the effects of habitat loss and degradation on vernal pool herpetofauna (Gibbs 1993; Kittredge 1996; Melvin and Roble 1990; Windmiller 1996). Conservation of these species requires effective and efficient methods for surveying their populations. Perhaps the most common method of surveying for adult amphibians involves drift fence arrays in combination with pitfall traps. This method has been used successfully to capture a variety of forest floor vertebrates (Bury and Corn 1987; Gibbons and Semlitsch 1981), including ambystomid salamanders (DeGraaf and Rudis 1990; Madison 1998; McWilliams and Bachmann 1988; Pechmann 1995; Stenhouse 1985; Whiteman et. al. 1994), other salamander species (Gill 1978a,b) and frogs (Guttman et. al. 1991; Yanosky et al. 1997).

Previous studies from around the world have compared the effectiveness of various terrestrial amphibian and reptile trapping techniques. These studies have found varying effectiveness of drift fence/pitfall trap arrays when compared to other methods such as cover boards, pipe traps, visual surveys, box traps and calling surveys (Christiansen and Vandewalle 2000; Crosswhite et al. 1999; Lohoefener and Wolfe 1984; Parris et al. 1999; Sutton et al 1999; Webb 1999). Another method, terrestrial funnel traps, was found to be successful for capturing amphibians along drift fence arrays in the southeastern United States (Enge 1997a). Comparisons of funnel traps to pitfall traps in the Pacific Northwest and the Southwest have shown that snakes and some lizards are more susceptible to capture in funnel traps (Bury and Corn 1987; Jorgensen et al. 1998).

To our knowledge, the only study in the northeastern United States comparing terrestrial trapping techniques for amphibians and reptiles found funnel traps in conjunction with drift fence arrays to be more effective than plastic cover sheets (Kjoss and Litvaitis 2001). A rigorous comparative evaluation of the effectiveness of funnel traps and pitfall traps has not been conducted in the Northeast. Because of rocky soils and wet conditions often found adjacent to amphibian breeding sites in the northeast comparing the effectiveness of terrestrial trapping techniques that can be used in these situations will be valuable.

The goal of this study was to evaluate the effectiveness of terrestrial funnel traps and pitfall traps for capturing amphibians and reptiles by placing the traps along drift fence arrays that encircle wetlands used by amphibians for breeding. Our specific objectives were to: (1) quantify differences between trap types in capture rates for individual species; (2) quantify community resemblance and differences in species diversity between trap types; and (3) describe mortality rates and logistic constraints associated with each trap type.

We established a drift fence completely around the perimeter of five pools with breeding populations of marbled salamanders (*Ambystoma opacum*) in the town of South Hadley, Massachusetts. Drift fences were installed ca. 2–5 m from the shore (high water) of the pool to intercept all individuals moving to and from the pool. Drift fences consisted of 35 cm aluminum flashing buried 10 cm in the ground and held in place with wooden stakes. We installed pitfall traps and funnel traps alternately every 10 m along each fence for a total of 94 pitfall traps and 102 funnel traps. More funnel traps were used at 4 of the 5 pools because of an odd number of trap sites. A single trap was placed at each location on both sides of the fence. Pitfall traps were made from single #10 tin cans as opposed to double #10 tin cans recommended by Dodd and Scott (1994). We decided to use single cans due to the wet and rocky situations that are often found adjacent to amphibian breeding in the northeast. Each trap contained a wetted sponge and was covered by a board that was leaned against the drift fence to provide shade and prevent desiccation but would not interfere with the capturing of animals. Funnel traps were constructed from aluminum screen by creating a cylinder (41.4 cm long and 18.4 cm diam) and attaching an inverted funnel on either end (Enge 1997b). Like pitfalls, each trap contained a wetted sponge and was covered by a board.

We checked all traps daily between August 20 and November 30 for a total of 103 trap nights per trap. Each trap was checked by removing the sponge and searching through any organic material that may have accumulated in the trap. All animals captured were recorded and released approximately 2 m from the trap on the opposite side of the fence.

To compare the relative effectiveness of each trapping technique, we used a variety of simple descriptive statistics and a series of two-sample t-tests. Specifically, we determined the number and percentage of individuals caught in each trap type across all pools. We used paired t-tests to test the null hypothesis that mean capture rates did not differ between trap types. Here, the pool was the experimental unit. Mean capture rates for each technique were paired by pool to account for differences in overall capture rates among pools. In effect, this tested the null hypothesis that the mean difference in capture rates between techniques did not differ from zero (i.e., zero difference in mean capture rates between techniques exists when the relative capture rates between the two techniques is the same at each pool, regardless of differences in the absolute magnitude of capture rates among pools). For this analysis, capture rates for each species were calculated at all five pools by dividing the number of animals captured in a given trap type by the number of traps of that type. This step was necessary to account for minor differences in the number of traps of each type at a pool.

To compare the relative effectiveness of each trapping technique at estimating amphibian and reptile diversity, we computed Simpson's diversity index (Simpson 1949) for each trap type at each pool. Simpson's diversity index is calculated as the proportion of each individual species' abundance relative to the total abundance of all species squared. The squared proportions for all species are then summed, and the reciprocal is taken. We tested the null hypothesis that diversity did not differ between trap types using a paired t-test, as described above. In addition, we compared the community structure as determined by each technique using two different community resemblance measures. Specifically, we computed Jaccard's Coefficient of Community Similarity (Mueller-Dombois and Ellenberg 1974:212–214) to assess similarity in species composition. Jaccard's index is defined as the number of species common to both trap types divided by the total number of species found in both trap types, and is zero when two communities have no species in common and is a maximum of one when two communities share all species. We also computed percentage of similarity (Wolda 1981) to assess similarity in community composition and structure between trap types. Percentage of similarity is defined as the sum of each species' lowest percent composition from either trap type. Percent similarity is zero when two communities have no species in common and is a maximum of one when species composition and relative abundances are identical. For this analysis, we computed community resemblance for each pool separately and then summarized these results across all five pools.

Collectively, a greater number of species (15 vs. 10) and more individual amphibians and reptiles (1622 vs. 764) were caught in funnel traps than in pitfall traps (Table 1). Based on total number of captures 14 of 15 species were captured more frequently in funnel traps than in pitfall traps. However, when we only looked at species with > 20 captures, eight species had higher capture rates with funnel traps compared to only one species with pitfall traps. Despite these results, because of high variability among pools, capture rates were significantly different at the $P < 0.1$ level for only three species (*Ambystoma opacum*, *Plethodon cinereus*, and *Rana sylvatica*) and at the $P < 0.05$ level for only one species (*Rana sylvatica*) based on paired t-tests. The only species to have significantly greater capture rates in pitfall traps was the marbled salamander (*Ambystoma opacum*).

Funnel traps consistently captured a higher diversity of species across the five pools (Fig. 1), although this difference was only mildly significant ($t = 2.36$, $P = 0.077$). The similarity in community composition between trap types was low (mean Jaccard's Coefficient of Community Similarity = 0.54). Similarity in community structure (i.e., composition and relative abundances) was

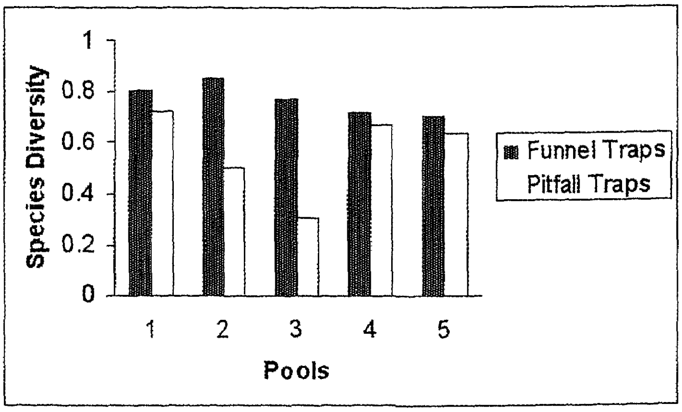

FIG. 1. Reptile and amphibian diversity captured in each trap type (funnel and pitfall) in Fall 1999 at 5 pools in South Hadley, Massachusetts.

TABLE 1. The number and percentage of captures in funnel (N = 102) versus pitfall (N = 94) traps, mean deviation in capture rates between trap types, and P-values from paired t-tests for individual species captured along drift fences around five vernal pools in South Hadley, MA during 1998. Deviations between trap types were computed for each pool separately and then averaged across pools. Positive deviations represent higher funnel trap capture rates; negative deviations represent higher pitfall trap capture rates. Mean deviations between trap types and associated P-values are only reported for species with greater than 20 total captures.

Species	Total Captures				Mean	
	Funnel Traps		Pitfall Traps		Deviation	P-value
Rana sylvatica	273	(93%)	19	(7%)	5.007	0.001
Bufo americanus	57	(78%)	16	(22%)	0.909	0.111
Hyla crucifer	4	(80%)	1	(20%)	—	—
Rana catesbeiana	2	(100%)	0	(0%)	—	—
Rana palustris	2	(100%)	0	(0%)	—	—
Rana clamitans	1	(100%)	0	(0%)	—	—
Ambystoma opacum	254	(42%)	342	(58%)	- 3.959	0.052
Plethodon cinereus	314	(87%)	47	(13%)	5.941	0.056
Notophthalmus viridescens	499	(71%)	207	(29%)	5.272	0.147
Hemidactylium scutatum	19	(66%)	10	(34%)	0.112	0.221
Ambystoma maculatum	117	(51%)	113	(49%)	- 0.784	0.365
Eurycea bislineata	20	(77%)	6	(23%)	0.356	0.391
Thamnophis sirtalis	52	(95%)	3	(5%)	1.076	0.120
Nerodia sipedon	6	(100%)	0	(0%)	—	—
Diadophis punctatus	2	(100%)	0	(0%)	—	—

slightly greater, but also low (mean Percentage of Similarity = 0.61).

Overall, mortality rates were low (< 2% of captures) and were similar between trap types, although there were notable differences among species (Table 2). Funnel traps accounted for higher amphibian mortality rates, primarily because animals captured in them were more susceptible to desiccation. Two species seemed especially prone to desiccation in funnel traps, *Notophthalmus viridescens* and *Plethodon cinereus*. Ambystomid species appeared to be less susceptible to desiccation, yet suffered greater mortality in pitfall traps due to predation by shrews. In addition, pitfall traps accounted for more small mammal mortalities, most likely due to high metabolic rates of carnivorous shrews (Churchfield 1990).

TABLE 2. Total number of mortalities associated with funnel traps and pitfall traps for species captured along drift fences around five vernal pools in South Hadley, Massachusetts during 1999.

Species	Funnel Trap	Pitfall Trap
Ambystoma maculatum	0	1
Ambystoma opacum	1	3
Eurycea bislineata	0	1
Hemidactylium scutatum	1	0
Notophthalmus viridescens	7	2
Plethodon cinereus	6	1
Rana sylvatica	3	0
Total Amphibians	18	8
Small Mammals	1	16
Total Mortalities	19	24

From a practical and logistical standpoint, both trap types required roughly an equal amount of initial labor (i.e., construction and installation), but funnel traps required more time to check and maintain and were more expensive to construct. In particular, funnel traps required resetting after they were checked. Resetting involved placing the trap tightly against the fence and the ground so that no gaps existed where animals might circumvent the trap. This proved not to be a problem in relatively wet areas, but in dry uplands, it took approximately 30 sec longer to reset a pair of funnel traps properly than to reset a pair of pitfall traps. Hence, with over 100 funnel traps to check in our study, funnel traps required almost an additional one hour of labor per day.

Clearly, species' capture rates and estimates of community composition and structure can differ markedly when different trap types are used in combination with drift fence arrays (Bury and Corn 1987; Lohoefener and Wolfe 1984). No one trap type is equally effective for capturing all species. However, pitfall traps are often employed as the only trap type in amphibian surveys. In our study, funnel traps were more successful for capturing most amphibians and reptiles and sampling a greater diversity of species than pitfall traps, with the exception of marbled salamanders. The differential vulnerability to trap types among species can be explained by the physical structure of the two trap types in relation to species' physical capabilities. In our study, we used relatively shallow pitfalls