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A Comparison of Aquatic Drift Fences with Traditional Funnel Trapping as a Quantitative Method for Sampling Amphibians

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Recent reports of amphibian declines have sparked increased efforts to inventory and monitor amphibian populations worldwide (Keisecker et al. 2001; Pechmann and Wilbur 1994). Standard techniques for the quantitative inventory and monitoring of amphibian populations include systematic observations, automated recording of calling anurans, drift fences with pitfall traps, and aquatic funnel trapping of amphibian larvae (Heyer et al. 1994). Terrestrial drift fence arrays with pitfall traps are an effective way to sample general species richness of amphibians and can be especially effective at detecting rare or cryptic species (Corn 1994; Gibbons and Semlitsch 1982). Drift fences intercept the movements of animals and guide them into traps, generally increasing capture rates (Corn 1994). Aquatic drift fences, or net leads, have been effectively used to increase trap capture rates for fish (Hubert 1983) and turtles (Vogt 1980); however, they have seldom been used to sample aquatic amphibian species and life stages (but see Beuch and Egeland 2002; Enge 1997a).

One preferred method for sampling aquatic amphibians and amphibian larvae is funnel trapping of aquatic environments (Heyer et al. 1994; Olson et al. 1997). A variety of funnel traps have been used, including cylindrical wire or plastic minnow traps, collapsible rectangular traps, and plastic soda bottles with the top inverted (Adams et al. 1997; Beuch and Egeland 2002; Willson and Dorcas 2003). Beuch and Egeland (2002) tested the efficiency of several different types of aquatic funnel traps for capturing amphibian larvae in seasonal forested wetlands in Minnesota. They applied the drift fence principle to aquatic funnel trapping by staking a 3.0-m section of minnow seine between two cylindrical minnow traps. They concluded that the seine did not increase trapping efficiency.

We compared the effectiveness of aquatic drift fences to traditional funnel trapping for capturing amphibians within a large ephemeral wetland in the western Piedmont of North Carolina. We used a paired-sample design, with five pairs of trap arrays, to account for spatial variation in amphibian abundance within the wetland. Each pair consisted of one experimental and one control array, set 1 m apart in a straight line (Fig. 1). The relative position (right or left) of the experimental and control arrays was determined randomly and locations for the five pairs of trap arrays within the wetland were chosen based on comparability of water depth (approximately 0.5 m) and uniformity of habitat.

Each experimental array consisted of four collapsible rectangular mesh minnow traps [model RN10; Memphis Net and Twine Co. Inc., Memphis, Tennessee; US $10.99] placed at each end and along the middle of a 3.0-m long section of silt fencing (Enge 1997) supported by three wooden stakes (Fig. 1). To ensure that trapped animals had access to air we placed an air-filled 0.6-L soda bottle inside each trap to serve as a float and tied traps loosely to 1-m bamboo garden stakes, allowing the trap to slide up and down with fluctuations in water level. Each control array consisted of four traps, positioned identically to the first array, but without silt fencing (Fig. 1). To examine the efficiency of this technique, we recorded the time required to set up and monitor both experimental and control arrays.

We checked traps every other day between 17 March and 3 April 2002 and identified to species, counted, and released all amphibians captured. MANOVA (SAS 2000; alpha = 0.05) was used to assess the effects of fencing on amphibian captures and to make univariate comparisons for individual species, life stages, and number of species captured between experimental and control traps.

Over the 18-day trapping period we captured a total of 998 amphibians representing 8 species (Fig. 2). Traps with drift fencing

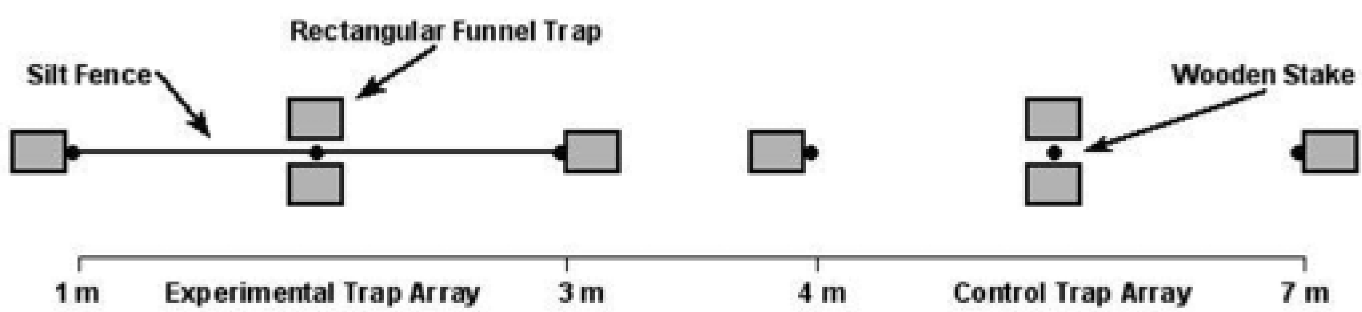

FIG. 1. Design for control and experimental trap arrays. Each array consisted of a set of four rectangular funnel traps. One array of funnel traps was placed along a section of silt fencing and one was not. Five pairs of trap arrays were set within the wetland.

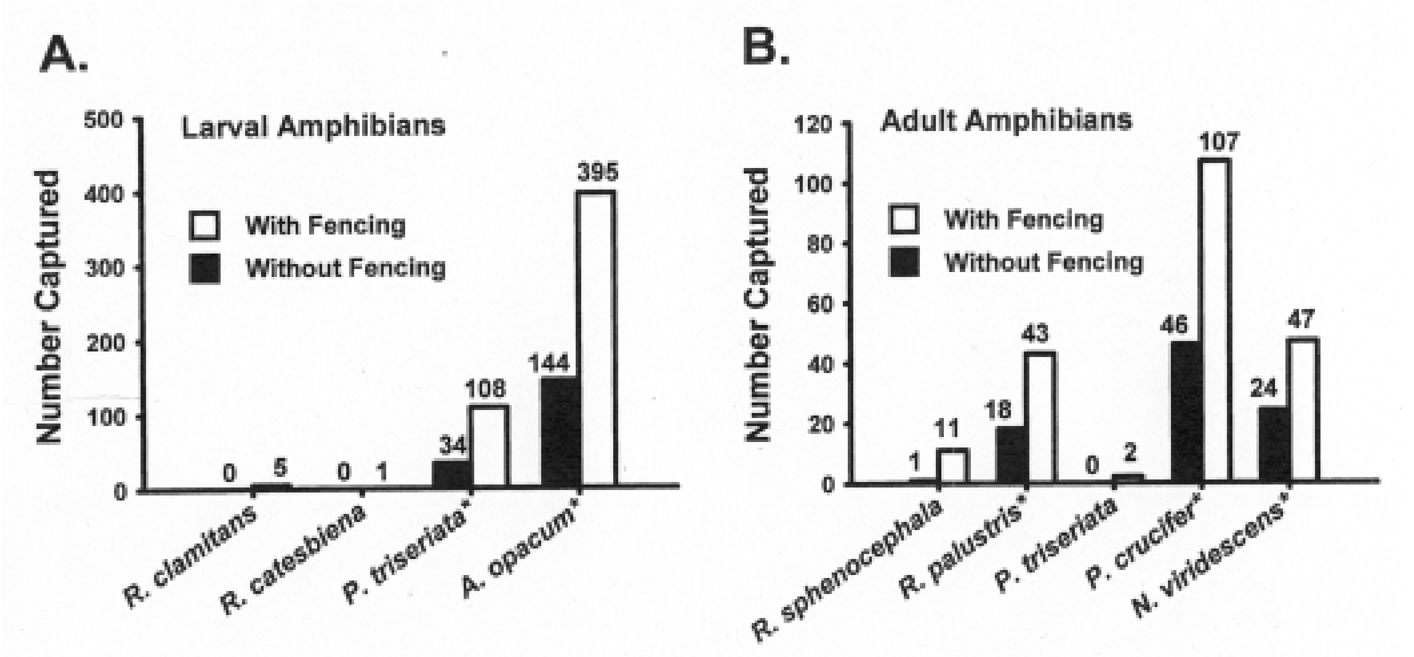

FIG. 2. Total captures of A) amphibian larvae and B) adult amphibians by species between trap arrays with and without drift fencing in a large seasonal wetland within the western Piedmont of North Carolina. Asterisks (*) denote significant differences in number of individuals captured between traps with and without fencing when compared using MANOVA.

captured over twice as many individual amphibians as did control traps (Fig. 2; MANOVA, P < 0.0001). Univariate comparisons revealed that traps with fencing captured significantly greater numbers of larval of *Ambystoma opacum* (F = 43.93, df = 1, p < 0.001), and *Pseudacris triseriata* (F = 12.15, df = 1, p = 0.001), and adult *Rana palustris* (F = 6.96, df = 1, p = 0.012), *P. crucifer* (F = 15.60, df = 1, p = 0.003), and *Notophthalmus viridescens* (F = 8.81, df = 1, p = 0.005) than did traps without fencing. Additionally, traps with fencing captured significantly more species or life stages per trap than did unfenced traps (F = 19.62, df = 1, p = < 0.001). Small sample sizes prevented detection of statistically significant differences in other species and life stages, though for all species, traps along the fences captured more individuals than traps without fencing (Fig. 2).

The construction of aquatic drift fences added approximately $1.50 US to the cost and approximately 4-min to the installation time of each trap when compared to funnel traps without fencing. However, both the amount of time and money invested per amphibian captured was substantially lower when drift fences were used in conjunction with the traps (Fig. 3).

Buech and Egeland (2002) found that net leads had no effects on capture rates of amphibians in Minnesota temporary wetlands. They speculated this result might be due to the sedentary nature of the larval amphibians they captured (*R. sylvatica, A. laterale*, and *P. crucifer*). In our study, placing funnel traps along lengths of silt fencing greatly improved capture rates of both large, highly mobile amphibians (e.g., adult ranid frogs, *P. crucifer*, and *N. viridescens*) and small amphibian larvae (e.g., *A. opacum* and *P. triseriata*). We suspect that we recorded substantially higher success rates with aquatic drift fences than did Buech and Egeland (2002) because we used rectangular funnel traps, which can be placed flush along the side of the fencing, rather than cylindrical funnel traps. Cylindrical funnel traps cannot not lie flush against the fencing material and thus allow amphibians to easily swim over or under the trap openings.

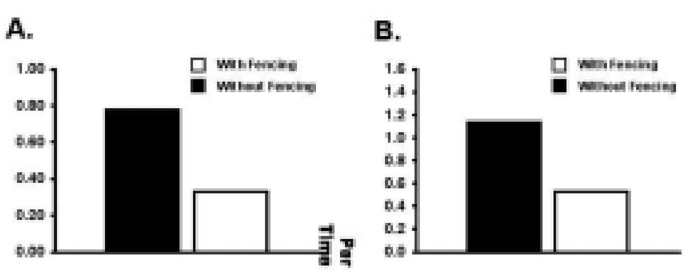

FIG. 3. Comparisons of A) cost and B) time invested per amphibian captured between traps with and without drift fencing.

In conclusion, creating aquatic drift fences by placing rectangular funnel traps along sections of silt fencing dramatically improved amphibian capture rates, and thus offers a valuable and efficient complement to traditional sampling techniques for surveying and monitoring amphibian populations. Although further research is necessary, we suspect that aquatic drift fences would also prove superior to traditional funnel trapping for capturing aquatic reptiles (e.g., watersnakes) and detecting rare aquatic reptile and amphibian species.

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PVC Pipe Diameter Influences the Species and Sizes of Treefrogs Captured in a Florida Coastal Oak Scrub Community

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Artificial refugia constructed of polyvinyl chloride (PVC) pipes has shown to be effective for capturing treefrogs, yet capture success has varied among species, size classes, pipe designs, and placement (Boughton et al. 2000; Moulton et al. 1996). Differential capture success in studies using multiple PVC pipe designs indicates that at least some species or size classes of treefrogs are selective in their use of artificial refugia (Boughton et al. 2000; Moulton et al. 1996). Therefore it is reasonable to expect that variation in the PVC pipe design may change the detection probability of different species and sizes of treefrogs under artificial refugia, bias count data, and population estimates, unless this effect is known. Consequently, a validation experiment was undertaken to critically assess the influence of PVC pipe diameter on the species and sizes of treefrogs captured under artificial refugia in a Florida coastal oak scrub community.

The study was carried out at Rookery Bay National Estuarine Research Reserve (RBNERR) in Collier County, Florida, USA. RBNERR encompasses ca. 50 ha of coastal oak scrub that occurs in a mosaic with pine flatwoods on well-drained and lightly colored sands. The most extensive tract of oak scrub located adjacent to Shell Island Road was selected for study on the basis that it offered an area large enough for investigation (> 5 ha) with uniform soils, vegetation and topography, while allowing easy access. The study site does not have a flowing water source, and the hydroperiod of small depression ponds is dependent upon localized rainfall and rising groundwater. The low (< 4 m) canopy is dominated by a sparse to dense layer of *Quercus chapmani*, *Q. geminata*, *Q. myrtifolia*, and *Ceratiola ericoides*, with *Pinus elliottii* appearing occasionally as an emergent. The lower shrub layers are more complete with *Serenoa repens*, *Lyonia lucida*, *Ximenia americana* and *Asimina reticulata*. Ground cover is sparse yet diverse, frequently with bare siliceous sand, or with lichen, spikemoss, and occasional tufts of grass and herbs. Preliminary surveys at the study site captured *Hyla cinerea*, *H. squirella*, and *Osteopilus septentrionalis* taking shelter in the cavities of *Q. chapmani* and axils of *S. repens* (pers obs.).

Three identical PVC pipe arrays were set out widely spaced (> 100 m) at random. Each array was comprised of 1-m long sections of four different diameter pipes (13, 25, 38, and 51 mm) inserted upright 10 cm into the ground directly along side each other. This pipe design and placement was chosen because of the naturally low canopy height combined with the preferences of *H. cinerea* and *H. squirella* for long (60 cm) PVC pipes driven into the ground or hung vertically in trees (Boughton et al. 2000). Each pipe was set up 20 July 2001, and data were collected during 12 widely spaced (15–35 d) capture sessions from 21 July 2001 to 5 May