

## Quantitative Sampling of Stream Salamanders: Comparison of Dipnetting and Funnel Trapping Techniques

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In recent years, increased awareness of amphibian declines has resulted in widespread efforts to inventory and monitor amphibian populations, thus initiating the development of standardized and quantitative sampling techniques. Accepted sampling methods for aquatic adult and larval amphibians include dipnetting, seining, and funnel trapping (Heyer et al. 1994). Numerous types of funnel traps have been employed and include simple wire minnow or eel traps (Fronzuto and Verrell 1999), expensive, species-specific traps (Mushet et al. 1997), and traps made from plastic jugs or soda bottles (Calef et al. 1973; Griffiths 1985; Richter 1995; Smith and Rettig 1996). While funnel trapping has proven to be a valuable technique for amphibian sampling in many lentic habitats, it has seldom been applied to lotic ecosystems.

The most widely accepted method for sampling lotic habitats for amphibians is timed dipnetting (Shaffer et al. 1994). Dipnetting, while effective for sampling some amphibian species, is sometimes difficult to standardize due to variation in effort among investigators. Partly due to a lack of standardized sampling techniques, stream-dwelling amphibian populations have not been monitored as closely as those in other habitats (Heyer et al. 1994). Here, we describe an inexpensive and quantitative method for sampling stream-dwelling salamanders using funnel traps constructed from plastic soda bottles. This technique, employed in small streams in the western Piedmont of North Carolina, yielded a greater diversity of salamander species and life-stages than did dipnetting.

Funnel traps were constructed from 3.0 L, 2.0 L, 1.0 L, and 0.6 L plastic soda bottles as described by Griffiths (1985). A range of bottle sizes were used to trap various microhabitats within streams. Larger (3.0 L and 2.0 L) bottles were used in stream pools and other deep-water areas while smaller bottles allowed trapping in shallow water along stream edges and were especially effective in trapping undercut banks, along submerged logs, and other areas frequented by adult salamanders. To create each trap, the top of the bottle was cut off and inverted. Holes were punched, using a metal single-hole punch, through the top and bottom of the trap mouth and a bamboo garden stake was passed through the holes to hold the inverted bottle top in place. The trap was anchored horizontally to the streambed by pushing the stake into the substrate. Traps were set in water slightly shallower than the diameter of each bottle, resulting in a layer of air inside of each bottle.

To test the efficacy of funnel trapping in small streams, we trapped a total of eight streams located within 11 km of Davidson, North Carolina. Each stream was trapped for two, one-week sessions, once in mid-February and again in mid-April 2001. During

each trapping session, 12 traps were set approximately 1 m apart along the stream edge and in slow-current areas where leaves and debris had collected. Traps usually were set facing into the current and were not baited. Each set of 12 traps contained one 3.0 L, four 2.0 L, three 1.0 L, and four 0.6 L bottles to allow for trapping in a variety of depth and current velocity locations. Traps were checked every other day during each week-long trapping session, at which time all animals found in the traps were removed. No in-trap mortality was observed. After checking, traps were moved a short distance (< 1 m) to ensure thorough trapping of all microhabitats within the stream. All salamanders captured in traps were taken to the laboratory for the remainder of the one-week trapping session to avoid recaptures and were subsequently released.

We compared the effectiveness of funnel trapping to timed dipnetting, the method recommended by Shaffer et al. (1994) for sampling amphibian larvae in streams. Dipnetting was conducted for two 2-day periods during the trapping period (late February and mid-April). During these periods, each of the eight streams was netted for a period of 30 minutes per stream. Netting concentrated on areas of submerged leaves, rocks, logs, and other cover objects and was confined to underwater microhabitats (Shaffer et al. 1994).

Funnel trapping and timed dipnetting both yielded high numbers of salamanders; however, trapping yielded a greater diversity of species and life-stages than dipnetting (Fig. 1). Dipnetting produced high numbers of *Desmognathus fuscus* and *Eurycea cirrigera* but the vast majority (97%) were larvae. Funnel trapping also yielded high numbers of *D. fuscus* and *E. cirrigera*, but with a much larger percentage (27%) of adult salamanders (Fig. 1). In addition, we captured three *Pseudotriton ruber* larvae and five adult anurans, of three different species (*Rana clamitans*, *R. catesbeiana*, and *Pseudacris triseriata*), in funnel traps. Of these species, only *R. catesbeiana* also was detected by dipnetting.

We estimated the time required to construct, set, and check the funnel traps used in this study and compared it to the time re-

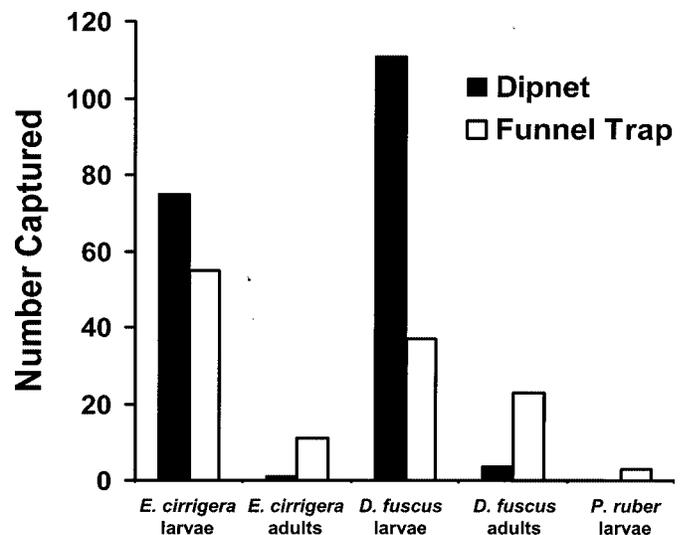


FIG. 1. Species and life-stage composition of salamanders captured by funnel trapping and by dipnetting. Note that while dipnetting yielded a greater total number of salamanders, funnel trapping captured many more adult salamanders. In addition, *Pseudotriton ruber* was detected only by funnel trapping.

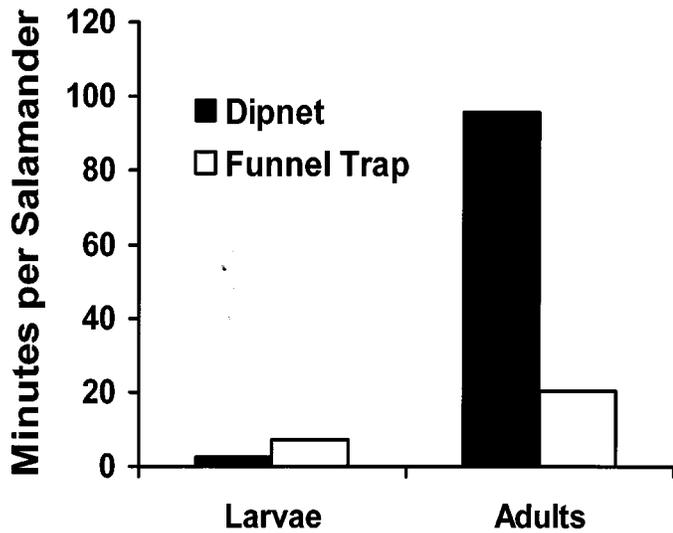


FIG. 2. Average time invested per salamander captured for funnel trapping and dipnetting. Note that while dipnetting captured more salamander larvae per unit of time, funnel trapping was much more efficient for capturing adult salamanders.

quired for dipnetting. Although time invested per salamander larva was lower for dipnetting, funnel trapping was much more efficient in capturing adult salamanders (Fig. 2). In addition, over the two-month study period, dipnetting only sampled each stream at two time points, while funnel trapping sampled each stream continuously over two week-long periods. This is important, considering that many amphibian species are only active at night or under specific climatic conditions (Peterson and Dorcas 1992). Finally, the cost of these funnel traps is negligible when compared to standard wire funnel traps, which generally sell for about \$10 USD each.

We demonstrate that utilizing funnel trapping in small streams in the western Piedmont of North Carolina yielded a greater diversity of amphibian species and much higher numbers of adult salamanders than dipnetting. Thus, this technique offers an inexpensive complement to traditional lotic sampling techniques in the surveying and monitoring of amphibian populations.

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