A New Stratified Aquatic Sampling Technique for Aquatic Vertebrates

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ABSTRACT

We developed a new type of passive-sampling minnow trap that enables aquatic sampling at depths of up to 70 cm without drowning obligate air-breathers. The trap demonstrated a heightened ability to capture bottom-dwelling animals that may otherwise be underrepresented by other trapping methodologies. The success rate of this new trap, relative to conventional minnow traps, seems to vary across wetlands and seasons. After 502 trap-nights with the new trap and 870 trap-nights with minnow traps at three wetlands, we present data for three species of permanently aquatic salamanders, seven species of aquatic snakes, and four species of fishes.

INTRODUCTION

Various environmental problems are contributing to fish, reptile, and amphibian declines across the world (Helfman et al. 1997, Gibbons et al. 2000, Halliday 2005). However, not all fluctuations in populations are the result of unnatural causes, and long-term and widespread standardized monitoring efforts are needed to separate confounding factors (Pechmann et al. 1991, Gibbons et al. 2000, Whiteman and Wissinger 2005).

Having knowledge of distributions, habitat usage, and life histories of target species allows for more effective and accurate sampling (McDiarmid 1994). However, species with diverse natural histories, behaviors, and habitat preferences require diverse methods of sampling. Using a variety of sampling techniques is an effective way of accounting for differential effectiveness of methodologies (Gibbons et al. 1997, Luhring 2007).

Drift fences with pitfall traps are very effective in catching smaller animals moving into or out of wetlands but do not account for completely aquatic groups (e.g., *Amphiuma* and *Siren*; Gibbons and Semlitsch 1981) and may not accurately sample highly aquatic animals that infrequently leave the wetland (e.g., *Seminatrix pygaea*; Gibbons and Dorcas 2004). However, aquatic drift fences used in conjunction with rectangular funnel traps may be an effective alternative (Willson and Dorcas 2004). Willson et al. (2005) showed that commercially available plastic and steel minnow traps are effective for trapping aquatic snakes and salamanders. However, these traps must be placed partially above water to avoid drowning obligate air-breathers such as reptiles and amphibians. Because of this, minnow traps may exhibit a reduced capability for sampling species that are active at greater depths or for trapping in parts of wetlands that are too deep to use minnow traps safely.

Johnson and Barichivich (2004) used commercially produced crayfish traps to safely sample air-breathing aquatic vertebrates at depths of up to 60 cm. The crayfish traps were much more successful at capturing their target species, greater sirens (*Siren lacertina*) and two-toed amphiumas (*Amphiuma means*), than plastic minnow traps, wire-screen funnel traps, and dip netting. However, they were non-collapsible and fairly expensive when a finer mesh was installed to prevent injury and mortality to trapped animals. This study investigated the use of a new trap design created to allow effective subsurface sampling of fishes, reptiles, and amphibians that is safe for obligate air-breathers with a substantially lower financial investment than commercially available traps.

METHODS AND MATERIALS

Trap Description

The trap used for this study was a modified 120-L heavy-duty plastic household trashcan outfitted with four steel funnels (Fig. 1). We salvaged the funnels from previously used cylindrical galvanized steel minnow traps with 6 mm mesh, but similar funnels can be made readily from 6 mm galvanized steel hardware cloth. An outline of each funnel was drawn on the exterior of the trashcan so that the lowest part of the funnel was approximately 50 mm from the bottom of the trashcan. A box-knife was used to cut out the outlined holes to create openings for the funnels, and an electric drill was used to drill small holes around the outside of the funnel opening. Cable ties were passed through the drilled holes and used to cinch the funnels into the openings. Trashcans were then fitted with 1.5 m pieces of nylon rope on each handle. Different numbers of knots were tied into the ropes to identify the traps. During part of the study, the ropes were used as safety lines to ensure that adjacent minnow traps did not sink below water level and inadvertently drown obligate air-breathers.

To reduce fish and crayfish mortality observed in the summer of 2005, two sides of each trashcan were fitted with 120 x 390 mm windows made from 2 mm mesh aluminum window screening. The purpose of this modification was to increase water flow and oxygen circulation inside the trap.

Trap Deployment

Trapping was conducted at three locations on the Department of Energy's Savannah River Site (Aiken and Barnwell Counties, South Carolina, U.S.A.) over the course of two successive summers (2004 and 2005). An additional trapping of three days was conducted during the spring of 2006 to evaluate the addition of screen windows. In all, there were 502 trashcan trap-nights and 870 minnow trap trap-nights.

Trapping in 2004 (6-12, 22-25 and 29 July) was conducted at the Pen Branch Delta (PBD). A riverine wetland, PBD is located at the mouth of Pen Branch Creek

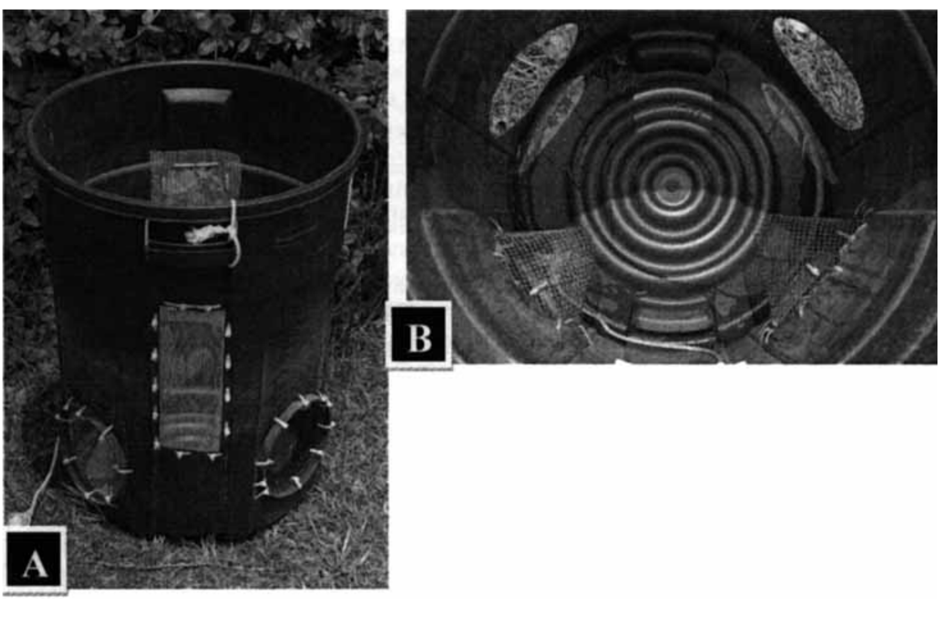

Figure 1. A) Side view and B) aerial view of the trashcan trap showing the screen window and two of the four steel funnels.

where it meets the Savannah River (Davis and Janecek 1997). Trapping in 2005 was conducted at Bay 152 (30 June-4 July), a permanent to semi-permanent wetland of about 3 ha, and at Steel Creek Bay (SCB; 5 July-5 August), a 8.8 ha semi-permanent shallow-water pond. Trapping in 2006 (15-17 March) was also conducted in SCB.

In all cases, traps were placed in association with emergent vegetation and structures that might increase capture rates (Willson et al. 2005). As the trashcan traps (TC) were being tested for differential capture rates of organisms by virtue of sampling deeper waters, all traps were located in water that ranged from 30 to 70 cm, with most traps set in water at around 55 cm. Plastic minnow traps (PM) and steel minnow traps (ST) were either fastened to the trashcan traps via ropes on the handles or placed in emergent vegetation that could keep part of the trap above water.

RESULTS

At PBD, TC's caught the highest number of reptile and amphibian species (n=6), half of which (*Farancia erytrogramma*, *Nerodia taxispilota* and *S. lacertina*) were not found in the other two types of traps. Trashcan traps also had higher capture rates (number of animals captured per trap-night) of *S. intermedia* and *Regina rigida* than either PM's or ST's (Table 1). Two mortalities occurred during this sampling period. One *R. rigida* drowned in an ST after getting its head stuck in the mesh underwater. The other mortality was a gravid *Nerodia fasciata* that drowned in a plastic minnow trap after getting stuck halfway through the funnel entrance. No mortalities occurred in the TC's.

At Bay 152, a *S. pygaea* was captured in a PM and two *R. rigida* were captured in TC's (Table 2). No reptile or amphibian mortalities were observed during this sampling period. However, crayfish that stayed in the TC's for multiple days were often found dead. Mud sunfish (*Acantharchus pomotis*) were found in both trap types and TC's had a higher capture efficiency (0.220) than PM's (0.040) for this species. Redfin pickerel (*Esox americanus*) was trapped only in PM's.

Of the five species of reptiles and amphibians caught at SCB, TC's had higher capture efficiencies for only two species (*A. means* and *F. abacura*). Notably, PM's had a higher capture efficiency than TC's for *S. lacertina* (0.065 and 0.035 respectively), a species that was caught exclusively by TC's in PBD (Table 3). Two reptile and amphibian mortalities occurred during this sampling period. The first was a *Nerodia floridana* that drowned in a PM that became submerged. The other was an *A. means* that was found floating dead in a TC. However, the likely source of mortality for the *A. means* was a *F. abacura* found in the same trap. This idea was later reinforced when

Table 1. Capture rates (captures per trap-night per trap) of reptiles and amphibians at Pen Branch Delta during 2004. Numbers of each species captured are given in parentheses. Species captured included rainbow snake [*Farancia erytrogramma* (F ERY)], banded watersnake [*Nerodia fasciata* (N FAS)], brown watersnake [*N. taxispilota* (N TAX)], glossy crayfish snake [*Regina rigida* (R RIG)], lesser siren [*Siren intermedia* (S INT)], and greater siren [*S. lacertina* (S LAC)]

Trap type	Trap-nights	F ERY	N FAS	N TAX	R RIG	S INT	S LAC
Trashcan	118	0.009 (1)	0.009 (1)	0.017 (2)	0.034 (4)	0.530 (63)	0.068 (8)
Plastic minnow	86	0 (0)	0.012 (1)	0 (0)	0.012 (1)	0.260 (22)	0 (0)
Steel minnow	40	0 (0)	0 (0)	0 (0)	0.025 (1)	0.100 (4)	0 (0)

another *F. abacura* regurgitated an *A. means* in a TC later in the same trapping period.

Screen windows were added to the TC's for the 2006 trapping period at SCB to reduce fish and crayfish mortality. There were no mortalities of fish or crayfish in TC's during the three nights that traps were being used after the screen window installation. During that time, eight TC and eight ST were used to sample SCB for fishes, reptiles and amphibians. *Amphiuma means* and *S. lacertina* were caught only in TC's, whereas lined topminnows (*Fundulus lineolatus*) and *N. fasciata* were caught only in ST's (Table 4).

Table 2. Capture rates (captures per trap-night per trap) of fishes and reptiles at Bay 152 during 2005. Numbers of each species captured are given in parentheses. Species captured included mud sunfish [*Acantharchus pomotis* (A POM)], redfin pickerel [*Esox americanus* (E AME)], glossy crayfish snake [*Regina rigida* (R RIG)], and black swamp snake [*Seminatrix pygaea* (S PYG)].

Trap type	Trap-nights	A POM	E AME	R RIG	S PYG
Trashcan	50	0.220 (11)	0 (0)	0.040 (2)	0 (0)
Plastic minnow	100	0.040 (4)	0.050 (5)	0 (0)	0.010 (1)

DISCUSSION

Relative trapping efficiencies of trap types (TC, ST, PM) varied among species, wetlands, and seasons. While TC traps were the most successful at capturing *S. lacertina* and *S. intermedia* in PBD, PM's had higher success rates in SCB for *S. lacertina* during the summer months. When SCB was sampled in spring of 2006, *S. lacertina* were captured only in TC's. This variation in capture efficiency of just one species suggests that multiple trapping techniques should be employed across habitats as well as across seasons.

In PBD, where *A. means* was not found and many *S. intermedia* were present, *S. lacertina* was only captured along the bottom water stratum in TC's. In SCB, where *A. means* was present and *S. intermedia* was not found, *S. lacertina* was captured more often along the top stratum of water in PM's. One possible reason for *S. lacertina*'s difference in water strata usage between the two wetlands could be antagonistic interactions of the three large aquatic salamanders. For example, Snodgrass et al. (1999) suggested that *S. intermedia* and *A. means* may have a negative impact on *S. lacertina*.

Animals that forage at the bottom of the water column would presumably be

Table 3. Capture rates (captures per trap-night per trap) of fishes, reptiles, and amphibians at Steel Creek Bay during 2005. Numbers of each species captured are given in parentheses. Species captured included two-toed amphiuma [*Amphiuma means* (A MEA)], mud sunfish [*Acantharchus pomotis* (A POM)], flier [*Centrarchus macropterus* (C MAC)], redfin pickerel [*Esox americanus* (E AME)], mudsnake [*Farancia abacura* (F ABA)], banded watersnake [*Nerodia fasciata* (N FAS)], green watersnake [*N. floridana* (N FLO)], and greater siren [*S. lacertina* (S LAC)].

Trap type	Trap-nights	A MEA	A POM	C MAC	E AME	F ABA	N FAS	N FLO	S LAC
Trashcan	310	0.045 (14)	0.139 (43)	0.013 (4)	0.006 (2)	0.032 (10)	0.006 (2)	0.010 (3)	0.035 (11)
Plastic minnow	620	0.013 (8)	0.102 (63)	0.015 (9)	0.082 (51)	0.002 (1)	0.008 (5)	0.019 (12)	0.065 (40)

caught more often in TC traps than those that spend most of most of their time at the surface. This seemed to be the case with *N. taxispilota,* which feeds primarily on catfish (Ictaluridae), *F. abacura,* which feeds primarily on large aquatic salamanders, and *R. rigida,* which feeds primarily on crayfish.

Aquatic funnel traps differ significantly from each other in their ability to capture particular species (Willson et al. 2005). Unfortunately, there does not appear to be a standard sampling method that can be used to sample aquatic organisms at discrete depths in the water column. Although minnow traps can be set at multiple depths, obligate air-breathers caught in a submerged trap would eventually drown. Trashcan traps can be adapted from the design used in this experiment to provide a standardized method of multi-strata aquatic sampling. Since the funnels can be installed in the sides of the trashcans at any depth, investigators can design TC's that sample specific depths that suit their experimental designs.

Trashcan traps that are modified to sample the top of the water column differ from bottom-sampling trashcan traps in their capture rates of different species of invertebrates and vertebrates (Luhring, unpublished data). Because the only difference between these two types of trashcan traps is the depth of water that their funnels sample, differences in capture rates between them should reflect differences in animal behavior and ecology (e.g., foraging behavior, habitat preference, predator avoidance). This may not be the case when comparing very different types of traps or methodologies that may have different biases (e.g., mesh size, funnel size, color, material) such as hoop traps and minnow traps.

Table 4. Capture rates (captures per trap-night per trap) of fishes, reptiles, and amphibians at Steel Creek Bay during 2006. Numbers of each species captured are given in parentheses. Species captured included two-toed amphiuma [*Amphiuma means* (A MEA)], mud sunfish [*Acantharchus pomotis* (A POM)], flier [*Centrarchus macropterus* (C MAC)], lined topminnow [*Fundulus lineolatus* (F LIN)], banded watersnake [*Nerodia fasciata* (N FAS)], and greater siren [*S. lacertina* (S LAC)].

Trap type	Trap-nights	A MEA	A POM	C MAC	F LIN	N FAS	S LAC
Trashcan	24	0.042 (1)	0.500 (12)	0.125 (3)	0 (0)	0 (0)	0.125 (3)
Steel minnow	24	0 (0)	0.333 (8)	0.208 (5)	0.208 (5)	0.042 (1)	0 (0)

ACKNOWLEDGMENTS

We thank K. Andrews, B. Boone, X. Glaudas, S. Poppy, J. Willson, C. Winne, C. Young, and the Davidson herpetology class for their assistance in checking traps. We thank S. Poppy for help during the original construction phase of the project. We also thank G. Helfman for his idea on modifying trashcan traps to reduce fish mortality and J. Gibbons for helpful comments on the manuscript. The manuscript was also greatly improved by suggestions from two anonymous reviewers and J. Kawatski. Salamanders were captured under scientific research permit #56-2003 from the South Carolina Department of Natural Resources, and experiments were conducted under University of Georgia IACUC approval # A2003-10167. Funding for this research was provided by the National Science Foundation (Awards DEB-0242874 and DBI-0139572) and the Savannah River Ecology Laboratory under Financial Assistance Award DE-FC09-96SR18-546 between the University of Georgia and the U.S. Department of Energy.

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Received: 5 March 2008 Accepted: 15 May 2008