# Pitfall Trap Versus Area Searches for Herpetofauna Research

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*Abstract:* Area searches and pitfall trap methods are commonly used to quantify presence or abundance of reptile and amphibian species. However, most studies do not use both methods simultaneously. We compared these methods with respect to detectability of herpetofauna species and detection rates for individual species on public lands in east central Mississippi. We conducted area searches along 300 $m^2$ belt transects measuring $50 \times 6$ m at distances of 0, 25, 50, 75, and 100 m from first and second order streams. Pitfall traps were placed along transects at 0, 50, and 100 m from streams. Transects were checked 2–3 times/year in 2001 and 2002. Transect data encompassed 84 surveys over 21 study sites. Twenty-four reptile species (741 individuals) and 17 amphibian species (615 individuals) were recorded during transect surveys. Nine reptile species (135 individuals) and 10 amphibian species (315 individuals) were captured using pitfall traps. Each method detected several species the other did not detect. Conclusions drawn from either method alone would differ significantly due to detection biases, but both methods together gave a more complete picture of the herpetofauna community. We encountered one possible bias that may have significantly altered pitfall data results. Depredation of captured animals in buckets by raccoons *(Procyon lotor)* was detected through the use of infrared-triggered cameras set near pitfall traps. We theorize that this type of depredation could influence herpetofaunal diversity detected by pitfall trapping. Furthermore, depredation of rare or protected herpetofauna captured in pitfall traps could have significant consequences for sensitive herpetofauna populations.

*Key words:* herpetofauna, sampling procedures, pitfall traps, area searches

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Many techniques are used for surveying populations of reptiles and amphibians, including anuran call counts, refugia pipes in trees, pitfall traps of various designs, time or area constrained searches, artificial cover boards, and funnel traps (see Heyer et al. 1994 for review of all techniques). Most techniques have known biases associated with them and tend to target a specific taxon or group of taxa. Pitfall traps (Corn 1994) and area searches (Jaeger 1994) are two of the most commonly used techniques due to their effectiveness in the detection of a variety of species. However, survey results can vary between methods, because each method detects animals in a different manner. A number of studies have evaluated area searches and pitfall traps separately or compared them with other methods. Detection capabilities and deficiencies have been well documented for pitfall trap methods (Gibbons and Semlitsch 1981, Campbell and Christman 1982, Vogt and Hine 1982, Brathwaite 1983, Bury and Corn 1987, Morton et al. 1988, Dodd 1991, Greenberg et al. 1994, Enge 2001) and to some extent for area searches (Anderson et al. 1979, Burnhan et al. 1985, Pearman et al. 1995, Brown 1997, Smith and Petranka 2000, Doan 2003). Factors that influence detection success of these two methods may include animal mobility, size, and life habits; micro and macro-habitat conditions; seasons of sampling; climate conditions during sampling periods; and survey design. For example, Smith and Petranka (2000) reported that seasonally migratory or relatively mobile species may be more susceptible to pitfall trapping, whereas relatively sedentary or secretive species were more effectively surveyed by active search methods. Gibbons and Semlitsch (1981) reported that pitfall traps were generally effective for toads (Bufonids), true frogs (Ranids), and pond-breeding salamanders (Ambystomids, *Notopthalmus* spp.) if pitfalls were established near breeding pools. Conversely, other researchers (Greenberg et al. 1994, Enge 2001) have reported that searches and other methods were more effective in the detection of arboreal or highly mobile species, such as treefrogs (Hylids) and larger snakes, due to their ability to escape pitfall traps.

One source of bias presented by pitfall traps is the possibility of depredation, although we found a paucity of information on this topic in published literature. Brown (1997) and Houze and Chandler (2002) briefly mention depredation as a possible bias but with no indication of the magnitude of the problem or possible predators. Animal groups that we consider as potential pitfall bucket predators include shrews (*Sorex* spp.), snakes (*Agkistrodon* spp., *Nerodia* spp., *Elaphe* spp.), opossums *(Didelphis virginiana),* raccoons *(Procyon lotor),* and mustelids (Family Mustelidae). Raccoons may have the most potential as pitfall trap predators, because they eat a wide range of food items (Tabatabai 1988), are known to develop search images when food can be obtained consistently from a given source, and are abundant in most forested habitats with densities ranging from 12–18 raccoons/ha (Chamberlain and Leopold 2001).

The information presented in this paper is a component of a large scale study that addressed herpetofauna diversity in publicly-owned forests at various distances from first- and second-order streams in north-central Mississippi. The primary goal of this paper was to 1) report herpetofaunal abundance and species richness at various distances from streams, 2) compare herpetofaunal abundance and species richness detected by pitfall trapping and area search methods, and 3) report potential sources of bias discovered using pitfall traps.

## Methods

This study was conducted on 18 sites in Tombigbee National Forest, Ackerman District (TNF) in Winston County, Mississippi, and 3 sites in Noxubee National Wildlife Refuge (NNWR) adjacent to TNF study sites. Each study site included a first- or second-order stream. Sites were located in mature, second-growth, mixed pine-hardwood forest stands >30 years of age. Study sites contained nutrient rich, upland soils with rolling topography (Vanderford 1962) and plant communities of generally upland species including pine (*Pinus* spp.), upland hickories (*Carya* spp.), oaks (*Quercus* spp.), beech *(Fagus grandifolia),* and ash (*Fraxinus* spp.).

First, a 50-m transect was placed parallel along a stream and marked with flagging. The starting point for the first transect was randomly chosen at a place along the stream. Next, 3 additional 50-m transects were systematically placed along the stream with 25 m of separation between the end of one transect and the beginning of another. Transects also were placed at distances of 25, 50, 75, and 100 m parallel to the stream in similar fashion (Jaeger 1994). If stand shape allowed, transect arrays were placed on alternating sides of the stream, This provided a total of twenty 50-m transects at each study site (Fig. 1).

Herpetofaunal communities were surveyed by walking all transects and recording every reptile or amphibian observed within 3 m on each side of transects; therefore, an area of 300 $m^2$ (6 × 50 m) was covered by each transect and 6,000 $m^2$ (0.6 ha) at each study site. Transects were walked slowly and refugia sites (i.e., brush piles, decaying logs, etc.) were investigated (Jaeger 1994). Logs are important habitat components for some herpetofauna, so they were not destroyed while searching and were returned to their original position after they were moved to check for animals. For stream-side transects, the land was investigated on one side of the stream, the side which had been marked with flags, and the stream bed was searched. Streams were relatively small with an average base flow depth for all streams of 20.0 cm (average depth range 7.0–57.8 cm), so stream bed searches were not difficult. Rocks and other cover objects in stream beds were searched. Nets were not used to sample animals. Surveys were conducted between 0900 and 1500 hours. Transects were surveyed at 17 sites in 2001 during spring, summer, and fall and at 21 sites in 2002 during spring and fall. Surveys were conducted when assistance was available during each sampling season without regard for rainfall events or other weather related variables.

A pitfall trap array consisted of four 19-liter buckets placed in the ground 5 m apart. Silt fencing placed between buckets as a lead fence was about 0.7 m in height after installation (Corn 1994). The resulting array was 15 m in length. Pitfall traps were placed along survey transects randomly selected from three strata (0, 50, and 100 m from streams) resulting in three arrays at each site. Lids were placed on the buckets except during surveys, and survey periods lasted for 10 days. Buckets were checked every two days during survey periods. Buckets were opened at 10 sites during spring, summer, and fall 2001 and at 21 sites during spring, summer, and fall 2002. Pitfall trap surveys were conducted within 30 days of area searches and soon after rainfall events if weather permitted during the desired sampling season.

Counts of individuals detected at each site were divided by number of surveys at each site to standardize data for statistical comparisons. Number of species detected during each survey were summed for each site and divided by number of surveys for an average number of species detected/survey by both methods. Reptile and amphibian species were treated separately in analyses.

Wilcoxon sum rank tests (PROC NPAR1WAY, SAS 1999) were used to test for

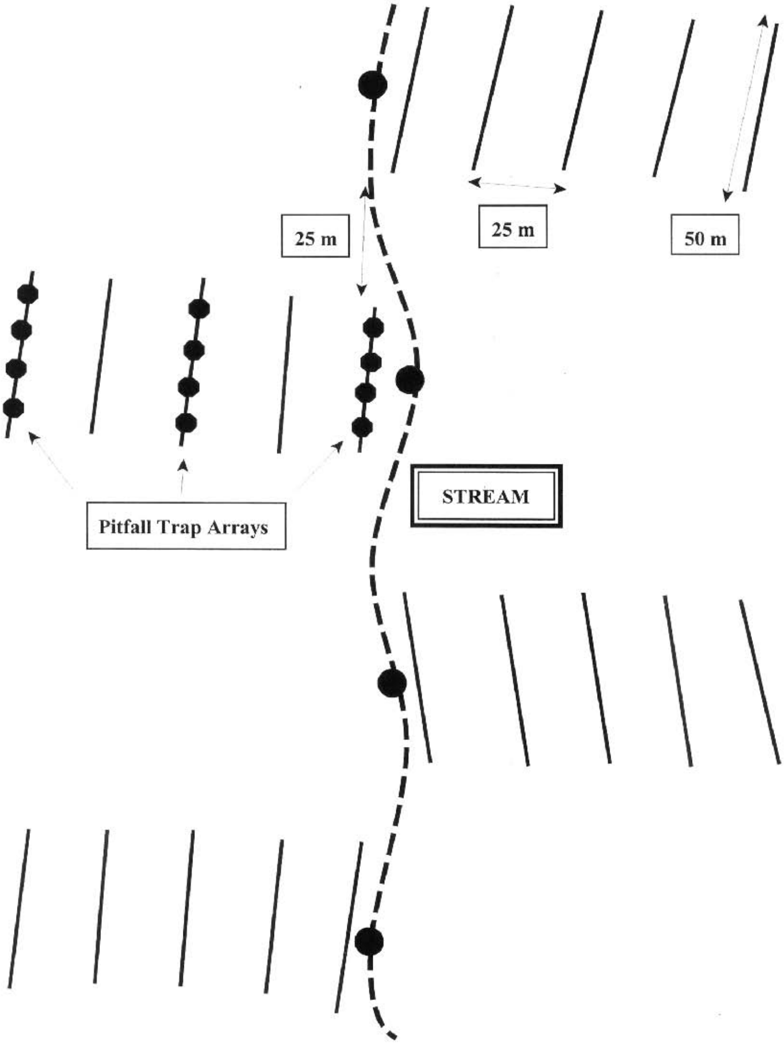


**Figure 1.** Herpetofauna survey design with area search transects and pitfall trap arrays.

differences between methods in average number of individuals and number of species detected. A non-parametric test was used because most data were not normally distributed (PROC UNIVARIATE, SAS 1999).

Because both area searches and pitfall trap arrays are essentially indices of true population size, we wanted to assess correlation of detection ability between methods. We expected some natural variation in reptile and amphibian density among sites, and if both methods were reliable indices of community size, there should be

**Table 1.** Reptile and amphibian counts from area searches and pitfall traps on Tombigbee National Forest and Noxubee National Wildlife Refuge, 2001–2002.

| | | Area Searches | | Pitfall Traps | |
|---|---|---|---|---|---|
| Scientific name | Common name | *N* | % of Reptiles | *N* | % of Reptiles |
| Order Squamata | | | | | |
| Suborder Serpentes | Snakes | | | | |
| *Agkistrodon contortix c.* | Southern copperhead | 2 | 0.27 | 1 | 0.74 |
| *Agkistrodon piscivorus p.* | Eastern cottonmouth | 15 | 2.02 | 0 | 0.00 |
| *Carphophis amoenus* | Eastern worm snake | 4 | 0.54 | 0 | 0.00 |
| *Coluber constrictor c.* | Northern black racer | 3 | 0.40 | 1 | 0.74 |
| *Crotalus horridus* | Timber rattlesnake | 1 | 0.13 | 0 | 0.00 |
| *Diadophis punctatus p.* | Southern ringneck snake | 11 | 1.48 | 1 | 0.74 |
| *Elaphe guttata g.* | Corn snake | 1 | 0.13 | 0 | 0.00 |
| *Elaphe obsoleta spiloides* | Gray rat snake | 1 | 0.13 | 0 | 0.00 |
| *Lampropeltis getula holbrooki* | Speckled kingsnake | 1 | 0.13 | 0 | 0.00 |
| *Lampropeltis triangulum elapsoides* | Scarlet kingsnake | 1 | 0.13 | 0 | 0.00 |
| *Nerodia erythrogaster flavigaster* | Yellowbelly water snake | 2 | 0.27 | 0 | 0.00 |
| *Nerodia sipedon pleuralis* | Midland water snake | 1 | 0.13 | 0 | 0.00 |
| *Opheodrys aestivus* | Rough green snake | 1 | 0.13 | 0 | 0.00 |
| *Sistrurus miliarius barbouri* | Dusky pigmy rattlesnake | 4 | 0.54 | 0 | 0.00 |
| *Storeria dekayi d.* | Northern brown snake | 1 | 0.13 | 0 | 0.00 |
| *Storeria occipitomaculata* | Redbelly snake | 1 | 0.13 | 1 | 0.74 |
| *Tantilla coronata* | Southeastern crown snake | 1 | 0.13 | 0 | 0.00 |
| *Thamnophis sauritus s.* | Eastern ribbon snake | 2 | 0.27 | 0 | 0.00 |
| Subtotal | | 53 | 7.15 | 4 | 2.96 |
| Species richness | | 18 | | 4 | |
| Suborder Lacertilia | Lizards | | | | |
| *Anolis carolinensis* | Green anole | 74 | 9.99 | 8 | 5.93 |
| *Eumeces fasciatus* | Five-lined skink | 39 | 5.30 | 49 | 36.30 |
| *Eumeces laticeps* | Broadhead skink | 3 | 0.40 | 15 | 11.11 |
| *Sceloporus undulatus* | Northen fence lizard | 9 | 1.21 | 32 | 23.70 |
| *Scinella lateralis* | Ground skink | 549 | 74.09 | 27 | 20.00 |
| Subtotal | | 674 | 90.96 | 131 | 97.04 |
| Species richness | | 5 | | 5 | |
| Order Testudines | Turtles | | | | |
| *Terrapene carolina triunguis* | Three-toed box turtle | 14 | 1.89 | 0 | 0.00 |
| Subtotal | | 14 | 1.89 | 0 | 0.00 |
| Species richness | | 1 | | 0 | |
| Total (reptiles) | | 741 | | 135 | |

significant correlation between methods for number of individuals and species detected by site. For example, if a site had relatively dense amphibian populations or high species richness, both area searches and pitfall trap arrays should yield greater counts of amphibians compared to a site with relatively small populations. Correlation between methods of reptile and amphibian counts and number of species detect-

**Table 1.** Continued

| Scientific name | Common name | Area Searches N | Area Searches % of Amphibians | Pitfall Traps N | Pitfall Traps % of Amphibians |
|---|---|---|---|---|---|
| Order Anura | Frogs and toads | | | | |
| *Acris gryllus g.* | Southern cricket frog | 67 | 10.23 | 0 | 0.00 |
| *Bufo fowleri* | Fowler's toad | 24 | 3.66 | 215 | 68.25 |
| *Gastrophryne carolinensis* | Eastern narrowmouth toad | 6 | 0.92 | 6 | 1.90 |
| *Hyla chrysoscelis* | Cope's gray treefrog | 47 | 7.18 | 0 | 0.00 |
| *Pseudacris crucifer* | Spring peeper | 12 | 1.83 | 0 | 0.00 |
| *Rana catesbiana* | Bullfrog | 3 | 0.46 | 6 | 1.90 |
| *Rana clamitans c.* | Bronze frog | 67 | 10.23 | 20 | 6.35 |
| *Rana sphenocephala* | Leopard frog | 101 | 13.61 | 8 | 2.54 |
| *Scaphiopus holbrookii h.* | Eastern spadefoot toad | 0 | 0.00 | 2 | 0.63 |
| Subtotal | | 327 | 49.92 | 288 | 91.41 |
| Species richness | | 9 | | 6 | |
| Order Caudata | Salamanders | | | | |
| *Ambystoma opacum* | Marbled salamander | 3 | 0.46 | 8 | 2.54 |
| *Ambystoma maculatum* | Spotted salamander | 0 | 0.00 | 5 | 1.59 |
| *Ambystoma talpoideum* | Mole salamander | 0 | 0.00 | 2 | 0.63 |
| *Desmognathus fuscus conanti* | Spotted dusky salamander | 1 | 0.15 | 0 | 0.00 |
| *Eurycea cirrigera* | Two-lined salamander | 62 | 9.47 | 0 | 0.00 |
| *Eurycea guttolineata* | Three-lines salamander | 125 | 19.08 | 0 | 0.00 |
| *Notophthalmus viridescens louisianensis* | Central newt | 1 | 0.15 | 0 | 0.00 |
| *Plethodon glutinosus g.* | Northern slimy salamander | 126 | 19.24 | 12 | 3.81 |
| *Plethodon websteri* | Webster's salamander | 2 | 0.31 | 0 | 0.00 |
| *Psuedotriton ruber vioscai* | Southern red salamander | 8 | 1.22 | 0 | 0.00 |
| Subtotal | | 328 | 50.07 | 27 | 8.57 |
| Species richness | | 8 | | 4 | |
| Total (amphibian) | | 655 | | 315 | |

ed was tested using Spearman's Rho coefficient (PROC CORR, SAS 1999). All tests were performed at $\alpha = 0.05$.

Infrared-triggered cameras (DeerCam DC-100, Non Typical, Inc.) were used to monitor predator activity around pitfall trap arrays. Cameras were placed at 10 study sites in December 2002 for 8 days and at 10 sites in May 2003 for 10 days. All sites could not be monitored due to limited availability of the cameras. One camera was placed at each pitfall trap array at 0.5 m in height on a nearby tree. Our primary objective was to determine presence of predators along pitfall trap arrays.

## Results

From 2001–2002, 84 area searches were completed. Twenty-four reptile species (741 individuals) and 17 amphibian species (655 individuals) were recorded during area searches (Table 1). From 2001–2002, 77 pitfall trap surveys were completed.

**Table 2.** Average number of individuals and species of reptiles and amphibians detected by site during area searches and pitfall trap surveys on Tombigbee National Forest and Noxubee National Wildlife Refuge, Mississippi 2001–2002.

| | Area Search | | | Pitfall Trap | | |
|---|---|---|---|---|---|---|
| | *N*[a] | $\bar{x}$ | *SD* | *N*[a] | $\bar{x}$ | *SD* |
| Reptiles | | | | | | |
| Individuals/survey | 21 | 9.15 | 5.11 | 21 | 1.29 | 0.80 |
| Species/survey | 21 | 2.66 | 0.80 | 21 | 1.22 | 0.71 |
| Amphibians | | | | | | |
| Individuals/survey | 21 | 8.83 | 6.36 | 21 | 3.00 | 2.53 |
| Species/survey | 21 | 3.12 | 1.73 | 21 | 1.46 | 0.78 |

a. Number of sites; number of individuals and species captured for each survey were summed for each study site and divided by number of surveys done at that site.

Nine reptile species (135 individuals) and 9 amphibian species (315 individuals) were captured with pitfall traps (Table 1). With pitfall traps we detected 3 amphibian species (1 frog, 2 salamander) not found with area searches. With area searches we detected 15 reptile (14 snake, 1 turtle) and 8 amphibian species (2 frog, 6 salamander) not found with pitfall traps.

Comparisons between methods were different with respect to average number of amphibians detected ($N = 21$, $w = 611.00$, $P = 0.0001$), average number of reptiles detected ($N = 21$, $w = 672.00$, $P = 0.0001$), average number of amphibian species detected ($N = 21$, $w = 606.00$, $P = 0.0001$), and average number of reptile species detected ($N = 21$, $w = 626.00$, $P = 0.0001$). In all comparisons, mean numbers were greater for area searches (Table 2).

No significant correlations were found between methods for average number of amphibians detected ($N = 21$, Spearman's $\rho = 0.031$, $P = 0.8953$), average number of reptiles detected ($N = 21$, Spearman's $\rho = 0.374$, $P = 0.0944$), average number of amphibian species detected ($N = 21$, Spearman's $\rho = 0.224$, $P = 0.3289$), and average number of reptile species detected ($N = 21$, Spearman's $\rho = 0.173$, $P = 0.4543$). Counts of reptiles and amphibians by distance from stream also indicated that area searches and pitfall traps do not sample species equally (Fig 2).

Eight mammals were detected near pitfall trap arrays by cameras. Images consisted of 8 pictures with 11 (1–2/picture) raccoons, 2 pictures each with 1 white-tailed deer *(Odocoileus virginianus),* 2 pictures each with 1 eastern cottontail *(Sylvilagus floridanus),* 2 pictures each with 1 bobcat *(Lynx rufus),* 1 picture with 1 armadillo *(Dasypus novemcinctus),* 1 picture with 1 southern flying squirrel *(Glaucomys volans),* 1 picture with 1 fox squirrel *(Sciurus niger),* and 1 picture with 1 gray fox *(Urocyon cineroargenteus).*

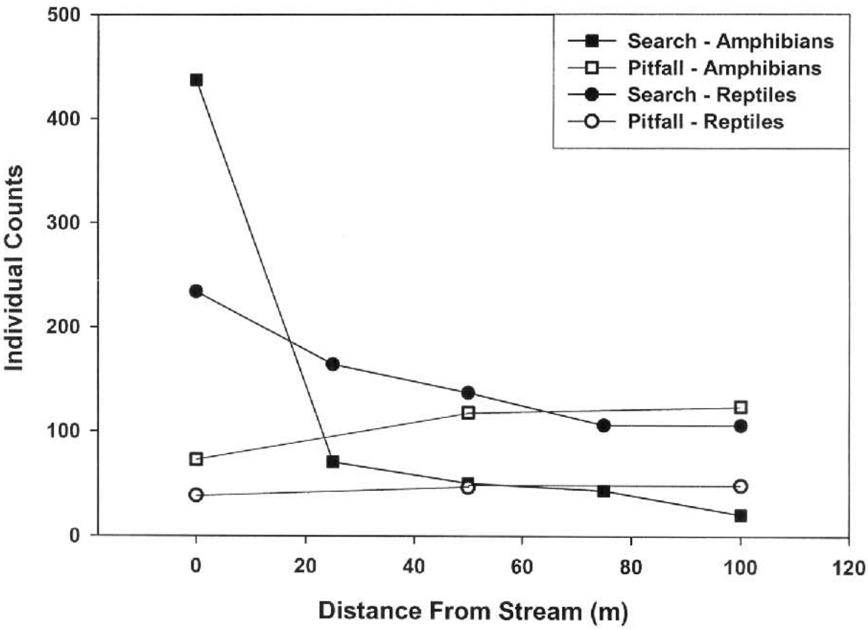


**Figure 2.** Reptile and amphibian counts by distance from stream for area searches and pitfall trap surveys on Tombigbee National Forest and Noxubee National Wildlife Refuge, Mississippi, 2001–2002.

## Discussion

We considered several survey methods and determined that both area searches and pitfall traps were appropriate and necessary to survey the wide range of reptile and amphibian species found in the forests of the southeastern United States. Our study results were similar to results reported on other published studies that found differential success of detection within herpetofauna taxa (Bury and Corn 1987, Heyer et al. 1994, Enge 2001). We also found that use of both methods simultaneously at all study sites was successful in detecting a variety of species. However, our data analyses indicated that area searches and pitfall trap surveys were generating conflicting information with respect to the occurrence of reptiles and amphibians at varying distances from streams (Fig. 2). Our original objectives did not include a comparison of these sampling methods with respect to herpetofauna richness and abundance, because we assumed that area searches and pitfall traps would detect different species with different success rates. Therefore, we used both methods to effectively detect species richness and abundance. However, because of the detected trends, we felt that this comparison was essential to the interpretation of our study results and would be of interest to other researchers conducting similar studies.

Area searches were superior for all variables of interest. Pitfall traps were relatively ineffective for snakes (Order Squamata), turtles (Order Testudines), and salamanders (Order Caudata). We believe that most mid-size to large snakes could escape our buckets, and box turtles appeared to avoid depressions as reported by Gibbons and Semlitsch (1981). Most notable was the low number of salamanders captured in pitfall traps as compared with salamanders detected by area searches. Only 27 salamanders were captured in pitfall traps which constituted about 9% of all amphibians captured. In contrast, 328 salamanders were found during area searches which comprised about 50 % of all amphibians found with that method. Pitfall traps are generally considered effective for salamander capture (Heyer et al. 1994), but in our study, 6 salamander species that were detected by area searches were not detected with pitfall traps. We acknowledge that our study sites may support low numbers of "migratory" salamanders, *Ambystoma* spp. and *Notopthalmus* spp., and this fact may have influenced our capture rates of these species in our pitfall traps. But, we observed many three-lined salamanders *(Eurycea guttolineata)* moving on the surface within 25 m of streams during area surveys and on nights when anuran call counts were attempted, so we anticipated capturing some three-lined salamanders in pitfall traps, but none were recorded. Anurans were the taxon that both methods detected effectively. However, about 80% of anurans in pitfall traps were toads (*Bufo* spp.), while area searches found a relatively even distribution of frog counts across 9 species (Table 1). Several frog genera that are accomplished leapers or that can climb bucket walls were not captured or retained in pitfall traps (e.g., *Acris, Pseudacris,* and *Hyla* spp.); however, we expected higher capture rates of juvenile *Rana* spp. which were abundant on many study sites as determined by area searches. Ranids that were found in buckets showed almost no ability to escape. Pitfall traps were more successful capturing lizards and skinks than anurans, but pitfalls captured only 12% of the number found with area searches.

There are known biases associated with both area searches and pitfall traps; some of them can be controlled while others must be accepted. With area searches one can control observer bias by training assistants in proper identification of specimens and search technique, but effects of weather on the activity of herpetofauna are more difficult to address. Two factors lead us to believe an additional bias other than those cited in other studies may be affecting pitfall trap success on our study sites. First, we expected counts of reptiles and amphibians by site to correlate between methods, but we did not detect any significant correlation for any response variable. Second, we found inverse trends between the two methods in abundance of reptiles and amphibians with increasing distance from stream (Fig. 2). With both methods, we expected to detect more animals, especially amphibians, such as *Plethodon* spp. and *Eurycea* spp., near streams. From area searches, we concluded that more amphibians occurred along streams than at greater distances away from streams. We did not believe that area searches were biased with respect to this conclusion. Why, then, did pitfall traps not detect more frogs and salamanders near streams compared to traps at 50 and 100 m? After cursory observation of mid-sized mammal sign along streams, we hypothesized that buckets nearest streams may have been regularly depredated.

Based on field sign, we believe that raccoons were the most likely candidates as pitfall trap predators on our study sites. They are opportunistic omnivores, and amphibians, specifically *Rana* and *Hyla* spp., have been documented as a significant portion of animal food items consumed by raccoons in the southeastern United States (Tabatabai 1988). Raccoons prefer mature hardwood forests adjacent to rivers and streams (McKeever 1959, Warr 1978) and use streams as travel corridors. Leberg (1985) found a direct correlation between distance to water sources and raccoon density in western Tennessee. Additionally, raccoons were the most common animal detected by our infrared-triggered cameras. Camera images displayed up to three raccoons per image near buckets on selected nights, and at least one raccoon reaching down into an open pitfall trap. Although we tightly secured lids so they were not easily removed by wind or water, we found some lids removed from buckets while visiting our study sites for field activities other than pitfall trap surveys. Typically, lids were turned over bottom-side up as if they had been flipped off the bucket. Location of pitfall traps in bottoms of mature forests prevents winds of great strength from removing lids. We theorized that raccoons regularly visited our pitfall traps and attempted to remove lids when pitfall trap surveys were not being conducted. When buckets were opened for surveys, raccoons likely inspected buckets nightly and found concentrations of food items, including frogs, salamanders, crayfish, small mammals, and possibly lizards and skinks, though we did not find literature that strongly supports reptiles as preferred raccoon prey items.

Of the amphibians captured in pitfall traps, toads were most common. Bufonids are unpalatable to most predators due to toxic excretion by paratoid glands located dorsolaterally behind the head. This defense mechanism could partially explain why toads comprised about 80% of anurans found in our pitfall traps. Raccoons may not select them for consumption because of their unpalatable nature. Pitfall trap arrays 50 and 100 m from streams may have been less likely to be visited by raccoons, because they selectively use areas near streams. This could account for the distribution of herpetofauna relative to stream proximity detected by our pitfall trap arrays.

## Management Implications

Both survey methods were beneficial to our study. Pitfall traps were more labor intensive to install but required less time and effort to survey than area searches. Pitfall traps at all sites could be checked in about 10 hours by one person, whereas one person could survey area search transects at one site in approximately four hours. Several species were more detectable with the use of pitfall traps, including fence lizards *(Sceloporus undulatus),* broadhead skinks *(Eumeces laticeps),* mole salamanders (*Ambystoma* spp.), spadefoot toads *(Scaphiopus holbrookii),* and toads (*Bufo* spp.). Data for these species would have been sparse with the omission of pitfall trapping in our study. However, we gained the most data from area searches. Numbers of individuals found by area searches comprised about 80% of all individuals combining counts by both area search and pitfall trap methods. We recommend the use of both survey methods for studies of entire terrestrial herpetofauna communities in mature, upland forests in east central Mississippi.

Predation of herpetofauna captured in pitfall traps by raccoons appeared to be a source of survey bias in our study. Researchers should assess the potential for data loss from raccoons and other predators when they install pitfall traps that will be retained over an extended period of time. Additionally, pitfall traps near water sources in forested habitats may be more vulnerable to depredation by raccoons and other mid-size mammals that use stream and wetland edges as travel corridors. We would not have been aware of this problem during our study if we had not conducted area searches on the same sites where pitfall traps were placed, and we had not conducted both sampling methods at various distances from streams.

We express an additional concern related to depredation and mortality of captured herpetofauna in pitfall traps. Our study sites provided habitat for amphibian species that were classified as locally rare, the southern red salamander *(Pseudotriton ruber vioscai)* and Webster's salamander *(Plethodon websteri).* These species were found along streams and could potentially be captured in pitfall traps. If traps were being visited by mammalian predators, depredation could cause increased mortality for rare species with low population numbers. Because of the observations and trends detected, we plan to test several devices to exclude mammalian predators from pitfall traps. We are currently designing a study in which we will monitor predator exclusion devices at various distances from streams and compare detection rates of herpetofauna between excluded and unexcluded pitfall traps. In addition to recommending the use of multiple survey methods for comprehensive sampling of herpetofaunal communities, we recommend that future studies address the potential effects that pitfall trap depredation may have on study results and captured herpetofauna.

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