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Comparison of Three Methods for Sampling Fishes and Macroinvertebrates in a Vegetated Wetland

B. J. Freeman

H. S. Greening

J. Douglas Oliver
Liberty University, doliver@liberty.edu

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B. J. Freeman, H. S. Greening, and J. Douglas Oliver

Institute of Ecology
University of Georgia
Athens, Georgia 30602

ABSTRACT

Three methods of sampling fishes, two seining methods and a drop trap method, were evaluated in heavily vegetated freshwater habitats. The portable drop trap method, which utilized a 1 x 1 m-sq. trap, collected significantly more macroinvertebrates and fish per unit area than did the seining methods. The meter square drop trap offered the additional advantages of a greater number of animals per unit effort and an integrated sample of vegetation, macroinvertebrates and fish in a given area. A 90% (s.d.= 7.4%) recovery of tagged fishes released into the traps in different habitats showed the m^2 drop trap to be a highly reliable and effective sampling method for fish in vegetated wetlands.

INTRODUCTION

Vegetated wetlands are characteristically difficult areas in which to quantitatively estimate fish and macroinvertebrate populations. Problems associated with sampling animal populations in a homogeneous area are further compounded by heterogeneous stands of vegetation, which hamper techniques normally employed for sampling aquatic organisms. Reliable population estimates are a prerequisite for accurate descriptions of community structure, production estimates, and food web analyses as well as population dynamics of individual species. This paper describes a sampling method for fauna found in these heavily vegetated habitats, which is superior to traditional techniques.

Quantitative methods for sampling fish and macroinvertebrate populations in vegetated areas include portable dropnets, pull up traps and drop traps in both marine and freshwater habitats. Hellier (1959) surrounded large (up to 930-m^2) areas by a drop net which was suspended above water. A trigger mechanism released the netting which enclosed the area. Fish were then removed by seining. Hoese and Jones (1963), Brook (1977), and Gore et al. (1981) adapted this method to sample smaller areas (229-m^2, 420-m^2, 10-m^2 respectively). However, these methods required large permanent pilings from which to drop the enclosing net; thus a single area was repeatedly sampled throughout these studies. The use of large drop net methods lacks mobility and thus replicability for the estimation of spatial variability between samples.

Some workers (e.g., Moseley and Copeland 1969; Kjelson and Johnson 1973) have successfully used a large portable drop net with a floating frame on which a drop net is hung electromagnetically. However, the drop net must be pulled across the sampling area, usually by boat, resulting in disturbance by movement and/or shadows in the

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water. Such a device is also complex and expensive. Pull-up traps have also been used for trapping fish and invertebrates in some shallow waters (Higer and Kolipinski 1967; Wetzel 1971; Kushlan 1974). These pull-up designs required secure corners which had to be pounded into place some time before sampling. Furthermore the capture net was placed on top of the substrate, creating an unnatural habitat and causing disturbance. These designs are used in a fixed location and thus have limited replicability.

Drop traps typically work well in marshy environments since they can penetrate rooted and suspended water column vegetation down to the substrate. Kahl (1963) sampled fish in southern Florida marshes (50-cm depth) with a metal sided 1-m x 1-m trap which dropped down a frame of four upright poles. Fish were removed through the open top by repeated passes with a dipnet. The apparatus was then moved to another area and the trap reset. After sufficient time for the water to clear and fish to return to the area in normal densities, the trap could again be tripped from a remote distance. Kushlan (1974) described a circular trap with mesh sides that dropped down a center pipe into a cicular metal base when triggered from a remote distance. We tried this method in habitats of the Okefenokee Swamp and found that although it worked mechanically, the bottom circular base pushed down the natural vegetation and the trap had to be left undisturbed for several hours prior to setting (J.D. Oliver, personal observation).

Faster and more portable trap methods have recently been evaluated. After using a 1-m^2 drop trap hung from a stationary frame, a 1-m^2 and a 2.25-m^2 throw trap with mesh sides, Kushlan (1981) found the 1-m^2 throw trap to be the most effective method for trapping fish in shallow marshes of the Everglades. Pihl and Rosenberg (1982) employed a .7-m high open-ended box (.5-m^2 opening) in vegetated and unvegetated shallow coastal waters of Sweden. This method allowed quantitative sampling of fish and macroinvertebrate populations.

Our research in the Okefenokee Swamp required a method for taking replicate samples in heterogeneous aquatic macrophyte prairies at frequent intervals. We believed, however, that a mesh-sided throw trap of the type employed by Kushlan (1981) would not be heavy enough to penetrate the dense vegetation. Therefore we used a 1-m^2 metal trap which could be carried and dropped into place. Possible disadvantages of this method are (1) that a 1-m^2 trap may be too small to adequately sample marsh fishes and/or macroinvertebrates, and (2) that animals may be disturbed and thus escape before the trap is dropped. Although it is not possible to measure drop trap efficiency without knowing animal densities, we have been able to evaluate drop-trapping in comparison to seining in open and enclosed areas by comparing numbers of individuals and species collected per unit area by the three methods.

METHODS AND MATERIALS

Sampling was conducted in the Okefenokee Swamp, a large freshwater wetland located in southeastern Georgia and northern Florida (Fig. 1). Three sampling sites with different types of aquatic vegetation were chosen to test collecting methods. Little Cooter Prairie is dominated by submerged and emergent *Nymphaea odorata*, *Eriocaulon compressum*, and *Rhynchospora inundata*, and has the highest live-vegetation biomass of the three sites. The Rookery Control and Rookery sites are dominated by *Nuphar luteum* and *Myriophyllum heterophyllum*,

with a relatively large biomass of water column plants such as *Utricularia sp.* and *Cabomba pulcherrima*. The water at all three sites is darkly stained because of the presence of organic acids. Water depth ranges from 20 to 60 cm. Water pH ranges annually from 3.3 to 3.9 (mean of 3.7), and water temperature ranges from 5 C to 36 C (Blood 1981). The substrate at all three sites is soft unconsolidated peat, the depth of which varies from several centimeters to more than a meter. This bottom material is easily suspended when disturbed, thus clogging nets and reducing visibility.

Three sampling procedures were employed during June, July and August of 1982 in each of the study sites. The large scale seining technique utilized a 3-m minnow seine (mesh size ca. 3-mm) to sample a 10 x 10-m quadrat. The seine was planted into the peat, after which four people kicked through the vegetation towards the net from a distance of approximately 2-m pushing water and presumably animals into the seine. This procedure was repeated until the entire 10 x 10-m quadrat had been sampled, an effort requiring four people approximately 2 hours.

The second seining technique, an enclosure-net method, was a modification of several previously described enclosure drop net methods (Hellier 1958; Hoese and Jones 1963; Brook 1977). Seines (mesh size 1.5 mm) were used to enclose a 5 x 5-m quadrat. They were carried into position and then unrolled to form the sides of the enclosure. Fishes and invertebrates were removed from within the quadrat by seining with a 2-m minnow seine (mesh size 1.5-m). The enclosure net/seining required three people about 1.5 hours to complete.

The drop trap method is portable and similar in design to the method described by Pihl and Rosenberg (1982). Our open-ended meter-square drop trap is constructed of 1-mm stainless-steel sheet and is 75 cm deep. This device was suspended (by means of handles welded to the box trap) on a 5.5-m pole carried between two people, dropped quickly on the area to be sampled, and then pushed into the substrate. Vegetation within the trap was uprooted, shaken in the water to remove any organisms clinging to the leaves, and retained for vegetation analysis. Animals were collected using a 50-cm square net with 1.5-mm mesh size. In addition, detritus (suspended in the water column by our sampling efforts) and uprooted vegetation collected in the dip net were preserved in the field and stained with Rose Bengal; animals were picked out of these samples in the lab. The inside of the trap was swept until 10 consecutive sweeps captured no vertebrates or macroinvertebrates. This method required three people approximately 30 minutes to complete.

Numbers of individuals captured were compared across the three sampling methods by Kruskal-Wallis one-way analysis by ranks (Elliott 1977). The Kruskal-Wallis K-statistic was calculated using the total number of 1) macroinvertebrates, and 2) fish captured in replicate samples. This non-parametric test was used because variances were large relative to density means for most taxa.

RESULTS AND DISCUSSION

The m^2 drop trap collected significantly more macroinvertebrates ($K = 21.9$, $p < .005$) and fish ($K = 22.2$, $p < .005$) per unit area than the seining methods (Table 1). A difference of several orders of magnitude existed between the 1-m^2 drop trap and the seining and enclosure-net methods for most macroinvertebrate taxa. Amphipoda,

Coleoptera, and Odonata were especially underrepresented numerically by the two large-area methods, and two taxa (Trichoptera and Isopoda) were completely absent from both seining and enclosure-net samples. The four most numerous fishes (*Leptolucania ommata*, *Gambusia affinis*, *Elassoma evergladei*, and *Enneacanthus obesus*) were also especially underrepresented with the two seining methods.

The high fish densities in drop trap samples compared with the number taken in collections made by seining an enclosed area suggests that large numbers of fish are not chased from the area by workers approaching with the trap. Also, 90% (s.d.= 7.4%) of tagged fish released into the traps during sampling were recovered, so we are confident that the procedure for netting fish from the traps is adequate. Fewer species of fishes were collected with the drop trap than with the enclosure seining method (Table 1), however, those fishes missed are relatively rare species and they have all been collected with the drop trap in subsequent trips. Kushlan (1981) reported that a 1-m^2 throw trap in fact collected more fish species than a larger throw trap when both were used in grass marsh habitats, and that fish densities estimated by the small enclosure trapping is a suitable method for sampling fish in marshy and swamp habitats.

Drop trap sampling in the Okefenokee macrophyte prairies involves the additional problem of large amounts of unconsolidated peat becoming suspended when the dip net is swept through the trap and vegetation is uprooted. During sampling, this detrital material is collected, preserved and stained and is then hand-sorted in the laboratory. Sorting this material was considered necessary for estimating densities of even large macroinvertebrates. Additionally, fish density estimates would have been substantially lower if the detritus had been discarded; an average 17% (s.d. = 10%) of the fish collected with the drop trap on a given date were recovered from the detritus during laboratory sorting. Thus, fish density estimates would have been substantially lower if the detritus had been discarded.

From these results it is obvious that of the three methods tested in the Okefenokee Swamp wetlands, the 1-m^2 drop trap is the best method for collecting fishes and macroinvertebrates in terms of efficiency and higher estimates of animal density. An important advantage of the 1-m^2 drop trap is that rooted and suspended water column vegetation can be quantitatively collected simultaneously with fishes and macroinvertebrates. Any associations between plant biomass and/or plant species collected and organisms caught can be detected by drop trap information with more accuracy than with the conventional seining techniques tested in this study. Concurrently collected information of this type is essential for (1) assessing species' microhabitat preferences, (2) examining possible interactions between habitat complexity and fish and/or invertebrate community structure, and (3) similar studies where an accurate description of an organism's immediate habitat is crucial.

The 1-m^2 drop trap could be modified for use in deeper water by lengthening the trap sides or attaching netting and floats to the top of the trap. The trap should not, however, be so deep that it drags in the water when carried into place, and operators must be able to efficiently remove captured organisms. The portable drop trap worked well in the Okefenokee because the shallow vegetated areas were inhabited by small, relatively slow moving fishes; larger, more mobile species (as might occur in deeper habitats) would be more difficult to sample by this method.

A steel-sided 1-m^2 portable drop trap was the best method tested

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in this study for our purposes of obtaining reliable density estimates of fishes and large macroinvertebrates as well as an accurate description of the vegetation habitat. Ease and simplicity of operation, ability to take many replicates within a short time, and the relatively low cost ($50 for enclosure and hand nets), coupled with the primary objectives stated above led us to use the 1-m^2 drop trap as our primary sampling method for long-term fish, macroinvertebrate, and aquatic macrophyte population and community studies in the shallow-water wetlands of the Okefenokee.

ACKNOWLEDGEMENTS

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Figure 1. Map of the Okefenokee Swamp showing the location of marsh sampling sites.

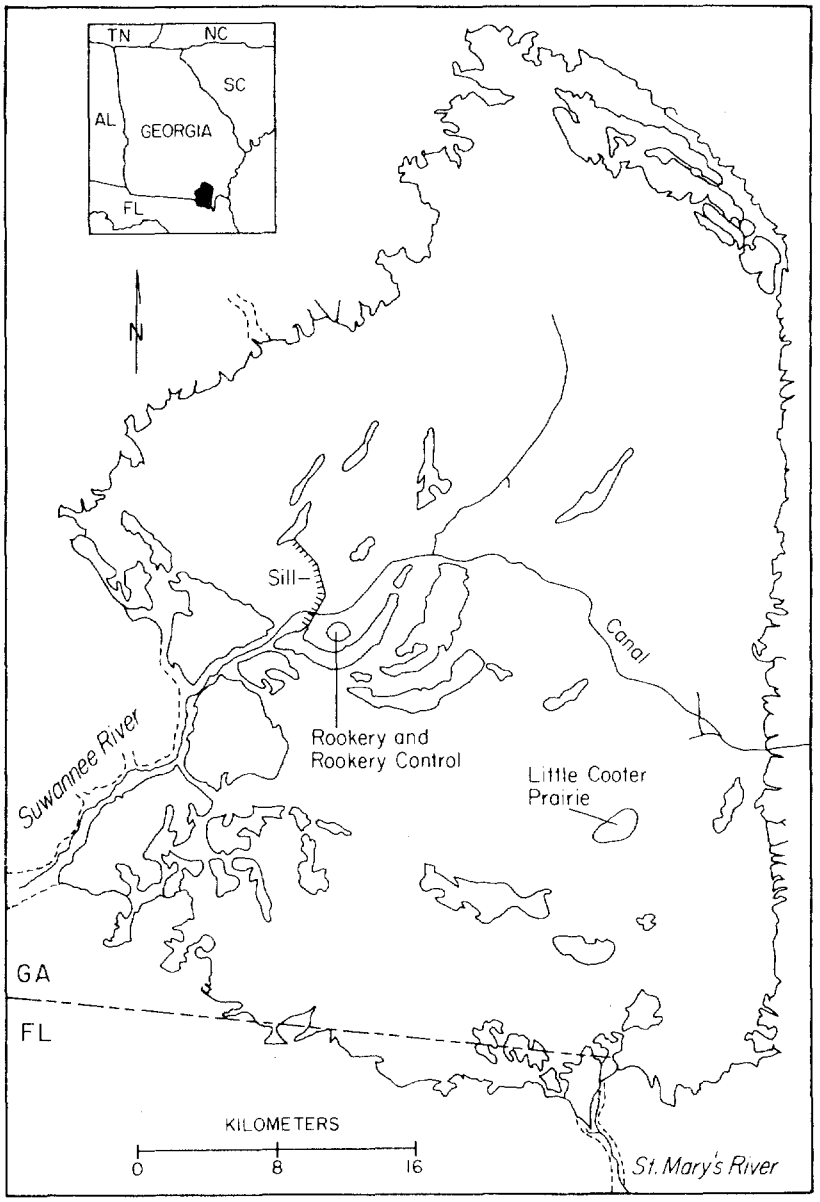

Table 1. Mean number of individuals of major species of fishes and orders of macroinvertebrates collected by three sampling methods in all habitats examined. Density per unit effort was calculated by summing mean numbers of individuals collected and dividing by the average time required to take one sample.

	1-m^2 drop trap		enclosure-net seine		seining	
	1 x 1 m n=8		5 x 5 m n=12		10 x 10m n=9	
Person Hours/ Replicate Sample	1.5		4.5		8	
	$\bar{X}$ #/m^2	(s.d.)	$\bar{X}$ #/m^2	(s.d.)	$\bar{X}$ #/m^2	(s.d.)
CRUSTACEA						
Amphipoda	142.5	(115.70)	0.01	(.02)	0.17	(.19)
Decapoda	10.22	(9.11)	1.88	(2.94)	0.29	(.30)
Isopoda	1.25	(1.89)	0.00		0.00	
INSECTA						
Lepidoptera	3.25	(3.11)	0.01	(.01)	0.01	(.01)
Coleoptera	13.11	(10.47)	0.04	(.06)	0.06	(.12)
Collembola	0.50	(.93)	0.00		0.01	(.03)
Hemiptera	19.25	(20.07)	1.06	(1.64)	0.07	(.07)
Odonata	64.00	(42.91)	0.49	(.40)	0.03	(.06)
Trichoptera	2.25	(2.49)	0.00		0.00	
Diptera	0.50	(.53)	0.00		0.01	(.01)
Density/Effort	171.2		0.78		0.09	
PISCES						
Erimyzon succetta	0.00		0.05	(.12)	0.00	
Ictalurus natalis	0.00		0.01	(.03)	0.00	
Leptolucania ommata	13.88	(9.05)	0.17	(.15)	0.00	
Gambusia affinis	13.63	(8.96)	3.38	(4.35)	0.24	(.26)
Elassoma evergladei	9.50	(2.12)	2.59	(2.37)	0.49	(.49)
E. okefenokee	2.20	(1.30)	0.35	(.38)	0.00	
Centrarchus macropterus	0.60	(1.34)	0.55	(.45)	0.00	
Enneacanthus gloriosus	8.60	(6.54)	0.65	(.80)	0.00	
E. obesus	0.50	(.76)	0.26	(.45)	0.09	(.11)
Etheostoma fusiforme	4.20	(2.63)	0.18	(.25)	0.00	
Density/Effort	35.44		0.99		0.10	

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#/m^2 (s.d.)

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