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ABSTRACT

Most of the usual methods for studying fish populations have been ineffective when applied in the shallow, freshwater marshes of southern Florida. Exceptions are devices which trap fish by rapidly enclosing a known area of marsh. Of these, pull-up traps are best suited for sampling large areas for relatively large or widely dispersed fish, whereas drop traps with bottom nets are the most efficient for studies of small species at permanent sampling sites. Each produces comparable but consistently biased results due to habitat disturbance. The most precise data on shallow water fish communities are obtained by use of bottomless drop traps which are moved to new sites for each sample.

The study of shallow-water fish communities in the marsh and swamplands of southern Florida has proven difficult because of problems in obtaining quantitative samples of fish populations. Sampling methods such as mark-recapture, electrical sampling, and poisoning, and mechanical devices such as hoop nets, trawls, drag-nets, push nets, and seines have all been used in southern Florida marshes by various investigators with little success. An alternative method of studying shallow-water fish communities is to take quantitative samples with a mechanical sampling device which rapidly encloses a known area of marsh, thereby trapping the fish in the water within that area. Several successful attempts to use such devices have been made during various studies in the southern Florida marshes. The purpose of this paper is to briefly discuss the difficulties and advantages of the devices which have been used in southern Florida and to provide construction details of those not previously published.

TYPES OF SAMPLING DEVICES

Hand-held devices have been used with much success in southern Florida (Table 1). Commonly used is a bottomless 75.6-liter (20-gal) galvanized garbage can or a 45.5-liter (12-gal) galvanized wash tub which is plunged through the water into the bottom mud. Fish are removed with a dip net. The two-man pole net, used in the Big Cypress Swamp by B. F. McPherson of the U. S. Geological Survey, consists of a sheet of 3-mm mesh nylon netting formed into an open box 1.2 m on a side with a wooden pole attached to each corner. A string of lead weights and a chain are tied to the bottom of the net, and floats are strung along the top. Holding the poles 1.2 m apart, two operators plunge the ends and the weighted bottom of the net into the water and then push the poles solidly into the sediment. Fish are removed by dip net. The main drawback of both methods is that the proximity of the operator to the sampling site undoubtedly influences the results, particularly underestimating the abundance of fast-swimming species. Hand-held devices can also be used as throw traps. They can be solid, i.e. weighted wash tubs, or open-ended boxes of pipe and netting material. To sample, they are thrown into the water at some distance from the operator. Effectiveness depends on vegetation density.

The Kahl drop trap (Kahl 1963) is light enough to be portable, but its light weight causes difficulty when one is sampling in dense vegetation. During a study of fish populations of a pond in the Big Cypress Swamp (Kushlan 1972), I modified the Kahl trap to sample in thick emergent vegetation. The movable cage is 1 m wide and 1.2 m tall. Its frame is constructed of 3-mm sheet iron, with sides of 1.5-mm mesh fiberglass screen bolted to the frame. Vertical poles of 38-mm pipe are screwed into cross-bars at the top, and the bottom ends are sunk into the mud. The trap is guyed by diagonal lines tied to

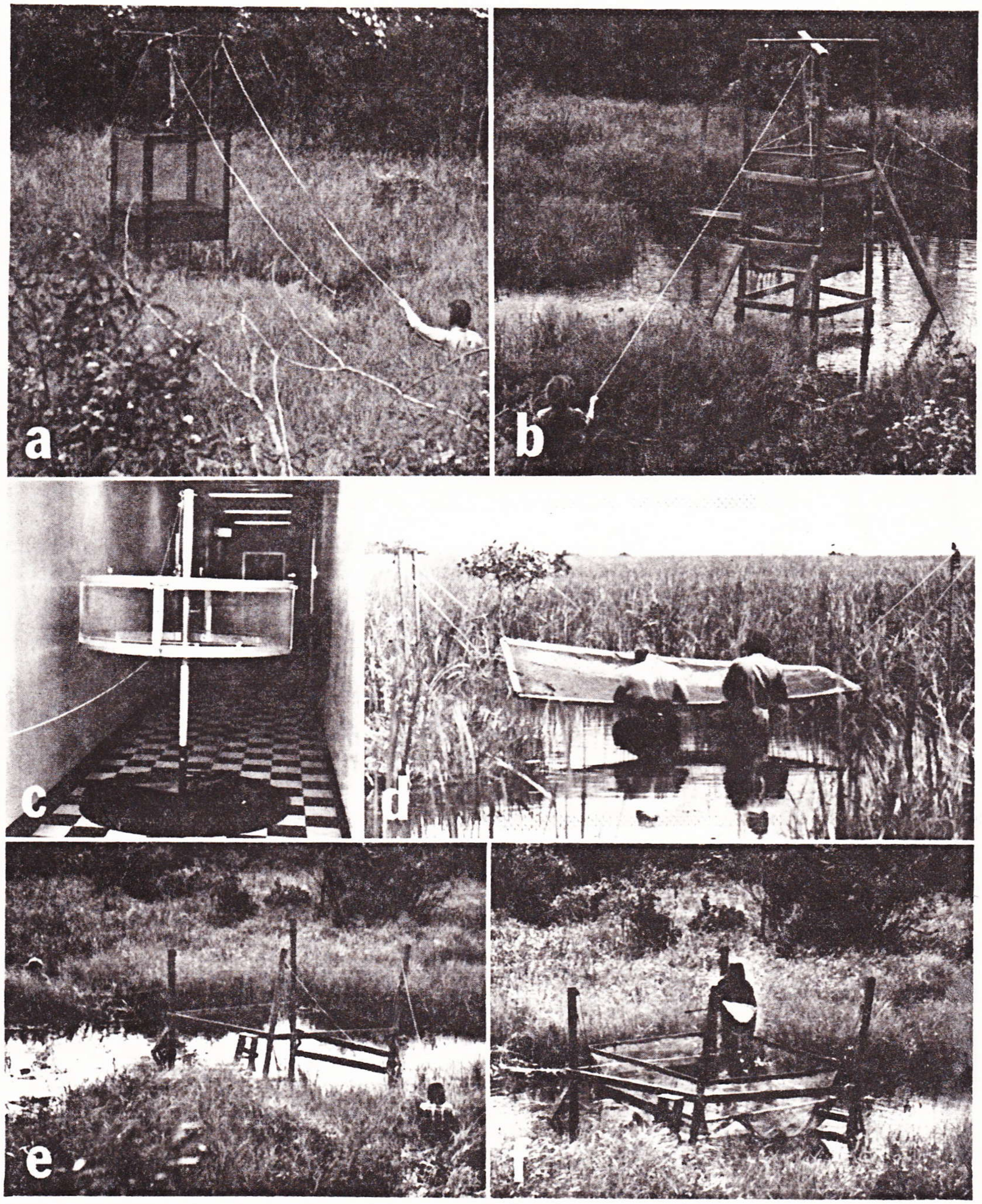

FIGURE 1.—Mechanical fish sampling devices used in southern Florida. (a) Modified Kahl drop trap, (b) Kushlan free-fall trap, (c) Higer drop trap, (d) Higer pull-up trap, (e) Lifting Kushlan pull-up trap, (f) Removal of fish from Kushlan pull-up trap.

the top crossbars, and the cage is raised by block and tackle. An operator standing 20 m away releases the cage by pulling a line which trips a pelican clamp (Fig. 1a). The cage achieved a quick and clean descent through a dense stand of emergent maidencane (*Panicum hemitomon*). However because of the size and weight of the cage, the trap became

TABLE 1.—*Characteristics of some mechanical fish sampling devices*

Device	Surface area sampled (m)	Position of operator	Portability	Approximate sampling time (min)	Approximate maximum effective water depth (m)
75.6-liter garbage can	0.15 m^2	Adjacent	Portable	20	0.5
45.5-liter wash tub	0.23 m^2	Adjacent	Portable	15	0.25
Two-man pole net	1.5 m^2	Adjacent	Portable	30	1.3
Kahl drop trap	1.0 m^2	Remote	Portable	30	1.0
Modified Kahl drop trap	1.0 m^2	Remote	Stationary	30	1.3
Kushlan free-fall trap	1.0 m^2	Remote	Stationary	30	1.6
Higer drop trap	1.2 m^2	Remote	Portable	15	1.0
Higer pull-up trap	4.7 m^2	Remote	Stationary	10	1.0
Kushlan pull-up trap	4.0 m^2	Remote	Stationary	10	1.6

increasingly difficult to reset and secure. Futhermore. the use of a dip net to remove fish eliminated plants from the sample site and eventually negated the need for a heavy trap. Good results in a similar situation can therefore be achieved with a lighter and more easily operated device.

I designed a free-fall drop trap (Fig. 2) for use in the more sparsely vegetated central area of the pond (Kushlan 1972). The cage frame is constructed of 13-mm-diameter galvanized steel pipe formed into a box by elbow joints and joiners. The sides are 1.5-mm mesh fiberglass screen tied to the frame by monofilament fishing line. The top and bottom are open. The cage is supported by a scaffolding of 50 × 100-mm wood set in the mud and steadied by guy lines and diagonal wooden braces. One raises the cage by a simple pulley system, holds it in place by securing the line to a pole 20 m away. and drops it by releasing the line (Fig. 1b). The cage falls free within the scaffolding. The drop trap is inexpensive, relatively easy to construct in the field, and samples well unless obstructed by dense plant growth. Metal strips of suitable weight can be bolted to the pipe at the bottom of the cage to overcome this problem. The life of the nylon screen is approximately 2 years. The design of the free-fall drop trap is quite versatile. being readily adapted for various purposes by use of other types of supports and cages. By proper modification it can be made portable.

The Higer drop trap (Fig. 3) is useful for sampling areas where flocculent bottom sediment inhibits the removal of fish by dip net. The base is a round sheet of aluminum surrounded by a 76-mm-high vertical rim. A wedge shaped section of the disk is replaced by a removable bag of 3-mm nylon net. A central pole of 38-mm aluminum pipe is fastened to the center of the disk. The base is painted black to match the sediment. The movable cage consists of a cylindrical aluminum frame 1.2 m in diameter. Cages 0.6 m and 0.9 m high have been used in various water depths. The cage is enclosed on the top and sides by sections of 3-mm nylon net

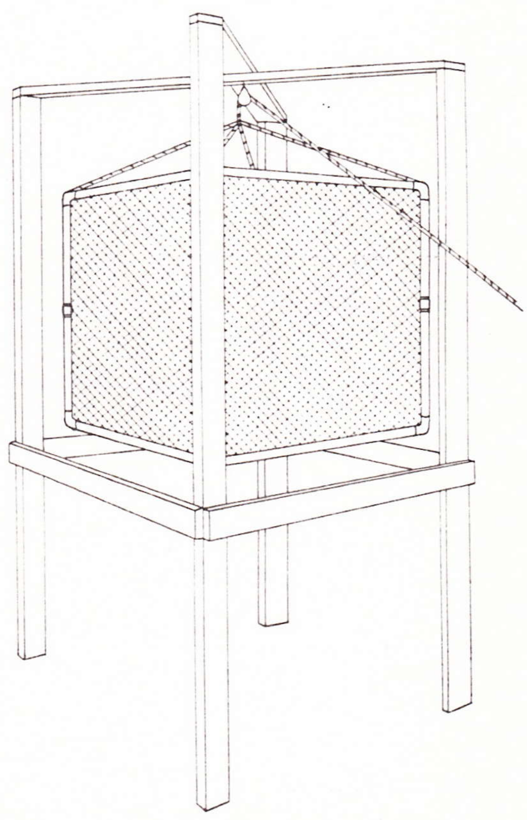

FIGURE 2.—Construction details of Kushlan free-fall trap.

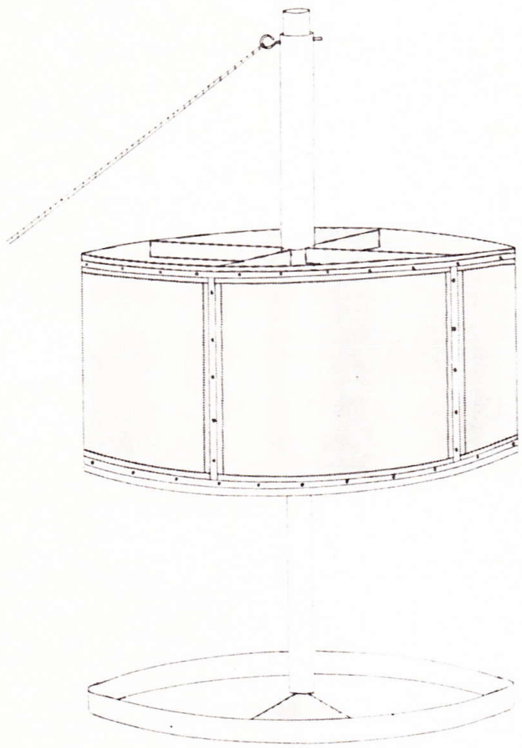

FIGURE 3.—Construction details of Higer drop trap.

secured by aluminum frames screwed into the cage. An aluminum pipe 50 mm in diameter is fastened to the center of the cage by four spokes. In operation the base is positioned and allowed to settle into the mud. The central pipe of the cage is then slipped over the central pole of the base and is supported above the water by a pin inserted into corresponding holes in the two central poles (Fig. 1c). Later, one pulls the pin from a distance which triggers the trap. The cage slides down the central pole and comes to rest on the bottom disk. A pin is then inserted into corresponding holes in the two central poles, making it possible to lift the entire trap off the bottom and out of the water as a unit. Water poured through the top washes fish into the removable bag.

This trap has the advantage of not requiring the use of a dip net and so can be used in soft-bottomed areas. However several persons are needed to raise the trap after sampling. If there is no flocculent bottom sediment at the sample site, the base and the top screening

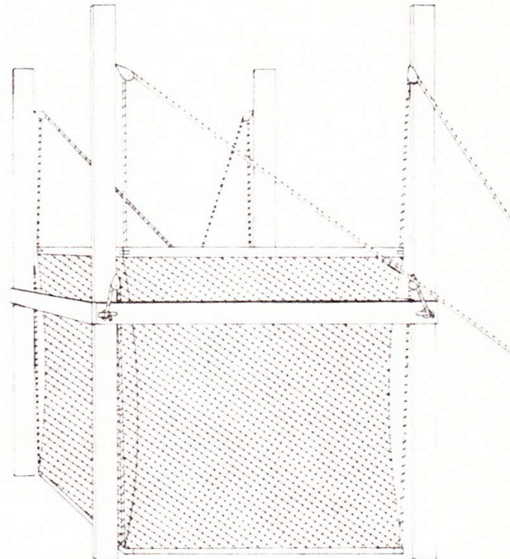

FIGURE 4.—Construction details of Kushlan pull-up trap.

of the cage can be eliminated. A single pipe driven into the ground supports the cage, and fish are removed by dip net. With this system a single cage can be used with permanently positioned poles at various sample sites.

The Higer pull-up trap (Fig. 1d) (Higer and Kolipinski 1967) has the advantage of being easily and quickly operated. However it is suitable only for shallow (1 m) water, and before it is used an extensive trapping site must be cleared of all rooted vegetation. In the Everglades this habitat alteration is partially offset by the rapid growth of periphyton over the submerged net.

I designed a pull-up trap (Fig. 4) to sample the larger species of fish (e.g., centrarchids, ictalurids) in the deeper water of a pond (Kushlan 1972). This trap consists of a bag 2 m wide and 1.8 m tall. The sides and bottom are made of 6-mm stretch nylon net: the top is open. The bottom is weighted down by a square of 13-mm pipe 2 m long on a side. The top of the bag is attached to a similar square made of aluminum bars 41 mm wide by 3 mm thick. The netting is tied to the bars and pipes by nylon cord. Attached to each corner of the aluminum square is a line which passes through a pulley nailed to a vertical 50- × 100-mm piece of wood which is part of the scaffolding surrounding the net. The lines from two corners of the top square are secured on each side of the trap to a stake 16 m away. The aluminum frame, side netting, and bottom netting rest underwater on and in the mud. Two operators, one on either side of the trap, pull the lines attached to the corners of the aluminum square (Fig. 1e) bringing the square and the sides of the net out of the water. The bottom of the net is then raised out of the water by an additional set of lines attached to each corner of the bottom square of pipe. This permits an operator to easily remove the fish with a net (Fig. 1f). This trap has been a successful and efficient sampling device and has been raised swiftly and smoothly in up to 160 cm of water. Observations show that only a few fast-swimming species of fish evade capture. It produces best results when fish densities are high as occur during low water periods in southern Florida.

DISCUSSION

Permanently positioned traps through repeated use alter physical characteristics of the sampling site with a concomitant decrease in precision. This is true whether they are pull-up traps under which plants must be removed or drop traps in which use of a dip net eliminates vegetation at the trap site. In both cases characteristics of the sampling site become constant after a few uses, making samples collected at different times suitable, although consistently biased, indications of populational changes. However the best estimate of the actual structure of fish communities is obtained by use of portable traps in which a sample is not biased by previous habitat alteration.

Drop traps are more precise than pull-up traps because a cage or net pulled through the water column to the surface creates more opportunity for fish to escape than one dropped rapidly from above. The major drawback of bottomless drop traps is that the removal of fish by dipnetting can be time consuming and often requires tedious laboratory separation of animals from mud and debris. It is important to note, however, that using a dip net is a reliable method for removing the fish caught in a trap. Tests using the free-fall drop trap showed a removal efficiency of approximately 99% (Kushlan 1972). Because the efficiency of dipnetting decreases rapidly with increasing size of the drop trap, the area sampled by such traps is limited, and they are thus best used for small and comparatively abundant fish. Pull-up traps, such as the one I devised, can sample larger areas and are valuable for catching larger, more widely dispersed species or for sampling where fish density is low.

Whether a drop or pull-up trap, a device with a bottom lying underwater on the substrate produces somewhat biased results except in sparsely vegetated areas. However, such devices produce comparable samples and are rapidly operated. In addition, all fish caught are removed quickly, a characteristic often of much importance in a field study. In some cases a bottom has little effect on sampling efficiency. For example, if a drop trap is used in a permanent sampling site, the addition of a bottom which can be raised with the cage will not seriously affect the trap's performance but will significantly decrease sampling time.

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