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A Quantitative Sampler[1] for Biomass Estimates of Aquatic Macrophytes

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INTRODUCTION

A study[4] was initiated in 1984 to estimate the biomass of certain submersed and floating weeds in Reelfoot Lake, Tennessee, following introduction of the plant-eating white amur [*Ctenopharyngodon idella* (Val.)]. Most vegetation occurs in waters less than two meters deep, often among submerged stumps and logs and inundated baldcypress trees [*Taxodium distichum* (L.) Rich.]. Submersed weeds also grow within extensive stands of lotus [*Nelumbo lutea* (Willd.) Pers.] and spatterdock [*Nuphar luteum* subsp. *macrophyllum* (Small) Beal].

Poorly consolidated sediments, underwater obstructions, and low visibility within the shallow, hypereutrophic waters of Reelfoot Lake made biomass determinations impractical by free divers (Rickett, 1920), SCUBA (Wood, 1963), optical methods (Owens et al., 1967), or fathometry (Maceina and Shireman, 1980). Numerous specialized sampling devices have been used in lakes to retrieve aquatic vegetation. Westlake (1969) has summarized the use of a scoop, the Ekman dredge, a cylindrical sampler, and a pronged grab. An enlarged mechanical grab was described by Dromgoole and Brown (1976) and a core sampler was used for collecting propagules of hydrilla (*Hydrilla verticillata* Royle) from lake sediments (Sutton, 1982). Other samplers, considered for Reelfoot Lake, were a rotary cutter (Howard-Williams and Longman, 1976) and those used for collecting both aquatic macrophytes and epiphytic macrofauna (Hiley et al., 1981; McCauley, 1975). For various reasons, none of these devices was adequate for sampling Reelfoot Lake vegetation.

The Osborne sampler (Osborne, 1984) and the Waterways Experiment Station sampler (Sabol, 1984) seemed promising. However, both require a pontoon boat. Pontoon boats are used on Reelfoot Lake but only as tour boats within well marked, obstruction-free lanes. Such boats cannot be operated among logs, stumps and trees where much of the Reelfoot Lake vegetation occurs. These samplers also were not designed to shear the large rhizomes, roots and leaves of seasonally emergent macrophytes. A cylindrical sampler, similar to that described by Unni (1976), was constructed and tested. This device was difficult to use and would not allow quantitative removal of plant organs from the hydrosoil.

This paper describes a sampler (the Reelfoot Sampler) and transport system developed for quantitative estimation of aquatic macrophyte biomass in Reelfoot Lake.

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[4]Sliger, W. A. and J. W. Henson. 1987. Decline of submersed macrophytes of Reelfoot Lake following introduction of the White Amur. J. Tenn. Acad. Sci. 62:31-32 (Abstract).

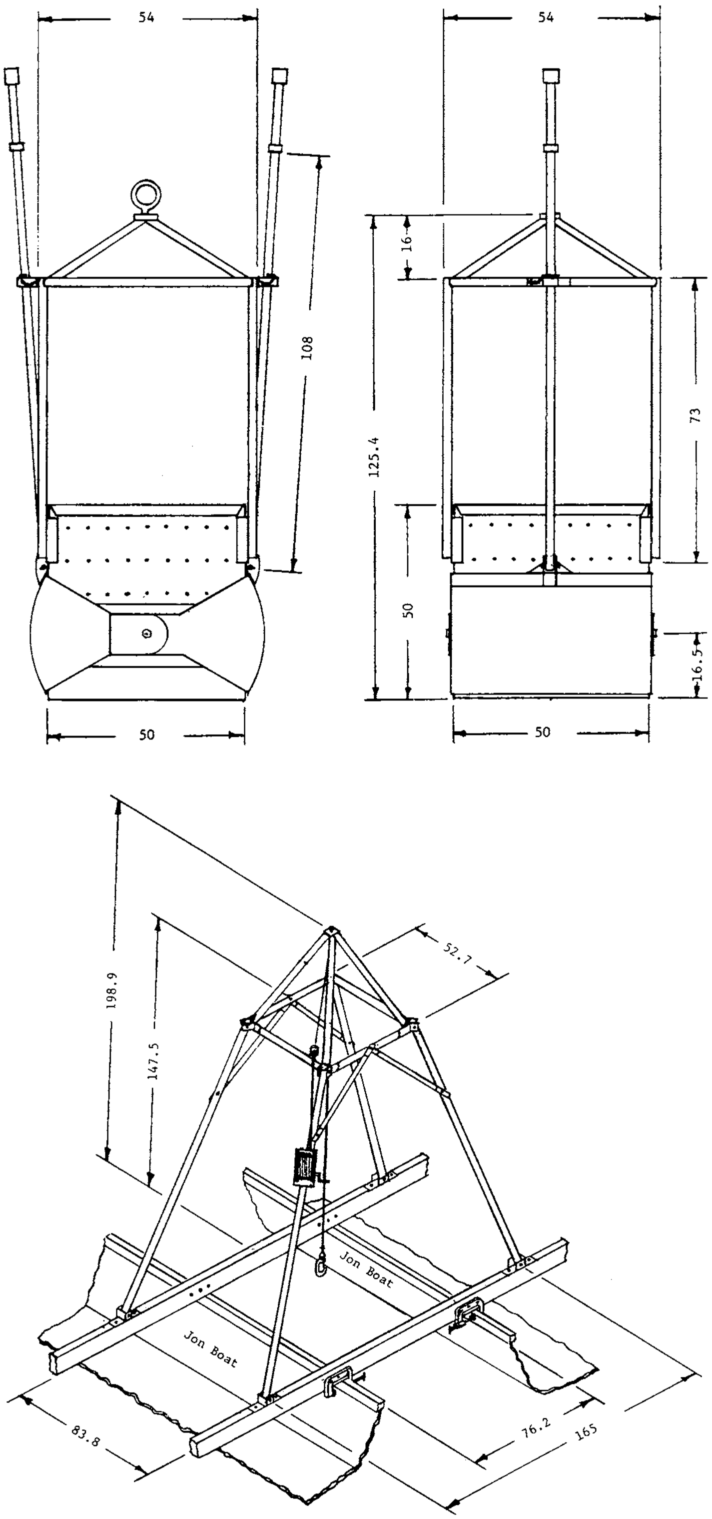

Figure 1. a. Side and front views of Reelfoot Sampling Dredge shown with jaws in open position. Dimensions are in centimeters. b. Derrick used with Reelfoot Sampler.

SAMPLER DESIGN AND OPERATION

The Reelfoot Sampler was designed and constructed from basic characteristics of both the Ekman dredge and Osborne sampler, together with original features.

Figure 1 illustrates the sampling dredge and derrick used for its suspension between two flat-bottom Jon boats. The dimensions of one boat are: length = 4.3 m, width = 1.22 m and depth = 40 cm. The other boat measures 3.2 by 1.17 m with a depth of 35 cm. Two wooden beams hold the boats together. The derrick is secured to the beams. Plywood platforms on bow and stern sides of the derrick provide additional working space. A 6-hp outboard motor mounted on the larger boat powers the unit in lake transport. Boats of unequal size provide for easy steering. Draft is about 15 cm. Although larger Jon boats could be used, the above are considered minimum sizes for providing stability during transport and weed harvesting.

The dredge was constructed from low-carbon, sheet steel (3.04 mm thick) with welded seams. Sharpened edges of the movable jaws overlap to provide shearing action. Hand-operated push rods (with removable extensions for variable water depths) allow positive closing with a force great enough to shear large rhizomes and nonligneous roots. An area of 0.25 m^2 is sampled by the square box. The frame at the top of the box, welded from steel pipe (12.7 mm I.D.), provides lateral stability and allows attachment of a steel wench cable. The derrick was fabricated from steel pipe (2.54 cm I.D.). Weight of sampler and derrick is 75 kg. Materials cost for the sampling system, exclusive of boats, was less than $300 (1989 dollars).

During operation, the dredge is lowered and raised through a space between the boats by a hand-operated wench mounted on one derrick leg. Jaws are open as the sampler is lowered through the water column and a removable, plastic top-screen (6.35-mm mesh) prevents loss of vegetation. Small floating macrophytes can be collected by halting the dredge before complete submergence, removing the screen, and skimming plants from the water surface. Once lowered to the lake bed, simultaneous downward thrusts on the pushrods close the jaws. After raising the dredge into the derrick, a wooden-frame sieve tray supported by sides of the two boats is inserted underneath. Plastic screening (6.35-mm mesh) forms the bottom of the sieve tray. Water is allowed to drain through a series of holes (3.8 mm in diameter) in the sides of the sampler box prior to releasing the dredge contents into the tray. Lake water is used to sieve fine sediments through the screen and for washing each sample as it is collected. Sieving is facilitated by removal of the top screen and collecting the bulk of plant materials before raising the dredge completely out of the water.

SAMPLER EVALUATION

The sampler was tested at several sites prior to adoption in June 1984 for long-term biomass assessment of aquatic weeds in Reelfoot Lake.

This sampler allows quantitative collection of biomass within the water column and from the hydrosoil. The device functions equally well with submersed, emergent or floating plants. It collects foliage, root systems, tubers, and the large rhizomes of seasonally emergent macrophytes. If desired, separate measurements can be made for the number and biomass of plant reproductive structures retained by the screen. Screen mesh size can vary, depending upon the nature of sediments, amounts and kinds of debris, and types of plant material to be collected.

The transport system with mounted sampler can be assembled by two persons in less than one-half hour on land or in water. The sampler is operated on site by two persons. It functions in dense weed beds, among inundated baldcypress, and in log and stump infested waters. Weeds have been harvested from water depths less than 0.5 to 2.5 m. The maximum operational water depth has not been determined but effective use of added extensions to the push rods likely is a limiting factor. Sampling in windy weather requires the use of boat anchors.

Time required for sample collection varies according to quantity and type of the vegetation, degree of sorting by species and/or propagules, nature of the bottom sediment, and amount of debris present. Most individual samples are collected in less than 15 minutes.

As with other dredge samplers, tree limbs or other hard debris may lodge between the jaws preventing closure. An "edge effect," discussed by Sabol (1984), was observed with the Reelfoot Sampler. Disturbance of plants around the perimeter of the box occurred as some vegetation was pushed to the lake bottom prior to shearing. With the transport system designed for minimum draft on Reelfoot Lake, it was not possible to enlarge the sampler in order to minimize the edge effect.

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