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A Sled-Mounted Suction Sampler for Benthic Organisms

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ABSTRACT

The sampler is an underwater vacuum device mounted on a sled; a venturi-type water dredge provides suction. This equipment collects quantitative samples of young pink shrimp, Penaeus duorarum duorarum, and is effective in capturing other small benthic organisms.

INTRODUCTION

Pink shrimp, Penaeus duorarum duorarum, are the basis of an important commercial fishery on the offshore Tortugas grounds, northwest of Key West, Fla. We measured the abundance of juvenile shrimp in the shallow coastal waters before their offshore migration, to predict and evaluate fluctuations in the yield of the adult pink shrimp.

Longhurst (1964) described problems involved in obtaining quantitative samples of benthic organisms. Pink shrimp are particularly difficult to sample because of variations in their burrowing habits. Although they usually remain burrowed in the substrate during daylight and become active at night, certain environmental conditions can disrupt this pattern (Fuss and Ogren, 1966).

Conventional shrimp sampling gear, such as trawls or pushnets, primarily capture only unburrowed shrimp. Obviously, a different type of gear is needed to capture both unburrowed and burrowed shrimp. Various suction devices have been used to remove organisms or eggs from the substrate. Brett (1964) used a hydraulic suction dredge to sample benthic macrofauna encircled by a shallow cylinder. We believed, however, that active animals, such as shrimp, would escape from a cylinder and for reasons described later, we preferred to have samples that were taken continuously along a transect. Manz (1964) collected eggs of walleyes, Stizostedion vitreum vitreum, by using a sled to transport a suction hose across the bottom. His device was not designed for quantitative sampling of infauna, however, and his pumping system was too bulky for our use and tended to clog on mud, silt, or sand bottoms. To overcome those deficiencies, we developed the sled-mounted suction sampler described briefly by Costello and Allen (1966).

DESIGN

The suction sampler has three main components: (1) winch assembly; (2) vacuum sled; and (3) raft-mounted water dredge (fig. 1).

Winch Assembly

A hand-operated wincn is bolted to a mounting flange on a 112-cm. upright stand of 3.2-cm. aluminum pipe. Welded to the base of the stand for stability is an "H" shaped platform of 0.6- by 5.1-cm. aluminum flatstock. About 18.3 m. of 0.3-cm. nylon parachute cord is wound on the winch drum. The cord is led through a block affixed to the stand, 45.7 cm. below the drum, to ensure a low angle of pull. A snap is fastened to the cord end for ready attachment to the sled bridle.

Vacuum Sled

The sled is composed of two major parts: the sled frame and the suction head (fig. 2). The sled frame, 0.3-cm. aluminum stock, is made of four curved vertical runners welded at each end to a 11.3- by 45.7-cm. transverse plate. Gussets are welded at the angles between the vertical runners and transverse plates for rigidity. The two outside runners are welded to the ends of the plate and have 3.8-cm. wide strips welded to their undersides to form skis that prevent the sled from sinking

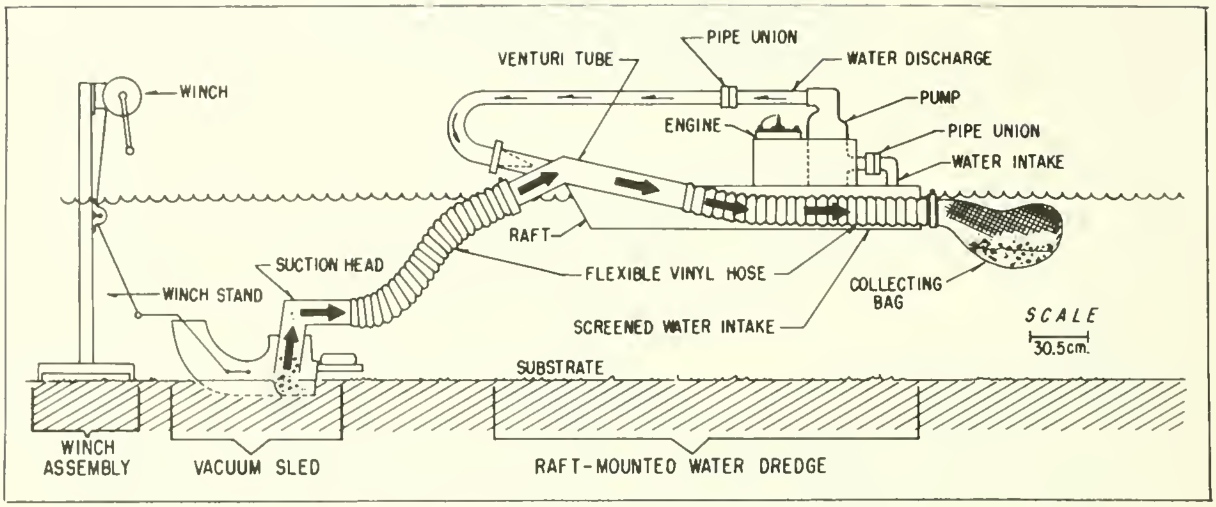

Figure 1.--Schematic drawing of the suction sampler.

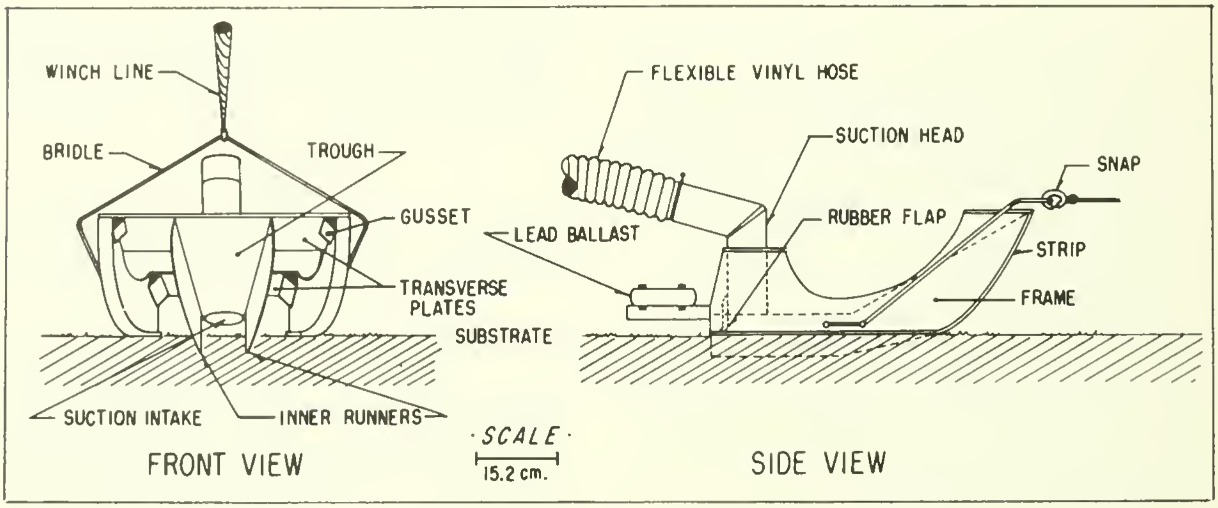

Figure 2.--Schematic drawings (front and side view) of the vacuum sled. Note that the inner runners penetrate substrate.

into the substrate and thus control the depth sampled. The two inner runners are spaced 8.0 cm. apart down the center of the sled frame and form the sides of a trough. These runners project 3.8 cm. below the skis, penetrate the substrate, and effectively limit the width of the swath sampled.

The suction head is constructed of two 15.2-cm. sections of 7.6-cm. outside diameter aluminum irrigation pipe, welded to form a 100° elbow. The suction head is inserted through a 7.6-cm. diameter circular hole in the after transverse plate of the sled frame and through a 7.6-cm. access hole in the roof of the trough. The opening on the suction head is 5.7 cm. above the substrate which it faces. An adjustable brass clamp serves to hold a hard rubber flap, 0.3 cm. thick by 7.6 cm. wide, in place around the after portion of the suction head. The flap spans the width and depth of the trough behind the suction head. Because the opening on the suction head is in the afterpart of the trough, most organisms are enclosed before being subjected to suction. In addition to preventing the escape of organisms, the enclosing effect of the trough and flap serves to concentrate and increase suction directly under the suction head intake.

A bridle and ballast complete the sled assembly. The wishbone-shaped bridle, constructed from 1.0-cm. stainless steel rod, is affixed rigidly to the outer sled frame. The ballast, a 9.1-kg. lead block is supported by a pair of 2.5- by 2.5-cm. aluminum angle pieces welded to the inner runners. The angle pieces extend 25.4 cm. behind the sled body. The ballast causes the two inner runners to cut into the substrate when the sled is pulled. The sled, including ballast, weighs 16.3 kg. and is 84 cm. long, 45.7 cm. wide, and 30.5 cm. high.

Raft-Mounted Water Dredge

The water dredge has several components. The power unit consists of a 5.1-cm. self-priming centrifugal pump coupled directly to a 2-1/2-hp. 4-cycle gasoline engine. The engine and pump are housed in a shallow waterproof box with a removable top. The pump unit and box are mounted on a twin sponson raft that is 1.8 m. long overall, 81.3 cm. wide, and 8.9 cm. deep. The individual sponsons, 1.8 m. long, 30.5 cm. wide, and 8.9 cm. deep, are hollow and made of 0.6-cm. plywood. Transverse 2.5- by 15.2- by 91.4-cm. wooden stringers tie the two sponsons together.

A venturi tube (fig. 3) is mounted in the forward portion of the raft between the two plywood sponsons. The tube housing is constructed of two 45.7-cm. sections of 7.6-cm. outside diameter aluminum irrigation pipe, welded to form a 150° elbow. A moulded plastic water jet nozzle is flange-mounted inside a 15.2-cm. section of 5.1-cm. outside diameter irrigation pipe. The nozzle assembly is aligned and welded over a 5.1-cm. access hole in the housing so that the water jet is directed down the center of the elbow section, which leads to the collecting bag.

All pipe fittings are rigid 3.8-cm. PVC (polyvinylchloride); union fittings at the intake and discharge lines facilitate removal of the pump unit for repairs (fig. 1).

Coarse 0.6- by 0.6-cm. galvanized hardware cloth is stapled across the center space on the underside of the raft. This screening prevents debris from clogging the finely screened water intake in the after part of the raft.

Hoses are used to link the sled, venturi tube, and collecting bag. A 7.6-cm. inside diameter flexible vinyl hose leads from the suction head on the sled to the suction portion of the venturi tube (fig. 1). Another length of 7.6-cm. diameter hose leads from the discharge end of the venturi, aft down the center of the raft into the collecting bag. The reusable collecting bag, 60 cm. long and 30 cm. wide, is made of 2.0-mm. bar mesh nylon netting and has a drawstring at the top. Hose and collecting bag connections are made with 10.2-cm. stainless steel hose clamps. The raft-mounted water dredge weighs 43.6 kg.

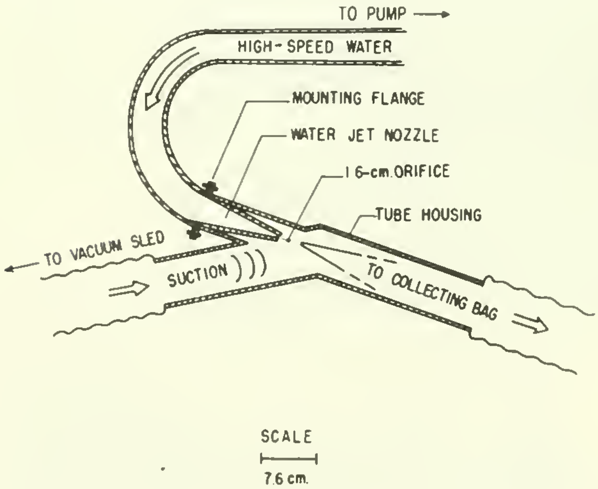

Figure 3.--Schematic drawing of the venturi tube.

SAMPLING PROCEDURE

After the pump is started, the sled is drawn across the substrate at a constant speed by means of the hand-operated winch (fig. 4). Penetration of the substrate is deepest at the slowest speed. Pump, venturi tube, intake and discharge lines, and collecting bag, which are supported by the raft to facilitate mobility, are drawn behind the sled by the sampling hose. As the sled moves, marine organisms and loose substrate straddled by the inner sled runners are drawn into the suction head and discharged into the collecting bag. The mesh size of the bag can be varied, depending upon the size of the organisms to be retained. Sediment and organisms finer than the mesh size of the bag are flushed through it. The collecting bag with its contents is removed, labelled, sealed, and placed in preservative. The entire unit can be disassembled quickly and transported between stations on a 5-m. boat, although we found a 6-m. boat more satisfactory (fig. 5).

Although the sampler operates effectively in deeper water, use of the device has been generally limited to a depth of 1 m. or less, where young pink shrimp are numerous enough to provide a density index. The shrimp often are concentrated in marine vegetation near the low-tide mark in a band parallel to the shoreline. Because this zone of concentration may be either narrow or transitory in respect to water level, season, or other factors, samples taken parallel to shore do not always give a realistic measure of shrimp abundance per unit area at a station. For a more accurate measure, we draw the sampler perpendicular to shore. The sled's inner runners limit the width of the swath to 8.0 cm., so that when the sled is drawn 12.5 m. across the bottom, 1 m^2 of substrate is sampled. Possible environmental changes caused by repeated sampling are minimized since only a narrow strip of the bottom is disturbed.

The sampler may be used for several types of collecting. We used it primarily as described above with the suction head mounted on a sled so that organisms may be sampled from an elongated section of bottom. As previously mentioned, Brett (1964) inserted a free suction head into a cylinder which encircled a prescribed area of substrate. Suction then removed all organisms and plants. The suction head can be removed from the sled and used in vacuum cleaner fashion to sweep

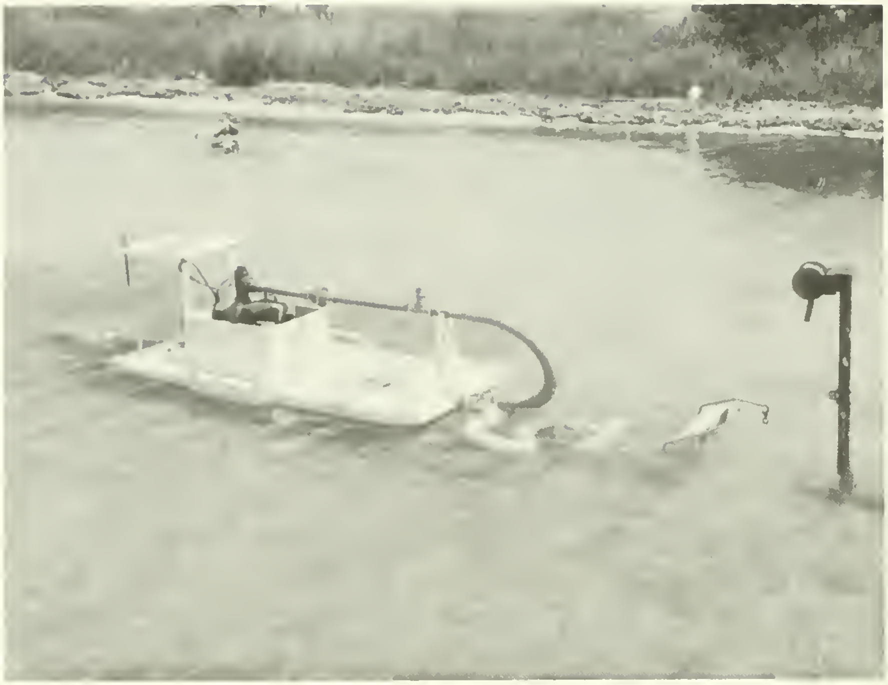

Figure 4.--The suction sampler in position for sampling in shallow water.

Figure 5.--The suction sampler ready for transport on the stern of a 6-m. boat.

samples from among mangrove roots, and from rocky crevices inaccessible to conventional sampling gear. Similarly, the device can be used to collect plankton samples from the water column. We also have operated the sampler with the suction head attached to a funnel-shaped hood to sample a small area of substrate.

EVALUATION

Field use has shown that the sampler is effective and versatile. The number or organisms captured can be related accurately to the size of the area sampled. Because the top layer of substrate is removed by suction as the sled moves across the bottom, the sampler is particularly effective in capturing young shrimp that are burrowed and inaccessible to conventional sampling gear. The result is increased accuracy in determining juvenile shrimp abundance per unit area. In addition, because the device samples a narrow strip, it is useful in determining zonation of juvenile shrimp in the shallow waters bordering bays and rivers (Costello and Allen, 1966).

We compared the shrimp-catching efficiency of the suction sampler with that of the slednet.[1] Tests were made in the daytime in shallow water on firm sand or shell-mud substrates supporting the seagrasses, Thalassia testudinum and Diplanthera wrightii. The sampler and the slednet were pulled adjacent and parallel to one another over the same distance and the catches of young pink shrimp per unit area were compared (table 1). The catches of shrimp by the sampler exceeded those by the slednet in 36 of 43 trials, and the average catch by the sampler was almost twice that by the slednet.

The sampler is effective in capturing other small benthic animals including amphipods, isopods, lobsters, crabs, worms, mollusks, and fish. Marine plants and substrate particles larger than the mesh of the collecting bag also can be obtained with the sampler.

The catch is limited to those animals capable of passing through the 7.3-cm. inside diameter suction head. Although sampling efficiency has not been tested for animals other than shrimp, the sampler is probably quantitative for all except rapidly moving epifauna or deeply embedded infauna. Almost none of the captured organisms are mutilated because they do not pass through the pump. The gear is most effective on level bottoms. The relatively large suction head prevents most clogging. Maximum operating depth is not known.

[1] A hand-pulled frame trawl, similar to that described by Pullen, Mock, and Ringo (1968).

Table 1.--Comparison of the numbers of pink shrimp[1] caught per 6 m.^{2} of bottom sampled by the suction sampler and by the slednet.

Trial No.	Shrimp caught: Suction sampler	Shrimp caught: Slednet	Trial No.	Shrimp caught: Suction sampler	Shrimp caught: Slednet
	Number	Number		Number	Number
1	36	14	23	72	56
2	24	4	24	36	38
3	12	8	25	24	26
4	12	4	26	36	20
5	12	10	27	36	40
6	36	8	28	84	32
7	48	4	29	24	36
8	12	4	30	36	12
9	24	16	31	60	16
10	24	16	32	36	20
11	36	20	33	12	22
12	72	16	34	36	18
13	36	12	35	12	24
14	48	20	36	24	6
15	72	26	37	72	30
16	12	8	38	12	24
17	48	24	39	60	6
18	60	40	40	18	11
19	24	16	41	42	15
20	24	18	42	48	13
21	60	24	43	30	18
22	60	24			
Total catch................				1,602	819
Average catch per 6 m.^{2}....				37	19

[1] Size range 20 to 86 mm. total length (tip of rostrum to tip of telson).

LITERATURE CITED

BRETT, C. EVERETT.
1964. A portable hydraulic diver-operated dredge-sieve for sampling subtidal macrofauna. J. Mar. Res. 22: 205-209.

COSTELLO, THOMAS J., and DONALD M. ALLEN.
1966. Florida Bay ecology project. In Annual report of the Bureau of Commercial Fisheries Biological Laboratory, Galveston, Texas fiscal year 1965, p. 15-18. U.S. Fish Wildl. Serv., Circ. 246.

FUSS, CHARLES M., JR., and LARRY H. OGREN.
1966. Factors affecting activity and burrowing habits of the pink shrimp, Penaeus duorarum Burkenroad. Biol. Bull. (Woods Hole) 130: 170-191.

LONGHURST, ALAN R.
1964. A review of the present situation in benthic synecology. Bull. Inst. Océanogr. Monaco 63(1317) 54 pp. (In English and French.)

MANZ, JERRY V.
1964. A pumping device used to collect walleye eggs from offshore spawning areas in western Lake Erie. Trans. Amer. Fish. Soc. 93: 204-206.

PULLEN, E. J., C. R. MOCK, and R. D. RINGO.
1968. A net for sampling the intertidal zone of an estuary. Limnol. Oceanogr. 13: 200-202.

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