United States
Department of
Agriculture

Forest Service

Pacific Northwest
Research Station

Research Note
PNW-RN-490
December 1989

A Floating Trap for Sampling Downstream Migrant Fishes

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Abstract

Fishery scientists and managers are interested in obtaining information about downstream movements of fish species for biological and economic reasons. Different types of nets and traps have been used for this purpose with only partial success. The floating, self-cleaning downstream migrant trap described here proved successful for sampling several salmoniform and cypriniform species. The trap functions effectively for several streamflow ranges and handles small floating debris without loss of efficiency. Data from these floating traps show a range of trapping efficiency from 5.0 to 46.6 percent.

Keywords: Smolts, fish traps, Humphreys trap.

Introduction

Fishery scientists and managers study migration of fish species for several biological and economic reasons. The smolt stage in the life history of anadromous salmonids is of particular interest because enumeration of downstream migrant smolts can be used to project future returns of adults, assess the effects of land-use activities on fish production, and evaluate the effects of habitat restoration and enhancement activities. Downstream migration of spring chinook salmon (*Oncorhynchus tshawytscha* Walbaum), coho salmon (*O. kisutch* Walbaum), and steelhead trout (*O. mykiss,* formerly *Salmo gairdneri* Richardson) smolts, species of particular economic interest in the west, generally occur during high spring streamflow (March-June) in Western North America. High streamflow and moderate to heavy loads of floating woody debris complicate trapping and enumeration of smolts during this time of the year. A variety of nets, traps, and weirs (Lister and Genoe 1970, Moring and Lantz 1975, Raymond and Collins 1975, Salo and Bayliff 1958) have been used to capture migrating smolts, but all have limitations for dealing with high streamflow and floating debris, and some are prohibitively expensive. Most trapping devices currently available are generally successful at capturing smolts when stream flows and debris loads are moderate to low. To improve trapping of downstream migrant juvenile salmonids throughout the range of water conditions normally experienced during the migration season, a floating trap with a self-propelled, self-cleaning traveling screen has been designed and modified. The trap overcomes many problems associated with traps currently being used.

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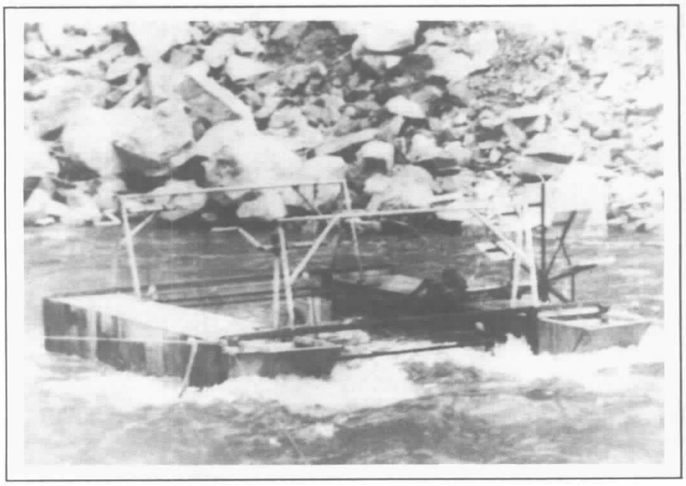

Figure 1—The first self-cleaning scoop trap in operation on the Grande Ronde River, Oregon, 1966.

Prototype Trap

The "Humphreys" trap, a floating trap with a self-propelled traveling screen, was developed by the Oregon Department of Fish and Wildlife in 1966 for sampling downstream migrant salmonids. This trap consisted of two 4.3-meter plywood, Styrofoam-filled pontoons in a catamaran configuration. A 1.2-meter-wide inclined-plane traveling screen, a collecting box, and a rotating debris screen were positioned between the pontoons. The traveling screen was fitted with baffles to help transport fish to the collecting box. Both screens were powered by a single paddle wheel and gear assembly attached to one of the pontoons. Power was transmitted from the paddle wheel to the traveling screen by using a reversing gear. The inclined-plane screen assembly and trap box were supported at each end by adjustable cables attached to A-frames. Hand-operated winches on each A-frame allowed the screen assembly to be positioned and adjusted in the water column (fig. 1).

The trap was designed to function in high velocity water (1 to 3 meters per second) in the stream thalweg. It was held in position with cables running from the pontoons to the streambanks. Fish moving downstream were swept onto the traveling screen and momentarily held there until the screen lifted them above the water column and dropped them into the collecting box. Debris transferred to the collecting box by the traveling screen was moved on downstream by the rotating debris screen at the back of the collecting box.

The first trap was used in the Grande Ronde River from May 11 to June 20, 1966. During this period, 1,015 spring chinook salmon, 145 steelhead trout, and 63 coho salmon smolts were trapped with an average capture efficiency for all species of 11.8 percent; streamflow averaged 9 cubic meters per second during the period.

Modified Trap

Many modifications of the original Humphreys trap have been made since 1966: Styrofoam-filled steel pontoons, design changes in the A-frames, and many small changes in the traveling screen assembly and drive mechanism. Scaled-down versions of the trap were made in 1986 to allow for use of the trap in smaller streams. The new designs include traps with 0.9- and 0.6-meter-wide traveling screens that are shorter, narrower, and lighter in weight than those on original trap (table 1). The 3/4- and 1/2-scale traps are made entirely from aluminum and stainless steel components to resist corrosion. Unlike the full-scale Humphreys trap, the debris screen, collecting box, and upper axle of the traveling screen of the scaled-down versions remain in a fixed position when the trap is in operation. The traveling screen is adjusted with one A-frame winch assembly and cables attached to the lower axle of the traveling screen (figs. 2 and 3). A spacer bar is attached to the bottom of the lower axle of the traveling screen to keep the screen from contacting the stream substrate during operation.

Table 1—Physical dimensions, weights, and capabilities of Humphreys traps with 1.2-, 0.9-, and 0.6-meter-width traveling screens

	Width traveling screen (m)		
Characteristic	1.2	0.9	0.6
Length (m)	4.9	3.4	3.4
Width (m)	3.0	2.0	1.7
Height (m)	1.8	1.2	1.2
Weight (kg)	1135.0	340.0	295.0
Maximum fishing depth (m)	.9	.8	.8
Optimum stream size (m^3/s)	<15.0	<8.0	<3.0

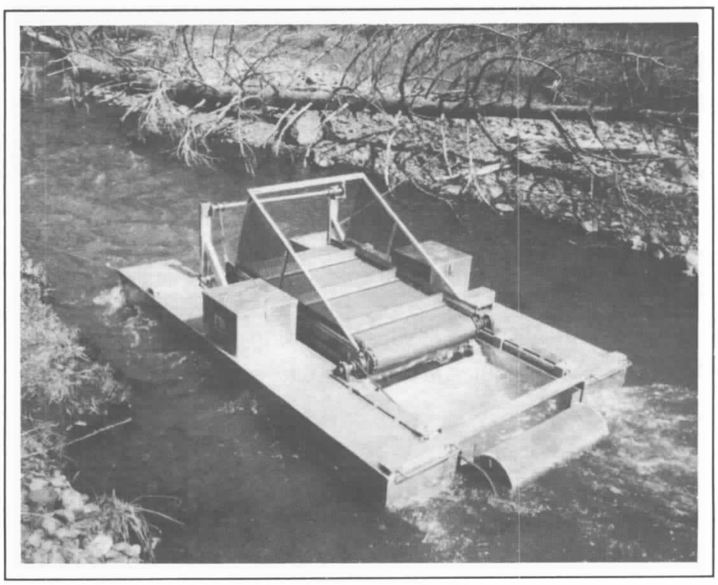

Figure 2—One of three 3/4-size aluminum Humphreys traps in operation at Meadow Creek, Union County, Oregon, 1987.

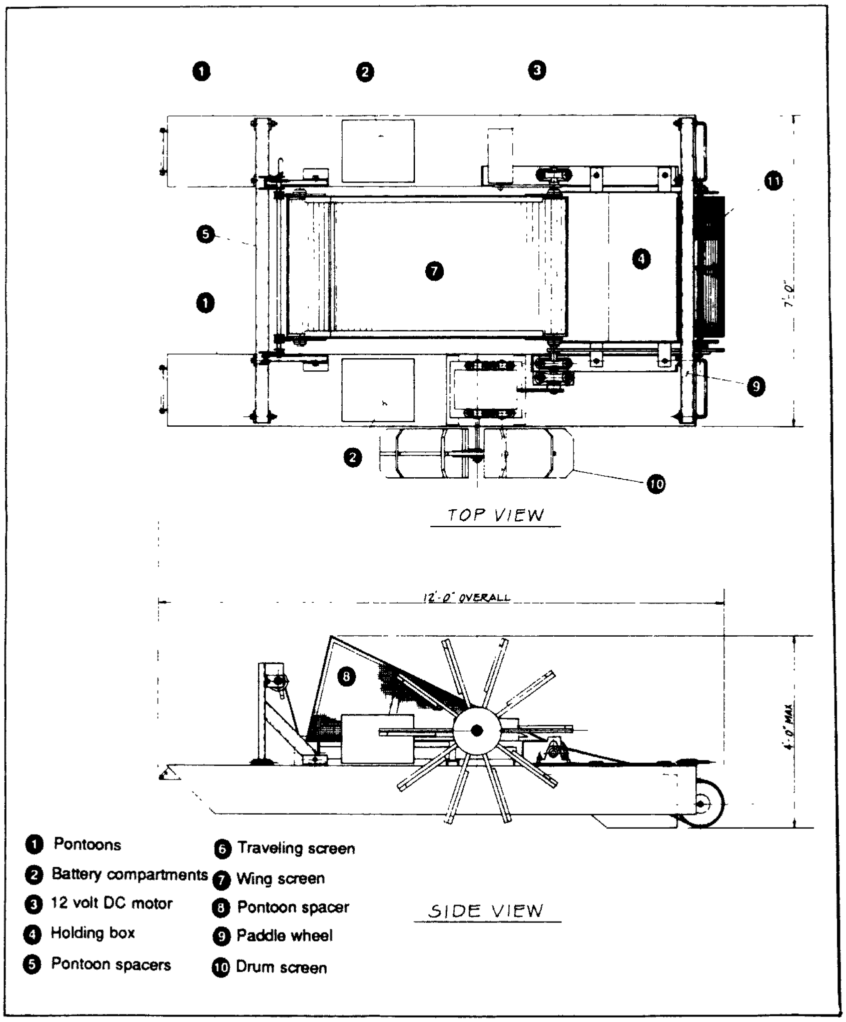

Figure 3—Schematic drawings showing (A) side and (B) top views, and listing major parts common to both 1/2- and 3/4-size trap.

The scaled-down traps can be powered by either a paddle wheel (water powered) or an electric motor. There are two methods for electrical operation: (1) a 1/14-horsepower, 12-volt direct current motor coupled to a 92:1 gear reducer that is powered by deep cycle batteries (maximum continuous running time is about 48 hours on four 105 ampere-per-hour batteries); (2) a shore power source of 110-volt alternating current is channeled through a step-down transformer to the motor-drive system described above. This system permits operation from water or current power or by using the batteries.

Table 2—Species of fish effectively sampled with floating Humphreys traps in western Oregon

Common name	Scientific name
Coastal cutthroat trout	*Salmo clarki* Richardson
Steelhead rainbow trout	*Onwrhynchus mykiss,* formerly *Salmo gairdnei*
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)
Coho salmon	*Oncorhynchus kisutch* (Walbaum)
Mountain whitefish	*Prosopium williamsoni* (Girard)
Umpqua squawfish	*Ptychocheilus oregonensis* (Richardson)
Speckled dace	*Rhinichthys osculus* (Girard)
Longnose dace	*Rhinichthys cataractae* (Valenciennes)
Redside shiner	*Richardsonius balteatus* (Richardson)
Bridgelip sucker	*Catestomus columbianus* (Eigenmann and Eigenmann)

The modified versions of the Humphreys trap are being used extensively in Oregon, Idaho, and southeast Alaska. The different sizes of traps have been used effectively in streams ranging in flow from 0.3 to over 30 cubic meters per second. The traps function well in streams with moderate to large loads of small floating debris. Large floating debris (logs, large limbs) may damage the traveling screen and drive mechanism; several fish species have been sampled effectively with the traps (table 2).

Blue prints for the 1.2-, 0.9-, and 0.6-meter-wide traveling screen for the modified Humphreys traps can be acquired from Manley Thompson, Midwest Fabrication Company, 30398 Brewster Lane, Corvallis, Oregon 97333.[1] Blue prints include the most recent changes in pontoons, collecting box, traveling screen assembly, and traveling screen for the three sizes of modified Humphreys traps.

Discussion

Self-cleaning floating traps that sample only a portion of the cross-sectional area of streams have many advantages compared to other techniques used to enumerate downstream migrant fishes. Advantages include low cost (as compared to fixed weir facilities), ability to effectively dispose of small floating debris, light weight portability when disassembled, and ability to easily reposition the traps to take advantage of changing flow conditions. Another advantage is the very low mortality of fish captured with this type of trap. Two disadvantages of using the self-cleaning floating traps also exist: the need to calibrate the efficiency of the trap for the species of fish and flow levels experienced during the period of migration, and the inability of traps to estimate the number of migrants.

[1] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others.

Efficiency of the traps is determined by releasing a specific number of marked fish 500 to 1000 m upstream of the trap and then assessing the capture rate of these fish. Because capture efficiency changes with flow level, efficiency checks must be made at all levels of flow experienced while the trap is in place. The trap must be tended daily or twice daily when large numbers of fish are migrating downstream (Everest and others 1985, 1986).

Velocities greater than 2.8 meters per second tend to overpower the trap, and velocities less than 0.9 meters per second reduce the capture rate of large fish. The optimum velocity that produces the best efficiency is between 1.5 and 2.0 meters per second.

Trapping efficiency differs with stream size and water velocity at the trap site (table 3). For example, low trapping efficiency of both coho salmon and steelhead trout in Fish Creek in 1987 correlated to three freshets large enough to prevent the trap from capturing fish effectively for several days during the migration season. The trap is designed to capture trout smolts up to 200 mm in length, but it also effectively catches smaller fish. The efficiency for capturing coho salmon 37 to 45 millimeters in length has ranged from 11.8 to 32 percent. Trout fry 27 to 39 millimeters in length have been captured at efficiencies of 5.2 to 8.8 percent. Chinook salmon fry 39 to 47 millimeters in length have been caught at trapping efficiencies ranging from 10 to 26.5 percent.

The Humphreys trap provides a viable alternative to the different fixed-weir facilities and sampling devices presently used for enumerating downstream migrant fishes. The available size options and convertible power sources make the device versatile for several environmental conditions and applications.

Table 3—Range and overall efficiency of coho salmon and steelhead rainbow trout smolts captured in floating traps within the State of Oregon

				Trap efficiency percent		
Location	Year	Date	Species	Low	High	Overall
Fish Creek	1985	4/15-6/23	Coho	15	48	38
Fish Creek	1985	4/15-6/30	Steelhead	10	41	27
Fish Creek	1986	3/14-7/18	Coho	12	62	48
Fish Creek	1986	3/14-6/5	Steelhead	19	37	28
Fish Creek	1987	2/15-6/20	Coho	6	15	13
Fish Creek	1987	2/15-6/20	Steelhead	4	4	2
East Creek	1988	3/9-6/3	Coho	35	100	41
East Creek	1988	3/9-6/3	Steelhead	21	50	21
Moon Creek	1988	3/9-6/3	Coho	15	100	34
East Fork Lobster Creek	1988	3/9-6/3	Coho	33	100	47
South Fork Lobster Creek	1988	3/9-6/3	Coho	20	100	33

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