SEPARATION OF RESIDENT AND ANADROMOUS FISH IN FISHWAYS

by

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September 1964

FISH-PASSAGE RESEARCH PROGRAM
U.S. Bureau of Commercial Fisheries
Seattle, Washington

INTRODUCTION

Fish facilities primarily for the passage or collection of adult anadromous fishes are frequently utilized by large numbers of migrating resident species. In some instances these resident fish may be so numerous that they impair the passage of salmonids or even threaten their survival through transmission of disease and depletion of oxygen in confined areas. This problem occurred at Oxbow Dam on the Snake River, necessitating the removal of the resident species from problem areas. 1/

When John Day Dam is completed, extensive chinook salmon spawning areas will be inundated by the resulting impoundment. Fishery agencies have proposed that the stock now utilizing this area be separated from other upriver populations and held for artificial spawn taking. Salmon of this stock would be identified by their coloration and mechanically sorted from the other fish as they ascend the fishways. Although resident fish will probably not be numerous enough to offer a serious threat to the anadromous species, their presence may complicate the task of sorting out the desired fish.

The object of this study is to explore various methods of separating migrants in fishways or collection devices in an effort to develop an economical and efficient means of removing the surplus, less desirable species when necessary.

Initially, our approach has been to investigate means of separating fish by species, based upon characteristic differences in behavior, relative size, and body shape. Previous experiments at the laboratory indicated that in a pool-and-overfall-type fishway with submerged orifices, the resident species (suckers, squawfish, and carp) generally demonstrate a preference for orifice passage. Since many of these fish are smaller than the anadromous species, it was reasoned that a volitional separation might be accomplished in a conventional fishway pool simply by placing a grill or other device in the orifice with openings just large enough to pass the resident freshwater fish. The salmon, steelhead trout, and shad would be allowed unobstructed passage over the weir crest. The others would, by choice, pass through the grilled orifice and could be trapped and removed from the facility. Currently, this method is being tested with both parallel pipe grills and perforated plates.

1/ Graban, James R., Evaluation of Fish Facilities Brownlee and Oxbow Dams. State of Idaho Fish and Game Department, 1964.

METHODS AND MATERIALS

A simulated fishway pool was created by placing a weir across a 4-foot channel (fig. 1). The weir was 6 feet high with a rounded (McNary type) crest and an 18-inch square orifice centered at the bottom. Guides were attached to the upstream face of the weir to accommodate the removable grills and perforated plates which were used in front of the orifice. Another set of guides for the grills and plates was installed 4 feet downstream from the weir. Perforated plates were mounted on the upstream end of a wire-screen funnel which could be raised clear of the water during control tests or when grills or plates were being tested in the orifice. A swinging screen covered the top of the funnel to prevent fish from evading the orifice once they had passed through the separating device in the funnel. A 4-foot high stub-weir, placed 10 feet downstream from the test weir, completed the test area. This was done to create hydraulic conditions similar to those in a normal fishway pool.

A watertight chamber with a clear plexiglass wall was installed adjacent to the pool for observing the behavior of fish in the pool and recording their passage through the separating devices and orifice (fig. 2). The plexiglass wall was 10 feet long and extended from the downstream end of the funnel to the orifice count station approximately 4 feet upstream from the weir. An adjustable lead was used to divert fish passing through the orifice toward the plexiglass wall so they could be counted and identified.

Tests of separating devices thus far have been restricted to perforated plates and parallel pipe grills. The perforated plates were similar to the type used successfully at Oxbow Dam although in a slightly different manner. Our perforated plates were constructed of 1/4-inch plywood in 20-inch square frames. One contained 36 holes, 2-1/2 inches in diameter; and the other contained 25 holes, 3 inches in diameter. The plate with 3-inch perforations did not withstand the orifice velocities and was subsequently replaced with a more durable plate (1/4-inch aluminum).

The grills were constructed of parallel 5/8-inch (outside diameter) metal pipes mounted in a 20-inch square frame. The open space between the parallel pipes was 2 inches in one grill and 2-1/2 inches in the other. Pipes and frame were painted brown. A third grill, composed of 5/8-inch plastic rods spaced 2-1/2 inches apart was also tested. These rods were nearly transparent. The square frame allowed the grills to be tested in either a horizontal or vertical position.

Fish were tested both individually and in groups. In tests with individual fish, estimated length and time required to pass through the channel and test area were obtained for each fish. During group tests, fish entered the channel at random. The fish were tallied and identified by two observers as they crossed the

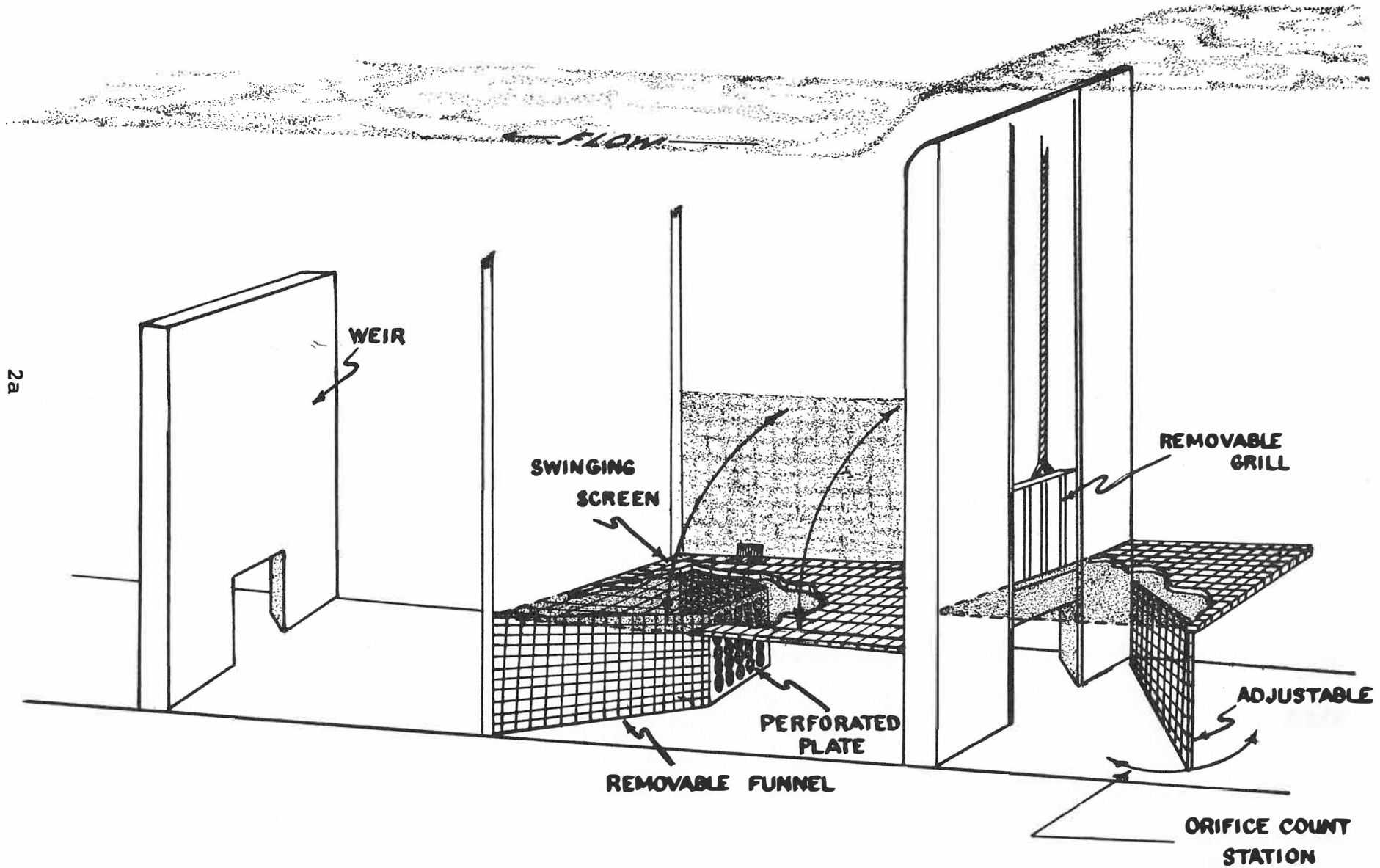


Figure 1.--Sketch of simulated fishway pool showing orifice and sorting devices.

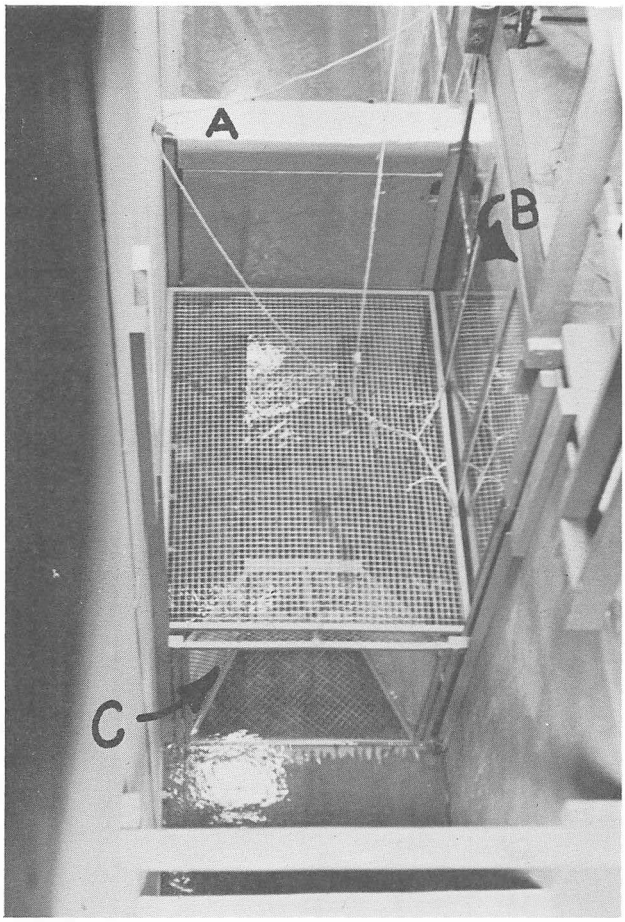


Figure 2.--View of simulated fishway pool illustrating (A) weir with 18" square orifice, (B) observation chamber with plexiglass wall, and (C) removable funnel with overhead swinging screen.

weir or passed through the orifice. One observer was stationed directly overlooking the weir crest (fig. 3), and the other was located in the submerged observation chamber at the orifice count station (fig. 4).

During the experiments, grills and perforated plates were tested in both the funnel and orifice positions. Control type tests (no separating device in use) were conducted periodically to evaluate the influence of the sorting devices. Head on the weir ranged from 8 to 12 inches during the tests.

RESULTS

To date, tests have been conducted with chinook salmon, sockeye salmon, steelhead trout, shad, lampreys, suckers, squawfish, and carp (table 1). Of the resident species, only the suckers have been sufficiently abundant to evaluate the sorting devices.

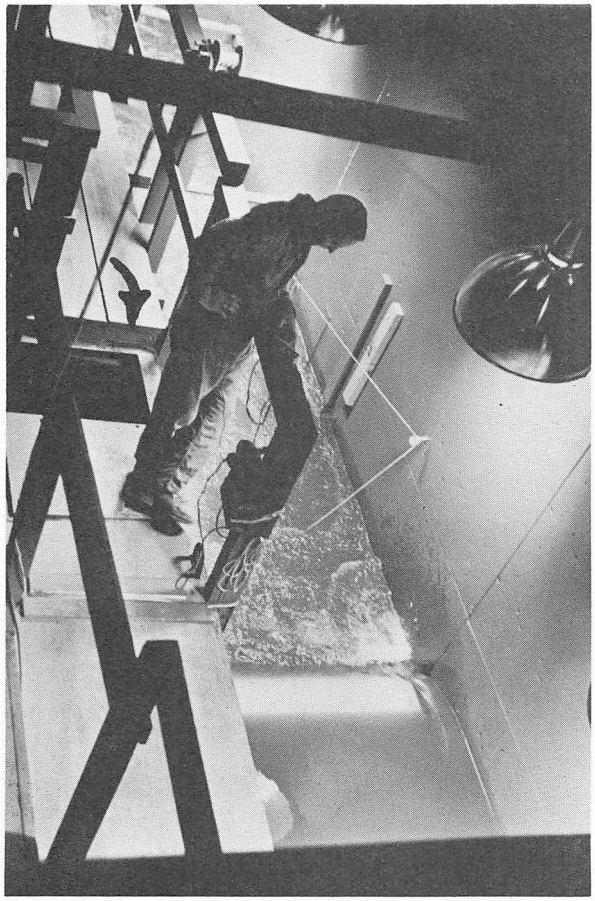
As anticipated, suckers demonstrated a preference for orifice passage. With no separating device in use (control test) 77.8 percent passed through the orifice (table 2). Only two squawfish were tested; both of these chose the orifice. Of the anadromous species, 29.6 percent of the chinook salmon, 14.1 percent of the sockeye salmon, 68.0 percent of the steelhead trout, 10.2 percent of the shad, and 61.3 percent of the lampreys selected the orifice when no separating device was in use.

The function of the separator was to eliminate this orifice passage of salmon and trout without deterring the passage of suckers and other resident species through the orifice. A comparison of the results of the various tests (table 2) illustrates that the use of perforated plates in the orifice position was the most successful method for separating the two groups of fish. Using the plate with the 2-1/2 inch diameter holes, 61.3 percent of the suckers passed through the orifice, whereas all of the chinook salmon, sockeye salmon, steelhead trout, and shad passed over the weir crest. Comparison with the control tests indicates that 16.5 percent (77.8 minus 61.3) of the suckers that might normally pass through the orifice were, however, also diverted to the weir crest.

The most efficient grilled separator had 2-inch spacing placed horizontally in the orifice position. This separator did not appear to deter suckers from passing through the orifice and diverted a large percentage of the salmon and trout to the weir crest.

Although preliminary, the results indicate that separation of anadromous and freshwater fish within fishways may be possible. Suckers appear to be the most adaptable to the methods tested, but further testing is needed to determine whether squawfish and carp can be separated by these methods.

Figure 3.--Observer counting sockeye salmon over weir crest. Observer is standing on top of observation chamber. Arrow indicates access opening to orifice count station.



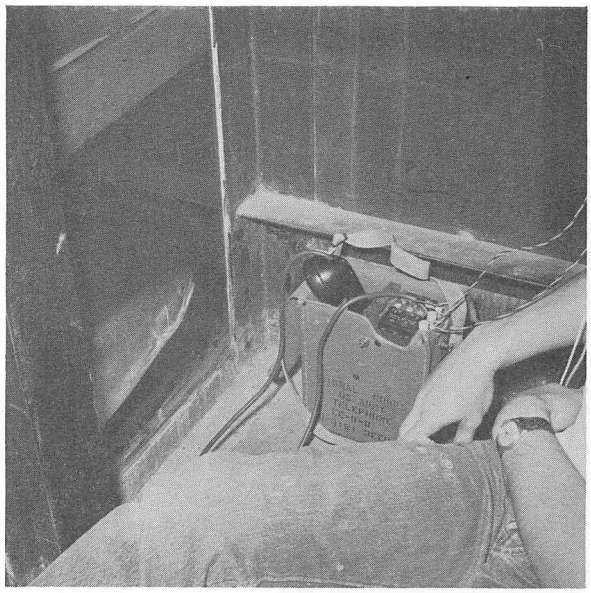


Figure 4.--Steelhead trout passing window of submerged observation chamber at orifice count station.

Table 1.--Number of anadromous and resident species tested

	Separating device -- size, position and location	ANADROMOUS SPECIES					FRESHWATER SPECIES		
		Chinook salmon	Sockeye salmon	Steelhead trout	Shad	Lamprey	Sucker	Squaw-fish	Carp
	*None (Control)	203	220	178	49	31	45	2	0
Grill 2" spacing	Horizontal in orifice	193	299	175	120	10	76	2	0
	Vertical in orifice	45	52	48	23	5	27	1	1
	Horizontal in funnel	33	33	59	35	5	21	1	2
	Vertical in funnel	23	26	45	3	0	8	0	0
Grill 2 1/2" spacing	Horizontal in orifice	60	64	68	1	5	19	0	0
	**Horizontal in orifice	45	32	65	31	5	16	2	0
	Vertical in orifice	21	16	26	0	8	3	0	0
	Horizontal in funnel	23	2	51	1	0	22	0	0
	Vertical in funnel	74	78	14	0	2	0	0	0
Perforated plate	2 1/2" holes in orifice	40	121	32	27	2	31	1	1
	2 1/2" holes in funnel	19	35	48	20	1	7	0	0
	3" holes in orifice	21	6	22	10	2	8	0	0
	3" holes in funnel	0	2	4	0	1	13	0	0

* No separating device was used. Fish were offered an unobstructed passage through orifice or over weir crest.

** Grill composed of 5/8" diameter plastic rod.

Table 2.--Average percentage of anadromous and resident species passing through the orifice during the various test conditions

	Separating device -- size, position, and location	ANADROMOUS SPECIES					FRESHWATER SPECIES		
		Chinook salmon	Sockeye salmon	Steelhead trout	Shad	Lamprey	Sucker	Squaw-fish	Carp
	*None (Control)	29.6	14.1	68.0	10.2	61.3	77.8	100.0	----
Grill 2" spacing	Horizontal in orifice	0.0	8.0	2.3	0.8	80.0	77.6	100.0	----
	Vertical in orifice	4.4	50.0	39.6	4.3	80.0	70.4	100.0	0
	Horizontal in funnel	6.1	21.2	0.0	0.0	100.0	76.2	100.0	0
	Vertical in funnel	4.3	19.2	11.1	33.3	-----	75.0	-----	----
Grill 2 1/2" spacing	Horizontal in orifice	3.3	23.4	23.5	0.0	40.0	73.7	-----	----
	**Horizontal in orifice	2.2	12.5	18.5	0.0	60.0	81.2	100.0	----
	Vertical in orifice	9.5	56.2	53.8	----	100.0	100.0	-----	----
	Horizontal in funnel	17.4	0.0	31.4	0.0	-----	72.7	-----	----
	Vertical in funnel	8.1	23.1	64.3	----	0.0	-----	-----	----
Perforated plate	2 1/2" holes in orifice	0.0	0.0	0.0	0.0	100.0	61.3	100.0	0.0
	2 1/2" holes in funnel	0.0	2.9	0.0	0.0	100.0	57.1	-----	----
	3" holes in orifice	0.0	16.7	0.0	0.0	100.0	87.5	-----	----
	3" holes in funnel	----	50.0	0.0	----	0.0	38.5	-----	----

* No separating device was used. Fish were offered an unobstructed passage through orifice or over weir crest.

** Grill composed of 5/8" diameter plastic rod.