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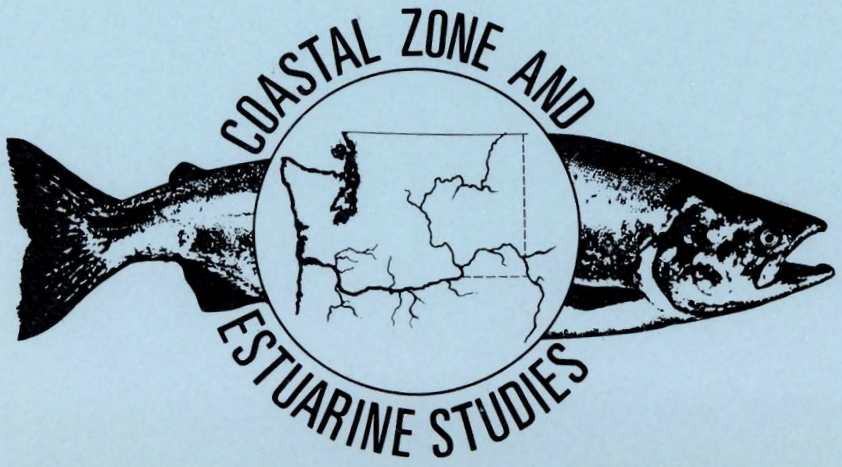

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BACKGROUND

Since 1982, the fishery management agencies of the Pacific Northwest have used a "spread the risk" policy for protecting migrating juvenile spring chinook salmon, Oncorhynchus tshawytscha, at dams on the lower Snake River. The approach entails providing spill at some Snake River dams and spill and/or transportation of smolts at others. In recent years, 25 to 50% of the spring chinook salmon smolt population was transported from Lower Granite and Little Goose Dams, depending on flows and spill available each year.

As a part of the fish protection effort, considerable research has been done at main stem dams to develop the following: (1) screen diversion systems to guide young fish from turbine intakes and (2) bypass systems to carry the fish to the tailrace level or collection area in a safe manner. It is generally believed that these systems are operating safely and efficiently at Lower Granite Dam, although research continues to enhance the guiding efficiency of the traveling screens.

At Lower Granite Dam, juvenile fish may pass downstream via three routes: (1) over the spillway, (2) through the turbine (migrants not guided by the screen system), and (3) through the bypass system (migrants guided successfully from turbine intakes). Studies have never measured the mortality during passage via the above routes at Lower Granite Dam. In 1986, the National Marine Fisheries Service under contract with the U.S. Army Corps of Engineers (COE) began studies to measure survival of yearling spring chinook salmon during downstream passage through Lower Granite Dam.

OBJECTIVE

The primary objective was to estimate the comparative short-term survival and condition of juvenile spring chinook salmon after passing through either the spillway, the turbines of a screened turbine intake, or the bypass system at Lower Granite Dam.

METHODS

Test fish were spring chinook salmon from the Dworshak National Fish Hatchery (NFH). To avoid impacting normal fish handling operations at Lower Granite Dam, hatchery fish were used so we could make test releases prior to the normal downstream migration which usually begins about 10 April. The recovery of test fish was targeted for Little Goose Dam, about 35 miles downstream from the test area. By agreement with fisheries managers, the recovery of test fish by gatewell dipping at Little Goose Dam would cease when 2,000 naturally migrating spring chinook salmon were dipped on successive days--thus ending the experiment. The test releases began on 27 March at Lower Granite Dam.

Test fish were hauled from Dworshak NFH beginning 24 March in fish transport tankers (3,500-gal capacity) provided by the COE. Upon arrival at the dam, fish were held in a portable aluminum raceway equipped with a 450-gal/min flow-through river water source. An anesthesia method whereby fish were anesthetized prior to handling (referred to as a pre-anesthetic system) was installed at the end of the raceway near the marking building. Once anesthetized, the fish were dipnetted, carried to the marking building, branded, and passed via fresh water in a 3-inch diameter hose to a 300-gal capacity distribution tank. Fish from the raceway were marked at random for release at one of the following test locations:

1. Control--released in the river channel near the barge dock at the juvenile fish transport facility about 600 yards downstream from the powerhouse.

2. Spillway--released in Spillbay 2, about 4 feet above the ogee and 15 feet upstream from the spillgate.

3. Bypass system--released in Gatewell 4B about 15 feet from the bottom.

4. Turbine--released into the turbine intake of Slot 4B just downstream from the lowered end of the operating traveling screen.

Fish were marked by a distinctive brand for each of three replicates for each release day for each treatment group. The marked fish were transferred from the marking facility in the fish distribution tanks to a portable raceway located near the intended release site. Each portable raceway at the release site was partitioned so the three replicates awaiting release were held in equal sized compartments supplied with a flow through supply of river water; all marked fish were held at the release site 24 to 30 h prior to the actual release. All releases were made via a 3-inch diameter hose.

The experiment was comprised of three tests--27 and 30 March and 2 April. A total 162,000 fish were released during the experiment which was made up of 36 groups each containing 4,500 fish (Table 1).

Fish for the bypass group were released prior to the turbine, spill, and control groups to ensure the best possible "mixing," since fish in the bypass system required more time to exit the system. To determine the timing necessary, a trial release of 2,000 hatchery spring chinook salmon was made on 21 March at 1400 h. Following their release, we monitored their egress at the fingerling collection facility (terminal end of bypass system). About 50% of

Table 1.--Experimental design for survival estimates of spring chinook salmon juveniles during passage through the spillway, turbine, and bypass system at Lower Granite Dam, 1986.

Replicate and treatment		Tests and dates					
		1st test (27 Mar)		2nd test (30 Mar)		3rd test (02 Apr)	
		Time	No. fish	Time	No. fish	Time	No. fish
1	Control	1800	4,500	1800	4,500	1800	4,500
	Spill	1800	4,500	1800	4,500	1800	4,500
	Turbine	1800	4,500	1800	4,500	1800	4,500
	Bypass	1400	4,500	1400	4,500	1400	4,500
2	Control	1930	4,500	1930	4,500	1930	4,500
	Spill	1930	4,500	1930	4,500	1930	4,500
	Turbine	1930	4,500	1930	4,500	1930	4,500
	Bypass	1530	4,500	1530	4,500	1530	4,500
3	Control	2100	4,500	2100	4,500	2100	4,500
	Spill	2100	4,500	2100	4,500	2100	4,500
	Turbine	2100	4,500	2100	4,500	2100	4,500
	Bypass	1700	4,500	1700	4,500	1700	4,500
	Totals		54,000		54,000		54,000
	Grand total		162,000				

the trial fish passed in 4 h; therefore, during releases of test fish, the bypass group was always released 4 h prior to the other groups, which were assumed to pass the dam immediatley.

Tests began at 1400 h on 27 March with the release of the bypass treatment group; comparison treatments for the first replicate were released at 1800 h. Treatments for the second and third replicates of a test were released in a similar pattern 90 and 180 minutes later, respectively (Table 1).

During the experiment, river flow ranged from 100 to 120 kcfs and probably provided optimum migration conditions for fish passage between Lower Granite (release site) and Little Goose Dams (recovery site).

Spill was begun 30 min prior to releasing fish in the spillway (Bay 2) and was maintained at 10 kcfs in Bays 1, 2, and 3 throughout each release, terminating 30 min post-release. Spill usually continued at Lower Granite Dam following the releases, but this condition resulted from normal nighttime project operation as power demand decreased.

Turbine Unit 4 operated at nameplate load from 27 March to 3 April to provide comparable operations for each of the turbine and bypass system treatment groups. The bypass group passed through the 42-inch diameter transfer pipe, through the operational fish separator, and then to the river via the barge loading line for smolt transportation. This bypass mode was studied because in future operations, whether smolts are collected for transportation or bypassed directly to the river, they must pass through the separator (no sampling could occur without this mode of operation). No operational requirements were associated with the control groups.

Short-term survival was based upon the recovery of branded fish from each treatment group at Little Goose Dam, approximately 35 miles downstream. Differences in fish condition were based on descaling rates of recovered fish from each treatment group.

All gatewells at Little Goose Dam, were dipped daily after 28 March to recover branded fish. Recoveries were examined for brands to determine the appropriate treatment and replicate. Also, each test fish recovered was examined for descaling. Fish were categorized as descaled (according to standard criteria used in Columbia River studies[1/]), partially descaled, or non-descaled.

The statistical analysis planned for the project required approximately 15,000 fish to be recovered. This would enable us to detect a 5% difference in survival between treatment groups with an α (Type I error) of 0.05 and β (Type II error) of 0.20 considering each release group a comparative trial.

Gatewell dipping operations were suspended on 12 April when the daily catch exceeded 2,000 natural migrating fish on consecutive days. Branded fish were also recovered incidentally during other research and smolt monitoring activities at Little Goose, Lower Monumental, and McNary Dams.

RESULTS AND DISCUSSION

All release phases of the study went smoothly and were completed by 2 April 1986. Transport mortality from the hatchery to the dam was 0.13%.

1/ The standard fish descaling index originated at an inter-agency workshop conducted by Steve Pettit, Idaho Department of Fish and Game, at McNary Dam on 29 March 1983.

The 24-h post-marking mortality was 0.03%. All releases were made as scheduled with the proper powerhouse and spill conditions prescribed for the test.

Following the releases, it became apparent that the fish were not migrating downstream as rapidly as expected--even though river flows were very favorable (100 to 125 kcfs). The first marked fish was recovered at Little Goose Dam 5 d following its release at Lower Granite Dam. A total of 2,505 fish (far short of the 15,000 recoveries required for statistical treatment) was recovered at Little Goose Dam--most during traveling screen research activities.

To determine if there were any gross observations that we could make based on additional recoveries at other downstream dams, we examined recovery data taken at Lower Monumental and McNary Dams during the smolt migration for comparison with that observed at Little Goose Dam. The recovery data at McNary Dam were comparable in both numbers and differences between treatment groups (Table 2). From inspection of the data, no difference in survival comparisons among treatment groups could be defined. It appeared, however, that the survival of fish released in the lower turbine area (beneath the traveling screen) was approximately equal to that of controls released in the tailrace of the dam. The lack of turbine mortality indicated is counter to previous mortality studies. The fish from earlier studies, however, were released near the ceiling not the center of the intake. Previous work by Long[2/] indicated fish passing through the center of the turbine would pass the hub where mortality is least. Therefore, further study is warranted to define

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2/ Clifford Long, 6535 Pacific Ave. S.E., Olympia, WA 98503. Pers. Commun. 1987.

Table 2.--Number of juvenile spring chinook salmon recovered at Little Goose, Lower Monumental, and McNary Dams that were released at Lower Granite Dam to evaluate mortality during passage through the bypass system, spillway, and turbine.

Treatment group	Recovery site			Total
	Little Goose	Lower Monumental	McNary	
Control	693	223	596	1,512
Bypass	517	220	538	1,275
Spill	598	243	579	1,420
Turbine	697	196	602	1,495
Total	2,505	882	2,315	5,702

turbine mortality characteristics. Also, it appears that fish released in the bypass system sustained the highest mortality of all groups. It should be stressed, however, that some fish were known to have delayed in the gatewell up to 1 week, and undoubtedly some fish from that group never reached the downstream dams because they were transported to below Bonneville Dam during the COE smolt transport program.

Descaling data were recorded for 1,662 fish recovered at Little Goose Dam to determine if there was a treatment effect on survivors (Table 3). These data were also inconclusive, as descaling (severe) ranged from 1.04% (spill treatment) to 1.96% (control).

Low overall descaling and the delayed migration were likely due to a relatively low level of smoltification.

CONCLUSIONS AND RECOMMENDATIONS

1. Many of the marked fish released failed to migrate prior to termination of sampling at Little Goose Dam; consequently, the number of recoveries were insufficient for analyses.

2. The study should be repeated with later releases, i.e., when the fish are more prone to migrate.

3. The newly developed PIT tag could be used to advantage during a repeat of this study (Prentice et al. 1986).

4. Steps should be taken in a repeat of this study to make sure that releases designed to measure survival in the bypass system are released so they "mix" with the control release.

Table 3.--Number (percent) of spring chinook salmon by descaling category that were recovered at Little Goose Dam following release at Lower Granite Dam in the tailrace (control), bypass system, spillway, and turbine.

Treatment group	Descaling category		
	Non-descaled	Partially descaled	Descaled (severe)
Control	418 (91.0)	32 (7.0)	9 (2.0)
Bypass system	313 (90.2)	29 (8.4)	5 (1.4)
Spillway	355 (93.2)	22 (5.8)	4 (1.0)
Turbine	424 (89.3)	42 (8.8)	9 (1.9)

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Prentice, Earl F., Donn L. Park, Thomas A. Flagg, and Thomas McCutcheon. 1986. A study to determine the biological feasibility of a new fish tagging system, 1985-1986. U.S. Dep. of Commer., Natl. Oceanic Atmos. Admin., Nat. Mar. Fish. Serv., Northwest and Alaska Fish. Cent., Seattle, WA. 89 p. (Report to the Bonneville Power Administration, Contract DE-A179-84BP11982, Project 83-19).