EFFECT OF TRANSPORTATION ON SURVIVAL AND HOMING OF COLUMBIA RIVER COHO SALMON

by

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ABSTRACT

In April 1977 a group of juvenile coho salmon (*Oncorhynchus kisutch*) reared at Willard National Fish Hatchery, Washington State, were separated into two lots and marked. One lot (test) was transported, by truck, 9 km to the Columbia River; then transported via barge approximately 35 km downstream; and, lastly, released into the river below Bonneville Dam. The other lot (control) was released at the hatchery. In 1978, more adult coho salmon from the transported lot were caught by the sport and commercial fisheries than were adults from the non-transported lot. However, transportation did not increase the numbers of adults returning to the Little White Salmon River, on which Willard National Fish Hatchery is located; apparently transportation did affect the homing ability of the fish.

INTRODUCTION

During the winter and spring of 1976-77 the Pacific Northwest experienced the worst drought in recent times. Flow in the Columbia River, which is dammed extensively for hydroelectric generation, was extremely low during the spring of 1977 (averaging less than 4245 m^3/s). In low flow years, very little water is spilled at these hydroelectric projects. Consequently to pass the dams in 1977, many juvenile Pacific salmon (*Oncorhynchus* spp.) and steelhead trout (*Salmo gairdneri*) were destined to go through the turbines where substantial numbers would be killed in the process (Chaney and Perry 1976) unless remedial steps were taken. Realizing that the losses of juvenile salmonids could be catastrophic in 1977, the National Marine Fisheries Service (NMFS) and the U.S. Army Corps of Engineers (CofE) prepared two barges to supplement trucks as means for transporting juvenile salmonids around dams on the Columbia and Snake Rivers (McCabe et al. 1979).

To assess the effectiveness of barging, various experiments were conducted. One experiment, a joint activity by NMFS, the U.S. Fish and Wildlife Service (FWS), and CofE, involved transporting tagged coho salmon (*Oncorhynchus kisutch*) from Willard National Fish Hatchery (Little White Salmon River), Washington State, to a release site in the Columbia River downstream from Bonneville Dam (Fig. 1). The experiment had the following objectives: 1) determine if transported coho salmon would return to the Little White Salmon River and 2) determine if survival could be enhanced by barging the fish below Bonneville Dam.

METHODS AND MATERIALS

Two lots of coho salmon from Willard Hatchery were identified by tagging with magnetic microwire tags (Ebel 1974). In addition, adipose fins were excised from fish in both lots to identify them as wire tagged. One lot (20,625 control fish) was released at the hatchery on 18 April 1977. On 22 April 1977 the second lot (19,785 test fish) was transported by tanker truck about 9 km to Drano Lake on the Columbia River where the fish were loaded via flexible hose into a waiting barge. Shortly after loading, the barge departed; approximately 4 h later the coho salmon were released into the river downstream from Bonneville Dam. The difference in release dates allowed the control fish 4 days to migrate downstream to the site where the test fish were released. It was assumed that both groups would then be mixed and encounter the same environmental conditions until they were subsequently recaptured as adults.

The barge, which had a steel cargo tank 33.2-m long and 8.5 m-wide, was essentially a floating raceway (Fig. 2). One or two stern pumps supplied river water to a bow spray bar. After exiting from the spray bar, water flowed through eight screened compartments and exited via four stern overflow scuppers. One complete turnover of water took approximately 20 min with both pumps operating.

Evaluation of the barging experiment was based on a comparison of the numbers of adults from the two lots that returned to the hatchery in the fall of 1977 (these early arriving fish were precocious males which are called "jacks" in the Pacific Northwest) and 1978 or were taken in the fisheries. Adult fish returning to the Willard Hatchery were collected in a trap at the Little White Salmon National Fish Hatchery, located approximately 7 km downstream from Willard Hatchery. In 1977 and 1978, all of the coho salmon in the trap were examined for the wire tags used in this experiment. Fish and wildlife agencies from Washington, Oregon, California, and Canada provided tag information on coho salmon caught in sport and commercial fisheries.

In analyzing tag returns, we compared hatchery returns for the transported group and the control group, fisheries returns for the two groups, and total returns for the two groups. We used a chi-square test of independence for each of the three comparisons.

RESULTS AND DISCUSSION

Returns of adult coho salmon to the trap at Little White Salmon Hatchery and to the fisheries (both sport and commercial) are presented in Table 1. Total recoveries of tagged releases were 0.19% for the control group and 0.39% for the barge group. There was no difference in hatchery returns between the control and barge groups; however, there was a highly significant difference between the two groups in returns to the fisheries (Table 2). If we assume equal estuary and ocean mortality for the two groups, then the contribution to fisheries was increased 170% (figure adjusted for a difference in numbers released) by the barge-truck transportation program. Trucking coho salmon from Willard Hatchery to the barge may have contributed to better survival; however, no information is available on juvenile mortality of the control group during their migration from Willard Hatchery to Drano Lake.

Columbia River flow was unusually low (averaging less than 4,245 m^3/s) in the spring of 1977, and there was no spilling at Bonneville Dam during the experimental release. These unusual conditions no doubt contributed to the significantly lower survival of the hatchery release. However, with the completion of the second powerhouse at Bonneville Dam in the early 1980's, reduced or no spill will become a reality every year. Therefore, transportation may be a practical way to enhance survival of salmonids reared in hatcheries above Bonneville Dam.

Coho salmon returns to the Little White Salmon River indicated that barging and/or trucking affected the imprinting process of the juvenile coho salmon. If transportation significantly increased ocean survival of the coho salmon, as catch data indicated, then hatchery returns of the transported group should have been significantly greater than that of the controls, unless the homing process of transported coho salmon had been impaired. Possibly many of the juveniles didn't imprint to Little White Salmon River water because of improper timing of the barge transport operation--i.e, perhaps the coho salmon weren't ready to migrate.

From 1955 to 1958 the Washington State Department of Fisheries conducted fish transportation experiments using both trucks and a screened barge (Ellis and Noble 1960). Fall chinook salmon (Oncorhynchus tshawytscha) from the Klickitat Hatchery were loaded into the barge (from a truck) at the confluence of the Klickitat and Columbia Rivers, transported 265.5 km downstream, and released. Returns to the Klickitat River were less for fall chinook salmon that were barged as juveniles than for the hatchery control releases (1961 and 1962 returns were not included).

Current NMFS and FWS research may be able to provide some answers as to why the transported group of coho salmon from Willard Hatchery apparently failed to home to the hatchery at the same rate as control fish. Data from two groups of fall chinook salmon barged from Spring Creek National Fish Hatchery, also located along the lower Columbia River, will be available in several years. The results should provide additional information on the effects of barging on the survival and homing ability of Pacific salmon. In addition, ongoing experiments include testing different methods of imprinting coho and chinook salmon from various hatcheries on tributaries of the lower Columbia River.

With answers to the homing question, NMFS may be able to improve hatchery returns; however, even if homing is not improved, results of this study indicate that transportation still should be used to preclude large numbers of fish from passing through turbines. One of the major goals of hatcheries is to provide greater numbers of fish to the sport and commercial fisheries, and it appears that transportation can significantly increase coho salmon catches without reducing returns to the hatchery compared to returns from a traditional hatchery release above Bonneville Dam.

ACKNOWLEDGMENTS

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Table 1.--Summary of barge and control releases of coho salmon from Willard National Fish Hatchery. Included are returns to the hatchery and fisheries.

Category	Control	Barge
Tagged fish released (No.)	20,625	19,785
Size at release (weight)	10.2/kg	10.9/kg
Release date	18 April 77	22 April 77
Returns to Willard Hatchery--jacks (No.)	1	4
Returns to Willard Hatchery--adults (No.)	13	10
Returns to Bonneville Hatchery[a/] (No.)	2	1
Returns to sport & commercial fisheries (No.)	24[b/]	62[c/]
Total returns (No.)	40	77
Return of tagged release (%) (Willard Hatchery)	0.07	0.07
Return of tagged release (%) (fisheries)	0.12	0.31
Return of tagged release (%) (total)	0.19	0.39

a) Only jacks were recovered at Bonneville Hatchery.

b) Fish were taken in the following areas: Washington - 5, Oregon - 16, California - 3.

c) Fish were taken in the following areas: Washington - 20, Oregon - 34, California - 7, and Canada -1.

Table 2.--Chi-square values for comparisons of barge and control groups of coho salmon from Willard National Fish Hatchery.

Hypothesis	Chi-square[a/]
Coho salmon barged as juveniles return in greater numbers to the Little White Salmon River than do juveniles released from the hatchery.	0.04
Coho salmon barged as juveniles contribute greater numbers to the sport and commercial fisheries than do juveniles released from the hatchery.	17.73
Overall, coho salmon barged as juveniles contribute greater numbers than do juveniles released from the hatchery.	13.05

a/ χ^2 at 99.9% level (df, 1) = 10.83

Figure 1.--Map of lower Columbia River showing Willard National Fish Hatchery, Little White Salmon Hatchery, Drano Lake, and the release site.

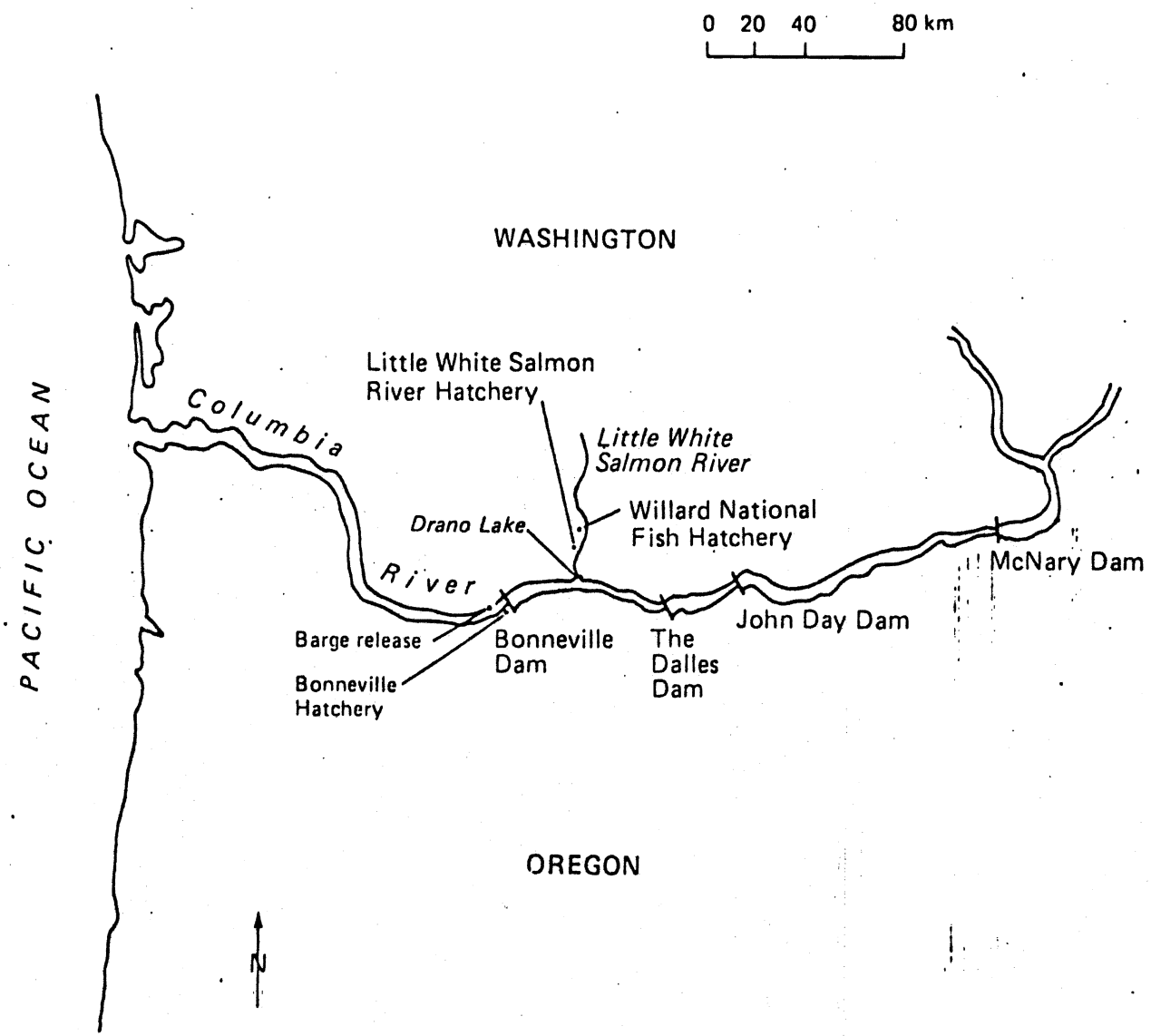
0 20 40 80 km
WASHINGTON
OREGON
PACIFIC OCEAN
Columbia River
Little White Salmon River Hatchery
Little White Salmon River
Willard National Fish Hatchery
Drano Lake
Barge release
Bonneville Hatchery
Bonneville Dam
The Dalles Dam
John Day Dam
McNary Dam
N

Figure 2.--The barge and tugboat used to transport coho salmon from Drano Lake to the release site below Bonneville Dam (photo courtesy of U.S. Army Corps of Engineers).

Fig. 1