18 250 Cop. 11/23/81

CZES Coastal Zone and Estuarine Studies

Transportation Research on the Columbia and Snake Rivers, 1980

by

Donn L. Park, Jerrel R. Harmon,
Bruce H. Monk, Thomas E. Ruehle,
Timothy W. Newcomb, Larry R. Basham,
and Thomas A. Flagg

October 1981

TRANSPORTATION RESEARCH ON THE COLUMBIA AND SNAKE RIVERS, 1980

by

Donn L. Park

Jerrel R. Harmon

Bruce H. Monk

Thomas E. Ruehle

Timothy W. Newcomb

Larry R. Basham

and

Thomas A. Flagg

Annual Report of Research
Financed by
U.S. Army Corps of Engineers
(Contract DACW68-78-C-0051)

and

Coastal Zone and Estuarine Studies Division
Northwest and Alaska Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
2725 Montlake Boulevard East
Seattle, Washington 98112

October 1981

CONTENTS

INTRODUCTION

The National Marine Fisheries Service (NMFS) is continuing research to increase the survival of juvenile salmonids migrating to sea by transporting them by trucks and barges around dams without interfering with their homing ability as adults. Research includes improving the functional operations of collection and bypass systems at dams.

In 1980, research activities were directed in the following areas: (1) collecting and marking juvenile salmon and steelhead smolts at McNary Dam for transport by barge or truck to below Bonneville Dam; (2) evaluating adult returns from previous transportation experiments at Lower Granite, Little Goose, and McNary Dams; (3) evaluating a new bypass system at Little Goose Dam; and (4) developing an automatic wire tag detection and decoding system.

TRANSPORTATION OF SMOLTS FROM MCNARY DAM

Research emphasis was placed in three major areas: (1) collecting, marking, and transporting smolts; (2) delayed mortality of transported smolts; and (3) barrier and traveling screen tests.

Collection, Marking, and Transportation of Smolts

In 1980, collection facilities were ready for the arrival of smolts by 1 April. As in 1979, three submersible traveling screens and three bar screens were used in turbine intakes to enhance collection capabilities. Fingerlings were counted daily from 3 April to 5 September 1980, and over 2 million fish entered the collection raceways (Appendix Table 1). Of these, 380,660 were marked for truck and barge transport experiments (Table 1), and 1,740,545 fish (marked and unmarked) were transported by truck or barge to release sites below Bonneville Dam (Appendix Tables 2 and 3).

Table 1.--Summary of marked and unmarked salmonids (five species/stocks) that were transported to below Bonneville Dam by truck or barge or were released as controls (marked only) at McNary Dam in 1980.

Group and release site	Marked					Unmarked				
	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
Trucked Bonneville	80,213	40,938	1,569	3,950	22,362	569,453	282,016	13,808	17,506	60,484
Barged Bonneville	0	44,023	43	328	30,382	2,012	428,164	17,933	28,603	96,758
McNary Dam (Control) tailrace	84,587	46,585	1,429	2,960	21,291	0	0	0	0	0
Totals	164,800	131,546	3,041	7,238	74,035	571,465	710,180	31,741	46,109	157,242

Juveniles were collected for marking and transportation on a 24-h basis. Each day started at 1200 h (noon) and was divided in two 12-h periods. Fish collected between 1200 to 2400 h and 2400 to 1200 h were handled in the fish processing building between 0800 to 1200 h and 1200 to 1600 h, respectively. During each 4-h processing period, as many fish as time allowed were sorted by species, counted, and/or marked. Normally, one experimental group (i.e., control, truck, or barge group) could be marked within the 4-h period. Depending on barge schedules, barge and truck groups were normally marked on alternate days. Random marking with respect to daily collection was reasonably well achieved. With the exception of 7 days during the peak of the outmigration, 60 to 100% of the 24-h catch was processed daily.

On days when less than 100% of the fish were examined, it was likely that those processed were not an entirely random sample of those collected. Due to fish behavior and the configuration of the crowding screens, the largest fish in the raceway were normally the last to be crowded out of the raceway into the building, and the smallest fish sometimes passed between the brushes on the screen and the raceway walls. The degree of bias in the sample was unknown but probably small.

When smolts were brought into the marking facility, they were anesthetized to immobility, sorted by species, and diverted to marking stations. While immobile, the fish were branded, tagged with a magnetic coded wire tag, and the adipose fin was excised. The fish were treated in an instantaneous bath (<2 sec) of 50 ppm malachite green which was subsequently recovered by a screening system. The fish subsequently passed through a pipe in fresh water to the truck (truck transport group only) or back to a raceway (control and barge groups). Fish examined, but not marked, were handled in the same system except they were not exposed to the malachite green treatment.

A guide to wire code abbreviations is shown in Appendix Table 4. Summaries for fish marked in each experimental group are indicated in Appendix Tables 5-7, and the number of fish marked for truck and barge transport on a daily basis are in Appendix Tables 2 and 3, respectively.

Juveniles were trucked in fresh water throughout the season (9 April to 5 September). However, the number of smolts hauled by truck was greatly reduced when barges were available (22 April to 30 May).

In 1980, the Columbia River flow at McNary Dam was low to moderate (little or no spill) until 30 May when spill, as a percent of total flow, increased dramatically. Heavy spill continued for 3 weeks with insignificant amounts of water used for generation. Although the number of smolts collected dropped significantly (especially after 4 June), the total impact of spill on smolt collection was relatively unimportant at McNary Dam. Historically, early migrants such as spring chinook salmon, steelhead, and sockeye salmon migrated on early freshets and were past McNary Dam by 1 June. For example, even in 1979 when there was little or no spill in June, daily fish collection in June was only 5,000 to 7,000 fish indicating there were relatively few fish available for collection.

Late migrants such as mid-Columbia "0-age" summer/fall chinook salmon are not sufficiently developed to take advantage of any of the spring freshets and hence pass McNary Dam in July and August. The migrations in the summer of 1980 were substantial, indicating that these "0-age" chinook salmon were not flushed out by the spill in June (Park et al. 1980).

Condition and Delayed Mortality of Transported Fish

During May, spring chinook salmon arriving in the collection raceways were more descaled than those observed in 1978-79. A part of the descaling was caused from an improperly placed hose that carried fingerlings from the sorter to the raceway. This condition was remedied, but descaling persisted (20% of the fingerlings collected were descaled). We believe a major part of the descaling occurred prior to arrival at McNary Dam--possibly at the Snake River projects since the problem was most severe when Snake River fish were present, and there was little descaling on coho, sockeye, and fall chinook salmon. To determine whether descaling affected survival of spring chinook salmon subsequently transported by truck or barge, delayed mortality tests were conducted on transported salmon upon their arrival at Bonneville Dam.

Between 16 May and 6 June, eight tests were conducted using spring chinook and coho salmon smolts to evaluate delayed mortality due to transportation by truck or barge. Between 30 May and 6 June, similar tests were conducted with five groups of sockeye salmon and two groups of fall chinook salmon smolts. A control group of sockeye salmon was sampled and held at McNary Dam. A lack of holding facilities at McNary Dam precluded taking control groups of the other species. Due to the presence of fish from Lower Granite and Little Goose Dams in the barge, experimental fish were placed in live cages on board the barge before departing McNary Dam. All test samples were collected at Bonneville Dam using a small dual lead-line seine and a watertight dip net. Fish transfers were in water, a few fish at a time; all transfer water was oxygenated. Extreme care was taken to ensure a minimum of added stress in all subsequent handling. No attempt was made to remove descaled fish in the sample.

Test tanks, 6 feet in diameter and containing approximately 200 gallons of water, were used to hold each test group. All test tanks were maintained at a loading density of <0.1 lb/gallon, flow rates exceeded 2.0 gallons/min, dissolved oxygen was maintained near 100% saturation, and water temperature was ambient river temperature (12.8° to 16.1°C). Total dissolved gas did not exceed 112% during these tests. Fish were not fed, and mortalities in each tank were recorded daily. Mortalities were categorized after 2 days (this time period had been used in previous years) and after 14 days which might correspond with the length of time required to reach seawater.

Very little delayed mortality (0 to 10.4%) was observed on any species after holding 2 days. After 14 days, sockeye exhibited nearly twice the mortality of spring chinook salmon, and mortality of fall chinook salmon was lower than spring chinook salmon (Table 2). There was less mortality of barged fish than of trucked fish after holding 2 days, but this advantage appeared to be lost or even reversed by the end of the 14-day holding period. (Details on all delayed mortality tests are shown in Appendix Table 8).

We continue to have considerable concern over the length of time smolts should be held to properly evaluate delayed mortality. It appears that a 2-day holding period is not long enough; however, holding smolts 14 days may create additional problems which may mask those we are striving to resolve. For example, smolts are biologically anxious to reach the sea, and extended holding restricts normal movement and feeding activity. Also latent disease may contribute to mortality in holding, and general confinement may cause minor stresses in itself. An intermediate holding period of 4 to 7 days may be more appropriate for this type of test.

Barrier and Traveling Screen Tests

In August 1980, a test was designed to substantiate the requirement of

Table 2.--Delayed mortality of spring chinook, sockeye, and fall chinook salmon following collection and transportation by truck and barge from McNary Dam to Bonneville Dam after 2-day and 14-day holding.

Species	Transport mode	Sample size	2-day mortality (%)	4-day mortality (%)
Spring chinook salmon	Truck	2,001	6.8	44.2
	Barge	346	0.6	42.5
Sockeye salmon	Truck	147	10.4	70.8
	Barge	126	0.0	90.6
Fall chinook salmon	Truck	131	7.4	31.0

using vertical barrier screens when submersible traveling screens are used in the turbine intake at McNary Dam. To conduct the test, a traveling screen was operated with a barrier screen in place in one slot, and in a nearby unit (slot), the barrier screen was removed, and only the traveling screen was in place. During the test, both traveling screens were operated at the same guiding angle, and the turbines were operated at identical loading for power generation.

Marked fish were released simultaneously into both test gatewells (near the bottom of gatewell just above the traveling screen). Three replicates of 200 fall chinook salmon were released in each gatewell, and a single control group of 200 marked fish was released into the juvenile collection flume at a point between the two test gatewell orifices. All fish were recovered at the juvenile collection facility. The control group was used to provide an index of expected maximum recovery. Evaluation was based on recoveries at 2, 4, 6, 8, 10, 12, 16, 24, and 34 h following release of the fish.

Results showed that vertical barrier screens are an absolute necessity. Only 2.2% of the fish were recovered in the gatewell without a barrier screen, compared to 66.0% of the fish recovered in the gatewell with a vertical barrier screen in place. The results were not surprising since the traveling screen diverts considerable water into the gatewell; and in the absence of a barrier screen, fish in the water mass can pass downward rather quickly back into the turbine intake.

The most interesting part of the test was the length of time it took fish from the control group to traverse the flume and enter the collection system. Nearly 30% of the fish recovered were in the flume for more than 8 h. Some spent more than a full day in the flume, and relatively few fish passed through it in the first 2 h following release. A similar observation was made at Lower Granite Dam where steelhead were observed to reside in the collection flume; however, no precise length of residence was established (Smith et al. 1981).

EVALUATION OF ADULT RETURNS

Transportation from McNary Dam 1978-79

Adult return data available from juvenile salmonids transported in 1978 and 1979 were analyzed. Numbers of juvenile chinook, coho, and sockeye salmon and steelhead marked; mode of transportation; and release areas for the 1978-79 transportation experiments are given in Table 3. The major differences between the years were: (1) only trucks were employed in 1978, whereas both trucks and barges were used to transport fish in 1979 and (2) a second control release in the forebay was added in 1979 to provide a measure of sampling efficiency at McNary Dam. This group was not used in evaluating transport benefits, since many were subsequently collected and transported as evidenced by a higher return rate than the tailrace release at all recovery points (three collector dams, Indian fishery, and sports fishery).

The adult trapping facility at McNary Dam is the primary evaluation point for transportation originating at that dam. The facility operates in the north fishway at McNary Dam; however, recovery of adult returns was limited since most adults used the south fishway. To provide a complete evaluation of adult returns, recoveries of adults at Bonneville and Lower Granite Dams, as well as recoveries from ocean commercial and sport fisheries, in-river commercial and sport fisheries, and hatcheries were included in the analyses. Returns through 26 June 1981 were included in this report.

Table 3.--Number of steelhead and salmon marked for transportation experiments at McNary Dam 1978 and 1979.

	Release site				
	Barged Bonneville	Trucked Bonneville		Control McNary Tailrace	
	1979	1978	1979	1978	1979
Species/race					
Salmon					
Sockeye	4,796	6,831	9,601	5,509	8,207
Coho	1,626	22,358	1,343	21,767	983
Spring chinook	40,126	32,147	42,748	31,376	31,229
Fall chinook	0	40,361	129,777	38,137	112,718
Steelhead	18,182	20,785	15,399	15,585	8,595

In 1979, the adult trapping facility at McNary Dam went into operation on 8 August. In 1980 and 1981, operations commenced in early June so that sampling covered the entire period when steelhead were migrating. To minimize handling of the presently precarious run of upriver spring chinook salmon, there was no trapping in April or May in 1979, 1980, or 1981. Evaluation of spring chinook salmon has therefore been limited to recoveries in the fishery, at hatcheries, at Lower Granite Dam (1979-81), and Bonneville Dam (1981).

Sockeye Salmon

Because of the lack of opportunity to sample sufficient numbers of sockeye salmon and the low numbers of juveniles marked in 1978 and 1979 (Table 3), there were insufficient data to provide an evaluation of transport benefits on these fish.

Coho Salmon

Adequate numbers were marked in 1978 to provide an analysis of transport benefits for coho salmon that year (Park et al. 1980). Briefly, the results indicated that: (1) twice as many transported coho salmon were caught in the ocean fishery as controls; (2) 248 fish were caught in the fishery, and 30 were caught at Bonneville and McNary Dams (0.87% of the transported fish released and 0.4% of the control fish released); and (3) straying was minimal since the transport to control ratio in the fishery and back at the dam was nearly the same. Insufficient numbers of juveniles were marked in 1979 for an evaluation of transport benefits (Table 3).

Steelhead

Adult return data are complete on 1- and 2-ocean age returns from those marked as juveniles in 1978. Transportation from McNary Dam provided a significant benefit to steelhead; combined returns to river collector sites at Bonneville, McNary, and Lower Granite Dams showed a rate of return of 1.4% for transported fish compared to 0.5% for control releases. This equated to a transport benefit of +204% (Table 4). This benefit was also noted in the Indian set-net fishery (+238%) and in the sport fishery (+216%) (Table 5). The consistency in transport benefits in the fisheries and at dams indicates that straying was minimal. The variability in the rate of return at the sampling sites was due to differences in sampling and/or harvest rate.

Adult return data on those released in 1979 must be considered preliminary since only 1-ocean age returns were available. Results, though, indicated essentially the same transport benefit in all sampling areas--previously noted for steelhead transported in 1978 (Tables 5 and 6). A comparison of barge vs truck transport modes indicated that barged fish returned at a higher rate than trucked fish. The small number of fish taken in the Indian fishery indicated no significant delay in steelhead reaching their upriver destinations. Additional details on recovery of steelhead in the sport and Indian fisheries are contained in Appendix Tables 9, 10, and 11.

The significance of transportation at McNary Dam relative to restoration of the steelhead sport fishery in the mid-Columbia River is illustrated in Table 7. The Methow River is a significant component of the mid-Columbia River fishery. The Washington Department of Game (WDG) estimated that 932 steelhead were harvested in the 1980-81 season (Schuck et al. 1981). Of these, 699 or about 75% were 1-ocean age fish from the 1979 smolt outmigration.

Table 4 .--Preliminary returns of 1- and 2-ocean age steelhead from control and transport of smolts from McNary Dam in 1978. Recoveries were made at Bonneville, McNary, and Lower Granite Dams from 2 July 1979 to 1 June 1981.

Release site and experimental group	Number of smolts released	Number of adults recovered: Bonneville Dam 1-ocean	Bonneville Dam 2-ocean	McNary Dam 1-ocean	McNary Dam 2-ocean	Lower Granite Dam 1-ocean	Lower Granite Dam 2-ocean	Total	% of smolt release returning as adults	Transport benefit (%)
Control	15,585	5	9	9	9	23	18	73	0.468	---
Bonneville										
Truck transport	20,416	16	29	18	44	110	74	291	1.425	+204
Total	36,001	21	38	27	53	133	92	364		

Table 5.--Preliminary recovery of 1- and 2-ocean age steelhead from control and transport releases of smolts from McNary Dam in 1978-79. Recoveries are from river site collectors, Indian Set-Net Fishery, and from sport fisheries indicating number of each experimental group, the percent return, and transport benefit ratio. (Return from 1 June 1979 to 1 June 1981.)

	1978 Releases			1979 Releases		
group	Number of adult recovered (1- and 2-ocean fish)	% of smolt release	Transport benefit (%)	Number of adults recovered (1-ocean fish only)	% of smolt release	Transport benefit (%)
River site collectors						
Control (McNary tailrace)	73	0.468	---	13	0.151	---
Truck transport	291	1.425	+204	50	0.325	+115
Barge transport				81	0.446	+195
Indian Set-Net Fishery						
Control (McNary tailrace)	2	0.013	---	1	0.012	---
Truck transport	9	0.044	+238	9	0.059	+391
Barge transport				9	0.049	+308
Sport Fishery						
Control (McNary tailrace)	21	0.135	---	8	0.093	---
Truck transport	87	0.426	+216	39	0.254	+173
Barge transport				55	0.303	+226

Table 6.--Preliminary returns of 1-ocean age steelhead from control and transport releases of smolts from McNary Dam in 1979. Recoveries were made at Bonneville, McNary, and Lower Granite Dams 2 July 1980 to 26 June 1981.

Release site and experimental group	Number of smolts released	Number of adults recovered: Bonneville Dam	McNary Dam	Lower Granite Dam	Total	% of smolt release	Transport benefit (%)
McNary Dam (control)							
Forebay	8,131	12	9	8	29	0.357	---
Tailrace	8,595	2	5	6	13	0.151	---
Transport (below Bonneville)							
Truck	15,379	12	19	19	50	0.325	+115 a/
Barge	18,182	20	30	31	81	0.446	+195 a/
Total	50,287	46	63	64	173		

a/ Transport benefits are computed on the basis of McNary Dam tailrace control group.

Table 7.--Estimated contribution of 1-ocean age steelhead that were transported by truck and barge from McNary Dam in 1979 and were taken in the sport fishery in the Methow River in 1980-81.

Transport mode	Number of marked smolts transported	Estimated number of marked adults in fishery[a/]	Number of unmarked smolts transported	Estimated number of unmarked adults in fishery	Total adults in fishery
Truck	15,399	36	51,168	120	156
Barge	18,182	65	83,384	298	363
Total adults		101		418	519

a/ Data from 1980-81 Columbia River and tributary tag recovery report, Schuck et al. Washington Department of Game, 1981.

1979 was the first year that both marked and unmarked steelhead smolts were transported at McNary Dam. The total number of adults taken in the fishery from transported fish is estimated to be 519 fish or 74.2% of all 1-ocean age fish harvested. The analysis was a straight expansion of marked to unmarked fish in the fishery (Table 7). No adjustment was made for differential rate of survival of marked (handled) vs unmarked smolts.

The barge group provided a Methow River harvest of 0.357% of the smolt release (65/18182). If the catches from all fishing areas were taken together, the combined sport catch would probably have exceeded 1% of the smolts transported by barge.

We concluded that transportation of mid-Columbia River steelhead at McNary Dam is providing excellent benefits--similar to those shown for Snake River stocks transported from Lower Granite and Little Goose Dams in recent years.

Spring Chinook Salmon

Since trapping of adults was restricted, as mentioned previously, more reliance was placed on recoveries of tagged spring chinook salmon in ocean and Columbia River commercial and sport fisheries and returns to hatcheries.

Spring chinook salmon returning to the dam collector sites following transportation in 1978 are more numerous than nontransported fish (controls)(Table 8). To date, all except two recoveries were made at Lower Granite Dam. The two recoveries (one each from Bonneville and McNary Dams) were actually summer run fish (based on the timing of their interception). We have observed considerable overlap in the timing of spring, summer, and fall chinook salmon on their seaward migrations. Hence, we have unavoidably marked some summer-fall fish as springs and vice versa.

Table 8.--Preliminary return to three river collector sites of 1- and 2-ocean age spring and fall chinook salmon from control and transport releases of smolts from McNary Dam in 1978-79. Recoveries were made from 1 April 1979 to 3 December 1980.[a/]

1978 releases	Number released	Bonneville Dam 1-ocean	Bonneville Dam 2-ocean	McNary Dam 1-ocean	McNary Dam 2-ocean	Lower Granite Dam 1-ocean	Lower Granite Dam 2-ocean	Total	% of smolt release	Transport benefit (%)
Spring chinook salmon										
Control	31,376	--	0	--	0	1	2	3	0.010	---
Truck transport	32,147	--	1	--	1	3	10	15	0.047	+370
Fall chinook salmon										
Control	38,137	4	1	6	2	1	0	14	0.037	---
Truck transport	40,361	19	4	66	15	6	0	110	0.273	+638
1979 releases - (1-ocean only)										
Spring chinook salmon										
Control										---
Tailrace	31,229	0	0	1	--	1	--	2	0.006	---
Forebay	24,650	0	0	0	0	0	0	0	0.000	---
Truck transport	42,748	0	0	0	0	1	0	1	0.002	-66
Barge transport	40,126	1	0	0	0	3	0	4	0.010	+66
Fall chinook salmon										
Control										
Tailrace	112,718	4	0	2	0	0	0	6	0.005	----
Forebay	19,810	1	0	0	0	0	0	1	0.005	----
Truck transport	132,919	27	0	29	0	0	0	56	0.042	+740

a/ In 1979-80 the adult collector did not operate at McNary and Bonneville Dams during the spring run.

To date, the limited returns obtained from the fisheries and hatcheries upstream from McNary Dam reflect low returns but positive benefits based on transport/control ratios (Table 9). The seven transport and two control fish recovered at Snake River hatcheries represented all of the hatchery returns from the 1978 releases of spring chinook salmon from McNary Dam (Appendix Table 12). However, none of the tagged fish recovered at mid-Columbia hatcheries in 1980 or 1981 have been evaluated. There are 340 marks from Leavenworth Hatchery alone (1980); some of which certainly are fish tagged and transported from McNary Dam in 1978. Since 65 to 75% of the smolts that passed McNary Dam in 1978 were from the mid-Columbia River, one might expect between 25 and 40 eventual tag returns from mid-Columbia River hatcheries. Information from these tag recoveries will be helpful in evaluating benefits of transporting spring chinook salmon from McNary Dam.

Few spring chinook salmon transported from McNary Dam or released as controls in 1978 were found in the ocean, commercial, or sport fisheries. We believe that the limited number of spring chinook salmon released in 1978 that were recovered in the fisheries were fall chinook salmon misidentified during marking.

Jack returns to the collector dams from juvenile spring chinook salmon released in 1979 were low and provided little useful information. However, there have been numerous recoveries (jacks) of 1979 releases in the Columbia River commercial and sport fisheries, at the hatcheries, and in the ocean fisheries. Two things about these returns are of interest: (1) 41 of 44 fish recovered in the Columbia River were recovered at the Ringold Hatchery located just upstream from McNary Dam Reservoir and (2) since ocean recoveries of upriver spring chinook salmon are rare, the recovery of 56 jacks was surprising.

Table 9.--Preliminary recovery of 1- and 2-ocean age spring chinook salmon from control and transport releases of smolts from McNary dam in 1978-79. Recovery areas include river site collections, ocean commercial and sport fisheries, and Columbia River commercial and sport fisheries and hatchery returns. (Recoveries are from 1 April 1978 to 3 December 1980.)

	1978 (1- and 2-ocean)				1979 (1-ocean)			
	Number of smolts released	Number of adults recovered	% of smolts released	Transport benefit (%)	Number of smolts released	Number of adults recovered	% of smolts released	Transport benefit (%)
River site collectors								
McNary control (tailrace)	31,376	3	0.010	---	31,229	2	0.006	---
Bonneville (truck)	32,147	15	0.047	+386	42,748	1	0.002	-63
Bonneville (barge)	θ	--	------	---	40,126	4	0.010	+56
Ocean commercial and sport fisheries								
McNary control (tailrace)	31,376	3	0.010	---	31,229	13	0.042	---
Bonneville (truck)	32,147	7	0.022	+120	42,748	26	0.061	+46
Bonneville (barge)	θ	--	------	---	40,126	17	0.042	+2
Columbia River commercial and sport fisheries and hatchery								
McNary control (tailrace)	31,376	2	0.006	---	31,229	15	0.048	---
Bonneville (truck)	32,147	6	0.019	+192	42,748	21	0.049	+2
Bonneville (barge)	θ	--	------	---	40,126	8	0.020	-58
Total								
McNary control (tailrace)	31,376	8	0.025	---	31,229	30	0.096	---
Bonneville (truck)	32,147	28	0.087	+248	42,748	48	0.112	+17
Bonneville (barge)	θ	--	------	---	40,126	29	0.072	-25

The return of 41 jacks from one experimental year class (control, truck, and barge groups combined) to a single hatchery is unprecedented. Either the stock of fish represented at Ringold Hatchery have a very high propensity to return as jacks or they may have had substantital benefit from transportation.

There is strong evidence that the 56 jacks recovered in the ocean fisheries from the 1979 release (Table 9) were from the Ringold Hatchery. Data from the Washington Department of Fisheries (WDF)1/ show that the occurrence of Ringold Hatchery fish in the Washington coastal fishing areas was substantial in 1980. Fish tagged at Ringold Hatchery by WDF in 1979 were spring chinook salmon transferred from stock of the Cowlitz Hatchery2/--a stock with a history of contributing substantially to the ocean sport and commercial fisheries.

It is apparent that it is important to know the history of the stocks of experimental fish in any analysis of adult returns since many returns may show at unexpected locations--including the ocean fisheries for "upriver" stocks. In the aforementioned case, for instance, we believe that the unusually high occurrence of spring chinook salmon in the ocean fisheries in 1980 from transport experiments was an artifact and not typical of upriver stocks.

In summary, transportation of spring chinook salmon from McNary Dam in 1978 (truck only) shows positive benefits. However in 1979 when both trucks and barges were used, benefits are positive for only trucking. The

1/ Fish from Ringold Hatchery were identified by a separate tag. Personal communication, Richard O'Conner, Washington Department of Fisheries, Olympia, WA.

2/ Source: Releases of Coded-wire Tagged Salmon and Steelhead from Pacific Coast Streams Through 1980, Regional Work Processing Center, Portland, Oregon.

true overall benefit in 1979 is influenced heavily by relatively high adult return of trucked fish which contained a substantial portion of the aforementioned Ringold Hatchery fish. Since the barge was used after 20 April in 1979 at McNary Dam and most of the Ringold fish had already passed the dam, the barged group is unfavorably biased when compared to control and truck groups because few of the Cowlitz stock chinook salmon were barged.

Fall Chinook Salmon

Fall chinook salmon were transported only by truck in both 1978 and 1979. To date, only jacks from 1978-79 releases and 2-ocean age fish from 1978 have returned to the Columbia River. In 1981, 3-ocean age fish from 1978 releases should return to the river. It is well known that 3-ocean age fish are the principal producing age group, and they should provide a clearer picture of how transportation is benefiting this stock. Considerably fewer 2-ocean age fish have returned from 1978 than have 1-ocean age fish (jacks). Transport benefits for fall chinook salmon appear to be excellent. Positive transport benefits occurred in both 1978 and 1979 for fish intercepted at the collector dams, recovered in the fishery, or recovered at hatcheries (Table 10). The combined benefit of +467% in 1978, more than twice that measured for steelhead, makes it apparent that juvenile fall chinook salmon are incurring some severe mortality between McNary and Bonneville Dams. Since most of the seaward migration occurs during the summer when river flows are reduced, the long John Day Dam Reservoir must be suspected as a prime area for mortality. When recovery of adults from transport tests in 1978-79 are taken together (326), only 43 were from control releases. Clearly transportation is

Table 10.--Preliminary recoveries of 1- and 2-ocean age fall chinook salmon that were released as controls or transported from McNary Dam in 1978-79. Recovery areas are river site collections, ocean commercial and sport fisheries, and Columbia River commercial and sport fisheries and hatcheries. (Recoveries were made from 1 September 1978 to 3 December 1980.)

	1978 (1- and 2-ocean)				1979 (1-ocean)			
	Number of smolts released	Number of adults recovered	% of smolt released	Transport benefit (%)	Number of smolts released	Number of adults recovered	% of smolts released	Transport benefit (%)
River site collectors								
Control (tailrace)	38,137	14	0.037	---	112,718	6	0.005	---
Bonneville (truck)	40,361	110	0.273	+638	132,919	56	0.042	+740
Ocean commercial and sport								
Control (tailrace)	38,137	9	0.027	---	112,718	0	0	---
Bonneville (truck)	40,361	42	0.104	+333	132,919	14	0.011	---a/
Columbia River commercial, sport, and hatcheries								
Control (tailrace)	38,137	10	0.026	---	112,718	4	0.004	---
Bonneville (truck)	40,361	47	0.116	+346	132,919	14	0.011	+175
Total								
Control (tailrace)	38,137	33	0.087	---	112,718	10	0.009	---
Bonneville (truck)	40,361	199	0.493	+503	132,919	84	0.063	+700

a/ Transport benefit cannot be computed because no controls were recovered.

benefiting this stock. Data from returns of 3-ocean fish in 1981 should provide a clearer picture of the status of transportation of fall chinook salmon.

Transportation from Snake River 1977-79

The NMFS is continuing to evaluate the effect of transporting steelhead and chinook salmon smolts by trucks and barges from Lower Granite and Little Goose Dams to release sites in the Columbia River below Bonneville Dam. The primary evaluation technique is to intercept adults previously tagged as juveniles when they return to Lower Granite Dam. Additional data have also been obtained from recoveries of tagged fish in the sport and commercial fishery, on spawning grounds, and back at hatcheries.

Data summarized in this section cover all adult recoveries in 1980 and adult steelhead in the spring of 1981. These returns generally were from fish tagged as juveniles between 1977 and 1979. An additional thirty-six 3-ocean age steelhead, not previously reported, from the 1976 release were recovered at Dworshak Hatchery in the spring of 1980 (Appendix Table 13). These returns, however, did not materially affect benefits previously reported.

Steelhead

Adult return data from the 1977 outmigration are complete. An additional 88 tagged fish were recovered at the Lower Granite Facility in 1980 for a total return of 407 fish. These additional recoveries did not materially change the high transport benefits previously reported. The benefit ratios of 11:1 to nearly 16:1 reflect the severe mortality sustained by fingerlings migrating seaward during the drought in 1977

(Table 11 and Appendix Tables 14 and 15). Steelhead marked in 1977 and recovered as adults at Dworshak and Pahsimeroi Hatcheries are presented in Appendix Tables 16 and 17.

With the additional recoveries, the percent return from the 1977 outmigration did increase to about 1% for the transport groups but still remained below that of transport returns from other years (Table 11). This low rate of return reflected the poor condition of smolts arriving at Lower Granite Dam in 1977. Survival of nontransported smolts in 1977 was virtually nil (Ebel et al. 1979). Without transportation very few adults would have been produced; the mass-transport effort did at least return 12,000 adults to the Snake River (Park 1980).

Adult return data from the 1978 outmigration are nearly complete on 1- and 2-ocean age adults (Table 12 and Appendix Table 18). An additional 757 tagged fish from the various transport groups were recovered at the Lower Granite Facility in 1980, for a combined transport return of 1,678 fish--about 1% of the smolts released. Based on the ratio of detected to nondetected marked fish recovered at hatcheries in 1980 and 1981 (Appendix Tables 19 and 20), the estimated total return of marked fish was about 3% (Table 11)--the highest percent return we have measured to date (Park 1980). With the 3-ocean age fish still to come, the final rate of return will be over 3%. The additional recoveries in 1980 increased the transport benefits ratios from the nearly 4:1 previously reported to nearly 5:1. Only minimal differences were noted between treatment groups: freshwater vs saltwater, truck vs barge, and Little Goose Dam vs Lower Granite Dam (Appendix Table 17).

Returns of marked fish from the 1978 treatment groups at hatcheries and in the sport fishery were the highest since the inception of the

Table 11.--Adult return to Lower Granite Dam of steelhead transported from Lower Granite Dams from 1975-79 indicating test condition, percent return, and transport benefit ratio. Recoveries were from 1976 through 1 June 1981.

Year	Test condition	% observed	Return estimated[a/]	Benefit ratio[b/]
1975	Brand & wire tag	1.51	2.75	3.54:1
	Wire tag only	1.27	2.29	2.97:1
1976	Truck fresh water	0.60	1.79	2.13:1
	Truck salt water	0.53	1.43	1.88:1
1977	Truck salt water	0.28	1.14	15.56:1
	Barge	0.21	0.92	11.67:1
1978	Truck fresh water	1.05	2.78	4.73:1
	Barge	1.12	2.97	5.08:1
1979	Barge	0.18	c/	2.22:1[d/]

a/ Calculated from ratio of detected and nondetected tags recovered at hatcheries each year.

b/ Benefit ratios are computed on bases of observed returns.

c/ Only 1-ocean returns available.

d/ Calculated benefits may be low since controls were released below Lower Granite Dam. Approximately 50% of these controls were given the benefits of transportation from Little Goose Dam.

Table 12.--A comparison of numbers of adult steelhead with their respective transport benefit ratios returning to Lower Granite Dam, upstream hatcheries, and sports fishery for various transport groups 1977-79.

	Number recovered at L. Granite Dam	Benefit ratio	Number recovered at hatcheries	Benefit ratio	Number recovered in sport fishery (1980 season)	Benefit ratio
1977 - Lower Granite						
Truck-SW	230	15.56:1	149			
Barge	64	11.67:1	23			
1978 - Little Goose						
Bonneville-FW	361	4.55:1	38	5.35:1	23	2.44
Bonneville-SW	329	4.63:1	37	5.81:1	36	4.25
1978 - Lower Granite						
Bonneville-FW truck	497	4.73:1	114	11.15:1	35	2.80
Bonneville-barge	491	5.08:1	101	11.83:1	32	2.78
1979 - Lower Granite						
Bonneville-barge	55	2.22:1[a]	18	1.38:1[a/]	27	2.33[a/]

a/ Benefits are based on control fish that were released in the tailrace of Lower Granite Dam. No adjustment has been made for controls released below Lower Granite Dam that may have received benefit of transportation at Little Goose or McNary Dams.

program. Over 350 marked steelhead were recovered at the principal hatcheries [Dworshak National Fish Hatchery (NFH) and Pahsimeroi Hatchery] and satellite collection sites (Appendix Tables 19 and 20). From the sport fisheries, there were 150 marked fish recoveries via voluntary angler returns and state creel census studies. Although these returns came from a wide area, over 75% of the returns were from intense fisheries on the Clearwater and Salmon Rivers in Idaho (Appendix Table 22). Very little identifiable straying was noted.

Throughout our transportation studies, we have strived to mark random samples of fish so that all stocks in various experimental groups are treated equal. It appears from a comparison of recovery ratios of adults at upstream hatcheries from juveniles marked for treatment groups in 1978, that random marking did occur (Table 13). One should bear in mind that at Dworshak NFH returns are primarily 2-ocean age fish, whereas at Pahsimeroi Hatchery 1-ocean age fish are the rule. Random treatment at the dams is demonstrated by nearly identical ratios of 1-ocean age and 2-ocean age marked fish recoveries at each hatchery from each dam.

Only 1-ocean age returns are available from those transported in 1979. A total of 55 barged fish were detected at Lower Granite Dam. This represents an 0.18% return, much below the 0.75% return rate of 1-ocean age fish in 1978, and the lowest rate of return of 1-ocean age fish of any transport year except 1977 (Table 11 and Appendix Table 22). This apparent poor return was caused by problems with tag detection and reduced sampling effort at Lower Granite Dam in the fall of 1980 which allowed a higher than normal number of fish to pass the dam without interception. Marked fish recoveries in hatcheries showed how poor detection was at Lower Granite Dam. Only 1 of 34 tagged fish from the 1979 release that were recovered at

Table 13.--Adult steelhead returns to Dworshak and Pahsimeroi Hatcheries in 1980-81 (1-and 2-ocean fish) that were transported from Little Goose and Lower Granite Dams or released as controls in 1978. Recoveries in ( ) are from transport groups; the remainder are controls.

	Dworshak Hatchery	Pahsimeroi Hatchery	Total
1978 Little Goose releases			
1-ocean recovery	5 (5)	29 (26)	34 (31)
2-ocean recovery	28 (27)	4 (4)	32 (31)
Subtotal	33 (32)	33 (30)	66 (62)
1978 Lower Granite releases			
1-ocean recovery	12 (9)	90 (76)	102 (85)
2-ocean recovery	94 (81)	18 (15)	112 (96)
Subtotal	106 (90)	108 (91)	214 (181)
Total	139 (122)	141 (121)	280 (243)

the Pahsimeroi Hatchery had a jaw tag indicating it had been previously detected at a dam (Appendix Table 17). Previously detected tags in other years generally ranged from 20 to near 100% (Appendix Tables 17-21).

The detection problem was specifically identified as a magnetism deficiency in the tag at the time of implantation in the juveniles. Steps have been taken to correct the problem in future tagging, but there may be continued poor detection on groups released in 1979 and 1980.

The reduced sampling effort was put into effect at Lower Granite Dam between 20 September and 14 October 1980. During this period, approximately 40% of the adult migration was allowed to bypass the trapping facility to avoid trapping and handling of large numbers of adults tagged by other agencies.

Benefit ratios for the 1979 barge group are lower than indicated in previous years from recoveries at Lower Granite Dam (Table 12). Control fish in 1979 were released in the Lower Granite tailrace, however, and did not truly represent the survival of nontransported fish migrating downriver since at least 50% of the control group received the benefits of transportation from Little Goose Dam and McNary Dams.

Because of the lack of interception of adults at Lower Granite Dam and a nonrepresentative control release, it is difficult to evaluate benefits of transportation in 1979 from marked fish recoveries. However, since 67% of the entire smolt migration was transported in 1979, it is possible to provide a preliminary assessment based on unmarked fish returns. The 1-ocean age returns to the Snake River, those caught in the sport fishery, and those returning to hatcheries all indicate that the 1979 run might be one of the best runs produced since the 1970-71 outmigrations. The return to the Snake River in 1980 was about 45,000 fish, nearly twice that of 1979 and 5,000 fish above the 1970-79 average. Indications are that the 1981 count may be even higher. During the fall of 1980 and the spring of 1981, the sport fishery in the Salmon River (dominated by 1-ocean age Pahsimeroi Hatchery fish) was the best it has been in years. The return of 3,491 fish to the hatchery was the best since 1971. The total return of fish to the Pahsimeroi River (sport catch plus hatchery escapement) has not been calculated, but probably will rank among the best since the 9,589 fish returned from the 1970 outmigration.[3/] Final assessment of the success of transportation in 1979 will have to wait until 2-ocean age returns of both marked and unmarked fish have been evaluated.

Based on unofficial counts at Ice Harbor Dam (1 June 1980-1 June 1981), about 47,200 steelhead entered the Snake River. This was the highest count since 1977 and was indicative of a substantial steelhead population. A problem developed, however, between Ice Harbor Dam and Lower Granite Dam.

The unofficial count of steelhead at Lower Granite Dam (the last dam encountered before fish reach their spawning tributaries) was 37,800--only 80% of the count at Ice Harbor Dam. NMFS biologists, as well as many others, are extremely concerned over this apparent failure of 9,400 fish to pass the upper dam. Since only one minor tributary is located between Ice Harbor and Lower Granite Dams, a major delay or mortality factor is suspected. This problem is new this year, as a comparison of annual steelhead counts at the two dams from 1975 (the year Lower Granite Dam was completed) to 1979 showed that the counts were nearly equal.

The increased steelhead returns to the Snake River are, in most part, a result of the juvenile transportation program. Therefore, the

[3/] Personal communication, Robert Moore, Manager, Pahsimeroi Hatchery, Ellis, Idaho 83235.

possibility that the missing fish are a consequence of the transportation program is being examined; e.g., the possibility that transportation has interfered with the fish's ability to home to its natal area.

From the 1975-76 through the 1980-81 runs of adult steelhead which had been marked and transported as juveniles, about 80% passed Lower Granite Dam in the same calendar year they entered the Columbia River. In the runs prior to 1980-81, the remaining 20% continued their upstream migration to their natal areas the following spring. Historically, only a small percentage of fish ($\approx$7%) stayed in the mainstem river over the winter before moving up to their natal areas the following spring. Thus, there may have been some increased initial delay of transported fish. Since during the 1980-81 season, the fish did not continue their migration in the spring, there appears to be more involved than simply a delay associated with transportation.

During the winter of 1980-81, environmental conditions in the Snake River were different from previous years. The winter weather was unusually warm and affected water temperatures in the area of concern. For the 6-year period 1975 to 1980, January, February, and March mean water temperatures were 0.6°, 0.5°, and 5.0°C, respectively; whereas in 1981 the monthly water temperatures were 5.0°, 4.1°, and 7.9°C.

The significantly higher water temperatures during 1981 (especially January and February) could have resulted in earlier maturation of the steelhead and/or caused the fish to continue migrating during the winter. Unfortunately, daily fish count records routinely are not kept during January or February. It is not likely, however, that a substantial fish migration occurred, as passage was hampered because fish ladders were unwatered for normal annual maintenance during the following periods:

1. Lower Monumental Dam (two ladders)--one of the two was out of service from 23 January to 17 March.

2. Little Goose Dam (one ladder)--out of service 4 February to 6 March.

3. Lower Granite Dam (one ladder)--out of service from 5 January to 2 February, and no attraction pumps operating until March.

The exact cause of the missing fish remains unknown. However, a combination of elevated water temperatures, early gonad development, and delay caused by fish ladders being out of service could have resulted in mortality to some or all of the missing fish.

Chinook Salmon

In 1977, chinook salmon that were transported faired considerably better than those fish not transported. However, all fish were under stress from drought conditions prevalent that year. The total observed marked returns to Lower Granite Dam for various treatment groups were seven fish from Lower Granite Dam tests and two fish from Little Goose Dam tests. No marked fish from control groups returned (Appendix Table 23). Twenty-four fish from test groups were recovered at hatcheries or on spawning ground surveys.

The inefficiency of the Lower Granite Dam trapping facility (noted earlier) has definitely hampered our efforts in evaluating chinook salmon transportation for 1977. For example, of the 24 fish that were tagged as juveniles in 1977 and recovered as adults at hatcheries or on the spawning grounds, only 3 had been previously intercepted on their upstream migration at the dam, indicating trapping efficiency was only 12% (Appendix Table 24 and Park et al. 1980). The pattern of returns by transport group at the hatcheries was identical with that observed at the dams; i.e., most returns were from Lower Granite Dam tests, few were from Little Goose Dam test groups, and no controls from either dam were recovered.

Data are summarized in Table 14 for adults returning to Lower Granite Dam from fingerlings transported from Little Goose and Lower Granite Dams in 1978. It is clear that among all groups, fish transported by barge from Lower Granite Dam returned at the best rate. This group also had the highest number of returns noted at Kooskia and Rapid River Hatcheries (Appendix Table 24). The next best group was the truck-freshwater group transported from Lower Granite Dam. The companion group (truck-freshwater) transported from Little Goose Dam, however, returned at only 0.1 the rate of the Lower Granite Dam group. Fish held for 24 hours in fresh water prior to transportation in fresh water and those held for 24 hours in salt water before transportation in salt water returned at lower rates than control releases.

In 1980, adult returns from 1978 transportation groups were low. The trapping efficiency at Lower Granite Dam for 1- and 2-ocean age adult returns from transportation groups in 1978 was 33% (10 jaw tagged fish indicating interception at the dam vs 20 non-jaw tagged fish recovered at hatcheries and on the spawning ground). Even if all recoveries at the dam were to be expanded by a factor of three, the best group (Lower Granite barge) would have returned at only 0.3%, compared to the nearly 3% return of steelhead from the 1978 releases.

Stresses are probably occurring in the collection-transport system that are affecting the long-term survival of the transported chinook salmon as illustrated by the low return rates above. It is recommended that future research be designed to define where stresses are occurring, followed by further research to eliminate or reduce the stress.

Table 14.--Preliminary returns to Lower Granite Dam of 1- and 2-ocean age chinook salmon from control and transport releases of smolts from Little Goose and Lower Granite Dams in 1978. Recoveries were made from 24 April 1979 to 24 November 1980.

Release site and experimental groups	Little Goose Dam: No. of juveniles released[a]	Little Goose Dam: No. of adults recaptured, 1-ocean age	Little Goose Dam: No. of adults recaptured, 2-ocean age	Little Goose Dam: No. of adults recaptured, Total 1 & 2's	Little Goose Dam: Adult return in % of juveniles released	Little Goose Dam: Transport benefits[b] (%)	Lower Granite Dam: No. of juveniles released[a]	Lower Granite Dam: No. of adults recaptured, 1-ocean age	Lower Granite Dam: No. of adults recaptured, 2-ocean age	Lower Granite Dam: No. of adults recaptured, Total 1 & 2's	Lower Granite Dam: Adult return in % of juveniles released	Lower Granite Dam: Transport benefits[c] (%)
Control Tailrace	36,441	0	5	5	0.014	---	8,249	---	2	2	0.024	---
Control Forebay	---	---	---	---	---	---	46,094	2	8	10	0.022	---
Bonneville Barge transport (Freshwater)	---	---	---	---	---	---	56,346	6	50	56	0.099	+607
Bonneville Truck transport (Freshwater)	49,391	1	2	3	0.006	-57	43,455	4	24	28	0.064	+357
Bonneville Truck transport (Saltwater)[d]	47,661	0	0	0	0.0	---	---	---	---	---	---	---
Bonneville Truck transport (Freshwater 24-h hold)							38,685	2	3	5	0.013	-7
Bonneville Truck transport (Saltwater 24-h hold)[d]							40,841	0	4	4	0.010	-29
TOTAL	133,493	1	7	8			233,670	14	91	105		

a/ Transported fish adjusted for initial tag loss.

b/ Based on observed returns.

c/ The percent return of Lower Granite controls is unrealistically high because many juveniles were transported in the mass transport system at Little Goose and Lower Granite Dams. Therefore, transport benefits are calculated based on the observed percent of return of Little Goose controls.

d/ 10 ppt salt water.

Insufficient returns of chinook salmon transported in 1979 are available to provide any meaningful analysis (Appendix Table 34). It appears, however, that the trend of overall poor survival of Snake River spring chinook salmon is continuing.

Park (1980) pointed out that there may be factors such as estuarine or early ocean mortality that are severely reducing survival of chinook salmon. Regardless of such factors, prevalent or not, our best approach toward increasing survival may be to fine tune the collection and transport system so that stresses to fish are eliminated prior to their release below Bonneville Dam. Only in this manner will the fish be best fit to survive any future hazard experienced in the ocean.

EVALUATION OF THE JUVENILE BYPASS SYSTEM AT LITTLE GOOSE DAM

During 1978-79, the U.S. Army Corps of Engineers (CofE) constructed a new fingerling bypass system at Little Goose Dam to reduce injuries to smolts and to reduce the time juveniles spend in intake gatewells. The new facility was available for fish by 1 April 1980.

Pertinent features of the system include: (1) 12-inch diameter orifices in gatewells (two in each gatewell), (2) an open collection flume in the powerhouse, (3) a 42-inch diameter makeup water gate to automatically regulate the water elevation at the downstream end of the flume, and (4) an enclosed fingerling transfer pipe from the flume to the smolt separator at the tailrace level of the dam.

Although the system was ready for smolt collection by 1 April, few fish were available for observations until 20 April. Daily mortality from 9 April to 28 April averaged 4.7%, and by 28 April, the daily mortality had climbed to an unacceptable 10.5%. (Daily collection mortality data are reported by Smith et al. 1981.) The following actions were taken to reduce mortalities to fish:

1. The bypass system was shut down, and the 42-inch diameter pipe was inspected to determine if the three constrictor rings placed in the pipe to reduce velocity were functioning properly. No malfunctions were noted.

2. Additional stop logs were placed at the downstream end of the powerhouse collection flume to raise the water level and thereby provide a water cushion for fingerlings exiting through orifices from the gatewells. No improvement in fish condition was noted.

3. Twelve-inch diameter steel sleeve inserts were installed in all the south and north orifices of Turbine Units 1 through 4, and 8-inch diameter sleeve inserts were installed in the south orifices of Turbine Units 5 and 6. The sleeves extended from the gatewell slot to the face of each valve to ensure a straight discharge from the orifices so that chances of smolts striking the sides of the valves would be minimized. No change in fish condition was noticed. Appendix Table 26 shows orifice sizes and placement used in 1980.

4. Finally, the flume water level was adjusted by operating the orifices only, and the makeup water gate was closed. Chinook salmon mortalities immediately decreased to 3.6% and stayed low with this mode of operation through the remainder of the season.

Because the mortality was significantly reduced when the makeup water was not used, it was assumed that a sheer plane was occurring at the interface of the flume and makeup water flow. To eliminate this sheer plane, the U.S. Army Corps of Engineers (CofE) designed, constructed, and installed a diffuser to baffle the flow from the makeup water gate. In late June we tested the modified flow by placing marked lots of fish in the collection system at strategic locations. Chinook salmon smolts which had indicated by far the greatest susceptibility to injury were no longer available. Therefore, we used steelhead parr from Dworshak NFH.

Fish were marked by a tattoo in three replicated groups of 100 fish each for four test locations. The initial test was conducted with the makeup gate closed, and the test was repeated with the makeup gate 40% open. Fish were released in the following locations:

1. Group 1 was released in the collection flume through Orifice 1B (south).

2. Group 2 was released in the hopper above the makeup water gate.

3. Group 3 was released into the bypass pipe below the hopper.

4. Group 4 was released into the upwell of the fingerling sorter at the tailrace level.

Groups 1-3 were released by hose and Group 4 was released via a live car. All fish were recovered in a raceway at the collection facility and examined for injury.

Results of the experiment are shown in Table 15. It is clear that fish released in the hopper area with the makeup water valve open received the greatest injury. Mortality, however, was low for all groups. Results of this test coupled with findings earlier in the season when mortality to smolts was high, lead us to the conclusion that velocities within the pipe (downstream from the hopper) may accelerate somewhat when the makeup valve is used. After consultation with NMFS and CofE engineers, it was decided to install a pinch-valve in the bypass pipe to control water velocity in the pipe, and thereby allow greater flexibility in controlling water

Table 15.--Injury and mortality to hatchery steelhead released at various locations during tests with the makeup water valve closed and open at Little Goose Dam, 1980.

Makeup water valve closed			Makeup water valve open		
Release site	Injury rate (%)	Mortality rate (%)	Release site	Injury rate (%)	Mortality rate (%)
1B	1.5	0.5	1B	2.7	1.3
Upper hopper	0.5	0	Upper hopper	5.9	1.8
Lower hopper	1.6	0.5	Lower hopper	5.0	0.45
Upwell	1.8	0.45	Upwell	2.4	0.4

NOTE: These test fish were nonsmolting Dworshak steelhead parr. They were not as susceptable to injury as natural smolting steelhead.

elevation in the collection flume through automatic regulation of the makeup water gate.

DEVELOPMENT OF AN AUTOMATIC WIRE TAG DETECTION AND DECODING SYSTEM

NMFS has been pursuing the development of an automatic tag detector with tag decoding capability for 2 years. Such a system would provide the following benefits: (1) adult salmonids carrying coded wire tags could be detected and the tag "read" without removing the fish from water; (2) tag data read by computer would be available more quickly to all interested parties (summary data could be called for at any time); (3) fish would no longer need to be branded to identify specific tag code groups; (4) tags would never need to be extracted (if the system were to be widely accepted), thereby reducing labor intensity; and (5) the system could be used in a broad area of research; e.g., in genetic studies selected groups of tagged adults could be identified prior to spawning, then crossbred or inbred as desired.

The system we used in our experimental situation in 1980 was in two parts. In the first part, tagged fish were detected by conventional magnetic tag means. Once the tagged fish was in hand, the fish was placed in a moist tray and subjected to x-ray fluorescent spectroscopy. The x-ray spectroscopic process took 5-15 sec, and the total time the fish was removed from water was approximately 30 sec. The spectroscopic process was dependent upon the coating material used on the tag being analyzed.

Tags implanted in juveniles in 1979 (two experimental groups) contained a single code of rare earth metal in the coating fixed to each tag (a tag with two codes would contain two rare earth metals). Therefore, the tags we analyzed from 1-ocean age adults in 1980 contained only a single code. The system, however,was able to correctly "read" two-element coded tags from juveniles tagged in 1980.

The number of adults returning that were tagged with rare earth tags was disappointing. Only 15 adults were subjected to the element decoding process, all of which were correctly identified as verified by their external brand. Numerous rare earth tags from juveniles were correctly identified by the process.

Following X-ray bombardment, the system analyzes the tag for the various possibilities of code treatments and conveys results via a video screen and a permanent record is presented via punched tape.

The system as presently developed could be a useful one for fishery research especially at hatcheries, i.e., tags in snouts taken during spawning operations could be read automatically and fed into a computer. There wouldn't be the present labor costs to extract the tag and delay in obtaining the data from the mark recovery center. However, the feature that we desire for data retrieval from a tagged fish in water does not appear promising in the near future. We believe that the concept is still feasible, but that development of the underwater tag reading capability without handling the fish will be more costly than originally anticipated.

SUMMARY

1. At McNary Dam, 380,660 juvenile salmon and steelhead were marked for the third year of the transportation evaluaiton. A total of 1,740,545 smolts (marked and unmarked) were transported by truck or barge below Bonneville Dam.

2. Descaling of spring chinook salmon recovered in the collection system at McNary Dam was high at times, reaching 20%. In delayed mortality tests at Bonneville Dam following transport, mortality was 6.8 and 0.6% after 2 days for trucked and barged fish, respectively. After 14 days, mortality was 44.2 and 42.5%, respectively. In a single test using fall chinook salmon (truck only), mortality was 7.4% after 2 days and 31.0% after 14 days.

3. Transport benefits for steelhead hauled in 1978-79 to below Bonneville Dam were excellent. Adults returning to collector sites at dams from 1979 smolt releases reflect a transport benefit of over 200% (truck test). For 1978 smolts, truck tests indicate a benefit of over 100%, and barged fish reflect a benefit of nearly 200% (1-ocean returns). Similar high benefits were shown in the sport fishery. In Washington's Methow River, a stream fished intensively, 74% of the 1-ocean fish landed were transported as smolts from McNary Dam in 1979 (sport season 1980-81).

4. Transportation of spring chinook salmon appears to be good, however, data are lacking on adult recoveries to adequately assess benefits. Effort to collect data at McNary Dam has been restricted to avoid handling adults from precariously low runs, and hatchery return data from mid-Columbia hatcheries are incomplete at this time.

5. Transportation of fall chinook salmon has shown excellent benefits.

Data are available from ocean fisheries, at collector dams, and at hatcheries. Results from operations in 1978 indicate benefits of over 600% from truck transport, and in 1979 the benefit is over 700% (jacks only).

6. Evaluation of adults returning to the Snake River from smolt releases in 1977-79 continued at Lower Granite Dam. Steelhead form tests in 1977 at Little Goose and Lower Granite Dams show benefit ratios of 11:1 and 16:1, respectively. In 1978, survival of transported steelhead was the highest noted since inception of transport studies (nearly 3% return of most groups). Benefits for trucked groups from both dams were nearly 400%--a barged group from Lower Granite Dam was slightly higher. In 1979, benefits were over 100% for fish transported from Lower Granite Dam. This estimate is conservative since controls for the test received obvious benefit from transport at Little Goose and McNary Dams.

7. Transport of spring chinook salmon from Snake River Dams remains a problem because the rate of return of transported and nontransported fish is low. In 1977, few fish returned and then only transported fish. In 1978, rate of returns was still low--0.3% of the best transport group (Lower Granite barge). Transport benefit was about 600 and 350% for barge and fresh water truck groups, respectively (Lower Granite Dam). At Little Goose Dam, transport benefits were poor. In 1979, insufficient data are available to assess results of transport from Lower Granite Dam. No tests were made at Little Goose Dam in 1979.

8. A new fingerling bypass system was evaluated at Little Goose Dam. A severe mortality problem (10%) was identified and isolated in the pipe between the gallery make-up water gate and the fingerling sorter. If the make-up water gate was closed, mortality was greatly reduced. Through

consultation with the CofE, it was agreed to install a pinch-valve in the bypass pipe before the 1981 season. The valve would reduce water veolcity, provide better overall water control, and hopefully eliminate mortality to fish.

9. An automatic coded wire tag detection and decoding system was tested at McNary Dam. The system as presently designed can decode wire tags in live fish in 5 to 10 sec. It is probably a useful biological tool for many applications, but fish must be anesthetized to immobility to complete the data retrieval function.

LITERATURE CITED

Ebel, W. J., G. K. Tanonaka, G. E. Monan, H. L. Raymond, and D. L. Park.
1979. Status report--1978; The Snake River salmon and steelhead crisis: its relation to dams and the national energy shortage. Processed Report 79-9, Northwest and Alaska Fisheries Center, Seattle, Washington.

Park, D. L.
1980. Transportation of chinook salmon and steelhead smolts 1968-80 and its impact on adult returns to the Snake River. NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, Washington. 20 p. Processed.

Park, D. L., T. E. Ruehle, J. R. Harmon, and B. H. Monk.
1980. Transportation research on the Columbia and Snake Rivers 1979. NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, Washington.

Schuck, M. L., M. W. Mobbs, G. Van Lom, T. Y. Cho, R. G. Bisodi, and W. J. Ebel.
1981. 1980-1981 Columbia River and tributary tag recovery. Washington State Department of Game, Olympia, Washington. Processed report 81-19, 120 p.

Smith, J. R., G. M. Matthews, L. R. Basham, B. H. Monk, and S. Achord.
1981. Transportation operations on the Snake and Columbia Rivers 1980. NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, Washington. Report to U.S. Army Corps of Engineers, Contract No. DACW 68-78-C-0051 - operations. 31 p. with appendix. Processed.

APPENDIX

This appendix is made up of 26 tables that provide details of the 1980 Transportation Research Program.

Appendix Table 1.--Numbers of steelhead and apring chinook, fall chinook, coho, and sockeye salmon counted and observed as mortalities at McNary Dam, 1980.

Date	Steelhead	Spring chinook	Fall chinook	Coho	Sockeye	Daily total	Collection mortality	River flow avg. hourly in Kcfs	Percent river flow as spill
4-3	16	1,145	--	2	4	1,167	--	114.1	0.0
4-4	17	1,207	--	2	4	1,230	--	114.9	0.0
4-5	34	2,407	--	5	7	2,453	--	124.6	0.0
4-6	41	2,901	--	6	9	2,957	--	73.6	0.0
4-7	57	3,987	--	8	12	4,064	16	144.2	0.0
4-8	88	6,151	--	13	19	6,271	33	125.8	0.0
4-9	85	5,926	--	12	18	6,041	68	135.6	0.0
4-10	96	3,901	--	--	12	4,009	13	149.7	0.0
4-11	57	2,315	--	--	7	2,379	29	132.3	0.0
4-12	90	3,642	--	--	11	3,743	20	102.4	0.0
4-13	84	3,408	--	--	11	3,503	16	47.5	0.0
4-14	54	4,059	--	4	12	4,129	39	126.1	0.0
4-15	122	3,318	--	31	17	3,488	19	131.6	0.0
4-16	173	4,689	--	44	25	4,931	19	132.2	0.0
4-17	260	5,360	--	121	29	5,770	12	140.8	0.0
4-18	170	3,518	--	80	19	3,787	39	147.5	0.0
4-19	1,974	3,001	--	117	10	5,102	13	121.6	0.0
4-20	1,407	2,137	--	84	7	3,635	32	118.4	0.0

Appendix Table 1.--continued--Numbers of steelhead and spring chinook, fall chinook, coho, and sockeye salmon counted and observed as mortalities at McNary Dam, 1980.

Date	Steelhead	Spring chinook	Fall chinook	Coho	Sockeye	Daily total	Collection mortality	River flow avg. hourly in Kcfs	Percent river flow as spill
4-21	2,438	3,704	--	145	13	6,300	78	160.3	0.0
4-22	3,752	4,445	--	228	25	8,450	152	166.0	0.0
4-23	4,018	4,482	--	17	34	8,551	52	169.5	0.7
4-24	2,951	3,925	--	7	28	6,911	26	165.8	0.5
4-25	3,838	4,861	--	9	35	8,743	39	161.7	1.1
4-26	2,756	5,175	--	8	72	8,011	26	189.9	1.0
4-27	1,918	3,603	--	6	50	5,577	57	166.8	1.1
4-28	2,437	4,576	--	7	64	7,084	119	198.7	1.0
4-29	2,915	8,793	--	8	132	11,848	105	240.4	2.2
4-30	3,958	16,688	--	--	188	20,834	545	236.1	3.6
5-1	10,421	26,091	--	37	670	37,219	1,073	254.5	12.3
5-2	6,422	18,554	--	51	459	25,486	688	243.4	8.2
5-3	8,192	23,665	--	65	585	32,507	605	241.1	8.0
5-4	9,572	27,653	--	76	684	37,985	1,020	231.0	2.2
5-5	13,432	38,807	--	107	959	53,305	102	237.1	9.1
5-6	6,886	33,711	--	--	1,647	42,244	628	261.1	12.3
5-7	11,622	56,252	--	69	825	68,768	1,416	296.0	27.0
5-8	12,732	53,854	--	68	1,430	68,084	610	261.0	18.0

Appendix Table 1.--continued--Numbers of steelhead and spring chinook, fall chinook, coho, and sockeye salmon counted and observed as mortalities at McNary Dam, 1980.

Date	Steelhead	Spring chinook	Fall chinook	Coho	Sockeye	Daily total	Collection mortality	River flow avg. hourly in Kcfs	Percent river flow as spill
5-9	6,151	42,392	--	51	2,666	51,260	574	267.0	15.9
5-10	5,647	38,919	--	47	2,447	47,060	665	246.6	9.6
5-11	6,994	27,791	--	73	1,758	36,616	298	232.3	5.5
5-12	7,711	30,642	--	81	1,938	40,372	406	228.4	3.2
5-13	11,150	24,355	--	37	1,137	36,679	776	224.3	2.6
5-14	10,892	26,140	--	38	1,147	38,217	683	228.4	6.9
5-15	9,735	21,565	--	32	903	32,235	554	230.5	6.1
5-16	6,419	17,510	--	125	924	24,978	452	241.3	9.4
5-17	8,892	24,255	--	173	1,280	34,600	451	241.4	8.6
5-18	6,724	19,948	--	819	763	28,254	140	221.7	1.1
5-19	6,154	18,257	--	750	698	25,859	117	180.1	1.1
5-20	4,309	14,117	--	596	834	19,856	254	227.3	2.4
5-21	4,497	14,981	--	987	1,470	21,935	552	224.9	2.7
5-22	9,565	39,334	--	2,042	2,794	53,735	481	250.0	12.7
5-23	12,343	41,930	--	3,657	7,380	65,310	409	309.3	28.5
5-24	7,917	26,894	--	2,346	4,734	41,891	453	270.8	17.6
5-25	9,224	31,335	--	2,733	5,515	48,807	49	226.8	2.3
5-26	6,231	21,164	--	1,846	3,725	32,966	122	231.6	4.6

Appendix Table 1.--continued--Numbers of steelhead and spring chinook, fall chinook, coho, and sockeye salmon counted and observed as mortalities at McNary Dam, 1980.

Date	Steelhead	Spring chinook	Fall chinook	Coho	Sockeye	Daily total	Collection mortality	River flow avg. hourly in Kcfs	Percent river flow as spill
5-27	3,568	15,877	168	3,593	2,100	25,306	467	247.2	13.5
5-28	2,864	10,684	828	3,517	1,326	19,219	183	264.0	31.7
5-29	3,032	9,259	1,185	3,400	830	17,706	51	285.2	30.1
5-30	1,487	5,145	1,029	1,048	645	9,354	56	275.7	57.3
5-31	799	3,682	2,507	603	243	7,834	54	279.8	86.4
6-1	403	1,859	1,265	304	123	3,954	15	285.9	90.3
6-2	772	3,555	2,421	583	235	7,566	135	297.9	51.1
6-3	648	1,785	2,540	830	484	6,287	81	303.1	33.2
6-4	1,425	3,715	16,027	1,262	935	23,364	102	285.1	24.3
6-5	655	1,954	7,495	828	563	11,495	189	267.0	24.0
6-6	558	1,170	4,204	320	331	6,583	28	286.4	49.3
6-7	206	243	1,751	73	155	2,428	23	287.0	88.9
6-8	137	161	1,163	48	103	1,612	0	290.1	88.3
6-9	90	106	761	32	68	1,057	62	288.6	48.1
6-10	75	139	731	34	25	1,004	48	287.4	52.2
6-11	173	318	1,676	78	58	2,303	68	292.0	54.8
6-12	91	168	885	41	30	1,215	69	304.9	58.0
6-13	44	80	423	20	14	581	57	308.2	61.3

Appendix Table 1.--continued--Numbers of steelhead and spring chinook, fall chinook, coho, and sockeye salmon counted and observed as mortalities at McNary Dam, 1980.

Date	Steelhead	Spring chinook	Fall chinook	Coho	Sockeye	Daily total	Collection mortality	River flow avg. hourly in Kcfs	Percent river flow as spill
6-14	29	53	282	13	10	387	25	299.7	88.2
6-15	26	47	250	12	9	344	13	277.4	90.0
6-16	81	62	312	20	14	489	11	284.9	60.6
6-17	38	62	818	12	10	940	6	330.3	67.2
6-18	65	107	1,404	21	18	1,615	36	316.8	73.7
6-19	34	57	747	11	9	858	17	328.3	59.1
6-20	83	137	1,800	27	23	2,070	29	293.3	50.3
6-21	173	348	1,759	57	33	2,370	36	292.1	65.8
6-22	96	192	972	31	18	1,309	5	270.1	80.6
6-23	78	157	794	26	15	1,070	17	301.8	43.0
6-24	51	281	3,528	27	12	3,899	48	298.3	37.8
6-25	118	653	8,209	63	27	9,070	310	295.2	41.4
6-26	61	337	4,236	33	14	4,681	62	257.9	29.3
6-27	14	191	4,544	14	5	4,768	12	241.0	9.3
6-28	39	525	12,516	39	13	13,132	41	227.0	0.0
6-29	88	1,172	27,920	88	29	29,297	74	212.3	0.0
6-30	68	910	21,686	68	23	22,755	86	215.2	0.0

Appendix Table 1.--continued--Numbers of steelhead and spring chinook, fall chinook, coho, and sockeye salmon counted and observed as mortalities at McNary Dam, 1980.

Date	Steelhead	Spring chinook	Fall chinook	Coho	Sockeye	Daily total	Collection mortality	River flow avg. hourly in Kcfs	Percent river flow as spill
7-1	35	989	34,189	71	35	35,319	126	202.6	0.0
7-2	44	437	43,133	44	--	43,658	111	192.7	0.0
7-3	23	69	22,784	9	7	22,892	161	165.2	0.0
7-4	17	50	16,535	--	--	16,602	46	176.0	0.0
7-5	26	79	26,145	--	--	26,250	256	192.1	6.7
7-6	6	24	52,346	10	10	52,396	270	187.9	0.0
7-7	--	8	27,764	7	8	27,787	847	192.9	0.0
7-8	2	8	25,108	17	16	25,151	96	--	--
7-9	3	12	14,597	8	14	14,634	171	202.7	0.0
7-10	4	14	11,995	7	11	12,031	129	190.9	0.0
7-11	2	7	12,533	5	19	12,566	100	187.3	0.0
7-12	--	--	21,009	--	--	21,009	210	130.9	0.0
7-13	--	--	8,960	--	--	8,960	80	122.5	0.0
7-14	7	8	9,491	3	31	9,540	101	154.1	0.0
7-15	2	2	5,002	--	8	5,014	168	187.7	0.0
7-16	7	3	8,785	4	23	8,822	267	156.3	0.0
7-17	--	8	5,603	3	15	5,629	101	147.7	0.0
7-18	2	1	15,964	4	20	15,991	368	144.3	0.0
7-19	--	--	21,801	1	9	21,811	205	146.3	0.0

Appendix Table 1.--continued--Numbers of steelhead and spring chinook, fall chinook, coho, and sockeye salmon counted and observed as mortalities at McNary Dam, 1980.

Date	Steelhead	Spring chinook	Fall chinook	Coho	Sockeye	Daily total	Collection mortality	River flow avg. hourly in Kcfs	Percent river flow as spill
7-20	--	--	14,990	1	22	15,013	227	138.6	0.0
7-21	2	1	6,642	2	15	6,662	230	166.8	0.0
7-22	--	--	17,443	1	28	17,472	258	152.2	0.0
7-23	--	--	13,816	3	17	13,836	220	151.0	0.0
7-24	--	--	6,462	--	16	6,478	72	136.8	0.0
7-25	--	1	5,426	--	7	5,434	106	137.2	0.0
7-26	--	--	4,130	--	--	4,130	108	127.3	0.0
7-27	--	--	3,569	--	--	3,569	600	105.2	0.0
7-28	1	--	7,240	--	20	7,261	590	134.3	0.0
7-29	--	--	16,018	--	27	16,045	181	131.8	0.0
7-30	1	1	11,908	--	19	11,929	631	140.6	0.0
7-31	--	--	15,923	--	17	15,940	171	135.7	0.0
8-1	--	--	16,129	--	17	16,146	171	138.1	0.0
8-2	--	--	10,389	--	--	10,389	70	115.4	0.0
8-3	--	--	2,792	--	--	2,792	0	99.4	0.0
8-4	1	--	1,644	--	44	1,689	51	125.0	0.0
8-5	--	--	3,991	--	--	3,991	31	132.4	0.0
8-6	--	--	3,960	1	15	3,976	136	114.5	0.0

Appendix Table 1.--continued--Numbers of steelhead and spring chinook, fall chinook, coho, and sockeye salmon counted and observed as mortalities at McNary Dam, 1980.

Date	Steelhead	Spring chinook	Fall chinook	Coho	Sockeye	Daily total	Collection mortality	River flow avg. hourly in Kcfs	Percent river flow as spill
8-7	--	--	2,746	--	--	2,746	143	131.5	0.0
8-8	3	--	6,965	--	15	6,983	178	118.2	0.0
8-9	--	--	8,727	--	--	8,727	162	107.0	0.0
8-10	--	--	4,967	--	--	4,967	115	88.5	0.0
8-11	--	--	3,109	--	15	3,124	161	129.9	0.0
8-12	--	--	6,759	--	--	6,759	80	122.6	0.0
8-13	--	--	6,516	2	13	6,531	128	115.4	0.0
8-14	--	--	2,037	--	--	2,037	40	144.0	0.0
8-15	--	--	2,414	--	6	2,420	7	131.7	0.0
8-16	--	--	1,426	--	--	1,426	25	113.5	0.0
8-17	--	--	850	--	--	850	65	98.8	0.0
8-18	--	--	760	--	--	760	0	113.2	0.0
8-19	--	--	1,703	--	--	1,703	50	127.2	0.0
8-20	--	--	14,523	--	--	14,523	110	118.9	0.0
8-21	--	--	5,249	--	--	5,249	370	105.4	0.0
8-22	--	--	4,571	--	--	4,571	75	110.2	0.0
8-23	--	--	5,097	--	--	5,097	50	114.8	0.0
8-24	--	--	3,087	--	--	3,087	60	57.7	0.0
8-25	--	--	2,464	--	--	2,464	40	112.1	00

Appendix Table 1.--continued--Numbers of steelhead and spring chinook, fall chinook, coho, and sockeye salmon counted and observed as mortalities at McNary Dam, 1980.

Date	Steelhead	Spring chinook	Fall chinook	Coho	Sockeye	Daily total	Collection mortality	River flow avg. hourly in Kcfs	Percent river flow as spill
8-26	--	--	3,174	--	--	3,174	210	140.4	0.0
8-27	--	--	11,332	--	--	11,332	75	129.8	0.0
8-28	--	--	11,925	--	--	11,925	40	119.6	0.0
8-29	--	--	10,069	--	--	10,069	65	117.8	0.0
8-30	--	--	6,540	--	--	6,540	30	116.5	0.0
8-31	--	--	4,461	--	--	4,461	--	102.9	0.0
9-1	--	--	4,846	--	--	4,846	--	79.6	0.0
9-2	--	--	2,635	--	--	2,635	--	111.7	0.0
9-3	--	--	3,082	--	--	3,082	--	123.6	0.0
9-4	--	--	4,492	--	--	4,492	--	113.8	0.0
9-5	--	--	7,014	--	--	7,014	--	121.9	0.0
TOTALS	273,997	950,353	838,592	35,249	59,335	2,157,526	27,606		

Appendix Table 2.--Number of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead transported by truck from McNary Dam to below Bonneville Dam, 1980.

Date	Steelhead		Spring chinook salmon		Fall chinook salmon		Coho salmon		Sockeye salmon		Daily total trucked
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
4/9	38	246	4,050	14,627	--	--	6	35	--	66	19,068
4/14	61	96	5,955	5,658	--	--	2	12	1	31	11,816
4/18	273	152	5,657	3,209	--	--	75	133	24	28	9,551
4/23	2,273	2,077	2,104	2,706	--	--	2	18	7	31	9,218
4/24	1,134	161	775	1,564	--	--	--	1	3	20	3,658
4/28	1,099	239	1,005	2,026	--	--	3	8	11	28	4,419
4/30	1,049	109	2,878	3,194	--	--	2	-	27	36	7,295
5/2	2,412	1,649	2,377	12,443	--	--	10	9	45	314	19,259
5/5	--	11,502	--	33,228	--	--	--	91	--	822	45,643
5/6	2,363	1,828	3,540	19,852	--	--	10	9	148	780	28,530
5/7	--	5,992	--	29,004	--	--	--	35	--	425	35,456
5/8	1,999	2,485	3,151	18,700	--	--	10	10	48	489	26,892
5/12	1,640	5,417	2,149	13,756	--	--	11	9	251	962	24,195
5/14	1,836	5,440	1,847	15,115	--	--	6	7	94	649	24,994
5/16	1,246	3,841	1,553	10,017	--	--	51	37	170	520	17,435
5/21	1,071	2,028	3,238	6,428	--	--	270	447	357	538	14,377

Appendix Table 2.--continued--Number of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead transported by truck from McNary Dam to below Bonneville Dam, 1980.

Date	Steelhead		Spring chinook salmon		Fall chinook salmon		Coho salmon		Sockeye salmon		Daily total trucked
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
5/23	1,364	5,919	322	29,205	--	--	481	2,119	1,110	4,031	44,551
5/25	--	1,621	--	5,505	--	--	--	480	--	969	8,575
5/26	--	4,160	--	14,131	--	--	--	1,233	--	2,487	22,011
5/27	1,268	1,046	337	16,648	--	168	460	3,417	950	1,122	25,416
5/31	--	1,187	--	6,839	--	1,515	--	1,515	--	679	11,735
6/3	--	1,334	--	6,169	--	5,039	--	1,441	--	676	14,659
6/4	729	209	--	2,467	--	11,089	105	770	472	174	16,015
6/6	320	525	--	2,349	--	9,879	44	1,043	172	673	15,005
6/13	187	251	--	1,067	760	5,914	21	280	60	204	8,744
6/16	--	113	--	83	--	421	--	28	--	20	665
6/20	--	122	--	219	--	2,983	--	45	--	38	3,407
6/26	--	398	--	1,492	--	7,484	--	187	--	82	9,643
6/30	--	186	--	2,755	4,067	55,741	--	193	--	79	63,021
7/2	--	66	--	1,291	6,042	60,611	--	108	--	26	68,144
7/3	--	12	--	52	5,194	17,813		9	--	7	23,087
7/5	--	38	--	113	--	37,649	--	--	--	--	37,800

Appendix Table 2.--continued--Number of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead transported by truck from McNary Dam to below Bonneville Dam, 1980.

Date	Steelhead		Spring chinook salmon		Fall chinook salmon		Coho salmon		Sockeye salmon		Daily total trucked
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
7/7	--	2	--	31	5,357	69,327	--	17	--	18	74,752
7/8	--	8	--	21	5,094	10,767	--	17	--	16	15,923
7/9	--	2	--	10	3,471	5,505	--	8	--	14	9,010
7/11	--	5	--	21	4,072	9,166	--	12	--	30	13,306
7/14	--	5	--	6	5,419	27,671	--	3	--	31	33,135
7/17	--	4	--	9	--	5,357	--	7	--	46	5,423
7/18	--	1	--	3	6,125	4,464	--	4	--	23	10,620
7/21	--	2	--	1	7,215	28,946	--	4	--	46	36,214
7/23	--	--	--	--	8,172	11,023	--	4	--	45	19,244
7/25	--	--	--	1	3,789	2,876	--	--	--	23	6,689
7/28	--	1	--	--	2,949	3,990	--	--	--	20	6,960
7/30	--	1	--	1	8,177	7,225	--	--	--	46	15,450
8/1	--	--	--	--	4,310	13,010	--	--	--	34	17,354
8/4	--	1	--	--	--	7,863	--	--	--	44	7,908
8/8	--	3	--	--	--	14,256	--	1	--	30	14,290
8/11	--	--	--	--	--	14,575	--	--	--	15	14,590

Appendix Table 2.--continued--Number of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead transported by truck from McNary Dam to below Bonneville Dam, 1980.

Date	Steelhead		Spring chinook salmon		Fall chinook salmon		Coho salmon		Sockeye salmon		Daily total trucked
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
8/13	--	--	--	--	--	10,245	--	2	--	13	10,261
8/15	--	--	--	--	--	3,544	--	--	--	6	3,550
8/22	--	--	--	--	--	23,119	--	--	--	--	23,119
8/27	--	--	--	--	--	25,154	--	--	--	--	25,154
8/29	--	--	--	--	--	21,994	--	--	--	--	21,994
9/2	--	--	--	--	--	18,482	--	--	--	--	18,482
9/5	--	--	--	--	--	14,588	--	--	--	--	14,588
TOTALS	22,362	60,484	40,938	282,016	80,213	569,453	1,569	13,808	3,950	17,506	1,092,299

Appendix Table 3.--Number of juvenile spring chinook, fall chinook, coho, and sockeye salmon and steelhead transported by barge from McNary Dam to below Bonneville Dam, 1980.

Date	Steelhead		Spring chinook salmon		Fall chinook salmon		Coho salmon		Sockeye salmon		Daily total barged
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
4/22	3,936	828	4,034	3,577	--	--	1	364	--	35	12,775
4/26	3,141	2,889	2,435	5,187	--	--	2	8	10	43	13,715
4/30	2,586	364	3,494	5,761	--	--	8	--	63	99	12,375
5/2	3,529	1,338	3,810	17,183	--	--	8	11	73	403	26,355
5/4	--	16,188	--	46,768	--	--	--	128	--	1,156	64,240
5/8	2,279	7,180	4,408	46,382	--	--	19	34	125	1,063	61,490
5/10	1,646	9,370	5,417	73,408	--	--	2	97	20	5,107	95,067
5/12	--	6,357	--	43,813	--	--	--	53	--	2,755	52,978
5/14	2,402	5,855	5,036	12,629	--	--	--	25	36	834	26,817
5/16	1,912	4,102	3,807	9,798	--	--	3	14	1	646	20,283
5/18	--	14,451	--	39,418	--	--	--	281	--	2,081	56,243
5/21	2,799	5,526	5,499	19,769	--	--	--	1,182	--	1,350	36,125
5/23	1,982	9,400	6,083	41,096	--	--	--	2,545	--	3,451	64,557
5/25	--	10,434	--	35,444	--	--	--	3,092	--	6,238	55,208
5/28	2,623	1,893	--	19,869	--	828	--	6,699	--	2,525	34,437
5/30	1,547	583	--	8,062	--	1,184	--	3,400	--	817	15,593
TOTALS	30,382	96,758	44,023	428,164	--	2,012	43	17,933	328	28,603	648,246

Appendix Table 4.--Tag codes for rare earth metals used on wire tags.

Tag code	Rare earth elements
Ce	Cerium
Dy	Dysprosium
Er	Erbium
Eu	Europium
Gd	Gadolinium
Ho	Holmium
La	Lanthanum
Lu	Lutetium
Nd	Neodymium
Pr	Praseodymium
Pm	Promethium
Sm	Samarium
Tb	Terbium
Tm	Thulium
Yb	Ytterbium

Appendix Table 5.--Summary of brands and wire tag codes used to identify juvenile salmonids and steelhead released as controls below McNary Dam, 1980.

Marking period	Position a/ brand and orientation b/	Wire tag code	Steelhead	Spring chinook salmon	Fall chinook salmon	Coho salmon	Sockeye salmon	Total
4/8-5/12	LA-H, 1	ER-LA	15,272	32,478	-	177	650	48,577
5/14-6/9	LA-H, 2	CE-ND	6,019	14,107	-	1,252	2,310	23,688
6/9-7/14	LA-IF, 1	CE	-	-	39,005	-	-	39,005
7/16-7/31	LA-IF, 3	CE-DY	-	-	45,582	-	-	45,582
Total McNary tailrace release			21,291	46,585	84,587	1,429	2,960	156,852

a/ Position - LA indicates left-anterior side of fish.

b/ Orientation - Refers to rotation of the brand around its centerpoint (i.e., 1 corresponds to the normal orientation, A; 2 to ⊳ ; 3 to ∀ , 4 to ⊲).

Appendix Table 6.--Summary of brands and wire tag codes used to identify juvenile salmonids and steelhead transported by truck from McNary Dam to below Bonneville Dam, 1980.

Marking period	Position a/ brand and orientation b/	Wire tag code	Steelhead	Spring chinook salmon	Fall chinook salmon	Coho salmon	Sockeye salmon	Total
4/9-5/12	RA-V, 1	ND-SM	14,341	33,641	--	131	565	48,678
5/14-6/13	RA-V, 2	DY	8,021	7,297	--	1,438	3,385	20,141
6/13-7/14	RA-1C, 1	LA	--	--	39,476	--	--	39,476
7/18-8/1	RA-1C, 3	HO	--	--	40,737	--	--	40,737
TOTALS			22,362	40,938	80,213	1,569	3,950	149,032

a/ Position - RA indicates right anterior side of fish.

b/ Orientation - Refers to rotation of the brand around its centerpoint (i.e. 1 corresponds to the normal orientation, A; 2 to ⊳; 3 to ∀; 4 to ⊲).

Appendix Table 7.--Summary of brands and wire tag codes used to identify juvenile salmonids and steelhead transported by barge from McNary Dam to below Bonneville Dam, 1980.

Marking period	Position brand and orientation [a/] [b/]	Wire tag code	Steelhead	Spring chinook salmon	Coho salmon	Sockeye salmon	Total
4/22-5/18	RA-2, 1	ER-PR	21,431	32,441	43	328	54,243
5/21-5/30	RA-2, 2	LA-TB	8,951	11,582	--	--	20,533
TOTALS			30,382	44,023	43	328	74,776

a/ Position - RA indicates right anterior side of fish.

b/ Orientation - Refers to rotation of the brand around its centerpoint (i.e. 1 corresponds to the normal orientation, A; 2 to ⊳; 3 to ∀ ; 4 to ⊲).

Appendix Table 8.--Percent survival of spring chinook salmon collected at McNary Dam and subsequently transported to Bonneville Dam by truck or barge.

Species	Group	Date	N	Survival (%) 2-day	Survival (%) 14-day
Spring chinook	Truck	5-16-80	234	80.8	21.8
		5-23-80	683	94.1	47.1
		5-25-80	208	98.6	80.3
		5-26-80	407	98.8	72.0
		5-31-80	190	98.4	57.4
		6-06-80	279	88.5	56.3
			Mean	93.2	55.8
	Barge	5-26-80	98	100.0	71.4
		5-30-80	248	98.8	43.5
			Mean	99.4	57.5
Sockeye	Truck	5-31-80	96	88.5	39.6
		5-31-80	21	95.2	38.1
		6-06-80	30	85.2	10.0
			Mean	89.6	29.2
	Barge	5-30-80	85	100.0	18.8
		5-30-80	41	100.0	0.0
			Mean	100.0	9.4
	Control[a]	5-30-80	92	94.6	39.1
Fall chinook	Truck	5-31-80	9	100.0	66.7
		6-06-80	122	85.2	71.3
			Mean	92.6	69.0

a/ Control sample was held at McNary Dam and not subjected to transportation.

Appendix Table 9.--Steelhead recoveries (2-ocean age) in the 1980 fall and winter Indian net fisheries from transport and control releases of marked smolts from Little Goose, Lower Granite, and McNary Dams in 1978.

Release site and experimental group	No. of juveniles released[a]	No. of adults recaptured Fall	Winter	Total	% of release
Little Goose Dam					
Control					
Tailrace	30,364	3	0	3	0.010
Bonneville					
Freshwater transports	35,875	9	0	9	0.025
Saltwater transports	32,170	10	0	10	0.031
TOTALS	98,409	22	0	22	
Lower Granite Dam					
Control					
Forebay release	43,102	7	2	9	0.021
Tailrace	12,567	4	1	5	0.040
Bonneville					
Freshwater transports	47,572	13	2	15	0.032
Barge transports	43,770	19	10	29	0.066
TOTALS	147,011	43	15	58	
McNary Dam					
Control					
Forebay release	15,585	2	0	2	0.013
Bonneville					
Freshwater transports	20,416	6	3	9	0.044
TOTALS	36,001	8	3	11	

a/ Adjusted for initial tag loss

Appendix Table 10.--Steelhead recoveries (1-ocean age) in the 1980 fall and winter Indian set net fisheries from transport and control releases of marked smolts from Lower Granite and McNary Dams in 1979.

Release site and experimental group	No. of juveniles released[a]	No. of adults recaptured			% of release
		Fall	Winter	Total	
Lower Granite Dam					
Control					
Forebay release	17,319	1	2	3	0.017
Tailrace	21,050	0	2	2	0.010
Bonneville					
Barge transport	30,495	5	8	13	0.043
TOTALS	68,864	6	12	18	
McNary Dam					
Control					
Forebay release	8,131	4	1	5	0.061
Tailrace	8,595	1	0	1	0.012
Bonneville					
Freshwater truck tranport	15,379	5	4	9	0.059
Barge transport	18,182	4	5	9	0.049
TOTALS	50,287	14	10	24	

a/ Adjusted for initial tag loss

Appendix Table 11.--Recovery of adult steelhead from Oregon, Washington, and Idaho sports fisheries in 1980-81 that were tagged as juveniles and transported from McNary Dam or released as controls in 1978-79. (Data are inclusive of tags received by 1 June 1981.)

Collection site	1978 experimental groups		1979 experimental groups				
	Truck	Tailrace control	Truck	Barge	Forebay control	Tailrace control	Total
Lower Columbia R.		1	2	1		1	5
Deschutes R.	3	2	8	2	5		20
Umatilla R.				1			1
Walla Walla R.		1					1
N. Touchet R.				1			1
Ringold	17	2					19
Mid-Columbia R.	11	5		1			17
Wenatchee R.	7	2	2	8	2	4	25
Wells Hatchery			1	2	1		4
Methow R.	8	2	23	32	12	2	79
Entiat R.				3			3
Snake R.		1		1		1	3
Clearwater R.	4	1		1			6
Salmon R.	12		3	2	1		18
Unknown	1						1
Total	63	17	39	55	21	8	203

Appendix Table 12.--Adult returns to various Mid-Columbia and Snake River hatcheries during 1980 from chinook salmon marked as juveniles and transported from McNary Dam, 1978-79.

Experimental group			Experimental group	Number of returns	Percent of release
Time of release	Wire tag code	Number released			
Columbia River Hatcheries					
Ringold Hatchery (spring chinook)					
4/11-73/79	PR	19,009	Control release	14	
4/16-7/2/79	SM	23,176	Test (truck transport)	19	
4/25-5/22/79	RD-YW-LG	35,109	Test (barge transport)	8	
Leavenworth National Fish Hatchery (spring chinook)					
4/1-7/3/79	PR	19,009	Control release	1	
Wells Hatchery (summer chinook)					
7/19-8/30/78	LG	23,373	Test (truck transport)	2	
6/12-7/17/79	RD-YW-PK	51,558	Control release	3	
7/24-8/6/79	LB-YW-LB	40,398	Control release	1	
6/12-6/29/79	RD-PK-LB	43,482	Test (truck transport)	2	
7/24-8/6/79	LB-YW-LG	41,195	Test (truck transport)	2	
Priest Rapids Hatchery (fall chinook)					
7/19-8/30/78	LG	23,373	Test (truck transport)	2	
4/16-7/2/79	SM	679	Test (truck transport)	1	
6/12-6/29/79	RD-PK-LB	43,482	Test (truck transport)	3	
7/2-7/17/79	RD-PK-OR	25,620	Test (truck transport)	1	
7/24-8/6/79	LB-YW-LC	41,195	Test (truck transport)	4	
Snake River Hatcheries					
Rapid River Hatchery (spring chinook)					
4/17-5/19/78	RD-YW-RD	21,115	Control release	1	
4/21-5/19/78	GM	22,891	Test (truck transport)	4	
4/16-7/2/79	SM	23,176	Test (truck transport)	1	
Dworshak Hatchery (summer-fall chinook)					
5/22-6/12/78	RD-OR-RD	10,261	Control release	1	
7/19-8/30/78	LG	23,373	Test (truck transport)	1	
Hayden Creek Research Station (spring chinook)					
4/21-5/19/78	GM-WH	22,891	Test (truck transport)	1	

Appendix Table 13.--Recovery of adult steelhead at Dworshak Hatchery in 1980 that were tagged as juveniles and transported and released below Bonneville Dam or released as controls at Lower Granite or Little Goose Dams in 1976.

Color Code	Dworshak Hatchery: No. with jaw tag & wire tag	Dworshak Hatchery: No. with wire tag only	% with jaw tag & wire tag
1976 Lower Granite Dam controls			
WH-OR-LB	--	1	0.0
WH-OR-LG	--	3	0.0
Subtotal	--	4	0.0
1976 Lower Granite Dam transports			
WH-XR	1	--	100.0
WH-OR-LA-OR	3	4	42.9
WH-OR-OR-OR	1	1	50.0
WH-BL	--	1	0.0
WH-OR-RD-XR	--	2	0.0
WH-OR-GN-LG	1	1	50.0
WH-OR-BL-LB	1	3	25.0
WH-PU-XY-XY	--	1	0.0
Subtotal	7	13	35.0
1976 Little Goose Dam transports			
Green Stripe	1	2	33.3
Yellow Stripe	3	4	42.9
Solid Yellow	1	--	100.0
Solid Green	1	--	100.0
Subtotal	6	6	50.0
TOTAL	13	23	36.1

Appendix Table 14.--Returns to Lower Granite Dam of 1-, 2-, and 3-ocean age steelhead from control and transport releases of smolts from Little Goose Dam in 1977. Recoveries were made from 2 July 1978 to 1 June 1981.

Release site & experimental groups	No. of juveniles released[a]	No. of adults recaptured 1-ocean age	2-ocean age	3-ocean age	Total 1, 2, & 3's	Adult return in % of juveniles released Observed	Estimated[b]	Transport benefits (%)[c]
Control	22,204	0	4	0	4	0.018	0.049	---
Bonneville Freshwater transport	24,272	6	22	0	28	0.115	0.424	+539
Saltwater transport[d]	22,916	6	28	1	35	0.153	0.524	+750
Total	69,392	12	54	1	67			

a/ Transported fish adjusted for intial tag loss.

b/ Based on comparison of known recovery of fish with magnetized wire tags at Lower Granite Dam and the subsequent recovery of these and other marked fish at Dworshak and Pahsimeroi Hatcheries upstream from Lower Granite Dam. Returning fish identified at the dam were marked with jaw tags and released to continue their migration upstream. Numbers of externally-tagged fish arriving at Dworshak and Pahsimeroi Hatcheries were compared with the recovery of other wire tagged fish arriving at these hatcheries not previously detected and identified at Lower Granite Dam. Expansion factors for each ocean age group were: 1-ocean, 7.0; 2-ocean, 2.76; and 3-ocean, 0.0 (insufficient adults returned to make an adjustment).

c/ Based on observed returns.

d/ 10 ppt salt water.

Apprendix Table 15.--Returns to Lower Granite Dam of 1-, 2-, and 3-ocean age steelhead from control and transport releases of smolts from Lower Granite Dam in 1977. Recoveries were made from 2 July 1978 to 1 June 1981.

Release site & experimental groups	No. of juveniles released[a]	No. of adults recaptured: 1-ocean age	2-ocean age	3-ocean age	Total 1, 2, & 3's	Adult return in % of juveniles released: Observed	Estimated[b]	Transport benefits (%)[c]
Control	33,152	10	35	1	46	0.139	0.564 (182)	---
Bonneville Saltwater transport[d]	42,777	31	59	2	92	0.215	0.909	+1094
Dalton Point Saltwater transport[d]	40,899	32	106	1	138	0.337	1.371	+1772
Bonneville Barge transport	30,330	27	37	0	64	0.211	0.923	+1072
Total	147,158	99	237	4	340			

a/ Transported fish adjusted for initial tag loss.

b/ Based on comparison of known recovery of fish with magnetized wire tags at Lower Granite Dam and the subsequent recovery of these and other marked fish at Dworshak and Pahsimeroi Hatcheries upstream from Lower Granite Dam. Returning fish identified at the dam were marked with jaw tags and released to continue their migration upstream. Numbers of externally-tagged fish arriving at Dworshak and Pahsimeroi Hatcheries were compared with the recovery of other wire tagged fish arriving at these hatcheries not previously detected and identified at Lower Granite Dam. Expansion factors for each ocean age group were: 1-ocean, 5.26; 2-ocean, 3.73; and 3-ocean, 3.00.

c/ The percent return of Lower Granite controls is unrealistically high due to the fact that many of them were transported in a mass transport operation at Lower Granite and Little Goose Dams. Therefore, transport benefits are calculated based on the observed return percent of Little Goose controls.

d/ 10 ppt salt water.

Appendix Table 16.--Recovery of adult steelhead at Dworshak and Pahsimeroi Hatcheries in 1980 that were tagged as juveniles and transported and released below Bonneville Dam or released as controls at Lower Granite or Little Goose Dams in 1977.

	Dworshak Hatchery		Pahsimeroi Hatchery		Total		
Color code	No. with jaw tag & wire tag	No. with wire tag only	No. with jaw tag & wire tag	No. with wire tag only	No. with jaw tag & wire tag	No. with wire tag only	% with jaw tag & wire tag
1977 Lower Granite Dam controls							
WH-YW-GN	2	10	--	--	2	10	16.7
Subtotal	2	10	--	--	2	10	16.7
1977 Lower Granite Dam transports							
WH-YW-LB	14	56	--	--	14	56	20.0
WH-OR-XY	27	44	--	1	27	45	37.5
WH-YW-LG	4	18	--	1	4	19	17.4
WH-YW-BL	1	--	--	--	1	--	100.0
WH-PU-YW-GN	--	--	--	1	--	1	0.0
Subtotal	46	118	--	3	46	121	27.5
1977 Little Goose Dam transports							
W-YW-YW	9	20	--	--	9	20	31.0
W-OR-GN	8	10	--	--	8	10	44.4
Subtotal	17	30	--	--	17	30	36.2
TOTAL	65	158	0	3	65	161	28.8

Appendix Table 17.--Recovery of adult steelhead at Dworshak and Pahsimeroi Hatcheries in 1981 that were tagged as juveniles and transported and released below Bonneville Dam or released as controls at Lower Granite, Little Goose, or McNary Dams in 1977 and 1979.

Color code	Dworshak Hatchery: No. with jaw tag & wire tag	Dworshak Hatchery: No. with wire tag only	Pahsimeroi Hatchery: No. with jaw tag & wire tag	Pahsimeroi Hatchery: No. with wire tag only	Total: No. with jaw tag & wire tag	Total: No. with wire tag only	% with jaw tag & wire tag
1977 Lower Granite Dam controls							
WH-YW-GN	--	1	--	--	--	1	0.0
Subtotal		1				1	0.0
1977 Lower Granite Dam transports							
WH-OR-XY	1	1	--	--	1	1	50.0
WH-YW-LB	1	2	--	--	1	2	33.3
Subtotal	2	3			2	3	40.0
1977 Little Goose Dam controls							
WH-YW-PK	--	1	--	--	--	1	0.0
Subtotal		1				1	0.0
1979 Lower Granite Dam controls							
WH-RD-YW-GM	--	--	1	8	1	8	11.1
WH-RD-YW-LB	--	1	--	8	--	9	0.0
Subtotal		1	1	16	1	17	5.6
1979 Lower Granite Dam transport							
WH-RD-YW-OR	--	2	--	16	--	18	0.0
Subtotal	--	2	--	16		18	0.0
1979 McNary Dam transports							
WH-RD-YW-LG	--	--	2	1	2	1	66.7
WH-RD-LG-Pk	--	--	--	1	--	1	0.0
SM	--	--	--	3	--	3	0.0
Subtotal			2	5	2	5	40.0

Appendix Table 18.--Preliminary returns to Lower Granite Dam of 1- and 2-ocean age steelhead from control and transport releases of smolts from Little Goose and Lower Granite Dams in 1978. Recoveries were made from 9 July 1979 to 1 June 1981.

Release site and experimental groups	Little Goose Dam						Lower Granite Dam					
	No of juveniles released[a/]	No. of adults recaptured			Adult return in & of juveniles released	Transport benefits[b/] (%)	No. of juveniles released[a/]	No. of adults recaptured			Adult return in % of juveniles released	Transport benefits[c/] (%)
		1-ocean age	2-ocean age	Total 1 & 2's				1-ocean age	2-ocean age	Total 1 & 2's		
Control	30,364	47	20	67	0.221	---	55,669	114	67	181	0.325	---
Bonneville Barge transport (Freshwater)	---	---	---	---	---	---	43,770	331	160	491	1.122	+408
Bonneville Truck transport (Freshwater)	35,875	255	106	361	1.006	+355	47,572	336	161	497	1.045	+373
Bonneville Truck transport (Saltwater)[d/]	32,170	218	111	329	1.023	+363	---	---	---	---	---	---
Total	98,409	502	237	757			147,011	781	388	1,169		

a/ Transported fish adjusted for initial tag loss.

b/ Based on observed return.

c/ The percent return of Lower Granite controls is unrealistically high because many juveniles were transported in the mass transport system at Little Goose and Lower Granite Dams. Therefore, transport benefits are calculated based on the observed percent of return of Little Goose controls.

d/ 10 ppt salt water.

Appendix Table 19.--Recovery of adult steelhead at Dworshak, Pahsimeroi, Kooskia, and Hayden Creek Hatcheries in 1981 that were tagged as juveniles and transported and released below Bonneville Dam or released as controls at Lower Granite, Little Goose, or McNary Dams in 1978.

Color code	Dworshak Hatchery		Pahsimeroi Hatchery		Kooskia Hatchery		Hayden Creek Hatchery		Total		Trap efficiency %
	No. with jaw tag & wire tag	No. with wire tag only	No. with jaw tag & wire tag	No. with wire tag only	No. with jaw tag & wire tag	No. with wire tag only	No. with jaw tag & wire tag	No. with wire tag only	No. with jaw tag & wire tag	No. with wire tag only	
1978 Lower Granite Dam controls											
WH-RD-WH-RD	--	11	1	1	1	--	--	--	2	12	14.3
WH-RD-WH	--	1	--	--	2	1	--	--	2	2	50.0
WH-OR-YW	1	--	--	1	--	--	--	--	1	1	50.0
Subtotal	1	12	1	2	3	1	0	0	5	15	25.0
1978 Lower Granite Dam transports											
WH-RD-GN	--	3	--	--	--	3	--	--	--	6	0.
WH-RD-BL	8	29	3	5	2	4	--	2	13	40	24.5
WH-RD-RD	1	3	--	--	2	6	--	--	3	9	25.0
WH-RD-RD-OR	8	29	2	5	--	4	--	1	10	39	20.4
Subtotal	17	64	5	10	4	17	0	3	26	94	21.7
1978 Little Goose Dam controls											
WH-OR-PK	--	--	--	--	--	2	--	--	--	2	0.
WH-OR-GN-RD	1	--	--	--	--	--	--	--	1	--	100.0
Subtotal	1	0	0	0	0	2	0	0	1	2	33.3
1978 Little Goose Dam transports											
WH-RD-LG	2	9	--	1	2	--	--	2	4	12	25.0
WH-OR-GN-YW	2	1	--	1	--	1	--	--	2	3	40.0
WH-RD	--	3	--	--	--	2	--	--	--	5	0.
WH-RD-OR	2	8	--	2	2	3	--	--	4	13	23.5
Subtotal	6	21	0	4	4	6	0	2	10	33	23.3
1978 McNary Dam controls											
WH-RD-YW-RD	1	1	--	--	--	1	--	--	1	2	33.3
Subtotal	1	1	0	0	0	1	0	0	1	2	33.3
1978 McNary Dam transports											
WH-GM	2	3	1	1	--	--	--	--	3	4	42.9
WH-GM-WH	1	--	--	--	--	--	--	--	1	--	100.0
WH-RD-YW-YW	2	3	--	--	1	--	--	--	3	3	50.0
Subtotal	5	6	1	1	1	0	0	0	7	7	50.0
TOTAL	31	104	7	17	12	27	0	5	50	153	24.6

Appendix Table 20.--Recovery of adult steelhead at Dworshak Hatchery, Pahsimeroi Hatchery and Hells Canyon Dam in 1980 that were tagged as juveniles and transported and released below Bonneville Dam or released as controls at Lower Granite, Little Goose, or McNary Dams in 1978.

Color code	Dworshak Hatchery: No. with jaw tag & wire tag	Dworshak Hatchery: No. with wire tag only	Pahsimeroi Hatchery: No. with jaw tag & wire tag	Pahsimeroi Hatchery: No. with wire tag only	Hells Canyon Dam: No. with jaw tag & wire tag	Hells Canyon Dam: No. with wire tag only	Total: No. with jaw tag & wire tag	Total: No. with wire tag only	Trap efficiency %
1978 Lower Granite Dam controls									
WH-RD-WH-RD	1	1	7	1	1	--	9	2	81.8
WH-RD-WH	--	--	2	--	--	--	2	0	100.0
WH-OR-YW	--	1	2	2	--	1	2	4	33.3
Subtotal	1	2	11	3	1	1	13	6	68.4
1978 Lower Granite Dam transports									
WH-RD-BL	3	--	27	18	4	--	34	18	65.4
WH-RD-GN	1	1	--	1	--	--	1	2	33.3
WH-RD-RD-OR	2	--	10	18	5	1	17	19	47.2
WH-RD-RD	2	--	2	--	--	--	4	0	100.0
Subtotal	8	1	39	37	9	1	56	39	58.9
1978 Little Goose Dam controls									
WH-YW-BR-BR	--	--	1	2	--	--	1	2	33.3
Subtotal	--	--	1	2	--	--	1	2	33.3
1978 Little Goose Dam transports									
WH-RD-LG	1	2	5	6	--	--	6	8	42.9
WH-OR-GN-YW	--	--	2	--	--	--	2	0	100.0
WH-RD-OR	1	1	3	6	--	1	4	8	33.3
WH-RD	--	--	2	2	--	--	2	2	50.0
Subtotal	2	3	12	14	--	1	14	18	43.8
1978 McNary Dam controls									
WH-RD-YW-RD	--	--	1	--	--	--	1	0	100.0
Subtotal	--	--	1	--	--	--	1	0	100.0
1978 McNary Dam transports									
WH-GM-WH	--	--	1	--	--	--	1	0	100.0
WH-RD-YW-YW	--	--	3	--	1	--	4	0	100.0
Subtotal	--	--	4	--	1	--	5	0	100.0
TOTAL	11	6	68	56	11	3	90	65	58.1

Appendex Table 21.--Recovery of adult steelhead from Oregon, Washington, and Idaho Sports fisheries in 1980-81 that were tagged as juveniles and transported from Lower Granite or Little Goose Dams or released as controls in 1978-79. (Data are inclusive of tags received by 1 June 1981.)

Collection site	1978 Lower Granite						1978 Little Goose			1979 Lower Granite			TOTAL
	F.W. truck	Barge	24-h/hold truck	Salt truck	Forebay control	Tailrace control	F.W. truck	Salt truck	Tailrace control	Barge	Forebay control (barge)	Tailrace control	
Klickitat R.	1												1
White Salmon R.		1											1
Deschutes R.	6	3			1	1	1	1		10	1	1	25
John Day R.					1								1
Methow R.					1								1
Snake R.	2				1			2		1			6
Grande Ronde R.								1					1
Clearwater R.	12	13			7	1	10	19	2	2		1	67
Salmon R.	13	12			2		12	13	3	14	3	6	78
Unknown	1	3				1			3				8
Total	35	32			13	3	23	36	8	27	4	8	189

Appendix Table 22.--Preliminary returns to Lower Granite Dam of 1-ocean age steelhead from control and transport releases of smolts from Lower Granite Dam in 1979. Recoveries were made from 21 July 1980 to 1 June 1981.

Release site and experimental groups	Lower Granite Dam No. of juveniles released	No. of adults recaptured	Adult return in % of juveniles released	Transport benefit (%) [a/]
Control				
Tailrace	21,050	17	0.081	---
Control				
Forebay	17,319	12	0.069	---
Bonneville				
Barge transport (freshwater)	30,495	55	0.180	+122
Bonneville				
Truck transport (freshwater)				
Total	68,864	84		

a/ Transport benefit for Lower Granite Dam was calculated based on the observed percent of return of the tailrace control. No adjustment was made for control fish that were transported at Little Goose or McNary Dams.

Appendix Table 23.--Returns to Lower Granite Dam of 1-, 2-, and 3-ocean age chinook salmon from control and transport releases of smolts from Lower Granite and Little Goose Dams in 1977. Recoveries were made from 2 July 1978 to 31 August 1980.

Originating dam and experimental groups	No. of adults returning[a/] 1-ocean age	2-ocean age	3-ocean age
Lower Granite			
Air transport	0	3	0
Lower Granite			
Barge transport	0	2	0
Truck transport (Saltwater)	0	0	2
Little Goose			
Truck transport (Freshwater)	0	1	1
TOTAL	0	6	3

a/ Transport benefits not calculable because of zero controls returning.

Appendix Table 24.--Recovery of adult chinook salmon in 1980 at Kooskia, Rapid River, McCall, and Dworshak Hatcheries that were tagged as juveniles and transported and released below Bonneville Dam or were released as controls at Lower Granite and Little Goose Dams (1977-79).

Originating dam and year of release	Test condition	Number with jaw tag and wire tag	Number wire tag only	Total
		KOOSKIA HATCHERY		
Lower Granite 1978	Transport	1	1	2
		RAPID RIVER HATCHERY		
Lower Granite 1977	Transport	0	2	2
Lower Granite 1978	Transport	2	8	10
Lower Granite 1979	Control	1	1	2
Lower Granite 1979	Transport	1	0	1
Little Goose 1978	Control	0	2	2
Little Goose 1978	Transport	2	0	2
		McCALL HATCHERY		
Lower Granite 1978	Transport	1	0	1
Lower Granite 1979	Control	1	0	1
Lower Granite 1979	Transport	1	0	1
Little Goose 1978	Control	0	1	1
		DWORSHAK HATCHERY		
Lower Granite 1977	Transport	1	1	2
Lower Granite 1978	Transport	1	1	2
Little Goose 1978	Control	1	0	1
	Totals	13	17	30

Appendix Table 25.--Preliminary returns to Lower Granite Dam of 1-ocean age spring and summer chinook salmon from control and transport releases of smolts from Lower Granite in 1979. Recoveries were made from 26 April 1980 to 13 July 1980.

Release site and experimental groups	Lower Granite Dam			
	No. of juveniles released	No. of adults recaptured	Adult return in % of juveniles released	Transport benefit (%)[a]
Control tailrace	25,532	0	0.0	---
Control forebay	24,467	1	0.004	---
Bonneville barge transport	27,336	4	0.015	---
TOTAL	77,335	5		

a/ Transport benefits not calculable because no tailrace controls returned.

Appendix Table 26.--Size and location of orifices used at Little Goose Dam, 1980.

Operating unit	Size of orifice opening (inches)	Operating unit	Size of orifice opening (inches)
1A-S[a/]	12	4A-S	12
1A-N	8	4A-N	8
1B-S	12	4B-S	12
1B-N	12	4B-N	8
1C-S	12	4C-S	12
1C-N	12	4C-N	8
2A-S	12	5A-S	8
2A-N	12	5A-N	8 Plate only
2B-S	12	5B-S	8
2B-N	12	5B-N	8 Plate only
2C-S	12	5C-S	8
2C-N	8	5C-N	8 Plate only
3A-S	12	6A-S	8
3A-N	8	6A-N	8 Plate only
3B-S	12	6B-S	8
3B-N	8	6B-N	8 Plate only
3C-S	12	6C-S	8
3C-N	8	6C-N	8 Plate only

a/ S denotes south orifice location in gatewell--N denotes north orifice location in gatewell.