J M Matthews

CZES Coastal Zone and Estuarine Studies

Transportation Research on the Columbia and Snake Rivers 1979

by
Donn L. Park, Thomas E. Ruehle,
Jerrel R. Harmon and Bruce H. Monk

April 1980

Matthews

TRANSPORTATION RESEARCH ON THE COLUMBIA AND SNAKE RIVERS

1979

by

Donn L. Park

Thomas E. Ruehle

Jerrel R. Harmon

and

Bruce H. Monk

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

and

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

April 1980

TABLE OF CONTENTS

INTRODUCTION

The National Marine Fisheries Service (NMFS) is continuing research to increase the survival of juvenile salmonids by transporting them from upstream collector dams on the Snake and Columbia Rivers to safe release sites in the Columbia River below Bonneville Dam. In 1979, the major emphasis was to determine the benefits of transporting salmonid smolts from McNary Dam. If successful, the program will give protection to mid-Columbia River stocks as well as added protection to Snake River juveniles.

Activities in 1979 were directed to four areas: (1) transport and release groups of marked juvenile salmonids for testing the hypothesis that transportation by barge and truck from McNary Dam will increase survival of smolts without interfering with their homing abilities as adults; (2) install and operate an adult collection device at McNary Dam to evaluate the return of adults from experiments in 1978; (3) continue operation of the adult collector at Lower Granite Dam to evaluate the return of adults from previous mass transport experiments on the Snake River; and (4) continue monitoring adult returns to the collector at Bonneville Dam, the various fisheries, hatcheries, and natal spawning areas.

RESEARCH--COLUMBIA RIVER (McNARY DAM)

Collection, Marking, and Transportation of Smolts

Nearly four times as many smolts were collected at McNary Dam in 1979 than in 1978. (1,593,207 vs 420,689--See Appendix Table 1 for daily fish count by species). We believe the primary reason for the increased collection was that vertical barrier screens were installed in all units

(42 screens), thereby retaining fish in gatewells where they could volitionally enter the bypass system. In addition, six guiding devices (three submersible traveling screens and three bar screens) were operated in 1979, whereas only four were used in 1978.

Research activity began with collection of the first fingerlings on 9 April 1979. Collecting, marking, and transporting were concluded on 24 August.

Fish in all groups (transports and controls) were marked by adipose fin clip and distinctive freeze brands keyed to a specific coded wire tag injected into the snout. Test groups were transported by truck or barge to release sites downstream from Bonneville Dam. Control groups were released downstream and upstream from McNary Dam. The control group above the dam served as an index group to estimate the total population of smolts passing the dam (Raymond and Sims 1980). This group may also be used to evaluate the transport tests. A total of 486,000 fish were marked for transportation tests (Table 1). A comprehensive list of brands and tag codes used for each species by time are shown in Appendix Tables 2 through 7.

The number of fish collected at McNary Dam far exceeded the number needed for research (marking) purposes. Therefore, whenever practical the surplus fingerlings were transported unmarked either by barge or truck to Bonneville (Smith et al. 1980). A total of 1,247,120 fingerlings were transported, including fish marked for barge and truck test groups (Table 1 and Appendix Tables 8 and 9).

Table 1.--Summary of marked and unmarked salmonids (5 species) that were transported to below Bonneville Dam by truck or barge or were released as controls (marked) at McNary Dam in 1979.

Release Sites	Marked					Unmarked				
	Fall Chinook	Spring Chinook	Coho	Sockeye	Steelhead	Fall Chinook	Spring Chinook	Coho	Sockeye	Steelhead
Trucked										
Bonneville Dam	129,777	42,748	1,343	9,601	15,399	319,110	104,910	25,714	85,859	51,168
Barged										
Bonneville Dam	0	40,126	1,626	4,796	18,182	0	161,970	53,994	97,433	83,384
McNary Dam (control)										
Forebay	19,810	24,650	3,179	4,920	8,131	0	0	0	0	0
McNary Dam (control)										
Tailrace	112,718	31,229	983	8,207	8,595	0 [a/]	0	0	0	0
Totals	262,305	138,753	7,131	27,524	50,287	319,110	266,880	79,708	183,292	134,552

[a/] Fish of all species were returned to river during specific marking processes and are noted in Appendix Table 1.

Water Quality and Delayed Mortality in Transport Systems

Water quality in the transport system was monitored at Bonneville Dam when samples of fish were taken for delayed mortality tests. The following water quality parameters were measured: temperature, O_2, CO_2, and pH (Appendix Table 10). We believe that all parameters measured were within acceptable limits during the transportation periods.

Samples of 25 marked fish from each of 12 marked groups of fish that were transported were held at McNary Dam. These samples were held for 48 h to determine the delayed mortality effect of collection, handling, and marking. At Bonneville Dam, fish from transported groups (unmarked and marked) were also held for a similar 48 h period. We hypothesized that any delayed mortality measured at Bonneville Dam that exceeded the rate measured at McNary Dam would actually be the net delayed mortality caused by the transport process.

As expected, delayed mortalities for fish held at McNary Dam were less than measured after transport (Table 2). Chinook salmon had the highest delayed mortalities both before and after transport. Both chinook salmon and steelhead had a higher delayed mortality when held at Bonneville Dam after being transported by truck than when transported by barge.

Delayed mortality, in general, was highest when the majority of the spring chinook salmon were transported--16 April to 5 June. In later periods when summer-fall chinook salmon were transported, delayed mortality declined. These data suggest that fall chinook salmon are more tolerable of the stresses involved in collection and transportion than are spring chinook salmon; this was also indicated in 1978. This is very important since fall chinook salmon is the most abundant juvenile migrant species at McNary Dam.

Table 2.--Delayed mortality for chinook salmon and steelhead held for 48 h after marking at McNary Dam, and held for 48 h after marking and transport by truck or barge at Bonneville Dam.

Category	Chinook salmon			Steelhead
	16 April to 5 June	6 June to 10 July	11 July to 6 August	16 April to 5 June
	(%)	(%)	(%)	(%)
Held at McNary Dam	5.7	3.2	-	2.8
Barge	7.2	-	-	0
Truck	20.4	12.0	10.4	3.8

Evaluation of Adult Returns to McNary and Lower Granite Dams

McNary Dam is the primary point of evaluation for adults returning from releases of fingerlings originating from McNary Dam; however, additional information is obtained at the collector facilities at Lower Granite and Bonneville Dams. In some cases, data from all three river collection sites were useful in analyzing the adult recovery data.

The adult collector in the north fishway at McNary Dam began operations on 8 August 1979, in time to provide coverage for most of the steelhead run and all of the fall chinook and coho salmon runs. Installation and operation of the facility was purposely delayed until after the spring and summer chinook salmon runs had passed the dam, even though marked returns of 1-ocean age fish from these stocks were anticipated. By earlier agreement with fisheries agencies, it was determined that no interference should be imposed on these runs which were believed to be extremely depressed.

Fall Chinook Salmon--1978 Outmigration

Fall chinook salmon jacks (1-ocean age) returned to McNary Dam in meaningful numbers in 1979. These preliminary returns (76) indicate a transport benefit ratio of 10.25:1 (Figure 1). Additional recoveries at Bonneville and Lower Granite Dams also show a very positive transport/control ratio. Other recoveries (15) in ocean sport and commercial fisheries are noted in Appendix Table 11. Because these fall chinook salmon are only marginally legal sized fish at this stage of their life cycle, a substantial increase in landings should be reported in ensuing years.

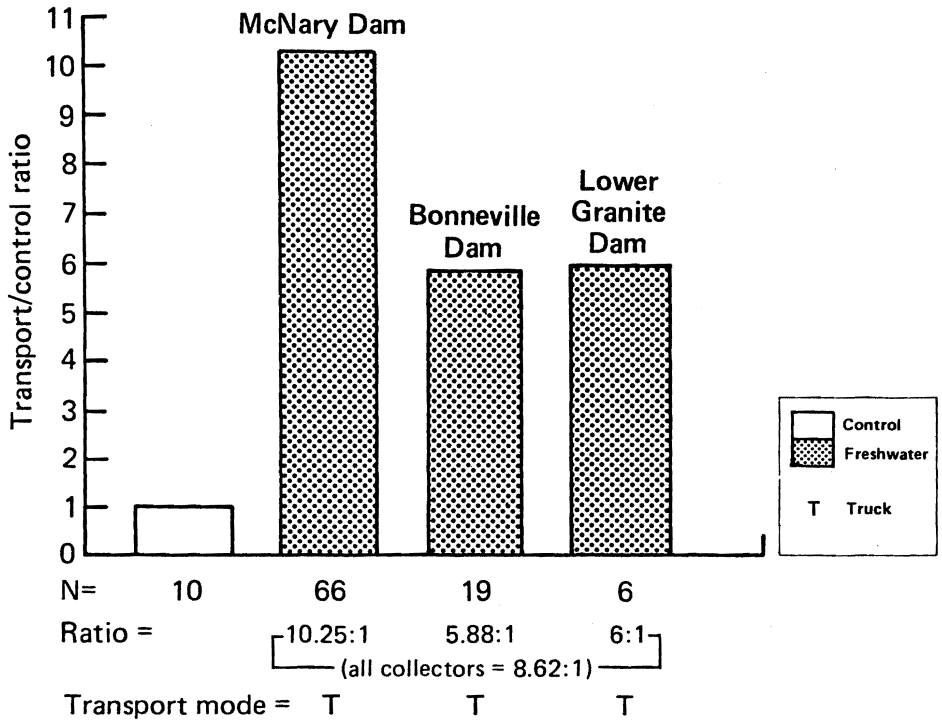


Figure 1.--Transport benefit ratios for fall chinook salmon transported in 1978 from McNary Dam and returning in 1979 to the adult collector facilities at Bonneville, McNary, and Lower Granite Dams. (Preliminary)

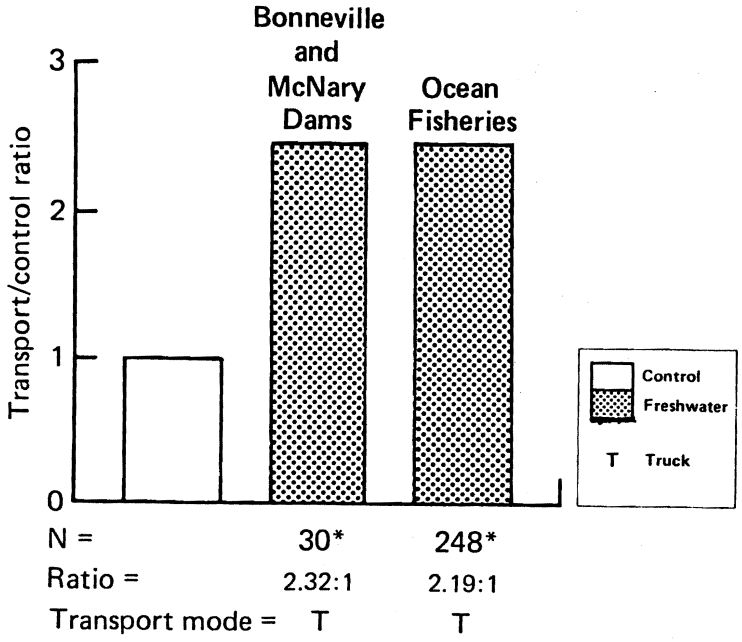
Recently, 14 jacks were recovered during collection/spawning operations at Priest Rapids Dam--three controls and 11 transports from the summer transport period (marked as juveniles after 19 July 1978[1/]). This indicates that these fish were imprinted by the time they reached McNary Dam; i.e., they will home back to their native stream or hatchery. These data also add credibility to the transport benefits measured at McNary Dam and indicate that extremely severe mortality is occurring to this stock in the river below McNary Dam--most likely in the John Day Dam and pool complex.

Jacks were recovered at Lower Granite Dam; their recovery, even though the number was small, is important because these fish obviously were of Snake River origin. All smolts marked in this group were transported from McNary Dam after 19 July 1978 indicating they probably migrated past Lower Granite Dam after transport operations at the dam were terminated. Because this race of fish is so depressed, it is encouraging that a summer transport program may indeed increase their survival. A summer transport effort on the Snake River may be considered if future data substantiate these preliminary findings.

Coho Salmon--1978 Outmigration

Coho salmon returning to McNary Dam from releases of transported and control groups of fish are complete. However, data presented in Figure 2 are preliminary because we believe that returns from the ocean fisheries are incomplete due to lag time in processing tags collected by sampling agencies.

[1/] Personal communications Washington Department of Fisheries Staff.



* Includes controls.

Figure 2.--Transport benefit ratios for adult coho salmon that returned to McNary and Bonneville Dams and the Ocean fisheries in 1978-79 from juveniles transported from McNary Dam in 1978.

Few coho salmon were collected at McNary Dam; therefore, we combined returns with those intercepted at Bonneville Dam. Since only 30 jacks and adults were recovered at river collector sites (Appendix Table 12), little emphasis can be placed on benefits for transportation derived from these data. However, the percent increase in return for transported fish is 130% (ratio = 2.3:1) as measured at river site collectors.

Based on ocean recovery data of coho salmon, we are confident that transportation significantly increased their survival and contribution to the fisheries. To date, 248 fish have been returned from the ocean fisheries, and benefit of transportation based upon these returns is 119% (ratio 2.19:1).

In recent years, coho salmon runs above McNary Dam have been sustained through hatchery production, and if hatchery production were reduced, the runs would soon be depleted to extinction. Our data supports the contention that ocean harvest rates on these fish are high. Even though recoveries from ocean and sport fisheries were on a sample basis, 88% of the transported fish and 89% of all fish recovered were from those fisheries. Therefore, if hatchery production were increased, indications are that transportation, by enhancing survival of smolts, is capable of compounding the benefits to the fishermen.

Steelhead--1978 Outmigration

Because only about 11% of the adult steelhead passing McNary Dam during the sampling period (8 August to 14 November) used the north fishway, the number of tagged adults that could be expected to be recovered at McNary Dam was limited. The number is dependent on the percentage of fish from the Snake River that were included in the fingerlings that were originally marked. Based on recoveries at McNary and Lower Granite Dams

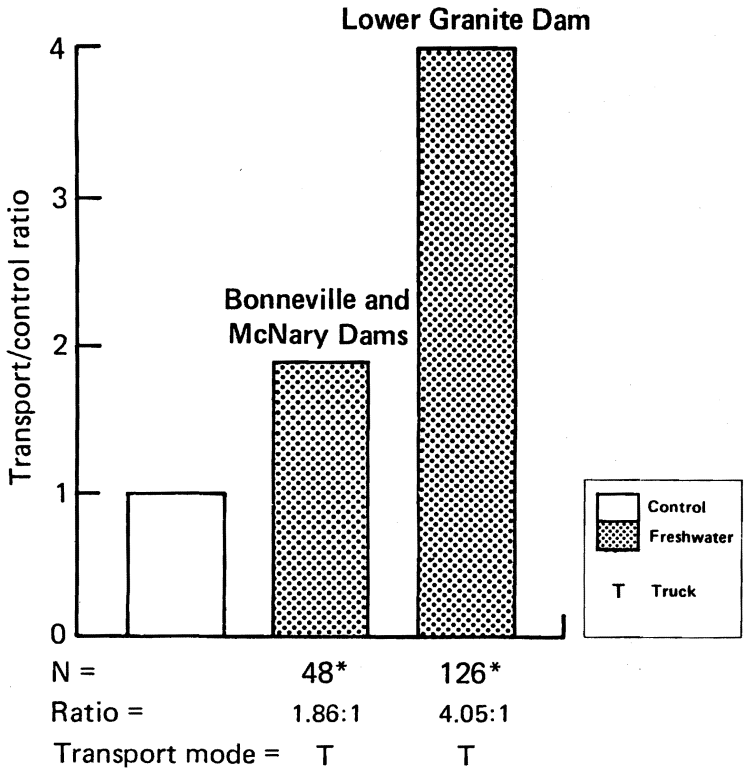
of steelhead of known Snake River origin, we can expect only 10 to 15% of the steelhead destined for the Snake River to use the north ladder. This explains in part why out of the total of 153 marked steelhead from McNary tests recovered at McNary and Lower Granite Dams, only 27 were recovered at McNary Dam.

The high benefit ratio (4.05:1) for McNary test fish recovered at Lower Granite Dam (Snake River stock) cannot be explained at this time (Figure 3). Since adults passing McNary Dam are mixed stock (Mid-Columbia and Snake River), the benefit measured at Bonneville/McNary Dam (1.86:1) may be a benefit more applicable to mid-Columbia stocks. However, the benefit measurements from all three river collection sites (3.14:1) may be a more accurate assessment of the true benefit ratio for all steelhead transported from McNary Dam. These preliminary ratios suggest that transport of steelhead from McNary Dam increases their survival and rate of return to the river. Future returns (2-ocean age) will provide additional data upon which a more meaningful analysis can be made.

RESEARCH - SNAKE RIVER

The NMFS is continuing to evaluate the effect of transporting 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.

Fish tagged as juveniles in 1976 through 1978 continued to return in 1979. Data on the returns of adult chinook salmon and steelhead to the Snake River in 1979 are combined with appropriate earlier data and reviewed in this section.



* Includes controls.

Figure 3.--Transport benefit ratios for steelhead transported in 1978 from McNary Dam and returning to adult collector sites in 1979. (Preliminary)

Returns of Adult Chinook salmon to Lower Granite Dam

1976 Outmigration

Chinook salmon returning from smolt releases in 1976 are complete and very disappointing (Appendix Tables 14 and 15). The numbers of fish returning from each marked group were so low that meaningful analysis was impossible. However, for general information, adult return data for tests originating at Lower Granite and Little Goose Dams are shown in Figures 4 and 5, respectively. It is difficult to explain why the returns were so poor; the smolts appeared to be in excellent condition at the time of release. One possible explanation is that ocean survival was poor, since many streams along the Pacific Coast also had poor returns from the 1976 outmigration of smolts.

1977 Outmigration

The mortality inflicted on chinook salmon migrating to sea in 1977 was severe. Drought conditions which resulted in a failure of some smolts to migrate (Park et al. 1978); slow passage through reservoirs; and high mortalities associated with dams, caused a near 100% mortality of smolts by the time they reached John Day Dam (Ebel et al. 1979).

To date, only six adult chinook salmon from tests originating from Lower Granite and Little Goose Dams in 1977 have been recovered at Lower Granite Dam. Although all six were 2-ocean age adults from transport groups (Appendix Table 16), returning numbers have been too low to accurately state positive benefits from transportation. However, transport operations allowed a limited return, whereas virtually no adults would have returned without transportation.

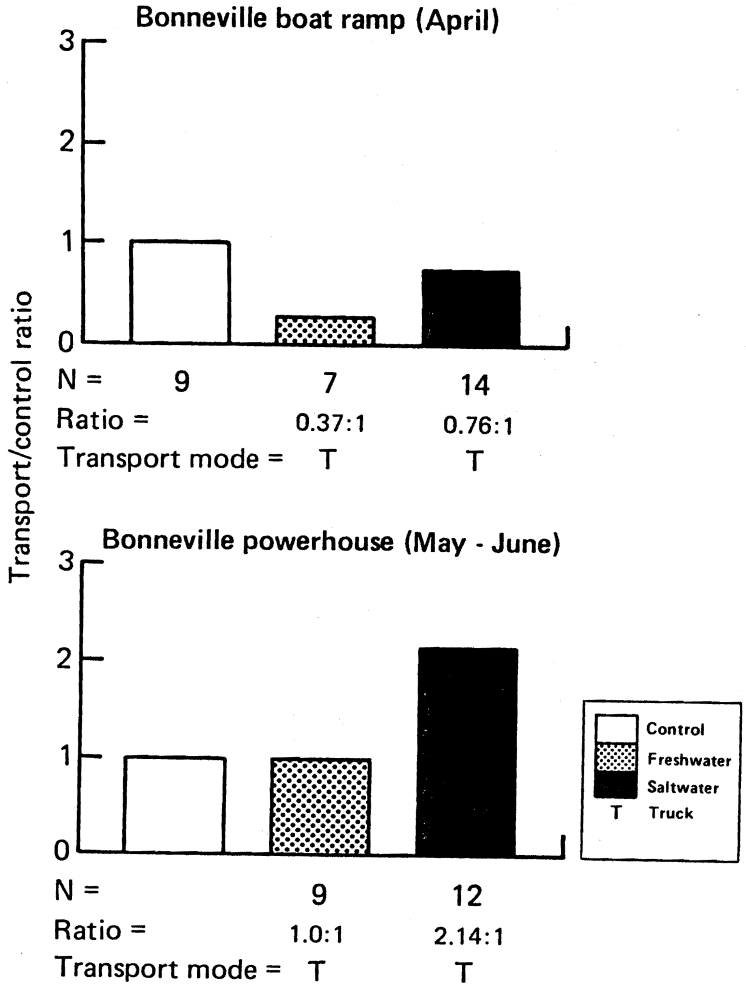


Figure 4.--Transport benefit ratios for chinook salmon transported in 1976 from Lower Granite Dam to two release sites below Bonneville Dam and returning to the Snake River in 1977-79.

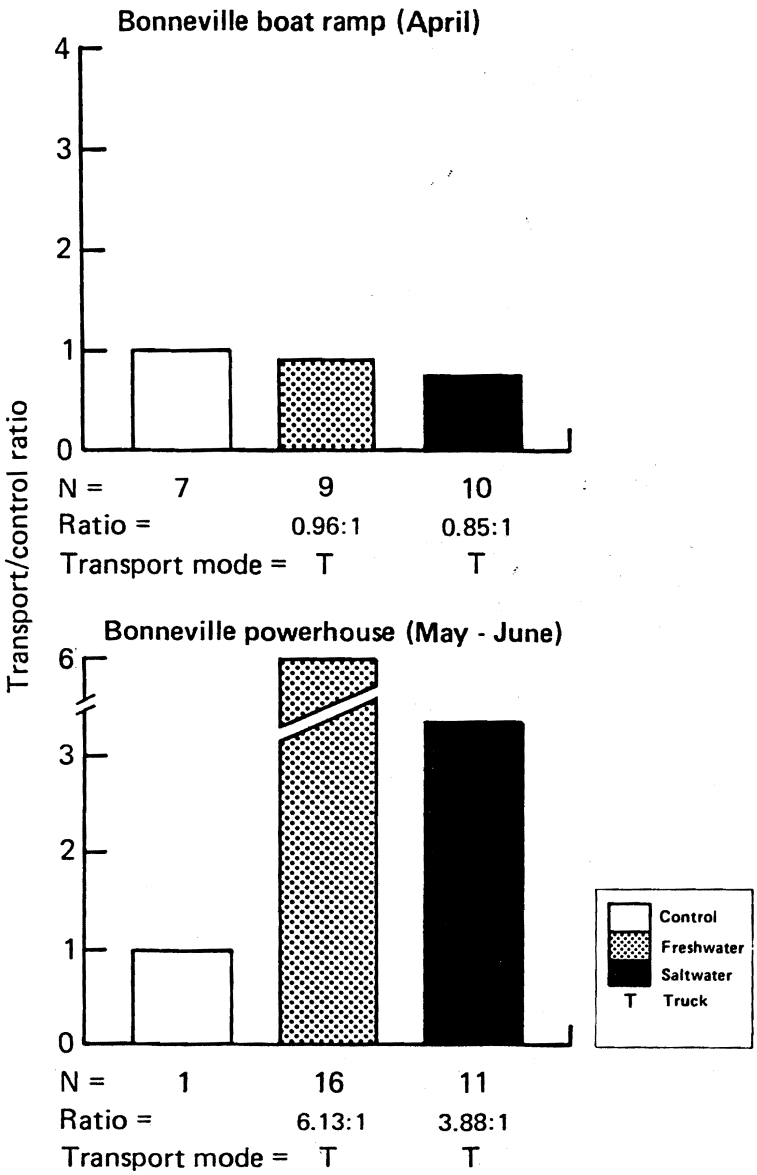


Figure 5.--Transport benefit ratios for chinook salmon transported in 1976 from Little Goose Dam to two release sites below Bonneville Dam and returning to the Snake River in 1977-79.

1978 Outmigration

In 1979, 28 jacks (1-ocean age) chinook salmon returned from releases in 1978 (Appendix Table 17). Most of the returns so far have been from smolts that were transported by truck or barge from Lower Granite Dam.

We can look forward to a reasonable number of 2-ocean age fish returning in 1980 from the Snake River tests, although indications are that the runs will be still considerably lower than the run following the 1975 outmigration, when the survival of transported fish was extremely high.

Returns of Adult Chinook Salmon to Hatcheries and Spawning Grounds

Complete surveys for recovery of fish from transport and control releases (1976-78) were made at Kooskia and Rapid River Hatcheries (Appendix Table 18). For the first time more fish from our tests were recovered at hatcheries than were intercepted at Lower Granite Dam.

It is obvious that detection of tagged fish at Lower Granite Dam has been a problem--especially for fish tagged in 1976-77. The problem was most likely associated with techniques used at the time of tagging and has little to do with tag detection operations. We believe the problem was caused by the magnets used to energize the tags, and we have taken steps to standardize and improve our tagging operation. Without the tag recovery efforts at hatcheries and on the spawning grounds, the problem would not have been detected.

In 1979, spawning ground surveys for tagged fish were curtailed because few fish were expected. One stream that is a primary index site, with a normal spawning population of several hundred fish, had less than 50 fish this year. Consequently, no more than a token survey effort could be justified, and no tagged fish were recovered on the spawning grounds.

Returns of Adult Steelhead to Lower Granite Dam

The return of adult steelhead from groups of fish released as controls or transported by truck and barge from Lower Granite and Little Goose Dams in 1976 through 1978 was much stronger than comparable returns for chinook salmon. We believe these returns reflect the hardier nature of steelhead smolts in that their ability to survive collection and transport stresses is greater than that of chinook salmon.

1976 Outmigration

Adult steelhead returning to the Snake River from releases of smolts in 1976 are virtually complete (a few 3-ocean age fish returning to hatcheries in the spring of 1980 may still be expected).

Transport benefit ratios for steelhead transported from Lower Granite Dam are shown in Figure 6 (detail for adults returning for each experimental lot are shown in Appendix Table 19). The benefits for steelhead released at the boat ramp site[2/] were nil (approximately 1.0:1 when saltwater and freshwater treatments are combined). However, the benefit ratio at the powerhouse site was about 2.0:1. Note that few fish were involved in the boat ramp releases and that substantial numbers were involved in the powerhouse site releases; hence the latter data are more meaningful.

It appears that the use of salt water as transport media did not add any benefit to the overall survival of steelhead transported from Lower Granite Dam. The estimated percent return of transport groups from both dams ranged from 1.19 to 2.71%, indicating excellent overall survival of transported fish. Numerous returns to hatcheries and relatively strong

2/ The boat ramp site was abandoned when construction activity relating to the second power house rendered it useless.

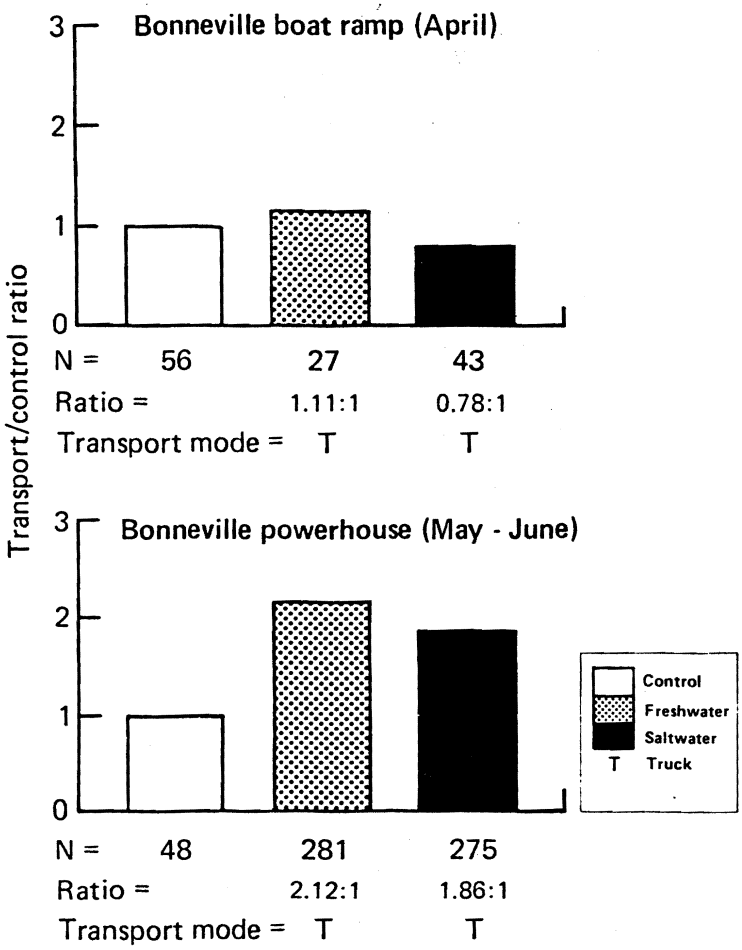


Figure 6.--Transport benefit ratios for steelhead transported in 1976 from Lower Granite Dam to two release sites below Bonneville Dam and returning to the Snake River in 1977-79.

returns to fisheries of the 1976 outmigration support our contention that the transport of steelhead in 1976 was successful and that benefits were excellent.

Benefit ratios and percent return of smolts released for nearly all test groups from Little Goose Dam exceeded that of Lower Granite Dam test groups. The benefit ratio for fish transported from Little Goose Dam and released at the boat ramp site (Approximately 7:1) was much higher than noted for releases from Lower Granite Dam; the ratio at the powerhouse site was near 3:1 (Figure 7). (Details for returns from all groups are shown in Appendix Table 20).

We have attempted to adjust returns to reflect numbers of fish that were transported from control releases. This was done by subtracting the estimated number of controls recovered at the collector dams from the total marked in each control group. This is very difficult to do accurately when one considers that control fish released above Lower Granite Dam may subsequently be transported from either Lower Granite or Little Goose Dams. We believe that the true rate of return of Lower Granite controls should never exceed that of the Little Goose controls. Therefore, the adjustment we have made is probably not accurate. In analyzing returns for future years, we will use Little Goose controls for transport/control ratios for both dams. Beginning in 1980, controls for transport assessment will be released below Little Goose Dam to avoid as much as possible the transport of control fish.

1977--Outmigration

Transport benefits ratios for steelhead transported in 1977 are extremely high (Figure 8). Benefit ratios ranging from more than 7:1 to

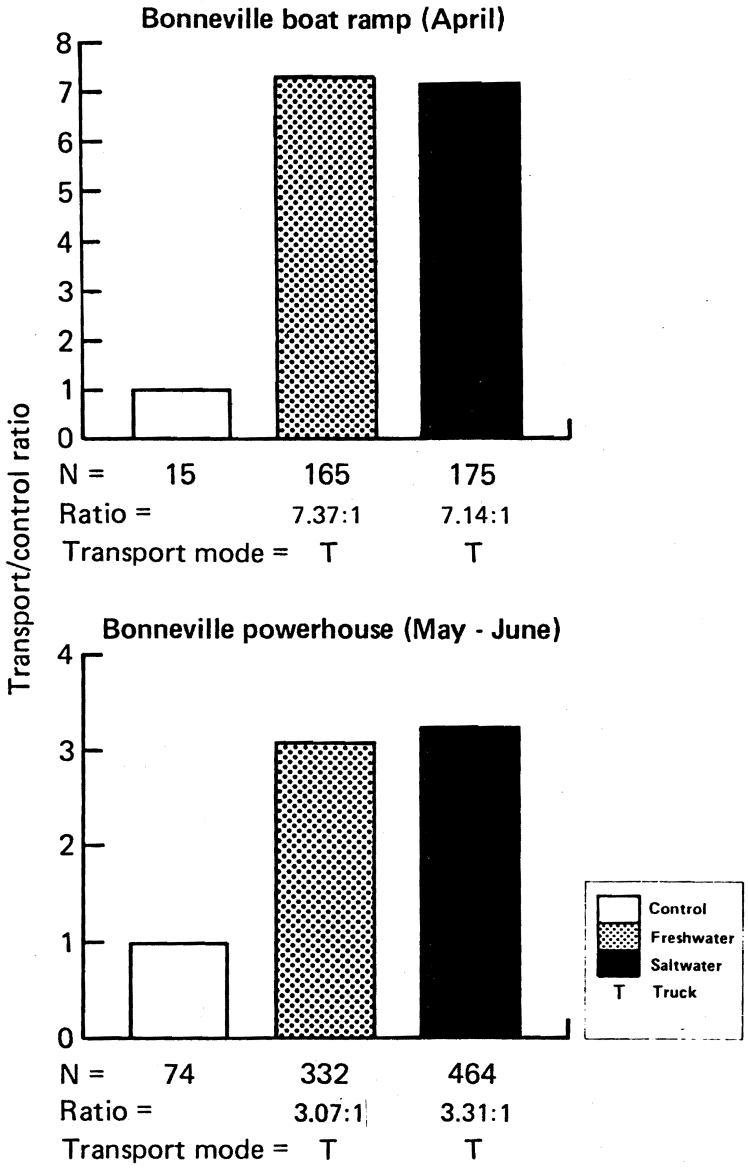
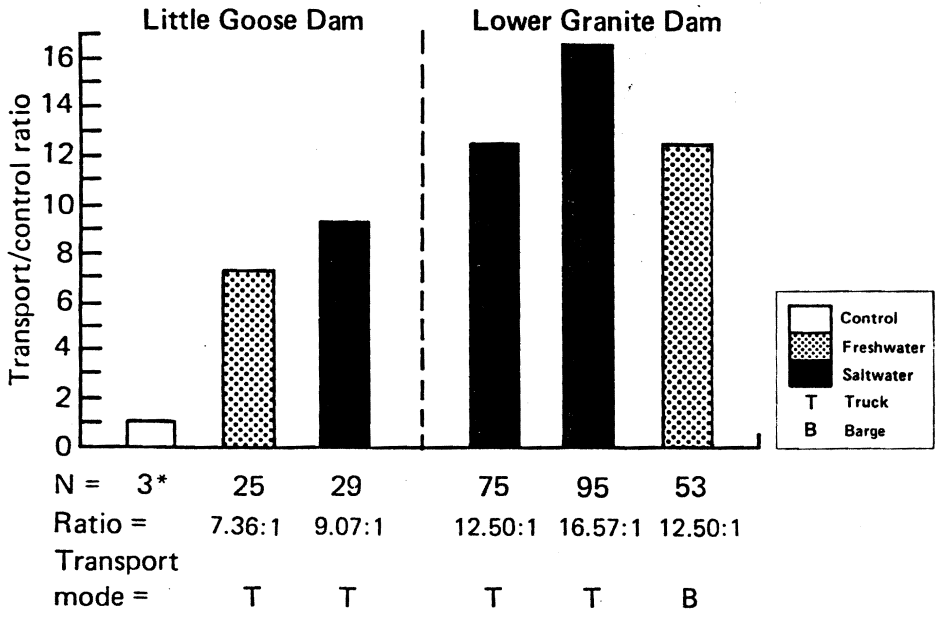


Figure 7.--Transport benefit ratios for steelhead transported in 1976 from Little Goose Dam to two release sites below Bonneville Dam and returning to the Snake River in 1977-79.



* All benefits calculated are based upon returns of steelhead released below Little Goose Dam (control).

Figure 8.--Transport benefit ratios for steelhead transported in 1977 from Little Goose and Lower Granite Dams and returning to the Snake River in 1978-79. (Preliminary)

more than 16:1 reflect the severe mortality inflicted on fingerlings migrating seaward during the drought in 1977.

The percent return of smolts released is considerably lower than for any year since our transportation program began. This low rate of return undoubtedly reflects the poor condition of fish at transport time. Even so, substantial numbers of adults have returned from the various transport groups (Appendix Table 21) and from additional fish hauled that were not marked. Survival of smolts not transported in 1977 was virtually nil (Ebel, et al. 1979).

1978--Outmigration

The condition of smolts arriving at Lower Granite Dam in 1978 was excellent, and the number of adult steelhead returning to the Snake River following transportation as smolts in 1978 is encouraging. Not only is the number of returns encouraging, but the percent return of smolts released is one of the highest since studies began in 1975 (Appendix Table 22). Prospects are excellent that the percent return will increase substantially when 2-ocean age fish return in the fall of 1980.

Transport benefit ratios are also excellent, averaging nearly 4:1 for steelhead transported from Little Goose or Lower Granite Dams (Figure 9). The high transport benefit ratios suggest there was substantial mortality to smolts which were not protected by transportation.

Based upon the very solid returns from fish transported in 1978 and the fact that over 2 million steelhead smolts were transported in 1979, we expect an excellent run of steelhead in the Snake River in 1980.

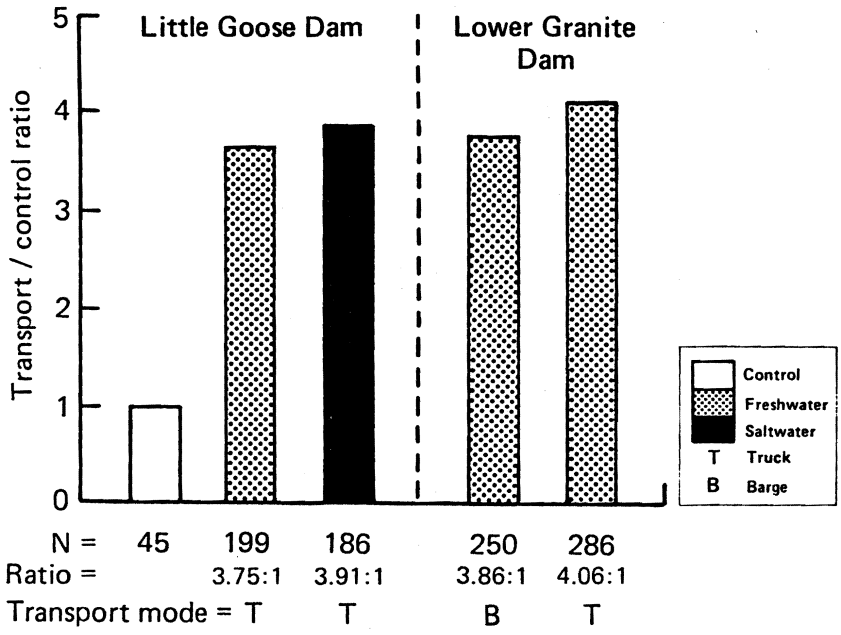


Figure 9.--Transport benefit ratios for steelhead transported in 1978 from Little Goose and Lower Granite Dams and returning to the Snake River in 1979. (Preliminary)

Returns of Adult Steelhead to Hatcheries and Sports Fishery

In 1979, about 500 steelhead from transport tests originating at Little Goose and Lower Granite Dams in 1975-77 were recovered at Dworshak and Pahsimeroi Hatcheries in Idaho (Appendix Table 23). Although these returns cannot provide a true overall transport benefit for steelhead because recovery data for wild fish is not included, they do provide another indicative measure of transport benefits and substantiate the fishes ability to home to specific locations far upstream of the transport point.

These data are most useful for making estimated total returns of transported (or control) fish passing Lower Granite Dam, e.g., establishing sampling rate or efficiency rate of the adult trapping facility.

Returns to the sport fisheries in 1979 are summarized in Appendix Table 24. Nearly all returns were from the Columbia River; however, no "catch and keep" fishery was allowed in such traditionally important streams as the Clearwater River. Returns noted for such streams were from tag numbers read and reported to us from fish caught and subsequently released--no illegal fishery is implied.

Returns to sports fisheries of steelhead from experimental releases marked at McNary Dam are summarized in Appendix Table 25.

Returns of Adult Steelhead to Bonneville Dam and Indian Set-Net Fishery

The adult collection facility was operated in the north shore ladder at Bonneville Dam for the second year. The trapping facility was in operation from late June to early October 1979. The operation is jointly funded by the CofE for this study and by BPA for homing-imprint studies.

This year 96 steelhead from Snake River and McNary Dam transport tests were recovered. We estimated that 5 to 7% of the steelhead passing over Bonneville Dam were sampled at the facility. Comparative numbers detected at Bonneville, McNary, and Lower Granite Dams are shown in Appendix Table 26. The data are useful for combining with McNary Dam collection data where sampling is also limited to a relatively small portion of the total run and for determining the effect of collection and transportation on homing.

NMFS again participated in a multi-agency sampling program for monitoring steelhead landed in the Indian Net Fishery in Zone 6. This year 90 steelhead from Snake River transport tests were recovered during the 1-month season (Appendix Tables 27 and 28). Recoveries of 2-ocean age fish (45) were down considerably from 1978 reflecting a poor 2-ocean year-class (severely impacted by the 1977 drought). However, 45 1-ocean age fish were also recovered, a relatively high number since 1-ocean age fish are not easily taken in this fishery because of restrictive mesh size regulations. This 1:1 ratio of 1- to 2-ocean age fish contrasts with the ratio of 8:1 2-ocean to 1-ocean age fish recovered in this fishery in 1978. These ratios are significant only in that the relative strength of each year class is important in assessing the overall status of the run. The 1:1 ratio in 1979 reflects a "rebuilding" situation for Columbia and Snake River steelhead runs following the drought year; and when viewed in this perspective, future prospects are encouraging.

SUMMARY

Activities in 1979 were part of the continuing research study to determine if transporting juvenile salmonids from McNary Dam to release sites in the Columbia River below Bonneville Dam increases their survival. Juveniles were collected, marked, and transported from McNary Dam, and returning adults from previous tests were monitored at adult collectors at Bonneville, McNary, and Lower Granite Dams; at hatcheries and spawning grounds; and in various fisheries.

More than 1.6 million fingerlings were collected at McNary Dam in 1979. Of these about 1.25 million (marked and unmarked) were hauled by truck or barge to release sites below Bonneville Dam. Nearly 0.5 million were marked for various transport tests.

Samples of water were examined from most transport loads (trucks and barges) to determine dissolved O_2, CO_2, pH, and temperature. None of the parameters examined indicated a threat to fish life during transport.

Delayed mortality for juveniles hauled by truck from McNary Dam to Bonneville Dam was 10.4 (late season) to 20.4% (early season) for chinook salmon and 3.8% for steelhead. Delayed mortality for fish transported by barge was low (chinook salmon 7.2% and no mortality for steelhead).

Benefit ratios for adults returning from fish transported from McNary Dam to Bonneville Dam in 1978 are encouraging: fall chinook salmon, 10:1 (jacks only); coho salmon, 2:1; and steelhead about 2:1. Most of the adult coho salmon returns have come from ocean sport and commercial fisheries.

Adult returns from transported and control releases of chinook salmon smolts from Lower Granite and Little Goose Dam in 1976-77 were poor. In general, the transport benefit ratios for 1976 were low and the ratios for

1977 were high; however the number of fish that have returned are very low. We speculate that ocean survival was poor in 1976 (possibly in 1977 also) and that drought conditions influenced survival prior to and following transport in 1977. So far, 28 jacks have returned from 1978 releases.

Returns of steelhead continue to be more numerous than returns of chinook salmon from the Snake River transport tests. Transport benefits in 1976 ranged from 0.78:1 (one test where insignificant numbers of fish were tested) to 7.37:1. Ratios were highest for steelhead transported from Little Goose Dam.

In 1977, all steelhead were impacted by drought conditions whether transported or not. Transport benefits ranged from 7.36:1 to 16.57:1. The use of salt water (transport media) in trucks may have increased survival slightly.

The returns of 1-ocean age steelhead from transport tests in 1978 are very encouraging. More transported fish are returning than in any year since 1975. Benefits are excellent and there is no significant difference between results of transportation from either dam. Benefit ratios range from 3:75:1 to 4.06:1. Preliminary returns indicate that steelhead hauled in fresh water from Lower Granite Dam survived best. It appears that salt water can increase survival but not enough to overcome adverse features such as added wear and corrosion in the transport equipment.

Returns to hatcheries and spawning grounds continue to provide a means of measuring the collection efficiency of the adult trapping facility at Lower Granite Dam where the primary evaluation of transportation benefits are made. Additional recoveries from fisheries provide useful data (as in coho salmon) when recoveries are limited at river collector sites. No tagged spring chinook salmon were found this year in Idaho streams during a curtailed survey effort.

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, Wash.

Park, D. L., J. R. Smith, E. Slatick, G. M. Matthews, L. R. Basham, and G. A. Swan
1978. Evaluation of fish protective facilities at Little Goose and Lower Granite Dams and review of mass transportation activities - 1977. NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, Washington. Report to U.S. Army Corps of Engineers, Contract No. DACW68-77-C-0111. 60 p. with Appendix. Processed.

Raymond, Howard L. and Carl W. Sims
1980. Assessment of smolt migration and passage enhancement studies for 1979. NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, Washington, Report to U.S. Army Corps of Engineers, Contracts DACW-68-78-C-0051 and DACW-57-79-F-0411, Processed.

Smith, J. R., G. M. Matthews, L. R. Basham, S. Achord, and G. T. McCabe
1980. Transportation operations on the Snake and Columbia Rivers, 1979. NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, Washington. Report to the U.S. Army Corps of Engineers, Contract No. DACW68-78-C-0051, 78 p. with appendix. Processed.

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, Wash.

Park, D. L., J. R. Smith, E. Slatick, G. M. Matthews, L. R. Basham, and G. A. Swan
1978. Evaluation of fish protective facilities at Little Goose and Lower Granite Dams and review of mass transportation activities - 1977. NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, Washington. Report to U.S. Army Corps of Engineers, Contract No. DACW68-77-C-0111. 60 p. with Appendix. Processed.

Raymond, Howard L. and Carl W. Sims
1980. Assessment of smolt migration and passage enhancement studies for 1979. NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, Washington, Report to U.S. Army Corps of Engineers, Contracts DACW-68-78-C-0051 and DACW-57-79-F-0411, Processed.

Smith, J. R., G. M. Matthews, L. R. Basham, S. Achord, and G. T. McCabe
1980. Transportation operations on the Snake and Columbia Rivers, 1979. NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, Washington. Report to the U.S. Army Corps of Engineers, Contract No. DACW68-78-C-0051, 78 p. with appendix. Processed.

APPENDIX

This appendix is made up of 28 tables that provide details about our 1979 Transportation Research Program.

Appendix Table 1.--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead counted, observed as mortalities in collection, and returned to Columbia River, by date at McNary Dam, 1979.

Date	Counted					Mortality in collection	Returned to river				
	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead		Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
4-9	--	1,392	--	--	56	--	--	--	--	--	--
4-10	--	1,391	--	--	56	--	--	--	--	--	--
4-11	--	1,391	--	--	56	--	--	3,559	--	--	--
4-12	--	3,701	--	--	57	--	--	3,089	--	--	225
4-13	--	2,108	--	5	130	--	--	--	--	--	--
4-14	--	2,108	--	6	131	--	--	--	--	--	--
4-15	--	2,108	--	10	131	--	--	--	--	--	--
4-16	--	2,108	2	10	130	24	--	--	--	--	--
4-17	--	2,312	--	21	180	--	--	1,921	--	21	179
4-18	--	2,224	--	11	129	4	--	1,149	--	7	127
4-19	--	1,697	1	17	148	5	--	--	--	--	--
4-20	--	1,268	--	36	127	6	--	--	--	--	--
4-21	--	1,417	--	45	240	--	--	--	--	--	--
4-22	--	1,415	--	45	241	--	--	--	--	--	--
4-23	--	1,415	--	46	240	9	--	--	--	--	--
4-24	--	1,605	4	121	1,138	2	--	--	--	--	--

Appendix Table 1.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead counted, observed as mortalities in collection, and returned to Columbia River, by date at McNary Dam, 1979.

Date	Counted					Mortality in collection	Returned to river				
	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead		Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
4-25	--	3,405	11	212	3,049	9	--	1,646	9	79	1,093
4-26	--	3,245	2	144	4,319	14	--	--	--	--	--
4-27	--	2,215	--	181	2,664	5	--	719	--	58	522
4-28	--	1,714	1	192	2,013	7	--	--	--	--	--
4-29	--	2,000	--	--	3,000	--	--	--	--	--	--
4-30	--	2,272	11	339	3,983	45	--	--	--	--	--
5-1	--	2,646	5	446	3,180	31	--	547	--	148	648
5-2	--	2,707	--	319	3,461	--	--	852	--	199	194
5-3	--	4,408	--	497	4,320	20	--	1,151	--	105	1,607
5-4	--	4,645	--	698	4,147	13	--	1,152	--	250	1,138
5-5	--	6,603	5	811	2,996	--	--	5,514	5	809	1,769
5-6	--	8,438	36	859	2,602	--	--	--	--	--	--
5-7	--	11,642	49	1,186	3,590	38	--	--	--	--	--
5-8	--	14,680	62	1,495	4,526	--	--	--	--	--	--
5-9	--	17,226	73	1,754	5,311	--	--	--	--	--	--
5-10	--	12,807	62	1,386	6,433	8	--	--	--	--	--

Appendix Table 1.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead counted, observed as mortalities in collection, and returned to Columbia River, by date at McNary Dam, 1979.

Date	Counted					Mortality in collection	Returned to river				
	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead		Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
5-11	--	15,312	74	1,657	7,693	62	--	2,038	41	481	810
5-12	--	15,015	75	2,759	7,010	--	--	6,213	3	634	1,023
5-13	--	12,447	164	2,231	5,630	--	--	--	--	--	--
5-14	--	14,192	187	2,544	6,419	26	--	2,595	70	393	997
5-15	--	16,348	137	1,328	5,083	49	--	--	--	--	--
5-16	--	16,036	1,133	2,163	4,145	44	--	3,787	255	643	309
5-17	--	14,545	445	4,501	5,244	--	--	5,325	64	2,898	2,407
5-18	--	16,121	1,816	5,665	7,701	53	--	13,672	1,074	6,609	3,042
5-19	--	16,588	1,888	13,335	8,355	484	--	5,083	1,047	1,770	978
5-20	--	15,267	380	19,443	7,086	687	--	--	--	--	--
5-21	--	14,782	661	14,781	13,899	1,211	--	--	--	--	--
5-22	--	12,250	549	12,249	11,519	118	--	--	--	--	--
5-23	--	11,813	2,173	13,612	6,348	78	--	2,539	61	213	529
5-24	--	11,066	3,578	8,313	4,569	438	--	--	--	--	--
5-25	--	19,940	10,744	12,094	7,196	111	--	3,135	212	196	505
5-26	--	15,656	21,032	9,225	6,800	13	--	--	--	--	--
5-27	--	10,657	14,318	6,280	4,629	1,003	--	--	--	--	--

Appendix Table 1.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead counted, observed as mortalities in collection, and returned to Columbia River, by date at McNary Dam, 1979.

Date	Counted					Mortality in collection	Returned to river				
	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead		Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
5-28	--	6,882	9,993	4,555	3,062	446	--	--	--	--	--
5-29	--	10,447	4,811	8,710	4,497	99	--	2,986	332	260	789
5-30	--	7,760	4,840	8,558	3,792	266	--	901	37	319	316
5-31	502	7,327	3,519	10,201	3,953	215	53	904	68	307	271
6-1	515	5,307	2,226	6,898	3,303	202	141	764	72	314	195
6-2	216	3,512	1,426	4,418	2,115	--	--	--	--	--	--
6-3	228	3,716	842	3,280	896	115	--	--	--	--	--
6-4	267	4,340	984	3,831	1,046	129	74	397	22	70	259
6-5	330	2,307	325	2,495	925	81	--	--	--	--	--
6-6	377	2,523	379	3,947	1,014	144	65	391	22	709	45
6-7	648	2,296	339	4,808	830	322	88	494	29	557	92
6-8	1,496	1,906	343	4,681	843	88	446	617	36	1,152	124
6-9	1,880	2,827	269	2,496	452	--	--	--	--	--	--
6-10	1,536	2,310	220	2,039	369	95	--	--	--	--	--
6-11	993	1,494	142	1,318	238	30	--	--	--	--	--
6-12	713	573	67	904	319	5	364	127	16	271	116

Appendix Table 1.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead counted, observed as mortalities in collection, and returned to Columbia River, bv date at McNary Dam, 1979.

	Counted					Mortality in	Returned to river				
Date	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead	collection	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
6-13	764	881	85	1,096	226	6	407	377	4	371	13
6-14	1,907	1,219	103	1,507	172	18	--	--	--	--	--
6-15	4,182	633	159	2,321	265	--	--	--	--	--	--
6-16	5,401	818	122	1,165	107	220	--	--	--	--	--
6-17	5,178	784	117	1,116	102	132	--	--	--	--	--
6-18	5,874	889	132	1,267	116	2	6,178	606	3	747	--
6-19	7,986	535	107	1,026	117	14	1,930	91	2	79	24
6-20	3,832	453	54	516	59	--	--	--	--	--	--
6-21	5,016	594	55	1,110	82	117	1,923	179	--	133	--
6-22	5,241	477	45	587	103	56	1,784	93	5	62	36
6-23	5,827	234	39	317	52	50	--	--	--	--	--
6-24	4,546	182	30	247	40	--	--	--	--	--	--
6-25	3,650	147	24	198	32	46	2,037	92	3	59	22
6-26	5,618	120	30	167	30	50	2,224	42	2	30	7
6-27	5,524	112	23	158	23	51	2,162	39	4	31	--
6-28	6,288	145	27	263	27	132	1,951	32	4	68	--

Appendix Table 1.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead counted, observed as mortalities in collection, and returned to Columbia River, by date at McNary Dam, 1979.

Date	Counted					Mortality in collection	Returned to river				
	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead		Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
6-29	7,964	245	61	437	35	158	1,904	65	5	77	--
6-30	4,657	215	21	450	16	12	--	--	--	--	--
7-1	1,552	72	7	150	5	--	--	--	--	--	--
7-2	967	45	4	93	3	--	3,142	139	--	205	--
7-3	3,725	95	12	228	8	100	3,087	87	1	128	--
7-4	7,944	119	8	156	8	32	--	--	--	--	--
7-5	2,937	44	3	58	3	97	5,688	47	--	39	--
7-6	10,398	87	11	32	11	--	3,079	--	--	--	--
7-7	6,177	72	--	31	--	--	--	--	--	--	--
7-8	2,898	34	--	15	--	46	--	--	--	--	--
7-9	1,974	23	--	10	--	26	6,283	--	--	--	--
7-10	10,139	95	--	21	--	28	3,003	--	--	--	--
7-11	8,316	75	8	34	8	17	3,096	--	--	--	--
7-12	3,456	21	--	17	3	10	3,016	--	--	--	--
7-13	1,775	36	4	24	6	--	1,606	--	--	--	--

Appendix Table 1.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead counted, observed as mortalities in collection, and returned to Columbia River, by date at McNary Dam, 1979.

Date	Counted					Mortality in collection	Returned to river				
	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead		Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
7-14	826	15	--	12	--	--	--	--	--	--	--
7-15	1,370	25	--	20	--	--	--	--	--	--	--
7-16	916	17	--	13	--	139	2,045	--	--	--	--
7-17	19,125	15	--	--	--	72	6,236	--	--	--	--
7-18	18,214	--	--	--	--	200	18,214	--	--	--	--
7-24	34,899	31	--	70	--	148	4,071	--	--	--	--
7-25	35,773	59	--	--	--	374	7,163	--	--	--	--
7-26	35,559	139	--	143	--	483	4,143	--	--	--	--
7-27	61,208	52	--	184	--	605	4,069	--	--	--	--
7-28	44,287	26	--	133	--	280	--	--	--	--	--
7-29	20,026	12	--	60	--	52	--	--	--	--	--
7-30	3,838	1	--	19	--	159	3,178	--	--	--	--
7-31	17,798	21	--	--	--	199	5,057	--	--	--	--
8-1	25,165	18	--	--	--	696	5,172	--	--	--	--
8-2	25,633	34	--	51	--	385	5,103	--	--	--	--
8-3	19,759	10	--	40	--	55	5,024	--	--	--	--

Appendix Table 1.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead counted, observed as mortalities in collection, and returned to Columbia River, by date at McNary Dam, 1979.

Date	Counted					Mortality in collection	Returned to river				
	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead		Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
8-4	7,558	2	--	23	--	27	--	--	--	--	--
8-5	5,016	1	--	15	--	12	--	--	--	--	--
8-6	2,221	1	--	7	--	66	6,484	--	--	--	--
8-7	1,947	1	--	--	--	--	--	--	--	--	--
8-8	7,043	3	--	--	--	447	3,627	--	--	--	--
8-9	7,245	--	--	--	--	--	--	--	--	--	--
8-10	6,470	--	--	--	--	350	4,024	--	--	--	--
8-11	12,136	--	--	--	--	--	--	--	--	--	--
8-12	7,995	--	--	--	--	50	--	--	--	--	--
8-13	2,249	--	--	--	--	96	7,441	--	--	--	--
8-14	4,013	--	--	--	--	64	1,059	--	--	--	--
8-15	2,590	--	--	--	--	5	2,481	--	--	--	--
8-16	1,649	--	--	--	--	32	--	--	--	--	--
8-17	1,220	--	--	--	--	6	--	--	--	--	--
8-18	1,205	--	--	--	--	--	--	--	--	--	--
8-19	848	--	--	--	--	--	--	--	--	--	--

Appendix Table 1.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead counted, observed as mortalities in collection, and returned to Columbia River, by date at McNary Dam, 1979.

Date	Counted					Mortality in collection	Returned to river				
	Fall chinook	Spring chinook	Coho	Sockeye	Steelhead		Fall chinook	Spring chinook	Coho	Sockeye	Steelhead
8-20	641	--	--	--	--	8	2,037	--	--	--	--
8-21	744	--	--	--	--	--	--	--	--	--	--
8-22	1,497	--	--	--	--	32	--	--	--	--	--
8-23	1,241	--	--	--	--	26	--	--	--	--	--
8-24	3,075	--	--	--	--	--	2,265	--	--	--	--
Total	604,413	453,859	91,694	231,818	211,423	13,342	154,624	75,156	3,508	21,501	20,411

Appendix Table 2.--Standardized abbreviations adopted by the Pacific Marine Fisheries Commission as codes for color-coded magnetic wire tapes.

Code	Color
BK	Black
BL	Blue
BR	Brown
CY	Chrome Yellow
DG	Dark Green
DR	Dark Red
GD	Gold
GM	Metallic Gray
GN	Green
GY	Gray
LA	Lavender
LB	Light Blue
LG	Light Green
MG	Medium Green
MO	Medium Orange
MX	Mixed
OR	Orange
PK	Pink
PU	Purple
RD	Red
TN	Tan
WH	White
XB	Oxide Brown
XR	Oxide Red
XY	Oxide Yellow
YW	Yellow

Appendix Table 3.--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 4.--Summary of brands and wire tag codes used to identify juvenile salmonids released as controls below McNary Dam, 1979.

Marking period	Position brand and orientation [a/] [b/]	Wire tag code [c/]	Fall chinook salmon	Spring chinook	Coho salmon	Sockeye salmon	Steelhead	Total
4/11-7/3	LA-5, 1	PR	294	19,009	449	4,247	5,449	29,448
5/14-5/31	LA-5, 2	WH-RD-LG-YW	53	10,074	445	1,428	2,618	14,621
6/4-6/21	LA-5, 3	WH-RD-LG-YW	520	1,926	77	2,373	499	5,395
6/25-7/5	LA-5, 4	WH-RD-LG-YW	--	220	9	159	29	417
6/12-6/29	LA-IM, 1	WH-RD-YW-PK	22,864	--	--	--	--	22,864
7/3-7/17	LA-IM, 3	WH-RD-YW-PK	28,694	--	--	--	--	28,694
7/2	LA-IM, 3	WH-RD-PK-OR	(3,142) [d/]					
7/24-8/6	LA-IM, 2	WH-LB-YW-LB	40,398	--	--	--	--	40,398
8/8-8/24	LA-IM, 4	WH-RD-LB-PK	19,895	--	--	--	--	19,895
Total McNary tailrace release			112,718	31,229	983	8,207	8,595	161,732

[a/] Position - LA indicates left-anterior position of brand, RA is right anterior.

[b/] Orientation - Refers to rotation of the brand around its centerpoint e.g. 1 corresponds to the normal orientation, A; 2 to ⋗ ; 3 to V ; 4 to ◁ .

[c/] See Appendix Tables 1 and 2 for wire tag code abbreviations.

[d/] On 7/2/79 a group of fish wire tagged WH-RD-PK-OR was improperly branded LA-IM, 3. The total number of fish branded LA-IM, 3 is 31,836. However, 3,142 of the total were released below Bonneville Dam.

Appendix Table 5.--Summary of brands and wire tag codes used to identify juvenile salmonids released as controls above McNary Dam, 1979.

Marking period	Position brand and orientation [a/] [b/]	Wire tag code [c/]	Fall chinook salmon	Spring chinook salmon	Coho salmon	Sockeye salmon	Steelhead	Total
5/3-5/19	LA-X3, 1	WH-RD-PK-LG	--	14,257	1,806	2,542	6,218	24,823
5/13	LA-X#, 1 [d/]	WH-RD-PK-LG	--	(5,053)	(756)	(322)	(2,054)	(8,195)
5/18-5/29	LA-X3, 3	WH-RD-PK-LG	--	10,393	1,373	2,278	1,913	15,957
7/5-7/16	LA-U⌒, 1	WH-YW-BL-LB	8,445	--	--	--	--	8,445
7/25-8/13	LA-U⌒, 3	WH-YW-BL-LB	11,365	--	--	--	--	11,365
Total McNary forebay release			19,810	24,650	3,179	4,820	8,131	60,590

[a/] Position - LA indicates left-anterior position of brand, RA is right anterior.

[b/] Orientation - Refers to rotation of the brand around its centerpoint e.g. 1 corresponds to the normal orientation, A; 2 to ⋗; 3 to ∀; 4 to ⋖.

[c/] See Appendix Table 2 for color code abbreviations.

[d/] The group of fish marked on 5/13/79 were inadvertenly loaded into a barge traveling downstream. Totals do not include the inadvertenly barged group.

Appendix Table 6.--Summary of brands and wire tag codes used to identify juvenile salmonids transported by barge from McNary Dam to below Bonneville Dam, 1979.

Marking period	Position brand and orientation [a/] [b/]	Wire tag code [c/]	Spring chinook salmon	Coho salmon	Sockeye salmon	Steelhead	Total
4/25-5/4	RA-R, 1	WH-RD-YW-LG	7,661	2	462	6,136	17,261
5/8-5/16	RA-R, 2	WH-RD-YW-LG	18,363	245	1,337	5,812	25,757
5/20-5/22	RA-R, 3	WH-RD-YW-LG	9,085	1.039	2,597	4,857	17,578
5/25	RA-R, 4	WH-RD-YW-PK	5,017	340	400	1,377	7,134
Total			40,126	1,626	4,796	18,182	64,730

[a/] Position - LA indicates left-anterior position of brand, RA is right anterior

[b/] Orientation - Refers to rotation of the brand around its centerpoint e.g. 1 corresponds to the normal orientation, A; 2 to ⋗; 3 to ∀; 4 to ◅ .

[c/] See Appendix Table 2 for wire tag color code abbreviation.

Appendix Table 7.--Summary of brands and wire tag codes used to identify juvenile salmonids, transported by truck from McNary Dam to below Bonneville Dam, 1979.

Marking period	Position brand and orientation [a/] [b/]	Wire tag code [c/]	Fall chinook salmon	Spring chinook salmon	Coho salmon	Sockeye salmon	Steelhead	Total
4/16-7/2	RA-3, 1	SM	679	23,176	472	3,914	9,224	37,465
5/14-5/31	RA-3, 2	WH-RD-LG-PK	296	10,118	593	637	4,915	16,559
6/4-6/21	RA-3, 3	WH-RD-LG-PK	3,114	8,911	268	4,637	1,232	18,162
6/25-7/6	RA-3, 4	WH-RD-LG-PK	--	543	10	413	8	974
6/12-6/29	RA-I+, 4	WH-RD-PK-LB	43,482	--	--	--	--	43,482
7/2-7/17	RA-I+, 3	WH-RD-PK-OR	22,478	--	--	--	--	22,478
7/2	LA-IM, 3	WH-RD-PK-OR	3,142 [d/]	--	--	--	--	3,142
7/24-8/6	RA-I+, 2	WH-LB-YW-LG	41,195	--	--	--	--	41,195
8/8-8/24	RA-I+, 4	WH-RD-LB-Yw	18,533	--	--	--	--	18,533
Total			132,919	42,748	1,343	9.601	15,379	201,990

[a/] Position - LA indicates left-anterior of brand, RA is right anterior.

[b/] Orientation - Refers to rotation of the brand around its centerpoint e.g. 1 corresponds to the normal orientation, A; 2 to ⋗; 3 to ∀; 4 to ◅.

[c/] See Appendix Tables 1 and 2 for wire tag code abbreviations.

[d/] On 7/2/79 a group of fish was improperly branded LA-IM, 3 with wire tag WH-RD-PK-OR. The total number of fish tagged WH-RD-PK-OR is 25,620.

Appendix Table 8.--Number of juvenile spring chinook, coho, and sockeye salmon and steelhead transported by barge from McNary Dam to below Bonneville Dam, 1979.

Date	Spring chinook		Coho		Sockeye		Steelhead		Daily Total Barged
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
4/24	2,540	1,699	1	--	22	114	453	267	5,096
4/29	1.034	679	--	1	95	95	771	1,238	3,913
5/1	2,015	2,233	1	10	119	214	2,726	4,242	11,560
5/4	2,072	2,321	--	--	226	271	2,186	2,129	9,205
5/8	6,522	28,934	60	60	546	3,082	2,558	9,864	51,626
5/11	4,270	23,183	62	81	355	2,614	2,480	11,310	44,355
5/13	--	5,262	--	756	--	323	--	2,163	8,504
5/16	7,571	7,428	123	25	436	901	774	3,436	20,694
5/20	3,392	12,206	955	899	2,582	12,403	1,530	8,487	42,470
5/22	5,693	36,712	84	1,805	15	47,288	3,327	20,555	115,479
5/25	5,017	9,649	340	6,420	400	8,166	1,377	5,364	36,733
5/28	--	29,758	--	43,208	--	19,698	--	13,238	105,902
6/2	--	1,906	--	729	--	2,258	--	1,081	5,974
Total	40,126	161,970	1,626	53,994	4,796	97,433	18,182	83,384	461,511

Appendix Table 9.--Number of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead transported by truck from McNary Dam to below Bonneville Dam, 1979.

Date	Fall chinook		Spring chinook		Coho		Sockeye		Steelhead		Daily Total Trucked
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
4-16	--	--	4,917	4,213	1	--	15	15	491	31	9,683
4-19	--	--	845	2,018	--	1	7	14	145	5	3,035
4-20	--	--	680	585	--	--	11	22	110	17	1,425
4-24	--	--	938	665	4	--	38	83	450	688	2,866
4-26	--	--	1,741	3,253	--	1	61	216	1,585	4,680	11,537
4-27	--	--	594	898	--	--	24	99	447	1,694	3,756
5-1	--	--	635	1,447	--	5	40	253	587	1,936	4,930
5-4	--	--	924	2,568	--	--	41	407	856	2,141	6,937
5-11	--	--	3,443	8,349	29	7	523	1,551	2,010	3,653	19,565
5-13	--	--	--	14,277	--	188	--	2,559	--	6,457	23,481
5-14	--	--	3,762	9,791	42	38	51	1,286	961	4,286	20,217
5-16	--	--	3,958	6,397	247	123	263	1,530	764	3,326	16,608
5-22	--	--	800	1,484	8	146	102	1,200	608	828	5,176
5-23	--	--	1,664	7.067	93	2,776	78	10,830	481	4,208	27,197
5-25	--	--	1,435	11,127	183	9,884	38	9,584	858	3,551	36,660
5-29	--	--	802	5,425	95	2,564	72	8,735	943	3,126	21,762
5-30	--	--	1,562	4,260	100	2,627	145	8,789	756	2,406	20,645
5-31	296	1	893	3,273	80	2,036	253	6,317	916	1,962	16,027
6-1	295	3	850	2,885	66	1,440	150	5,018	782	1,371	12,860
6-4	387	--	2,124	4,240	108	1,335	393	5,224	458	1,079	15,348
6-5	312	--	1,091	1,813	82	394	1,009	2,526	187	714	8,128
6-6	223	--	883	1,112	46	255	1,062	3,306	135	554	7,526
6-7	161	--	432	852	29	193	234	1,523	155	397	3,976

Appendix Table 9.--continued--Number of juvenile fall chinook, spring chinook, coho and sockeye salmon and steelhead transported by truck from McNary Dam to below Bonneville Dam, 1979.

Date	Fall chinook		Spring chinook		Coho		Sockeye		Steelhead		Daily Total Trucked
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
6-8	643	636	586	993	22	270	546	3,397	229	502	7,824
6-11	1,772	1,590	3,518	1,525	35	390	1,234	2,721	217	477	13,479
6-12	270	285	205	409	8	75	237	587	102	119	2,297
6-14	2,310	614	1,022	1,017	27	144	499	1,472	99	246	7,450
6-18	6,891	817	701	450	10	157	661	769	7	70	10,533
6-19	4,387	1,938	155	729	1	243	281	1,522	--	166	9,422
6-21	7,513	1,352	686	398	3	119	557	1,699	32	149	12,508
6-22	2,277	715	150	187	--	37	120	344	--	56	3,886
6-25	8,592	1,676	430	239	8	72	304	308	8	77	11,714
6-26	1,839	1,210	27	44	1	27	50	76	--	14	3,288
6-27	2,719	2,138	54	49	1	21	52	116	--	32	5,182
6-28	2,638	2,077	93	28	4	22	136	78	--	25	5,101
6-29	4,046	1,731	122	49	10	46	200	137	--	30	6,371
7-2	902	1,180	44	58	--	24	107	190	--	18	2,523
7-6	3,298	7,808	32	143	--	31	7	249	--	26	11,594
7-9	2,851	2,949	--	141	--	4	--	58	--	8	6,011
7-10	3,075	3,732	--	92	--	5	--	18	--	2	6,924
7-11	3,195	754	--	63	--	5	--	28	--	5	4,050
7-12	3,141	688	--	42	--	--	--	38	--	5	3,914
7-17	6,016	4,642	--	81	--	4	--	62	--	6	10,811
7-24	4,093	51,419	--	59	--	1	--	120	--	1	55,693
7-25	4,144	11,117	--	20	--	1	--	18	--	--	15,300
7-26	4,072	31,265	--	--	--	--	--	126	--	--	35,463

Appendix Table 9.--continued--Number of juvenile fall chinook, spring chinook, coho and sockeye salmon and steelhead transported by truck from McNary Dam to below Bonneville Dam, 1979.

Date	Fall chinook		Spring chinook		Coho		Sockeye		Steelhead		Daily Total Trucked
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
7-27	4,041	65,558	--	44	--	--	--	251	--	4	69,898
7-28	--	42,451	--	--	--	--	--	128	--	--	42,579
7-29	--	7,453	--	--	--	--	--	22	--	--	7,475
7-31	5,036	13,350	--	16	--	1	--	22	--	4	18,429
8-1	5,187	13,698	--	8	--	1	--	8	--	7	18,909
8-2	5,085	16,194	--	15	--	--	--	53	--	5	21,352
8-3	5,118	9,005	--	6	--	--	--	32	--	3	14,164
8-6	4,419	450	--	3	--	1	--	32	--	1	4,906
8-8	3,260	221	--	3	--	--	--	12	--	--	3,496
8-10	4,048	5,443	--	--	--	--	--	10	--	--	9,501
8-14	6,121	10,855	--	--	--	--	--	50	--	--	17,026
8-17	3,113	490	--	--	--	--	--	14	--	--	3,617
8-24	1,991	1,605	--	--	--	--	--	5	--	--	3,601
Total	129,777	319,110	42,748	104,910	1,343	25,714	9,601	85,859	15,379	51,168	785,609

Appendix Table 10.--Date, test condition, transport system water quality data, delayed mortality, and tag loss of marked juvenile chinook salmon, sockeye salmon, and steelhead after transport from McNary Dam to Bonneville Dam, 1979.

Date	Test cond. [a/]	Water quality				Delayed mortality and tag loss								
						marked chinook salmon			marked sockeye salmon			marked steelhead		
		Temp. (°C)	O_2 (ppm)	CO_2 (ppm)	pH	No. held	% mort	Tag loss(%)	No. held	% mort.	Tag loss(%)	No. held	% mort.	Tag loss (%)
4-16	1	6.7	17.8	6.7	7.5	127	23.6	--	--	--	--	11	9.1	--
4-19	1	8.0	33.8	2.7	7.6	103	36.9	--	--	--	--	2	0.0	--
4-20	1	6.7	39.4	2.2	7.6	90	30.0	--	--	--	--	6	0.0	--
4-24	1	6.7	30.1	2.5	7.5	74	9.4	--	--	--	--	35	11.4	--
4-24	2	10.0	13.2	1.5	7.6	49	6.1	--	--	--	--	34	2.9	--
4-26	1	10.1	33.1	10.5	7.3	98	8.1	--	--	--	--	46	8.7	--
4-27	1	10.5	29.0	4.0	7.6	72	20.8	--	--	--	--	26	3.8	--
4-29	2	11.1	10.7	1.2	7.9	83	10.8	--	--	--	--	--	--	--
5-1	1	10.5	--	2.0	7.4	56	28.6	--	--	--	--	43	2.3	--
5-1	2	10.5	10.4	1.2	7.6	49	4.1	--	--	--	--	7	0.0	--
5-4	1	11.1	18.9	3.0	7.2	101	26.7	--	--	--	--	86	2.3	--
5-4	2	12.2	10.4	1.5	7.7	160	2.5	--	--	--	--	56	0.0	--
5-9	2	12.2	9.2	1.2	7.4	67	1.4	--	--	--	--	88	1.1	--
5-11	1	11.1	24.1	11.0	6.8	150	8.7	--	--	--	--	15	0.0	--
5-11	2	12.0	9.6	1.1	7.3	28	0.0	--	--	--	--	14	0.0	--
5-13	2	13.5	10.3	1.7	7.6	36	8.3	--	--	--	--	29	0.0	--
5-13	1	12.2	27.6	13.0	6.7	118	11.9	--	--	--	--	32	0.0	--
5-14	1	12.2	18.7	10.0	6.7	96	33.3	--	--	--	--	68	7.0	--
5-16	1	12.8	26.2	8.5	6.6	157	17.8	--	--	--	--	16	6.2	--
5-16	2	13.8	9.4	2.5	7.3	57	1.7	--	--	--	--	15	0.0	--
5-20	2	14.0	9.6	1.0	7.2	109	2.7	--	--	--	--	14	0.0	--
5-22	1	12.2	30.4	5.0	7.1	57	49.1	--	--	--	--	39	2.6	--
5-23	2	14.8	10.2	1.5	7.7	9	0.0	--	--	--	--	17	0.0	--
5-23	1	13.8	21.0	6.5	6.9	89	19.1	--	--	--	--	21	0.0	--
5-25	1	12.8	28.3	14.0	6.9	16	6.2	--	--	--	--	10	10.0	--
5-25	2	15.4	9.9	2.0	7.3	9	0.0	--	--	--	--	54	0.0	--
5-28	2	14.4	9.4	1.5	7.1	--	--	--	--	--	--	13	0.0	--
5-29	1	13.9	22.0	6.1	6.7	14	35.7	--	--	--	--	4	0.0	--
5-30	1	13.9	18.1	6.2	6.5	99	20.2	--	8	37.5	--	36	5.5	--
5-31	1	13.3	25.5	5.5	6.7	92	46.7	--	26	57.7	--	43	4.6	--
6-1	1	13.3	24.5	3.7	6.8	76	40.8	--	13	76.9	--	32	6.2	--

a/ = Test Conditions

1 - Transported by truck in fresh water (traditional manner).

2 - Transported by barge in fresh water.

Appendix Table 10.--continued--Date, test condition, transport system water quality data, delayed mortality, and tag loss of marked juvenile chinook salmon, sockeye salmon, and steelhead after transport from McNary Dam to Bonneville Dam, 1979.

Date	Test cond. [a/]	Water quality				Delayed mortality and tag loss								
						marked chinook salmon			marked sockeye salmon			marked steelhead		
		Temp. (°C)	O_2 (ppm)	CO_2 (ppm)	pH	No. held	% mort	Tag loss(%)	No. held	% mort.	Tag loss(%)	No. held	% mort.	Tag loss(%)
6-4	1	13.9	24.6	3.0	6.8	146	13.7	--	14	14.3	--	22	4.5	--
6-5	1	15.0	16.1	2.1	6.8	87	10.3	0.0	100	55.0	0.0	10	0.0	0.0
6-6	1	15.2	28.6	3.5	6.9	103	19.4	0.0	116	53.4	0.0	9	0.0	0.0
6-7	1	15.2	28.7	2.7	6.6	74	23.0	0.0	56	67.8	0.0	13	0.0	0.0
6-8	1	15.2	26.8	3.5	6.8	131	10.7	0.0	58	43.1	0.0	6	0.0	0.0
6-11	1	15.0	24.7	2.5	6.9	151	7.9	1.5	124	28.2	1.1	--	--	--
6-12	1	16.1	19.5	2.0	6.9	46	9.2	0.0	35	45.7	0.0	--	--	--
6-14	1	16.1	22.4	1.7	7.0	215	21.4	--	19	10.5	--	--	--	--
6-18	1	16.7	24.1	1.7	7.0	167	10.8	1.3	22	27.3	18.7	--	--	--
6-19	1	16.7	24.7	2.0	7.0	161	14.3	0.0	8	0.0	0.0	--	--	--
6-21	1	16.7	26.4	2.3	7.0	228	12.3	0.0	--	--	--	--	--	--
6-25	1	16.1	24.5	6.0	6.7	179	4.5	1.7	--	--	--	--	--	--
6-26	1	16.7	30.1	1.9	6.9	179	14.5	--	--	--	--	--	--	--
6-27	1	16.7	30.2	2.1	6.8	94	19.1	2.6	--	--	--	--	--	--
6-28	1	16.7	25.1	1.8	6.8	105	11.4	3.2	--	--	--	--	--	--
6-29	1	17.2	24.2	--	--	154	14.9	0.8	--	--	--	--	--	--
7-2	1	17.8	23.6	2.0	6.9	--	--	--	--	--	--	--	--	--
7-6	1	15.0	26.3	4.0	7.1	151	9.3	--	--	--	--	--	--	--
7-9	1	19.4	25.2	2.8	6.5	171	3.5	1.8	--	--	--	--	--	--
7-10	1	19.4	23.8	3.5	6.5	141	13.5	0.8	--	--	--	--	--	--
7-11	1	19.4	23.5	2.5	6.4	108	12.0	2.1	--	--	--	--	--	--
7-12	1	19.4	23.2	2.5	6.6	117	5.1	0.0	--	--	--	--	--	--
7-17	1	--	24.4	8.0	6.3	227	5.3	0.0	--	--	--	--	--	--
7-24	1	21.1	19.8	19.5	6.1	144	20.1	0.8	--	--	--	--	--	--
7-25	1	21.1	20.6	4.7	6.2	150	22.0	0.0	--	--	--	--	--	--
7-31	1	20.0	20.9	10.0	6.5	243	13.2	0.0	--	--	--	--	--	--
8-1	1	20.0	21.0	6.5	6.1	194	7.2	0.5	--	--	--	--	--	--
8-2	1	20.0	17.7	9.0	6.8	174	6.9	0.0	--	--	--	--	--	--
8-6	1	20.0	24.9	2.0	--	188	5.6	3.9	--	--	--	--	--	--

a/ = Test Conditions
1 - Transported by truck in fresh water (traditional manner).
2 - Transported by barge in fresh water.

Appendix Table 11.--Preliminary returns (1979 recoveries) of 1-ocean age chinook salmon to the combined commercial and sport fisheries and Columbia and Snake River collector sites from control and transport releases of smolts from McNary Dam in 1978.

Release site and experimental groups	Number of smolts released	Adult recovery			Total	% of smolt release	% transport benefit
		Commercial	Sport fishery	River-site collectors			
Control							
Spring Chinook	31,376	1	0	1	2	0.006	--
Fall Chinook	38,137	2	1	11	14	0.037	--
Bonneville							
(Truck transport)							
Spring Chinook	31,854	5	0	3	8	0.025	+317
Fall Chinook	40,267	9	3	90	102	0.253	+584
Total							
Spring Chinook	63,230	6	0	4	10		
Fall Chinook	78,404	11	4	101	116		

Appendix Table 12.--Preliminary returns of jack and adult coho salmon to the combined commercial and sports fisheries and Columbia River collector sites from control and transport releases of smolts from McNary Dam in 1978. Recoveries were made from 16 July 1978 to 14 November 1979.

Release site and experimental groups	Number of smolts released	Recoveries					% of smolt release	Transport benefit (%)
		Commercial & sport fishery		River site Collectors[a]				
		Jacks	Adults	Jacks	Adult	Total		
Control	21,767	5	72	6	3	86	0.395	--
Bonneville								
Truck transport	22,065	29	142	8	13	192	0.870	+120
Total	43,832	34	214	14	16	278		

[a] Coho salmon were collected at Bonneville and McNary Dams.

Appendix Table 13.--Preliminary returns of 1-ocean age steelhead from control and transport releases of smolts from McNary Dam in 1978. Recoveries were made at Bonneville, McNary and Lower Granite Dams from 2 July to 3 December 1979.

Release site and experimental group	Number smolts released	Number of adults recovered			Total	% of smolt release
		Bonneville Dam	McNary Dam	Lower Granite Dam		
Control	15,585	5	9	20	34	0.218
Bonneville Truck transport	20,416	16	18	106	140	0.686
Total	36,001	21	27	126	174	

Appendix Table 14.--Returns to Lower Granite Dam of 1-, 2-, and 3-ocean age chinook salmon from control and transport releases of smolts from Lower Granite Dam in 1976. Recoveries were made from 2 July 1977 to 29 August 1979.

Release site and experimental groups	No. of juveniles released [a]	No. of adults recaptured				Adult return as % of juveniles released		Transport benefits [c] (%)
		1-ocean age	2-Ocean age	3-ocean age	Total 1 & 3's	Observed	Estimated [b]	
Control [d]	21,711	2	7	0	9	0.041	0.118	--
Bonneville boat ramp								
Freshwater transport	47,507	2	5	0	7	0.015	0.042	-63
Saltwater transport [e]	45,476	2	9	3	14	0.031	0.114	-24
Control [c]	2,847	0	1	0	1	0.035	0.100	--
Bonneville powerhouse [f]								
Freshwater transport	25,411	0	8	1	9	0.035	0.117	0
Saltwater transport [e]	15,970	1	8	3	12	0.075	0.289	+114
Total	158,922	7	38	7	52			

[a] Adjusted for initial tag loss.

[b] Based on comparison of known recovery of fish with magnetized wire tags at Little Goose and Lower Granite Dams and the subsequent recovery of these and other marked fish at Rapid River Hatchery and on spawning ground 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 up-river sites were compared with the recovery of other wire tagged fish arriving at up-river sites not previously detected and identified at Little Goose or Lower Granite Dams. Expansion factors for each ocean age group were: 1-ocean, 2.78; 2-ocean, 2.86; 3-ocean, 6.85.

[c] Based on observed return.

[d] Adjusted for control fish which were transported in the mass transport program at Little Goose & Lower Granite Dams.

[e] 5 ppt salt water at Lower Granite Dam.

[f] In early May 1976, the Bonneville boat ramp could no longer be used due to construction activity. Thereafter, the Bonneville powerhouse site was used.

Appendix Table 15.--Returns to Lower Granite Dam of 1-,2-, and 3-ocean age chinook salmon from control and transport releases of smolts from Little Goose Dam in 1976. Recoveries were made from 2 July 1977 to 29 August 1979.

Release site and 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[d]	27,315	1	4	2	7	0.026	0.102	--
Bonneville boat ramp								
Freshwater transport	36,239	3	6	0	9	0.025	0.070	- 4
Saltwater transport[e]	46,244	2	6	2	10	0.022	0.079	-15
Control[d]	12,255	0	1	0	1	0.008	0.023	--
Bonneville powerhouse[f]								
Freshwater transport	32,366	4	8	4	16	0.049	0.190	+513
Saltwater transport[e]	35,838	0	10	1	11	0.031	0.099	+288
Total	190,257	10	35	9	54			

a/ Adjusted for initial tag loss.

b/ Based on comparison of known recovery of fish with magnetized wire tags at Little Goose and Lower Granite Dams and the subsequent recovery of these and other marked fish at Rapid River Hatchery and on spawning ground 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 up-river sites were compared with the recovery of other wire tagged fish arriving at up-river sites not previously detected and identified at Little Goose or Lower Granite Dams. Expansion factors for each ocean age group were: 1-ocean, 2.78; 2-ocean, 2.86; 3-ocean, 6.85.

c/ Based on observed return.

d/ Adjusted for control fish which were transported in the mass transport program at Little Goose Dam.

e/ 10 ppt salt water at Little Goose Dam.

f/ In early May 1976, the Bonneville boat ramp site could no longer be used due to construction activity. Thereafter, the Bonneville powerhouse site was used.

Appendix Table 16.--Returns to Lower Granite Dam of 1-, and 2-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 29 August 1979 .

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

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

Appendix Table 17.--Returns in 1978 to Lower Granite Dam of 1-ocean age chinook salmon from control and transport releases of smolts from Lower Granite and Little Goose Dams in 1978.

Experimental group	Number adults returning
Little Goose controls	0
Little Goose transport	1
Lower Granite control	2
Lower Granite transport	12
Unknown control[a/]	1
Unknown transport[a/]	12
Total	28

a/ Unknown fish had garbled brands and therefore, could have been from experimental group of either Lower Granite, Little Goose, or McNary Dam releases.

Appendix Table 18.--Recovery of adult chinook salmon in 1979 at Kooskia and Rapid River Hatcheries that were tagged as juveniles and transported and released below Bonneville Dam or released as controls from Lower Granite, Little Goose, and McNary Dams (1976-1978).

Originating dam and year of release	Test condition	Number jaw tag[a] & wire tag	Number wire tag only	Total
Kooskia Hatchery				
Lower Granite 1976	Control	0	1	1
Little Goose 1976	Control	0	1	1
Lower Granite 1976	Transport	0	1	1
Little Goose 1976	Transport	0	2	2
Lower Granite 1977	Transport	0	1	1
Subtotals		0	6	6
Rapid River Hatchery				
Lower Granite 1976	Control	0	1	1
Lower Granite 1976	Transport	1	17	18
Little Goose 1976	Transport	1	1	2
Lower Granite 1977	Transport	1	12	13
Little Goose 1977	Transport	1	3	4
Lower Granite 1978	Transport	1	6	7
Lower Granite 1978	Control	1	1	2
McNary 1978	Transport	1	0	1
Subtotals		7	41	48
Totals		7	47	54

a/ Jaw tags were applied to adults at the Snake River adult collector (Lower Granite) to indicate that the fish had been intercepted at that point and appropriate data for each fish noted.

Appendix Table 19.--Returns to Lower Granite Dam of 1-, 2-, and 3-ocean age adult steelhead from control and transport releases of smolts from Lower Granite Dam in 1976. Recoveries were made from 28 May 1977 to 3 December 1979.

Release site and experimental groups	No. of juveniles released[a]	No. of adults recaptured				Adult return in % of juveniles released		Transport benefits[c] (%)
		1-ocean age	2-ocean age	3-ocean age	Total 1 & 2 & 3's	Observed	Estimated[b]	
Control[d]	16,791	31	25	0	56	0.334	1.526	---
Bonneville boat ramp								
Freshwater transport	7,304	19	8	0	27	0.370	1.691	+11
Saltwater transport[e]	16,504	33	8	2	43	0.261	1.193	-22
Control[d]	17,114	33	14	1	48	0.280	1.280	---
Bonneville powerhouse[f]								
Freshwater transport	47,392	128	150	3	281	0.593	2.710	+112
Saltwater transport[e]	52,641	157	115	3	275	0.522	2.386	+86
Total	157,746	401	320	9	730			

a/ 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 is: 4.57 for Lower Granite Dam smolt releases.

c/ Based on observed return.

d/ Adjusted for control fish which were transported in the mass transport program at Lower Granite Dam.

e/ 5 ppt salt water at Lower Granite Dam.

f/ In early May 1976, the Bonneville boat ramp site could no longer be used due to construction activity. Thereafter, the Bonneville powerhouse site was used.

Appendix Table 20.--Returns to Lower Granite Dam of 1-, 2-, and 3-ocean age adult steelhead from control and transport releases of smolts from Little Goose Dam in 1976. Recoveries were made from 28 May 1977 to 3 December 1979.

Release site and 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[d/]	7,135	8	7	0	15	0.210	0.357	---
Bonneville boat ramp								
Freshwater transport	10,666	86	76	3	165	1.547	2.630	+637
Saltwater transport [e/]	11,677	81	92	2	175	1.499	2.548	+614
Control[d/]	22,279	33	41	0	74	0.332	0.564	---
Bonneville powerhouse[f/]								
Freshwater transport	32,621	139	185	8	332	1.018	1.731	+207
Saltwater transport[e/]	42,197	222	236	6	464	1.100	1.870	+231
Total	126,575	569	637	19	1,225			

a/ 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 factor is: 1.70 for Little Goose Dam smolt releases.

c/ Based on observed return.

d/ Adjusted for control fish which were transported in the mass transport program at Little Goose Dam.

e/ 10 ppt saltwater at Little Goose Dam.

f/ In early May 1976, the Bonneville boat ramp site could no longer be used due to construction activity. Thereafter, the Bonneville powerhouse site was used.

Appendix Table 21.--Preliminary returns to Lower Granite Dam of 1-, 2-ocean age steelhead from control and transport releases of smolts from Lower Granite and Little Goose Dams in 1977. Recoveries were made from 2 July 1978 to 3 December 1979.

Release site & 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	22,204	0	3	3	0.014	--	33,152	10	29	39	0.118	--
Bonneville												
Freshwater transport	24,272	6	19	25	0.103	+636						
Saltwater transport[d]	22,916	6	23	29	0.127	+807	42,777[e]	31	44	75	0.175	+1079
Dalton Point Saltwater transport[d]							40,899	31	64	95	0.232	+1557
Bonneville Barge transport							30,330	27	26	53	0.175	+1150
Total	69,392	12	45	57			147,158[e]	99	163	262		

a/ Transported fish adjusted for initial tag loss.

b/ Based on observed returns.

c/ The percent return of Lower Granite controls is unrealisticly high due to the fact that many of them were transported in the 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.

e/ The number of fish in this release was reported incorrectly in Table 22 Park et al. (1979).

Appendix Table 22.--Preliminary returns to Lower Granite Dam of 1-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 3 December 1979.

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	No. of adults recaptured	Adult return in % of juveniles released	Transport benefits[c] (%)
Control	30,364	45	0.148	---	55,669	98	0.176	---
Bonneville Barge transport (Fresh water)					43,770	250	0.571	+286
Bonneville Truck transport (Fresh water)	35,875	199	0.555	+275	47,572	286	0.601	+306
Bonneville Truck transport (Salt water)[d]	32,170	186	0.578	+291	---	---	---	---
Total	98,409	430			147,011	634		

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.

Appendix Table 23.--Recovery of adult steelhead at Dworshak Hatchery, Pahsimeroi Hatchery, and Hells Canyon Dam in 1979 that were tagged as juveniles and transported and released below Bonneville Dam or released as controls at Lower Granite or Little Goose Dams (1975 - 1977).

Wire tag code [a]	Dworshak Hatchery		Pahsimeroi Hatchery		Hells Canyon Dam		Total		
	No. with jaw tag & wire tag [b]	No. with wire tag only	No. with jaw tag % wire tag [b]	No. with wire tag only	No. with jaw tag % wire tag [b]	No. with wire tag only	No. with jaw tag % wire tag [b]	No. with wire tag only	% with jaw tag % wire tag
1975 Lower Granite Dam transports									
WH-YW-XY-RD	1	--	--	--	--	--	1	--	100.0
WH-OR-XR	1	--	--	--	--	--	1	--	100.0
Sub-total	2	--	--	--	--	--	2	--	100.0
1976 Little Goose Dam transports									
Yellow Stripe	36	16	8	15	--	--	44	31	58.7
Green Stripe	18	13	11	7	--	--	29	20	59.2
Solid Green	6	7	4	1	--	--	10	8	55.6
Solid Yellow	15	3	4	4	--	--	19	7	73.1
WH-YW-PK-GN	1	1	--	1	--	--	1	2	33.3
Sub-total	76	40	27	28	--	--	103	68	60.2
1976 Little Goose Dam controls									
Pink Stripe	3	1	4	3	1	--	8	4	66.6
WH-PU-YW-RD	2	6	1	1	--	--	3	7	30.0
Sub-total	5	7	5	4	1	--	11	11	50.0
1976 Lower Granite Dam transports									
WH-OR-LA-OR	5	18	9	12	1	--	15	30	33.3
WH-OR-OR-OR	7	18	2	13	1	--	10	31	24.4
WH-OR-BL-LB	--	15	--	1	--	--	--	16	0.0
WH-PU-BR-XR	--	3	1	--	--	--	1	3	25.0
WH-BL	5	8	4	14	--	--	9	22	29.0
WH-OR-GN-LG	2	8	--	--	--	--	2	8	20.0
WH-OR-RD-XR	2	11	--	2	--	--	2	13	13.3
WH-PU-XY-XY	3	3	--	2	--	--	3	5	37.5
WH-XR	4	10	4	17	--	--	8	27	22.9
Sub-total	28	94	20	61	2	--	50	155	24.4
1976 Lower Granite Dam controls									
WH-OR-LG	1	13	1	3	--	--	2	16	11.1
WH-OR-LB	3	14	1	8	--	--	4	22	15.4
Sub-total	4	27	2	11			6	38	

[a] See Appendix Table 2 for color code used on wire tags.
[b] Indicates that each fish bearing a jaw tag had been previously detected at Lower Granite Dam.

Appendix Table 24.--Recovery of steelhead in sport fisheries that were externally tagged (jaw tagged) during their upstream migration at Bonneville, McNary or Lower Granite Dam collector facilities in 1979. Adults were from various test or control groups, 1976-1978.

Transport test area and year	Recovery area					
	Salmon River	Snake River	Clearwater River	Columbia River	Deschutes River	Unknown
Lower Granite Dam						
Transport - 1978	30	1	1	1	1	6
Controls - 1978	5	0	0	0	0	0
Little Goose Dam						
Transport - 1978	9	1	1	0	0	1
Control - 1978	0	0	1	0	0	1
Transport - 1976	1	0	0	0	0	0
Total	45	2	3	1	1	8

Appendix Table 25.--Sport fishery recoveries of 1-ocean age steelhead from juvenile smolt releases marked at McNary Dam in 1978.

Release site, date & experimental groups	Brand	No. of juveniles released	Areas of Recovery: Ringold and Priest Rapids (No.)	Wenatchee River (No.)	Methow River (No.)	Salmon River (No.)	Other (No.)	Total (No.)
McNary Dam								
Control								
4/17 - 5/19	LA-H	9,917	1	1	1	1	0	4
5/22 - 6/12	LA-S	5,668	0	0	0	0	0	0
Sub-total		15,585	1	1	1	1	0	4
Bonneville Dam								
Transport								
4/21 - 5/19	RA-V	12,115	0	6	7	2	2	17
5/22 - 6/08	RA-<	8,670	0	3	2	2	0	7
Sub-total		20,785	0	9	9	4	2	24
Total tagged steelhead recovered			1	10	10	5	2	28

Appendix Table 26.--Collection of adult steelhead in 1979 at Bonneville Dam with comparison of collection at McNary and Lower Granite Dams. Returning adults were from various transport and control releases of smolts in 1977-78.

Test group and originating dam	Year of release and recovery site					
	Bonneville		McNary		Lower Granite	
	1977	1978	1977	1978	1977	1978
Little Goose Dam						
control	0	2	0	4	3	45
transport	3	19	5	19	44	385
Lower Granite Dam						
control	1	7	1	10	29	98
transport	2	36	12	45	134	536
McNary Dam	No test		No test		No test	
control	-	5	-	9	-	20
transport	-	16	-	19	-	106
Total	6	85	18	106	210	1,190

Appendix Table 27.--Adult steelhead (2-ocean age) recovered in the Indian set net fishery in 1979 from transport and control releases of juvenile smolts from Little Goose and Lower Granite Dams in 1977.

Release site & experimental group	Little Goose Dam			Lower Granite Dam		
		Adult return			Adult return	
	No. of juveniles released[a]	No. of adults recaptured	% of juveniles released	No. of juveniles released[a]	No. of adults recaptured	% of juveniles released
Control	22,204	0	0	33,152	7	.021
Bonneville Freshwater transport	24,272	3	.012	45,513	11	.024
Saltwater[b] transport	22,916	6	.026			
Dalton Point Transport				40,899	14	.034
Bonneville Barge transport				30,330	4	.013
Totals	69,392	9		149,894	36	

a/ Adjusted for initial tag loss.

b/ 10 ppt salt water.

Appendix Table 28.--Adult steelhead (1-ocean age) recovered in the 1979 Indian set net fishery from transport and control releases of juvenile smolts from Little Goose and Lower Granite Dams in 1978.

Release site & experimental group	Little Goose Dam			Lower Granite Dam		
		Adult return			Adult return	
	No. of juveniles released[a]	No. of adults recaptured	% of juveniles released	No. of juveniles released[a]	No. of adults recaptured	% of juveniles released
Control	30,364	0	0	43,102	1	.002
Forebay rel.						
Tailrace				12,567	0	--
Bonneville						
Freshwater transport	35,875	11	.030	47,572	15	.032
Saltwater[b] transport	32,170	6	.018			
Barge transport				43,770	12	.027
Totals	99,009	17		147,011	28	

a/ Adjusted for initial tag loss.

b/ 10 ppt salt water.