CZES Coastal Zone and Estuarine Studies

# TRANSPORTATION ACTIVITIES AND RELATED RESEARCH AT LOWER GRANITE, LITTLE GOOSE, AND McNARY DAMS 1978

by

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# INTRODUCTION

During 1978 the National Marine Fisheries Service (NMFS), under contract to the U. S. Army Corps of Engineers (CofE), continued to develop a mass transport system for increasing the survival of downstream migrant salmonids at Lower Granite and Little Goose Dams and initiated research to evaluate fish protection facilities at McNary Dam.

A number of studies were carried out at Lower Granite and Little Goose Dams; however, emphasis was placed on mass transportation of unmarked smolts by barge and truck to safe release sites in the Columbia River below Bonneville Dam. At both upriver dams substantial numbers of fish were also marked and subsequently transported. From these marking studies, began in 1975 and concluded in 1978, information is being accumulated on homing (or straying); transport benefits based on the collection sites, release sites, and modes of transportation; and contributions to the various fisheries. Related research on load densities at Lower Granite Dam and orifice configurations at Little Goose Dam were also conducted in 1978.

At McNary Dam a research program for evaluation of fish protective facilities for juvenile salmonids was started. A major effort involved observing and "de-bugging" the fingerling bypass flume and separator facility. Tests were also begun on the initial use of traveling screens at McNary Dam. Fingerlings that were collected were marked and transported by truck to a safe release site below Bonneville Dam. The effects of the transportation on their survival and homing will be evaluated upon their return as adults.

The recovery of adults returning from fingerlings released in previous years is continuing. Over 2,000 adult salmonids that were previously tagged and transported as juveniles from Little Goose or Lower Granite Dams in 1975 to 78 were recovered at various locations in 1978.

## MASS TRANSPORT OF SMOLTS

Mass transport operations began at Lower Granite Dam on 4 April 1978. Because of unseasonable warm weather in mid-March, the outmigration of smolts began earlier than normal, and certainly far earlier than in the drought year of 1977. Overall, river flows were considered near average; for example, the mean daily discharge at Lower Granite Dam in May was 100,000 cfs. In any case, flows were excellent for fish, and smolts appeared to be in excellent condition upon collection at Lower Granite and Little Goose Dams.

Collection was enhanced by the availability of 18 traveling screens at each project. However, some problems arose, so less than 100% of potential collection was achieved. At Lower Granite Dam, unit one was out of service for the season for mechanical repairs. At Little Goose Dam, all vertical barrier screens in units one and two were dislodged on or about 19 May 1978. We believe the problem was caused by load rejections in the units which resulted in a sudden back flush of water of sufficient force to remove the screens. Traveling screens continued to operate, although removal of the barrier screens allowed most guided fish to return back to the turbine intake. We estimate that an additional 120,000 steelhead trout could have been collected had the barrier screens remained in place.

Although some collection problems existed, over 3 million salmonids were collected at the two dams. Table 1 shows that 2,978,508 salmonids were transported to safe release sites below Bonneville Dam. About 75% of the fish collected at Lower Granite Dam were transported by barge, and the remainder were trucked. All fish collected at Little Goose Dam were trucked. In total, transportation by barge and by truck accounted for nearly equal numbers of fish. As experience is gained, barging is definitely increasing its role in the transportation process.

Table 1.--Number of juvenile chinook salmon and steelhead trout transported from Lower Granite and Little Goose Dams and released below Bonneville Dam-1978.

| | Chinook | Steelhead | Total |
|---|---|---|---|
| **Lower Granite Dam** | | | |
| Truck | 351,825 | 151,559 | 503,384 |
| Barge | 651,180 | 827,192 | 1,478,372 |
| Subtotal (Lower Granite Dam) | 1,003,005 | 978,751 | 1,981,756 |
| **Little Goose Dam** | | | |
| Truck | 620,231 | 376,521 | 996,752 |
| Grand Total Transported | 1,623,236 | 1,355,272 | 2,978,508 |

Sims et al. (1979) estimated that 3,180,000 chinook salmon and 2,120,000 steelhead trout arrived at Lower Granite Dam in 1978 (Table 2). Therefore, by combined collection at the two dams, we transported 51% and 64% of the available chinook salmon and steelhead trout, respectively. (See Appendix Tables 1 to 4 for daily transport totals for each species and each dam. These tables also indicate disposition of all fish collected or counted, but not transported to Bonneville Dam.)

## RESEARCH-LOWER GRANITE DAM

### TRANSPORT TESTS

The principal objective of research in 1978 was to examine whether large numbers of juvenile salmonids can be efficiently collected at Lower Granite Dam (nearer rearing areas than Little Goose Dam) and transported to locations below Bonneville Dam thereby increasing their survival without the migrants losing their homing ability. In question is the premise that if smolts are collected and transported too soon after they begin their seaward migration, it may result in returning adults straying due to destroyed or impaired homing ability. Therefore, it is especially important to test the transport concept at Lower Granite Dam because of its proximity to nearby rearing areas and compare the results with those obtained at Little Goose Dam where transportation has a known record of success.

A total of over 2 million chinook salmon and steelhead trout was collected at Lower Granite Dam. Although most of these were transported to release sites below Bonneville Dam without marking, a portion was transported bearing distinctive coded wire tags and freeze brands. Similarly, control fish released in the forebay or tailrace of the dam also received distinctive marks. All marked fish had excised adipose fins, freeze brands, and were coded wire tagged.

Table 2.--Number of chinook salmon and steelhead trout smolts and percent of total Snake River outmigration transported below Bonneville Dam 1971-1978 (includes experimental fish marked for transport evaluation). (Estimated number of smolts at upper dam taken from various NMFS progress reports by rates and timing projects 1972-79.)

| | Chinook smolts | | | Steelhead smolts | | |
|---|---|---|---|---|---|---|
| Year | No. at upper dam (1,000) | No. hauled (1,000) | % hauled | No. at upper dam (1,000) | No. hauled (1,000) | % hauled |
| Transport from Little Goose Dam | | | | | | |
| 1971 | 4,000 | 109 | 3 | 5,500 | 154 | 3 |
| 1972 | 5.000 | 360 | 7 | 2,500 | 227 | 9 |
| 1973 | 5,000 | 247 | 5 | 5,500 | 176 | 3 |
| 1974 | 3,500 | 0 | 0 | 5,000 | 0 | 0 |
| Transport from Lower Granite and Little Goose Dams combined | | | | | | |
| 1975 | 4,000 | 414 | 10 | 3,200 | 549 | 17 |
| 1976 | 5,000 | 751 | 15 | 3,200 | 435 | 14 |
| 1977 | 2,000 | 1,365 | 68 | 1,400 | 895 | 64 |
| 1978 | 3,180 | 1,623 | 51 | 2,120 | 1,355 | 64 |

Adult return data from previous research at both Little Goose and Lower Granite Dams have shown substantial benefits from transporting juvenile steelhead trout; whereas, returns of chinook salmon, while beneficial, are less encouraging. Although the exact reasons for this lower level of success with chinook salmon remain obscure, we feel there is substantial evidence that indicates chinook salmon smolts are simply less capable of survival when subjected to the successive stresses inherent in the collection, handling, and hauling processes. If this is correct, a resting period between the collection process and handling (marking) or hauling processes should be beneficial. To test this concept, two similar experiments were conducted at Lower Granite Dam involving chinook salmon smolts. In one experiment, the fish were allowed a 24 h resting period in a holding raceway, marked, and hauled by truck in fresh water. In the second experiment, the fish were treated in a raceway for 2 h in a 10 ppt salt solution, held 24 h in the raceway, marked, and then hauled by truck in a 10 ppt salt solution. Adult returns in future years should indicate if this rest period between the collection and handling processes will increase survival and whether this process in conjunction with a mild saline bath, as described, will further increase survival.

In additional tests, juvenile steelhead trout and chinook salmon were marked to compare trucking vs. barging as transport modes: a) juvenile chinook salmon and steelhead trout were marked and hauled by truck in fresh water to below Bonneville Dam (traditional manner) and b) juvenile chinook salmon and steelhead were marked and hauled by barge below Bonneville Dam. Two groups of control fish were also marked—one group was released at Clarkston, Washington in the forebay of Lower Granite Dam, while the other group was released in the tailrace about 1 mile downstream from Lower Granite Dam.

Totals of 180,558 chinook salmon smolts and 91,669 steelhead trout smolts were marked as test fish for the various transportation experiments, and 54,343 chinook salmon smolts and 55,669 steelhead trout smolts were marked and released as controls from Lower Granite Dam in 1978. Table 3 and Appendix Tables 6 to 11 contain detailed summaries of all marked release groups. (Note: Appendix Table 5 contains a key to tag codes used in all groups in the report.)

DESCALING, DELAYED MORTALITY, AND WATER QUALITY MEASUREMENTS

As in past years, the average amount of descaling was used as the major criterion for assessing the relative condition of chinook salmon smolts hauled from Lower Granite Dam. The average descaling rate measured at the fish marking facility during the sorting process was 7.5% for chinook salmon and 5.8% for steelhead trout (See Appendix Tables 12 and 13); nearly identical to the rate measured in 1976 when river flows were similar. By contrast, a 4 to 5 times higher descaling rate was measured during the record low flows of 1977. These data substantiate our contention that adequate river flows are essential for both good smolt condition and downstream movement.

Water quality (temperature, dissolved $O_2$ and $CO_2$, and pH levels) and delayed mortality measurements were made from nearly all truck and barge transports arriving at Bonneville Dam. Appendix Table 14 lists these measurements by date and test condition. Samples of chinook salmon and steelhead trout smolts were held 45 h to determine delayed mortalities. Tag loss was also noted for all marked fish held. Delayed mortality averages for marked and unmarked chinook salmon from the 4 test groups are given in Table 4. The average delayed mortality, as expected, was highest for chinook salmon smolts hauled by truck in the traditional manner (Test #1). However, a substantial reduction in delayed mortality was

Table 3.--Summary of transported marked and unmarked chinook salmon and steelhead trout collected at Lower Granite Dam by test condition and release sites, 1978. (Includes controls that were marked but not actually transported.)

| RELEASE SITES | Transported[1/] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Marked[2/] | | | | Unmarked | | | |
| | Salt water | | Fresh water | | Salt water | | Fresh water | |
| | Chinook | Steelhead | Chinook | Steelhead | Chinook | Steelhead | Chinook | Steelhead |
| Trucked (test) Bonneville Dam | 41,087 | -- | 82,925[3/] | 47,899 | 13,516 | 24,098 | 214,297 | 79,562 |
| Barged (test) Beacon Rock | -- | -- | 56,546 | 43,770 | -- | -- | 594,634 | 783,422 |
| Clarkston, WA (control) | -- | -- | 46,094 | 43,102 | -- | -- | -- | -- |
| Lower Granite Tailrace (control) | -- | -- | 8,249 | 12,567 | -- | -- | -- | -- |
| TOTALS | 41,087 | | 193,814[1/] | 147,338[1/] | 13,516 | 24,098 | 808,931 | 862,984 |

1/ Includes controls that were marked but not actually transported.

2/ Numbers not adjusted for initial tag loss--see appendix tables.

3/ Includes two test groups; one was held 24 hours prior to marking, the other was marked after collection and hauled in the traditional manner.

Table 4.--Summary by test group of 45 h delayed mortality of marked and unmarked chinook salmon smolts before transport (fish from test #1 only) and after transport (all test groups) to Bonneville Dam from Lower Granite Dam, 1978.

| | Before transport (at Lower Granite Dam) | | | | | |
|---|---|---|---|---|---|---|
| | Marked | | | Unmarked | | |
| Test Groups[1/] | No. held | No. morts. | % mort. | No. held | No. morts. | % mort. |
| Test #1 | 429 | 59 | 13.8 | 34 | 7 | 20.6 |
| | After transport (at Bonneville Dam) | | | | | |
| Test #1 | 1586 | 271 | 17.1 | 1834 | 206 | 11.2 |
| Test #2 | 389 | 16 | 4.1 | 1482 | 21 | 1.4 |
| Test #3 | 936 | 97 | 10.4 | 156 | 14 | 9.0 |
| Test #4 | 950 | 45 | 4.7 | 248 | 10 | 4.0 |

1/ Test Groups

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

2-Transported by barge in fresh water.

3-Held in raceway for 24 h prior to marking and then marked and transported by truck in fresh water.

4-Held in 10 ppt salt water for 2 h then held for 24 h in raceway prior to marking and then marked and transported by truck in 10 ppt salt water.

observed when chinook salmon smolts were transported under any of the other three conditions. These data suggest chinook salmon smolts arrive at Bonneville Dam in better condition when transported by barge or when held for 24 h in a raceway prior to truck transport. As in most previous years, delayed mortality of steelhead trout smolts, whether marked or unmarked or hauled by truck or barge, was insignificant.

To gain an insight into the reliability and/or meaning of delayed mortality estimates at Bonneville Dam, a series of samples of fish were taken from truckloads of chinook salmon as they departed Lower Granite Dam. These fish were held at the dam in a similar manner to the samples that were subsequently held at Bonneville Dam to assess delayed mortality (Table 4). (Appendix Table 15 contains details for fish held at Lower Granite Dam.)

We expected that delayed mortality would be considerably less for fish held without transportation stresses compared to those transported; however, 13.8% is shown for fish held at Lower Granite Dam vs. 17.1% for those transported to and held at Bonneville Dam. We feel that the similarity in the two figures may be a consequence of sampling technique. We believe that the technique for sampling fish from the truck is critical, and that it is extremely difficult, if not impossible, to obtain a random sample. We suspect that fish swimming near the surface of the tanker are among the weakest individuals, and for obvious reasons, they are the most prone to being collected during sampling. Deeper swimming fishes are more elusive (healthier) and so upon retrieval of the sampling net, they are more likely to escape. Thus, we are frustrated in our sampling for delayed mortality specimens on one hand, but on the other, we have no reasonable alternative. We conclude that intensive delayed mortality sampling remains our best indicator of relative survival of juvenile chinook salmon in the various transport groups.

## LOADING DENSITY TESTS

The cost of transporting juvenile salmon and steelhead trout by tanker truck could be reduced if loading densities were increased from the present 1 lb of fish per gallon of water and fish life support systems were simplified. With these objectives in mind, in the fall and winter of 1977 we conducted fish density experiments in a small test container to determine if transporting a higher density of salmonids was practical. Load densities tested were 1.0, 1.5, 2.0, 2.5, and 3.0 lb of fish per gallon of water.

Chinook salmon were used in all the experiments. The sources and average sizes of the salmon were as follows: fall 1977 tests—Snake River fish from the collector at Lower Granite Dam (9 to 11 fish/lb) and the gatewells at Little Goose Dam (6 fish/lb); winter 1977 tests—Rapid River Hatchery (17 to 19 fish/lb).

The experimental fish tank was a Plexiglass[1/] container, measuring 9 inches square by 4 feet 11 inches high. Because high densities of salmon were tested, it was necessary to minimize the container size. Dissolved oxygen levels above 18 ppm were maintained during the tests by oxygen supplied to the test tank via two 2-inch diameter air stones mounted near the bottom. To maintain a near constant water temperature throughout each 9 h experiment, the Plexiglass container was immersed in a water bath. Throughout the experiments, no recirculation system was operated; however, in tests of 2.0, 2.5, and 3.0 lb/gallon, a mechanical agitator was used to break up the surface film of the water.

During each test, the following water quality parameters were monitored hourly: temperature, pH, carbon dioxide, and ammonia. At the conclusion of each test, the fish were removed from the container and held in circular tanks with running water for at least an additional 110 h to check for delayed mortality. Groups of similar, but untested fish held for the same amounts of time in circular tanks served as controls.

1/ Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Water quality data are presented in Table 5 and Appendix Table 16. During the tests only carbon dioxide and un-ionized ammonia levels appeared excessive, and it was apparent that the mechanical agitator was effective in impeding carbon dioxide buildup.

There was considerable variability in the mortality rates of the test fish (Table 6 and Appendix Table 17). The condition of the fish appeared to be a major factor in the mortalities. Fish from the gatewells at Little Goose Dam had high mortality rates—even the control fish had delayed mortalities as high as 14%. Whereas Rapid River Hatchery spring chinook salmon, which were parr and in excellent condition, were able to survive at high density tests (up to 3 lb/gal) having elevated carbon dioxide and ammonia levels with no apparent adverse effects.

From these limited tests, it appears that densities of salmon greater than 1 lb/gal could be transported in the tanker trucks if additional air stones were installed. In addition, mechanical agitators could operate in place of the present recirculation system, and the recirculation system used as backup. We believe the transportation of increased densities of chinook salmon should be attempted only if the fish are in excellent condition. Before any modifications are undertaken on tanker trucks, additional experiments should be conducted in a large test container which more closely resembles a transport tank than did the Plexiglass container. It is also important that any future experiments be done during the spring with chinook salmon smolts.

## TRAVELING SCREEN MONITORING

Traveling screens are the cornerstone of the collection system, and they must function correctly if smolts are to be diverted effectively and in good condition. The CofE is responsible for maintenance, placement, and operation of these critical units. So that inspectors can monitor the performance of the screens, remote indicators are located on the intake deck. However, screens

Table 5.--Effects of various loading densities and agitation on $CO_2$ concentrations when Snake River or Rapid River Hatchery stocks of chinook salmon were held for 9 h in a container.[1/]

Snake River stocks (no agitator used)

| Density (lb/gal) | Number of replicates | Water quality parameters | Hours in container 1 | 4 | 9 |
|---|---|---|---|---|---|
| 1.0 | 6 | Temp (°F) | 50.4 | 52.0 | 52.5 |
| | | $CO_2$ (ppm) | 25.7 | 32.0 | 38.3 |
| 1.5 | 2 | Temp (°F) | 54.5 | 54.9 | 55.0 |
| | | $CO_2$ (ppm) | 41.0 | 50.0 | 68.0 |

Rapid River Hatchery stock (agitator used)

| | | | | | |
|---|---|---|---|---|---|
| 2.0 | 3 | Temp (°F) | 47.8 | 48.9 | 49.1 |
| | | $CO_2$ (ppm) | 11.3 | 13.3 | 18.0 |
| 2.5 | 1 | Temp (°F) | 49.1 | 50.0 | 50.4 |
| | | $CO_2$ (ppm) | 14.0 | 22.0 | 26.0 |
| 3.0 | 1 | Temp (°F) | 47.3 | 50.0 | 51.8 |
| | | $CO_2$ (ppm) | 16.0 | 26.0 | 36.0 |

1/ For more detailed results, see Appendix Table 16.

Table 6.--Summary of average delayed mortalities by percent during chinook salmon loading density studies.[1/]

| Test conditions | Source of fish | No. of fish | Mortality during 9 h test | 110/136 h post test mortality |
|---|---|---|---|---|
| | | | (%) | (%) |
| 1.0 lb/gal | Snake River | 594 | 14.5 | 21.5 |
| Control | Snake River | 606 | 0.0 | 9.9 |
| 1.5 lb/gal | Snake River | 731 | 6.4 | 13.8 |
| Control | Snake River | 300 | 0.0 | 1.7 |
| 2.0 lb/gal | Rapid River Hatchery | 1789 | 0.0 | 0.0 |
| Control | Rapid River Hatchery | 400 | 0.0 | 0.0 |
| 2.5 lb/gal | Rapid River Hatchery | 489 | 0.0 | 0.2 |
| Control | Rapid River Hatchery | 100 | 0.0 | 0.0 |
| 3.0 lb/gal | Rapid River Hatchery | 561 | 0.0 | 0.0 |
| Control | Rapid River Hatchery | 100 | 0.0 | 0.0 |

1/ A more detailed summary by test replicate may be found in Appendix Table 17.

may encounter damage that cannot be monitored by inspecting personnel. The best indicator of overall performance of the screens is the condition of the fish diverted. Therefore, during the 1978 season, NMFS personnel monitored the effectiveness of the traveling screens by sampling a portion of the chinook salmon and steelhead trout diverted into gatewells and examining them for descaling.

Traveling screens were installed and operated in all units except unit one which was under extensive repair, and average descaling data on fish from each of the gatewells are presented in Table 7. (Daily descaling is shown in Appendix Tables 12 and 13). Traveling screens operated satisfactorily in 1978 based on the low average descaling rate of 5% for chinook salmon and 3% for steelhead trout. Descaling of chinook salmon appeared to be higher in unit six (7%) than in units two to five (4%). However, unit six did not become fully operational until 15 May 1978 when few fish were available for sampling. In general, the fingerlings diverted from the turbine intakes to the gatewells were in very good condition in 1978. The average descaling rates of 5% for chinook salmon and 3% for steelhead trout were more in line with the rates measured in 1976 (Park et al. 1977)--considerably reduced from the 25 and 17% rates measured for chinook salmon and steelhead, respectively, in 1977.

## RESEARCH-LITTLE GOOSE DAM

### TRANSPORT TESTS

A 3-year mark and release study to evaluate the potential of mass hauling juvenile chinook salmon and steelhead trout to increase their survival began at Little Goose Dam in 1976. Marking of juvenile fish was completed in 1978. Evaluation of returning adults from this study will be completed in 1981.

Table 7.--Average percent descaling for naturally migrating juvenile chinook salmon and steelhead trout collected from turbine intake gatewells at Lower Granite Dam, 1978.

| | Descaling--Chinook salmon | | | | |
|---|---|---|---|---|---|
| Unit | 2 | 3 | 4 | 5 | 6 1/ |
| Gatewell | A B C (%) | A B C (%) | A B C (%) | A B C (%) | A B C (%) |
| Average by gatewell | 4 5 4 | 4 4 * | 4 4 3 | 4 3 4 | 4 8 10 |
| Average by turbine unit | 4 | 4 | 4 | 4 | 7 |

Combined average for entire season 5%.

| | Descaling--Steelhead trout | | | | |
|---|---|---|---|---|---|
| Unit | 2 | 3 | 4 | 5 | 6 |
| Gatewell | A B C (%) | A B C (%) | A B C (%) | A B C (%) | A B C (%) |
| Average by gatewell | 3 3 3 | 3 4 * | 4 4 4 | 4 3 3 | 4 3 3 |
| Average by turbine unit | 3 | 4 | 4 | 3 | 3 |

Combined average for entire season 3%.

* Not sampled.

1/ Screen not fully operational until after 15 May and few fish were available for sampling.

Handling, marking, and transporting operations during 1978 were similar to those used at Little Goose Dam in 1976-77. Fingerlings were transferred from the raceways either into a transport truck or into the marking facility via a fish loading hopper. The hopper, containing approximately 175 gal of water and 3,000 fish, was lifted from the raceway and emptied in 30 s.

In 1978 mass transportation began at Little Goose Dam on 10 April. Collection of fingerlings was restricted only by the barrier screen problem mentioned previously. A total of 1,081,159 downstream migrants was collected during the period 4 April to 15 June 1978. (See Appendix Tables 3 and 4 for daily catch and marking statistics.) Totals of 620,231 chinook salmon and 376,521 steelhead trout were transported to a safe release site below Bonneville Dam. A portion of those transported and some of the remainder collected were marked for test purposes.

To monitor the benefits of the transportation program and to evaluate transportation in salt water, both juvenile chinook salmon and steelhead trout were marked and released in three lots: one lot (a control) was released in the tailrace at Little Goose Dam (frontroll of turbine), and the other two lots (test) were transported by truck and released at a site below Bonneville Dam--one lot hauled in fresh water and one lot in 10 ppt salt water.

During the season, we marked 136,029 chinook salmon and 99,973 steelhead trout for the mass transport experiments. In addition, totals of 520,642 unmarked chinook salmon and 306,912 unmarked steelhead trout were transported to the release site below Bonneville Dam (Table 8). (See Appendix Tables 18 to 20 for more details of marking by group.)

Table 8.--Summary of transported marked and unmarked chinook salmon and steelhead trout collected at Little Goose Dam by test condition and release sites, 1978. (Includes controls that were marked but not actually transported.)

| | Transported[1/] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Marked[2/] | | | | Unmarked | | | |
| | Salt water | | Fresh water | | Salt water | | Fresh water | |
| Release sites | chinook | steelhead | chinook | steelhead | chinook | steelhead | chinook | steelhead |
| Trucked (test) Bonneville Dam | 48,614 | 32,731 | 50,975 | 36,878 | 263,326 | 168,206 | 257,316 | 138,706 |
| Little Goose Tailrace (Control) | | | 36,440 | 30,364 | | | | |
| Totals | 48,614 | 32,731 | 87,415[1/] | 67,242[1/] | 263,326 | 168,206 | 257,316 | 138,706 |

1/ Includes controls that were marked but not actually transported.

2/ Number not adjusted for initial tag loss--see appendix tables.

## DELAYED MORTALITY, WATER QUALITY MEASUREMENTS, AND DESCALING

Delayed mortality among hauled groups was measured at Bonneville Dam. Mortality was compared among the following groups: 1) marked and unmarked chinook salmon, 2) marked and unmarked steelhead trout, and 3) freshwater and saltwater loads. Samples of fish obtained from transport loads were held for 45 h. Delayed mortalities and water quality parameters, including temperature, $O_2$, $CO_2$, and pH are detailed for each load in Appendix Table 21.

The use of salt water appeared to reduce delayed mortality for both chinook salmon and steelhead trout, and, as expected, marked groups had more delayed mortality than unmarked groups. Delayed mortality of marked chinook salmon hauled in fresh water ranged from 0 to 52.0% with an overall average of 13.1%; whereas delayed losses of marked chinook salmon hauled in salt water ranged from 0 to 23.0%, with an overall average of 8.8%. Delayed losses of unmarked chinook salmon hauled in fresh water ranged from 1.4 to 41.7%, with an overall average of 12.7%; while delayed losses from unmarked chinook salmon hauled in salt water ranged from 0 to 36.7%, with an overall average of 6.6%. Delayed mortality of steelhead trout was low (0.2 to 2.6%) in all transport groups.

Much has been said about the poor condition of smolts—largely brought about by the drought—transported in 1977. In 1978, it would appear that survival of smolts transported (based on delayed mortality) will be better than in 1977, but still somewhat reduced from the survival of smolts transported in 1976 (Table 9). Whether or not adult returns corroborate these data remains to be seen.

As in past years, we measured descaling of fingerlings at the fingerling marking facility to index the general condition of fish available for transport. The average rate of descaling for chinook salmon was 20% and ranged from 6 to 44%. Descaling of steelhead trout averaged 11.3% and ranged from 1 to 27%. Although the descaling rate for chinook salmon at Little Goose Dam was

Table 9.--Percent delayed mortality of marked and unmarked chinook salmon and steelhead trout transported by truck in fresh or salt water from Little Goose Dam, 1976 to 78.

| Year of transport | Fresh water | | | | Salt water | | | |
|---|---|---|---|---|---|---|---|---|
| | Chinook | | Steelhead | | Chinook | | Steelhead | |
| | marked | unmarked | marked | unmarked | marked | unmarked | marked | unmarked |
| 1976 | 6.1 | 3.2 | nil | nil | 4.1 | 4.3 | nil | nil |
| 1977 | 42.5 | 21.3 | 11.1 | 16.1 | 29.6 | 26.0 | 11.6 | 10.5 |
| 1978 | 13.1 | 12.7 | 2.6 | nil | 8.8 | 6.6 | nil | nil |

almost three times the rate shown for Lower Granite Dam (20 vs. 7.5%), the delayed mortality rate after transport was greater for the fish transported from Lower Granite Dam than it was for those transported from Little Goose Dam (17.1 vs. 13.1% in the comparable freshwater trucked groups). Again, adult returns should help in evaluating the usefulness of delayed mortality and descaling rates as indicators of fish condition.

ORIFICE CONFIGURATION TESTS

The present bypass system at Little Goose Dam incorporates the use of traveling screens located in the turbine intakes to guide migrating fingerling salmonids into the intake gate slots (gatewells). Vertical barrier screens in the gate slots restrict fish to the intake bulkhead gate slots, thereby denying fish access to the operating gate slot portion of the well. Fingerlings now exit the bulkhead slots through a single 6-inch diameter submerged orifice (elevation 631.5 ft) located near the north end of the upstream wall of the gatewell. Fingerling passage through these existing orifices has been inefficient (Ebel et al. 1971). Inefficiency has resulted in serious delays to migrants and excessive descaling, which is related to delay; i.e., the longer the fish spend in the gatewell, the more they are descaled.

In an effort to improve the bypass system at Little Goose Dam, tests were conducted from 8 April through 3 May 1978 using naturally migrating chinook salmon and steelhead trout smolts. Tests were conducted in slot A of unit one. Objectives of these tests were to: 1) determine optimum size and number of orifices to be used and 2) determine if it was feasible to pass fingerlings through orifices located on the downstream wall of the operating gate slot with the upper panel of the barrier screen removed.

## Procedures and Experimental Design

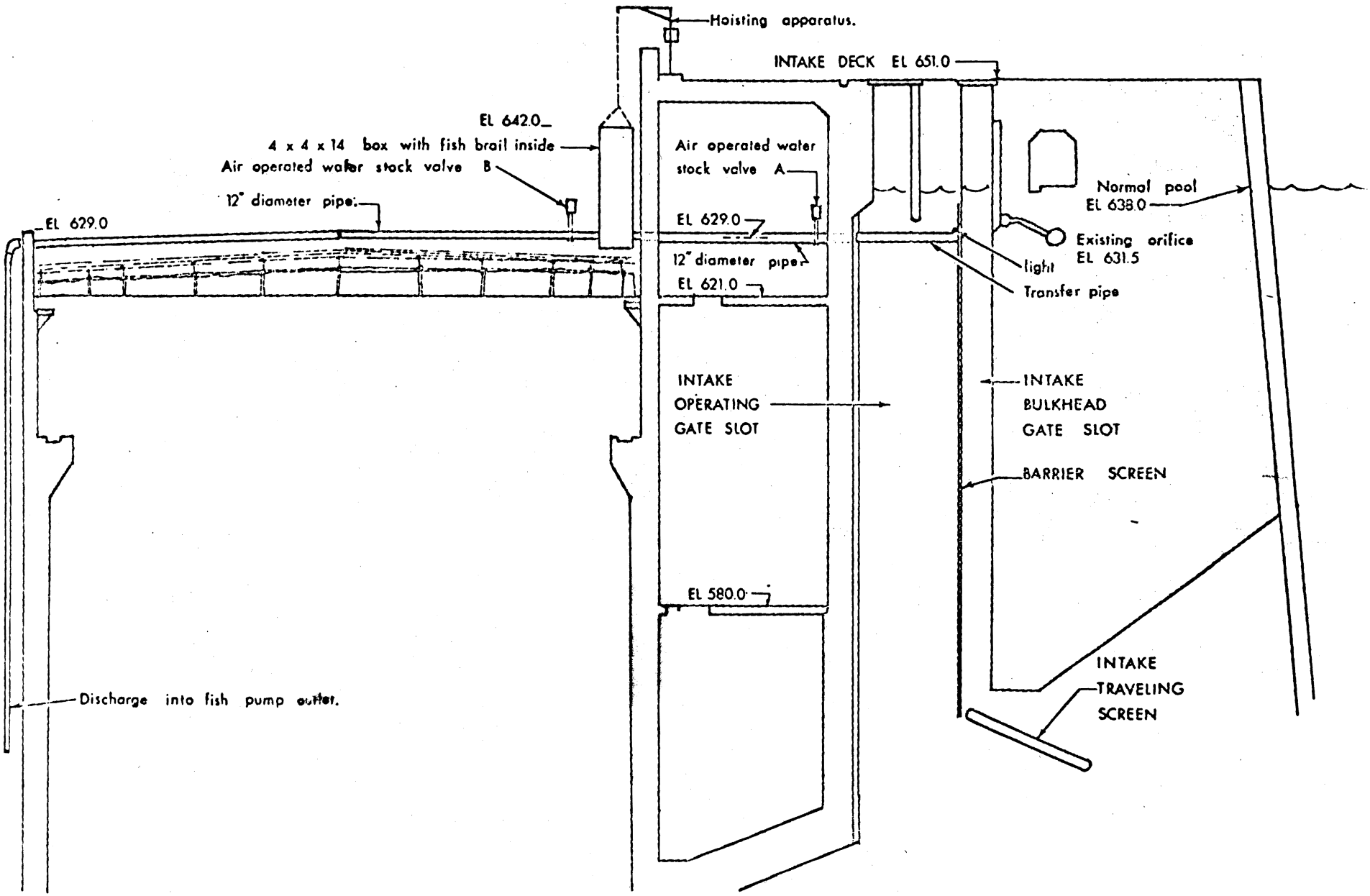
Submerged orifices were constructed and located near each corner on the downstream wall of the gatewell at elevation 629.0 ft. Orifices were illuminated with 75 watt swimming pool lights located on top of the transfer pipes near the entrance. Two fingerling transfer pipes 12 inches in diameter were capable of holding 8-inch or 10-inch diameter orifice inserts at their gatewell entrances. The transfer pipes carried fingerlings from the orifice entrance through the powerhouse to a collection facility.

Bypassed fish were collected at trap-hoppers located outside the powerhouse (Figure 1). A fish brail in the traps allowed fingerlings to be hoisted to the intake deck for inspection and enumeration. Excess water was eliminated at the holding boxes and carried to the tailrace level by an enclosed pipe.

Water level in the trap-hoppers was regulated by two air operated wafer valves. Water levels in the trap-hoppers were maintained 2 ft lower than the water in the gatewell. This provided stable velocities of 12 ft per second from the orifice entrances through the transfer pipes into the traps. During testing, valve A (near the orifice entrance) was operated wide open, but was closed for approximately 5 min every 2 h to restrict egress of fish from the gatewell to the trap while fish were brailed to the intake deck. Valve B at the trap outlet was adjusted to remove excess water from the traps while maintaining a 2 ft head differential between the gatewell and the trap.

Smolts used in this study were obtained by dipping bulkhead slots other than slot 1-A with a gatewell dip basket. Fish were transferred to a marking facility where they were anesthetized, marked, and held in stock tanks for 4 h to resume normal behavior before being released into the gate slots. Chinook salmon were marked with partial pectoral or pelvic fin clips. Steelhead were tattooed with a colored pigment.

Figure 1.--Layout of experimental orifices and trapping facility as operated in the intake bulkhead gate slot (unit 1-A) at Little Goose Dam. (All measurements and elevations are in feet unless otherwiest specified.)



The first test series involved passing fish with the transfer pipe extensions to the bulkhead slot (Figure 1). The following conditions were compared: 1) 8-inch diameter north and south orifices operated with lights; 2) 10-inch diameter north and south orifices operated with lights; 3) 10-inch diameter north and south orifices operated without lights; 4) 10-inch diameter north orifice operated with light (best single orifice); and 5) 12-inch diameter south orifice operated with light. Each test condition was replicated three times. Approximately 200 chinook salmon and 200 steelhead trout were released in each test.

The bulkhead slot was dipped clean at 1530 h each day to count residual marked and naturally migrating fish. Then at 1600 h each day, marked fish were introduced into the center of the slot at 20 feet of depth via a hose. During the 24-h test period, each hopper-trap was emptied every 2 h to count marked and naturally entering migrants. Since the vertical barrier screens were intact during these tests, all fish were removed from the bulkhead slot with the gatewell dip basket after each test replicate.

To evaluate orifice passage efficiency, marked fish from the traps plus those marked fish that were recovered in the gatewell at the end of a test were assumed to be the total number of fish available for passage. The number of marked fish removed from the orifice traps was expressed as a passage percentage of the total number of marked fish recovered.

Marked fish recovery was also compared to the recovery of naturally entering (unmarked) migrants. The number of natural fish removed from the orifice traps was expressed as a passage percentage--the same as in the analysis for marked recoveries.

A second test series involved passing smolts from the operating gate slot when the upper two panels of the vertical barrier screen between the bulkhead and operating gate slots were removed. The associated transfer pipes were also removed. This test was conducted to determine if fish would voluntarily

swim from the bulkhead slot to orifices in the downstream wall of the operating gate slot. The bulkhead slot was darkened during these tests.

Since a portion of the barrier screen was removed, gatewells were not dipped because the operating gate slot was not accessible, and therefore the presence of fish could not be detected. Reliance was made on marked fish recoveries in the trap to compare results of bulkhead and operating gate slot tests. The same series of five tests were scheduled for the operating gate slot that were used for the bulkhead slot tests.

## Results of Orifice Passage Tests

The recoveries of marked juvenile chinook salmon and steelhead trout released simultaneously in the bulkhead slot and recovered 24 h later are summarized in Table 10. Recoveries of unmarked, naturally entering juveniles made concurrently with marked fish are also shown.

During the tests, a special effort was made to maintain standard operating conditions within the turbine. That is, the traveling screen used to guide downstream migrating fingerlings from the turbine intake into gatewells was always running and a uniform turbine generating load of 155 megawatts was maintained.

The results of our tests, while not providing clear evidence for an optimum orifice passage arrangement, did show that: 1) two lighted, 8-inch orifices passed fish better than a single 10- or 12-inch diameter lighted orifice; 2) lighted orifices definitely increased passage rates for chinook salmon, but appeared to be of little additional value in passing steelhead trout; and 3) both species tested preferred the north orifice when offered a choice for passage.

Steelhead trout showed lower passage rates than chinook salmon throughout the test. We speculate that chinook salmon may have been more highly smolted during the testing period than steelhead trout, i.e., tests were run near the peak of the chinook salmon migration while testing was completed prior to the

Table 10.--Passage rate[1/] of test (marked) and naturally entering chinook salmon and steelhead trout through various combinations of 8, 10, or 12-inch diameter orifices installed in the downstream side of the bulkhead slot (Unit 1-A) at Little Goose Dam.

| Orifice test condition | Number of marked fish released (3 replicates) | Percent marked fish recovered from each orifice, and combination of orifices. | | | Percent naturally entering fish recovered from each orifice, and combination of orifices. | | |
|---|---|---|---|---|---|---|---|
| | | North | South | Comb. | North | South | Comb. |
| | | | | Chinook salmon | | | |
| North and south 8-inch orifices, lighted | 309 | 39 | 27 | 66 | 61 | 12 | 73 |
| North and south 10-inch orifices, lighted | 826[2/] | 37 | 37 | 74 | 47 | 25 | 72 |
| North and south 10-inch orifices, dark | 626 | 29 | 25 | 54 | 27 | 13 | 40 |
| North 10-inch orifice, lighted | 596 | 38 | -- | -- | 62 | -- | -- |
| South 12-inch orifice, lighted | 622 | -- | 59 | -- | -- | 63 | -- |
| | | | | Steelhead trout | | | |
| North and south 8-inch orifices, lighted | 575 | 24 | 17 | 41 | 31 | 10 | 41 |
| North and south 10-inch orifices, lighted | 694[2/] | 35 | 12 | 46 | 38 | 18 | 56 |
| North and south 10-inch orifices, dark | 595 | 30 | 16 | 46 | 28 | 23 | 51 |
| North 10-inch orifice, lighted | 471 | 26 | -- | -- | 29 | -- | -- |
| South 12-inch orifice, lighted | 534 | -- | 25 | -- | -- | 23 | -- |

1/ Passage rate equals number of recoveries divided by number released.

2/ Four replicates were used. The turbine was shut down during one test for 2 h. However, it did not appear to affect recovery rate, therefore, the data were used.

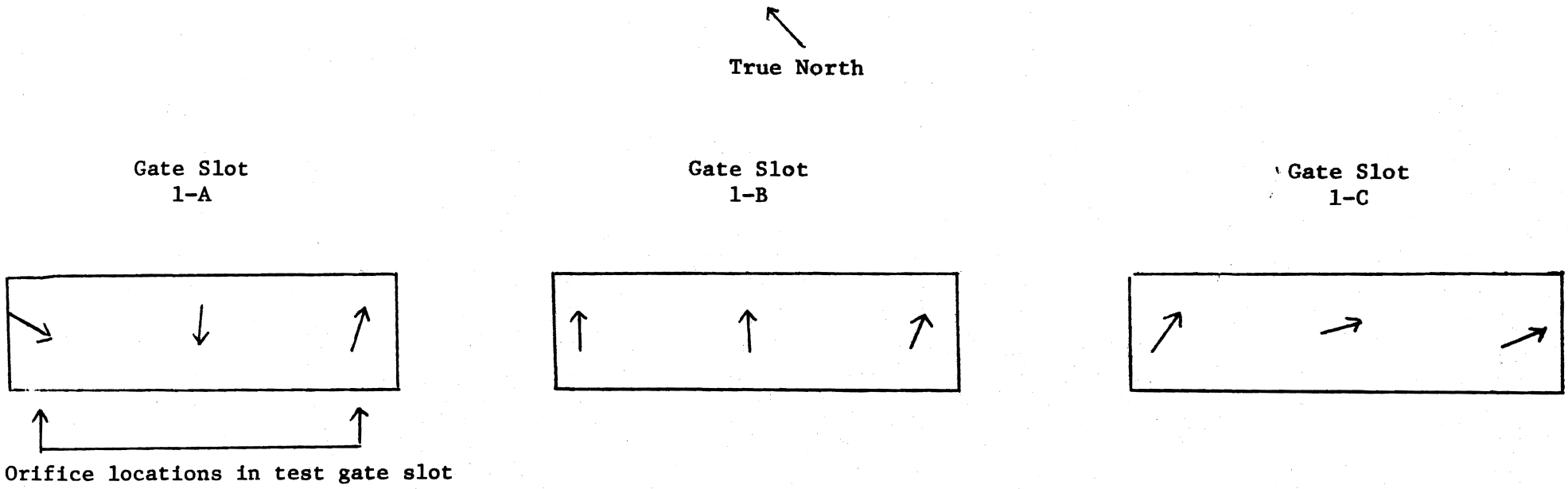
migration peak of steelhead. This could account for the greater passage rates for chinook salmon through orifices.

We had planned to complete the same experimental design in the operating gate slot that we used in the bulkhead slot. However, after completing the replicated tests with 8-inch diameter north and south lighted orifices, the scheme was abandoned. The passage rate for chinook salmon through the orifices was only 1% and for steelhead trout it was only 4%. It was apparent that removal of the upper two panels of the barrier screen to allow fingerlings access to orifices placed on the downstream wall (Figure 1) created an escape route back to the turbine intake. When we dipped the bulkhead slot following the tests, no test fish were recovered and very few naturally entering migrants were detected. This approach therefore should no longer be considered.

## Directional Currents in the Bulkhead Slot

We have shown that in all tests where a choice of north or south orifices was offered, both chinook salmon and steelhead trout preferred the north orifice. Our only clue to this preference was indicated by highly variable surface currents observed in the gatewells. Similar currents occurring at the orifice level could affect the entry rate of fish into the orifices. To check this, directional current readings were taken at the orifice level in the bulkhead slot of turbine units 1A, 1B, and 1C. On 19 May, three measurements were made in each slot, using a Sevonious-type directional current meter, while the turbine was operated under the same conditions that occurred during the orifice passage tests. Results are indicated in Figure 2.

Figure 2.--Directional current readings taken at elevation 629.0 ft (orifice level) in the intake bulkhead gate slots of Unit 1 at Little Goose Dam.



In the test gatewell, the current at orifice depth was oriented toward the north orifice and away from the south orifice. By contrast, the current was oriented away from projected orifice locations in gatewells B and C. If currents were a factor in the selection of the north orifice in 1-A, then a more equal distribution of fish to both orifices could be expected in 1-B and 1-C. This rationale presents further need for placement of two orifices per gatewell for any future orifice system.

## Recommendations and Conclusions

1. Lighted orifices increase passage rates for chinook salmon, but appear to have little effect on passing steelhead trout.

2. A complete orifice system could be constructed at Little Goose Dam which would entail the use of north and south 12-inch diameter lighted orifices in the downstream walls of the bulkhead slots, and a transfer pipe leading from the orifices to the downstream wall of the operating slot. However, we see no reason why similar orifices could not be used in the upstream wall where no transfer pipe is needed. To conserve water 8- or 10-inch diameter inserts could be discreetly used while maintaining adequate fish passage.

3. The removal of the upper portion of the barrier screen to allow fingerlings access to orifices in the operating gate slot creates an escape route back to the turbine intake. Therefore, construction of an orifice system in the operating gate slots is not possible under present conditions.

4. Current directions may have an effect on fish movement through orifices in gatewells. Testing conducted in the test bulkhead slot indicated that the current was oriented towards the preferred orifice (north). Currents were oriented away from similar orifice locations in other gatewells. Since current directions vary in different gatewells, it is apparent that two orifices must be used to realize satisfactory passage.

## RESEARCH-McNARY DAM

In 1978, NMFS began an evaluation of the newly constructed fingerling collection system at McNary Dam. In a sense, the system was incomplete because vertical barrier screens were installed in only 9 of the 42 gatewells, and only four gatewells had any form of guiding device extending into the turbine intake—three standard monofilament mesh screens and one parallel bar scoop. During much of the season, fish diverted into the screened gatewells were removed from the collection system as part of intake screening evaluation research being conducted under this and other CofE contracts. An increased number of fish through the system is anticipated with: 1) installation of vertical barrier screens in all units by 1979 and 2) subsequent installation of guiding devices in all turbine intakes by 1980.

At McNary Dam, once fingerlings are in the gatewell, they may enter the bypass system through a 12-inch diameter orifice leading to a flume suspended on the wall of the existing ice and trash sluiceway. At the north end of the powerhouse, fingerlings pass from the flume into a 20-inch diameter pipe terminating at an upwell located at the holding facility on the tailrace deck. Upon emergence from the upwell, they pass over a perforated plate water eliminator and onto grading bars before entering four water-filled bins where they must pass through an electronic fish counter before entering one of seven raceways. The raceways are elevated, permitting gravity transfer of the fingerlings to either a transport truck or to the laboratory building for examination and marking. Much of the design and operation features of the system were based on experience gained from similar operations at Little Goose and Lower Granite Dams.

The first year's activity under this contract centered on "debugging" the new facility, initiating research for the evaluation of fingerling transportation from NcNary Dam, and testing traveling screens in turbine intake gatewells. Testing of the non-traveling bar screen was done under a separate contract with CofE.

TRANSPORT TESTS

Collection and transportation at McNary Dam began on 10 April 1978 and continued through 30 August. During this period approximately 610,000 salmonid and steelhead fingerlings passed through the collection system.

Because of low collection capability, we proposed to mark only two groups (test and control) for each of the major species and races of fingerlings. Test groups were transported by truck to a release site below Bonneville Dam, and control groups were released into the McNary Dam tailrace. The experimental design for the transport tests is given in Table 11.

Each group was marked with a distinctive cold brand and coded wire tag; all groups had adipose fins removed. Releases included spring chinook, sockeye, coho, and summer/fall chinook salmon and steelhead trout. In 1978, 122,482 fingerlings were marked and transported to release sites below Bonneville Dam, and 111,924 were marked and released as controls at McNary Dam (Table 12). (Appendix Tables 22 to 25 contain marking data for each species by day including tag loss information and daily counts. Mortality in the collection system and numbers of fish returned to the river are shown in Appendix Table 26).

Evaluation of the survival of each group will be based on adult returns to the hatcheries; spawning grounds; commercial, sports, and Indian fisheries; and the adult separators at Bonneville and McNary Dams. (An adult separator is to be installed in the Washington shore fish ladder at McNary Dam in 1979.)

Table 11.--Experimental design for transport and control juvenile steelhead and Pacific salmon proposed to be marked at McNary Dam, 1978.

| Test condition | Species or race | Number to be marked | Release site |
|---|---|---|---|
| Transport (truck) | Steelhead trout | 40,000 | Bonneville tailrace |
| Control | " | 40,000 | McNary tailrace |
| Transport (truck) | Spring chinook salmon | 40,000 | Bonneville tailrace |
| Control | " | 40,000 | McNary tailrace |
| Transport (truck) | Summer-fall chinook salmon | 40,000 | Bonneville tailrace |
| Control | " | 40,000 | McNary tailrace |
| Transport (truck) | Coho salmon | 40,000 | Bonneville tailrace |
| Control | " | 40,000 | McNary tailrace |
| Transport (truck) | Sockeye salmon | 40,000 | Bonneville tailrace |
| Control | " | 40,000 | McNary tailrace |
| | Total | 400,000 | |

Table 12.--Number of steelhead trout and Pacific salmon marked for test and control releases at McNary Dam, 1978.

| Species (race) | Number in test release | Number in control release | Total marked |
|---|---|---|---|
| Steelhead trout | 20,785 | 15,585 | 36,370 |
| Spring chinook salmon | 32,147 | 31,376 | 63,523 |
| Summer-fall chinook salmon | 40,361 | 38,137 | 78,498 |
| Coho salmon | 22,358 | 21,767 | 44,125 |
| Sockeye salmon | 6,831 | 5,059 | 11,890 |
| | 122,482 | 111,924 | 234,406 |

It is obvious from Tables 11 and 12 that proposed goals for marking were only met for summer/fall chinook salmon. Numbers of coho and sockeye salmon and steelhead trout marked fell far short of expectations. Collection totals for these species were 64,000, 38,000, and 60,000, respectively (Appendix Table 26); therefore, it would appear that marking totals should have been much closer to our proposed totals. However, tagging capability in 1978 was not flexible enough to handle tagging of multiple species. On 4 May, for example, spring chinook, coho, and sockeye salmon and steelhead trout were all available in reasonable numbers. Since all species could not be tagged simultaneously, over half of the 12,000 fish collected that day were returned to the river. In 1979, more tagging machines will be available to cope with this problem.

DESCALING, DELAYED MORTALITY, AND WATER QUALITY MEASUREMENTS

Descaling was monitored in gatewells and at the fingerling marking facility to index the condition of fingerlings and to alert us to potential problems in the bypass system. Descaling of spring chinook salmon and steelhead was monitored to provide comparable data to similar work at Little Goose and Lower Granite Dams. Descaling of chinook salmon averaged 5% in gatewells and 10% at the marking facility. Descaling of steelhead trout averaged 4% in the gatewells and 6% at the marking facility (Table 13 and Appendix Tables 27 and 28). The level of descaling is tolerable, especially in view of the fact that descaling of chinook salmon was 4 to 6% in gatewells of units 7 and 8 where guiding devices were not used.

The effects of accumulated stress associated with collecting, marking, and transporting were assessed in terms of delayed mortality after transport at Bonneville Dam. An attempt was made to take samples of fish from each transport load. Water samples from each load were taken to measure temperatures, $O_2$, $CO_2$, and pH. (These data are presented in Appendix Table 29, which also includes information on tag loss.)

Table 13.--Average descaling rates (%) for naturally migrating juvenile chinook salmon and steelhead trout from samples taken at the turbine intake gatewells at McNary Dam throughout 1978.

| | Unit 4 | | | | Unit 7 | | | | Unit 8 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Barrier screen and traveling screen | | | | No screen | | | | Barrier screen only | | | |
| | 65° angle | Varied 55° angle | | | | | | | | | | |
| | A (%) | B (%) | C (%) | Ave (%) | A (%) | B (%) | C (%) | Ave (%) | A (%) | B (%) | C (%) | Ave (%) |
| Gatewell | | | | | | | | | | | | |
| Spring chinook | 7 | 6 | 4 | 6 | | 4 | | 4 | 7 | 3 | 7 | 6 |
| Steelhead trout | 4 | 4 | 4 | 4 | | * | | | 4 | 3 | 5 | 4 |

* Insufficient fish for valid sample.

Delayed mortality assessment is presented in Table 14. Delayed mortalities for spring chinook salmon and steelhead trout fingerlings marked and transported from McNary Dam were similar, but slightly higher than were measured for comparable species from the Snake River. The average delayed mortalities for other species ranged from 9.7% for fall chinook salmon to 33.4% for sockeye salmon. We see no aberration in trucking operations or water quality measurements that can account for the apparent higher delayed mortality of fingerlings transported from McNary Dam.

TRAVELING SCREEN TESTS

In 1978, three new adjustable-angle, monofilament-mesh traveling screens were installed in unit 4 to determine the guiding efficiency and the injury or descaling caused by screens at McNary Dam. Parameters influencing screen performance that were investigated included: 1) screen angle (five angles in $5^{o}$ increments from 45 to $65^{o}$); 2) lighting on the traveling screen frame (lights on or off); and 3) turbine generating load (70 or 80 megawatts).

### Experimental Design and Procedures

Traveling screens were placed in turbine intakes of unit 4 (slots A, B, and C). Slot B was chosen as the test slot, and the angle of the screen was varied throughout the season according to the test plan. Traveling screens in the A slot were set at $65^{o}$, and the screen in the C slot was set at $55^{o}$. A and C slot screens were operated at the designated angle throughout the season. (Angles of 65 and $55^{o}$ were selected on the basis of earlier research at Lower Granite Dam, which indicated satisfactory performance.)

A temporary lighting system was installed on all screens. The system consisted of an array of twelve 500 watt incandescent bulbs attached to a framework welded to the backside of the screen. Lights were spaced so that the entire screen was illuminated.

Table 14.--Percent delayed mortality of five species/races of juvenile salmon and trout that were marked and transported by truck from McNary Dam to Bonneville Dam, 1978. Similar data for fish transported from Lower Granite and Little Goose Dams to Bonneville Dam are presented for comparison.

| | Range of mortality | | | Weighted average mortality | | |
|---|---|---|---|---|---|---|
| Species | McNary (%) | Lower Granite (%) | Little Goose (%) | McNary (%) | Lower Granite (%) | Little Goose (%) |
| Spring chinook | 0.0-60.0 | 6.5-43.7 | 0.0-52.0 | 19.1 | 17.1 | 13.1 |
| Steelhead | 0.0-15.0 | 0.0-4.2 | 0.0-8.3 | 3.1 | < 1.0 | 2.6 |
| Coho | 0.0-42.5 | - | - | 19.5 | - | - |
| Sockeye | 9.1-75.0 | - | - | 33.4 | - | - |
| Fall chinook | 2.6-29.9 | - | - | 9.7 | - | - |

Tests were conducted using naturally migrating spring chinook salmon collected from gatewells. Fish were marked by tattooing with a fluorescent pigment. Test groups were made up of three replicates; each replicate contained 150 fish. We used a modified random design so that screen angle, turbine load, and lights were tested in no particular sequence (See Appendix Table 30).

Test fish were introduced into the intake of unit 4B through a 4-inch diameter hose placed behind the trash rack and held in place by cable. The hose terminated about 20 ft upstream from the traveling screen and 4 to 6 ft below the intake ceiling.

During tests, orifices in 4B were closed to prevent egress of fish from the gatewell. Fish were recovered by dipnetting the gatewell after each test group (3 replicates) was released. The number of fish recovered compared to the number of fish released provided a measure of guiding efficiency. All fish recovered were examined for descaling and the standard descaling rate was determined.

## Results

The traveling screen with monofilament mesh and 46% perforated plate backing was outfitted with lights and was made available for testing in unit 4B on 2 May 1978. A composite of 26 individual tests (including some repeated tests) with juvenile spring chinook salmon are ranked according to average percent guidance in Table 15. The best guidance (81%) was obtained at a 45° angle with screen lights off at a turbine load of 80 megawatts. This finding was viewed with suspicion, and when repeated, the ranking fell from 1 to 21 (55% guidance). In most tests where guidance was 70% or better, (rankings one to eight) screen angle was at either 60 or 65°. In all tests where guidance was 70% or greater, descaling was low (one to six percent). Guidance was apparently not related to use of lights (lights were on for four of eight tests where guidance was good, 13 of 26 tests overall). Changes in turbine load (70 or 80 megawatts) did not affect guidance in these tests.

Table 15.--Results of test using an adjustable angle traveling screen with 46% perforated plate under a variety of operating conditions at McNary Dam, 1978. (All tests conducted with juvenile spring chinook salmon.

| Order of results | Average recovery 1/ (%) | Average descaling 2/ (%) | Screen angle (degrees) | Lights | Unit load ( megawatts) |
|---|---|---|---|---|---|
| 1 | 81 | 1 | 45 | Off | 80 |
| 2 | 75 | 3 | 55 | On | 70 |
| 3 | 74 | 1 | 65 | Off | 80 |
| 4 | 72 | 6 | 60 | Off | 70 |
| 5 | 71 | 1 | 65 | On | 80 |
| 6 | 70 | 4 | 60 | Off | 80 |
| 7 | 70 | 5 | 65 | On | 70 |
| 8 | 70 | 6 | 60 | On | 80 |
| 9 | 68 | 6 | 55 | Off | 80 |
| 10 | *67 | 3 | [illegible] | On | 80 |
| 11 | *67 | 5 | 55 | On | 80 |
| 12 | 67 | 6 | 60 | On | 70 |
| 13 | *66 | 8 | 55 | On | 70 |
| 14 | *65 | 2 | 65 | Off | 80 |
| 15 | *62 | 4 | 45 | On | 80 |
| 16 | *61 | 4 | 55 | Off | 80 |
| 17 | 60 | 2 | 50 | Off | 80 |
| 18 | 59 | 11 | 55 | Off | 70 |
| 19 | *59 | 15 | 55 | Off | 70 |
| 20 | 58 | 6 | 65 | Off | 70 |
| 21 | *55 | 6 | 45 | Off | 80 |
| 22 | 53 | 10 | 45 | Off | 70 |
| 23 | 51 | 8 | 55 | On | 80 |
| 24 | 49 | 6 | 45 | On | 80 |
| 25 | 46 | 1 | 50 | On | 80 |
| 26 | 40 | 6 | 45 | On | 70 |

* Indicates the repeat of a test.

1/ Percentage of fish released into the turbine intake that were recovered in the gatewell.

2/ Percentage of fish having 10% or more of their scales missing.

Descaling was generally low for the test groups. In tests 18, 19, and 22 average descaling was 10% or greater; however, these results were produced at screen angles of 45 or 55°. In all cases of high descaling, lights were off and the unit was operated at 70 megawatts. Average descaling for the season, regardless of test condition, was 6% for chinook salmon and 4% for steelhead trout (Table 13). Appendix Tables 27 and 28 contain more detailed daily descaling information.

Based on our tests using spring chinook salmon, traveling screens should be operated at a screen angle of 60 or 65° to obtain maximum guidance (Table 16). Operating the generator unit at 80 megawatts may help reduce descaling. Lights on the back side of traveling screens as tested at McNary Dam appeared to be of little or no value. However, since lighting on screens at Lower Granite Dam did produce positive results, a decision on the use of lights on screens at McNary Dam should probably be deferred until more tests are done. Extensive replication of tests using a good screen angle (60 or 65°) with and without lights would provide these clarifying data.

From 26 May to 1 June 1978, a series of 24 h accumulation tests were conducted in 4B, 7B, and 8B. The purpose of the tests was to determine a relative collecting efficiency for traveling screens (4B); no screening of any type (7B); and barrier screens (8B). We assumed that equal numbers of naturally migrating species would be available to enter each unit.

To begin the test, the three test gatewells were dipped to remove all fish, and the orifices were closed. During the subsequent 24 h accumulation period, units generated at a constant load (80 megawatts). Accumulated fish were then removed by dipping, counted by species, and examined for descaling. The test was replicated four times.

Relative collecting efficiency (percent accumulation) and descaling for each species is summarized in Table 17. Numbers collected and descaling for

Table 16.—Average percent guidance of spring chinook salmon subjected to traveling screen angles of 45 to 65° in tests at McNary Dam.

| Screen angle | 45° | 50° | 55° | 60° | 65° |
|---|---|---|---|---|---|
| Number of tests | 6 | 2 | 8 | 4 | 6 |
| Average percent guidance | 56.6 | 53.0 | 63.3 | 69.7 | 67.5 |

Table 17.--Relative guiding efficiency (percent accumulation) and percent descaling by gatewell slot designation and species during 24 h accumulation tests conducted at McNary Dam, 1978.

| Slot | Species | % total accumulation by species | % descaling for each species |
|---|---|---|---|
| 4B Barrier screens & traveling screens | Chinook | 67 | 4 |
| | Steelhead | 66 | 3 |
| | Coho | 77 | 5 |
| | Sockeye | 63 | 9 |
| 7B (no screens) | Chinook | 10 | * |
| | Steelhead | 6 | * |
| | Coho | 4 | * |
| | Sockeye | 9 | * |
| 8B (Barrier screens) | Chinook | 23 | 2 |
| | Steelhead | 28 | 3 |
| | Coho | 19 | 4 |
| | Sockeye | 28 | 1 |

* Sample to small for validity

each test is detailed in Appendix Table 31. The average percent of all species guided (collected) was 68% for 4B (traveling screen), 25% for 8B (barrier screen), and 7% for 7B (no screen). Overall descaling was highest in 4B, but only slightly so. The number of fish collected in 7B was so small that useful descaling data could not be measured. Our results appear promising, but they need to be verified since the assumption on an equal entry rate could not be tested. Tests planned for the spring of 1979 will provide not only the needed verification, but a direct comparison of traveling screen and bar screen guiding efficiencies.

## EVALUATION OF ADULT RETURNS

### PRELIMINARY RETURNS OF ADULT CHINOOK SALMON TO THE SNAKE RIVER

The primary means of evaluating the transport of Snake River salmonids from the upper dams to safe release sites below Bonneville Dam is measured by their rate of return as adults back to the Snake River. From 1972 to mid-1978 these returnees were intercepted by an automatic detector and trapping facility at Little Goose Dam. In July 1978 the Little Goose facility was dismantled, and a similar facility was installed at Lower Granite Dam. The main change was that in the new facility an "off-ladder" water supply was directed through the trapping facility. In subsequent tables on adult returns to the Snake River, we indicate that fish have returned to Lower Granite Dam (since July 1978) or to Little Goose Dam (all prior to July 1978).

#### 1975 Outmigration

The return to the Snake River of adult chinook salmon tagged as juveniles in 1975 is complete. The juveniles were either transported by truck to below Bonneville Dam or released as controls at Clarkston, Washington. The data summarizing numbers released and numbers returning as adults are presented in Table 18.

Table 18.--Returns to Lower Granite and Little Goose Dams of 1-, 2-, and 3-ocean chinook salmon from control and transport releases of smolts from Lower Granite Dam in 1975. Recoveries were made from 13 April 1976 to 22 November 1978.

| Release site and experimental groups | Number of juveniles1/ released | Number of adults recaptured | | | | Adult return in % of juveniles released | | Transport benefits3/ % |
|---|---|---|---|---|---|---|---|---|
| | | 1-ocean age | 2-ocean age | 3-ocean age | Total 1's,2's,3's | Observed | Estimated2/ | |
| Lower Granite Dam4/ (Control) | 42,915 | 12 | 56 | 59 | 127 | 0.296 | 0.813 | --- |
| Bonneville Dam (Transport) | | | | | | | | |
| Brand & wire tag | 30,127 | 32 | 43 | 70 | 145 | 0.481 | 1.275 | + 62.5 |
| Wire tag only | 38,423 | 30 | 67 | 197 | 294 | 0.765 | 2.107 | +158.4 |
| TOTALS | 111,465 | 74 | 166 | 326 | 566 | | | |

1/ Adjusted for initial tag loss.

2/ Based on camparison of known recovery of fish with magnetized wire tags at Little Goose Dam and the subsequent recovery of these and other marked fish at Rapid River Hatchery and on spawning ground upstream from Little Goose 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. See Appendix Tables 32 and 33. Expansion factors for each ocean age group were: 1-ocean, 2.0; 2-ocean, 2.78; 3-ocean, 2.86.

3/ Based on observed return.

4/ Adjusted for control fish which were transported from Little Goose Dam.

The survival of fingerlings following transportation was excellent in 1975. Survival of controls (not transported) was also excellent; with the result that the percentage of returning adults from all smolts released was the greatest since transport studies began in 1971. It is obvious that even with excellent river conditions for downstream migrants, transportation provided additional benefits that further increased survival by 62.5 to 158.4% for the two test (transport) groups.

Two different marking procedures were used in 1975. In one group, chinook salmon were wire tagged and marked with an appropriate brand correlating to the tag code used; in the second group, fish were wire tagged only. This was done to demonstrate the effect of additional marking or handling on survival. The wire tagged only group survived at a significantly higher rate. Significance is at the 99.5% level, based on a "G" statistic value of 21.962617. From Table 18, transport benefits were 62.5% (wire tag and brand) vs. 158.4% (wire tag only). However, the percent return increase of the wire tag group over the wire tag and brand group was 62.9%.

We believe that this experiment clearly demonstrates that minimal handling of chinook salmon, as in "mass transport operations," will result in substantial survival benefits, and that transportation of this delicate species is fully warranted in future years.

## 1976 Outmigration

In 1976, juvenile salmonids were transported by truck from both Lower Granite and Little Goose Dams to below Bonneville Dam. All experimental fish were marked with coded wire tags, branded, and adipose clipped. (Park et al. 1977 details the specific marking experiments). Fingerlings were transported in salt and fresh water, and similar release sites were used for the tests conducted at each dam.

Returns of spring chinook salmon are preliminary--lacking 3-ocean fish at this time. Therefore, in our analysis for incomplete adult returns, we will not calculate number of estimated fish returning. However, some general conclusions may be drawn from returns indicated in Table 19. The number of returns from all groups (transport and control) are low when compared to returns from the 1975 outmigration. Survival of fingerlings migrating on their own to John Day Dam was believed to be good (Sims et al. 1977). However, returns of transported fish and other adults to Lower Granite Dam through the 1978 upstream migration have fallen far below expectations. The outlook for bolstering these returns by large numbers of 3-ocean fish in 1979 must be one of only guarded optimism at this time.

Preliminary returns indicate that the use of salt water (5ppt) in trucks at Lower Granite Dam may have been beneficial. In tests at Little Goose Dam (10ppt salt water) the reverse appears to be true. The Bonneville powerhouse release site seems to have been better than the boat ramp site (one mile downstream from the dam on the north shore).

### 1977 Outmigration

Returns to date of chinook salmon transported in 1977 are poor. Only two jacks returned in 1978--both of which were transported from Lower Granite Dam. Although fingerlings were trucked from Little Goose Dam to Bonneville Dam, no fish have returned from these groups. Since the condition of all juveniles in the Snake River was poor in 1977, the benefits of transportation in 1977 remain in question.

## PRELIMINARY RETURNS OF ADULT STEELHEAD TROUT TO THE SNAKE RIVER

### 1975 Outmigration

Juvenile steelhead trout were trucked from Lower Granite Dam to Bonneville Dam according to the same test plan used for chinook salmon in 1975. Adult

Table 19.--Returns to Lower Granite and Little Goose Dams of 1- and 2-ocean age chinook salmon from control and transport releases of smolts from Lower Granite and Little Goose Dams in 1976. Recoveries were made from 2 July 1978 to 22 November 1978.

| Release site & experimental groups | Little Goose Dam | | | | | | Lower Granite Dam | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of juveniles released 1/ | No. of adults recaptured 1-ocean age | 2-ocean age | Total 1 & 2's | Adult return in % of juveniles released Observed | Transport benefits 2/ (%) | No. of juveniles released 1/ | No. of adults recaptured 1-ocean age | 2-ocean age | Total 1 & 2's | Adult return in % of juveniles released Observed | Transport benefits 2/ (%) |
| Control 3/ | 27,315 | 1 | 4 | 5 | 0.018 | -- | 21,711 | 2 | 7 | 9 | 0.041 | -- |
| Bonneville Boat Ramp | | | | | | | | | | | | |
| Freshwater transport | 36,239 | 3 | 6 | 9 | 0.025 | + 38.9 | 47,507 | 2 | 5 | 7 | 0.015 | - 63.4 |
| Saltwater transport 4/ | 46,244 | 2 | 6 | 8 | 0.017 | - 5.6 | 45,476 | 2 | 9 | 11 | 0.024 | - 41.5 |
| Control 3/ | 12,255 | 0 | 1 | 1 | 0.008 | -- | 2,847 | 0 | 1 | 1 | 0.035 | -- |
| Bonneville Powerhouse 5/ | | | | | | | | | | | | |
| Freshwater transport | 32,366 | 4 | 8 | 12 | 0.037 | +362.5 | 25,411 | 0 | 8 | 8 | 0.031 | - 11.0 |
| Saltwater transport 4/ | 35,838 | 0 | 10 | 10 | 0.028 | +250.0 | 15,970 | 1 | 8 | 9 | 0.056 | + 60.0 |
| TOTAL | 190,257 | 10 | 35 | 45 | | | 158,922 | 7 | 38 | 45 | | |

1/ Adjusted for initial tag loss.

2/ Based on observed teturn.

3/ Adjusted for control fish which were transported in the mass transport program at Little Goose and Lower Granite Dams.

4/ 10 ppt salt water at Little Goose Dam and 5 ppt salt water at Lower Granite Dam.

5/ 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.

returns to the Snake River from these releases are essentially complete; a few 3-ocean returns may pass Lower Granite Dam and enter hatcheries in the spring of 1979. Returns to the adult collection facility are shown in Table 20.

Survival of test and control groups was excellent. Benefits provided by transportation were excellent, although survival of controls was also very good. (Note observed and estimated percent return of adults from groups of smolt releases.) Transportation benefits were 254% and 197% for brand and wire tag and wire tag only groups, respectively. The additional stress of branding did not impact the survival of steelhead trout as it did chinook salmon.

In our 1978 report we presented a rationale to indicate how transportation was instrumental in accounting for large numbers of steelhead trout expected to return to Dworshak Hatchery in the spring of 1978 (Park et al. 1978). We predicted that at least 24,600 steelhead from the 1975 outmigration would return to Dworshak Hatchery or enter the Clearwater River. We now know that approximately 12,700 fish returned to Dworshak Hatchery and 14,500 fish of Dworshak Hatchery origin were harvested in the sport fishery. Total return of Dworshak Hatchery fish to the Clearwater River was approximately 27,200.

In spite of the large sport fishery harvest, the number of returns to the Dworshak Hatchery was a record. Perhaps because extremely large numbers of fish were handled at Dworshak Hatchery in the spawning processes, sampling for marked fish (including those from NMFS transport studies) was not as efficient as it should have been. Neither the number of marked fish returning from special studies originating at the hatchery (564) nor from NMFS transported fish (135 transported fish recovered as noted in Appendix Table 32) was as high as expected.

Table 20.--Returns to Lower Granite and Little Goose Dams of 1-, 2-, and 3-ocean age adult steelhead trout from control and transport releases of smolts from Lower Granite Dam in 1975. Recoveries were made from 1 July 1976 to 22 November 1978.

| Release site and experimental group | Number of juveniles released 1/ | Number of adults recaptured | | | | Adult return in % of juveniles released 2/ | | Transport benefits 3/ (%) |
|---|---|---|---|---|---|---|---|---|
| | | 1-ocean age | 2-ocean age | 3-ocean age | Total 1, 2 & 3's | Observed | Estimated | |
| Lower Granite Dam 4/ (control) | 46,823 | 57 | 140 | 3 | 200 | 0.427 | 0.773 | -- |
| Bonneville Dam | | | | | | | | |
| Brand & wire tag (transport) | 24,078 | 100 | 262 | 2 | 364 | 1.512 | 2.745 | +254 |
| Wire tag only (transport) | 36,397 | 135 | 325 | 2 | 462 | 1.269 | 2.291 | +197.2 |
| TOTAL | 107,298 | 292 | 727 | 7 | 1026 | | | |

1/ Adjusted for initial tag loss.

2/ 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 Dworshak National Hatchery upstream from Little Goose. Returning fish identified at the dams were marked with jaw tags and released to continue their migration upstream. Numbers of externally-tagged fish arriving at Dworshak Hatchery were compared with the recovery of other wire tagged fish arriving at Dworshak Hatchery not previously detected and identified at Little Goose and Lower Granite Dams. (Appendix Table 32) Expansion factors for 1- and 2-ocean age fish are: 1.33 and 2.00, respectively. (2.00 is also used for 3-ocean fish pending returns to Dworshak Hatchery in 1979.)

3/ Based on observed return.

4/ Adjusted for control fish which were transported from Little Goose Dam.

We conclude that, because the ratio of marked transported fish to marked Dworshak Hatchery fish was higher than expected, we were justified in estimating a range of transport contributions for fish returning to Dworshak Hatchery of 36 to 65%. We further conclude that transportation from Lower Granite Dam is a very viable means for increasing survival of Snake River Steelhead trout without impacting their homing ability.

## 1976 Outmigration

The return of adult steelhead trout to the Snake River in 1977-1978 from smolts transported from Lower Granite and Little Goose Dams as juveniles in 1976 is nearly complete. Preliminary returns of control and transported fish are summarized in Table 21.

Benefits for steelhead trout transported from Little Goose Dam to release sites below Bonneville Dam are excellent, ranging from 190 to 601%, depending upon the test condition. Benefits from the Bonneville boat ramp site are considerably better than from the Bonneville powerhouse site. No substantial benefits can be seen for fish hauled in 10ppt salt water.

Benefits for steelhead trout transported from Lower Granite Dam to release sites below Bonneville Dam are poor compared to similar tests at Little Goose Dam. No benefit can be shown for fish transported to the boat ramp site. A positive benefit of 88 to 104% for the powerhouse site is more encouraging. No benefit was realized by using salt water (5ppt) in hauls from Lower Granite Dam, in fact, survival may have been reduced by its use.

It is not clear to us why transport from Lower Granite Dam in 1976 was relatively unsuccessful compared to similar transports from Little Goose Dam; especially when we noted excellent returns for steelhead transported from Lower Granite Dam in 1975. We are investigating the possibility of poor quality wire or wire tag detection capability for fish marked for transport releases from Lower Granite Dam in 1976. Recovery data at hatcheries in the spring of 1979 may help clarify the enigma.

Table 21.--Returns to Lower Granite and Little Goose Dams of 1- and 2-ocean age adult steelhead trout from control and transport releases of smolts from Lower Granite and Little Goose Dams in 1976. Recoveries were made from 28 May 1977 to 22 November 1978.

| Release site & experimental groups | Little Goose Dam | | | | | | Lower Granite Dam | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of juveniles released 1/ | No. of adults recaptured 1-ocean age | 2-ocean age | Total 1 & 2's | Adult return in % of juveniles released Observed | Transport benefits 2/ (%) | No. of juveniles released 1/ | No. of adults recaptured 1-ocean age | 2-ocean age | Total 1 & 2's | Adult return in % of juveniles released Observed | Transport benefits 2/ (%) |
| Control 3/ | 7,135 | 8 | 7 | 15 | 0.210 | -- | 16,791 | 31 | 24 | 55 | 0.328 | -- |
| Bonneville Boat Ramp | | | | | | | | | | | | |
| Freshwater transport | 10,666 | 86 | 71 | 157 | 1.472 | +601.0 | 7,304 | 19 | 5 | 24 | 0.329 | + 0.3 |
| Saltwater transport 4/ | 11,677 | 81 | 89 | 170 | 1.456 | +593.3 | 16,504 | 33 | 5 | 38 | 0.230 | - 29.9 |
| Control 3/ | 22,279 | 33 | 40 | 73 | 0.328 | -- | 17,114 | 33 | 13 | 46 | 0.269 | -- |
| Bonneville Powerhouse 5/ | | | | | | | | | | | | |
| Freshwater transport | 32,621 | 139 | 172 | 311 | 0.953 | +190.5 | 47,392 | 128 | 132 | 260 | 0.549 | +104.1 |
| Saltwater transport 4/ | 42,197 | 222 | 216 | 438 | 1.038 | +216.5 | 52,641 | 157 | 109 | 266 | 0.505 | + 87.7 |
| TOTAL | 126,575 | 569 | 595 | 1,164 | | | 157,746 | 401 | 288 | 689 | | |

1/ Adjusted for initial tag loss.

2/ Based on observed return.

3/ Adjusted for control fish which were transported in the mass transport program at Little Goose and Lower Granite Dams.

4/ 10 ppt salt water at Little Goose Dam and 5 ppt salt water at Lower Granite Dam.

5/ 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.

## 1977 Outmigration

In 1977 smolts were transported by truck from Little Goose Dam and by barge or truck from Lower Granite Dam. A preliminary summary of adult recoveries from these tests is shown in Table 22.

The poor condition of fingerlings related to prevailing drought conditions in 1977 is reflected by generally poor returns of transported steelhead trout. Transporting the fish appears to be far better than doing nothing however, as no control fish have returned to date. We believe that 2-ocean fish returning in 1979 will further bolster transport benefits, but total number of fish returning, whether transported or not, will be critically low. The results of a poor 2-ocean return may have severe impacts on production in streams or hatcheries where these stocks prevail (i.e., the Clearwater River and Dworshak Hatchery).

## RETURN OF ADULTS TO HATCHERIES, SPAWNING GROUNDS, INDIAN FISHERIES, COMMERCIAL FISHERIES, AND BONNEVILLE DAM

### Returns to Hatcheries and Spawning Grounds

In 1978, 37 adult chinook salmon from various test and control groups were recovered at Rapid River and Kooskia Hatcheries (Appendix Table 33). Most of these were from fish released in 1976. By contrast 23 chinook salmon were recovered on spawning grounds from various test releases (Appendix Table 34); all but one were from 1975 Lower Granite Dam test or control releases. It is interesting that recoveries at hatcheries were nearly all 2-ocean fish (this is normally true); however, recoveries on the spawning grounds were nearly all 3-ocean fish. Inspection of unmarked fish on spawning grounds indicated extremely few 1 and 2-ocean fish.

Recoveries noted above are most meaningful to us because: 1) they provide supportive evidence that transported fish are homing (comparable ratios of transport to control returns in fishery, at Lower Granite Dam trap, at hatcheries,

Table 22.--Preliminary returns to Lower Granite Dam of 1-ocean age steelhead trout from control and transport releases of smolts from Lower Granite and Little Goose Dams in 1977. Recoveries were made from 2 July 1978 to 22 November 1978.

| Release site & experimental groups | Little Goose Dam | | | | Lower Granite Dam | | | |
|---|---|---|---|---|---|---|---|---|
| | No. of juveniles released 1/ | No. of adults recaptured | Adult return in % of juveniles released Observed | Transport benefits 2/ (%) | No. of juveniles released | No. of adults recaptured | Adult return in % of juveniles released Observed | Transport benefits 2/ (%) |
| Control 3/ | 22,204 | 0 | 0 | -- | 33,152 | 0 | 0 | -- |
| Bonneville Freshwater transport | 24,272 | 4 | 0.016 | -- | 45,513 | 28 | 0.062 | -- |
| Saltwater transport 4/ | 22,916 | 6 | 0.026 | -- | | | | |
| Dalton Point transport | | | | | 40,899 | 30 | 0.073 | -- |
| Bonneville Barge transport | | | | | 30,330 | 26 | 0.086 | -- |
| TOTAL | 69,392 | 10 | | | 149,894 | 84 | | |

1/ Adjusted for initial tag loss.

2/ Not calculable because of zero controls returning.

3/ Not adjusted for control fish which were transported in the mass transport program at Little Goose and Lower Granite Dams.

4/ 10 ppt salt water.

and on spawning grounds) and 2) the number of wire-tagged adults carrying jaw tags can be compared to the number of wire-tagged adults without jaw tags, thereby providing an index of trap efficiency at the adult collector at the dam.

Recoveries of steelhead trout at upstream facilities are useful in the same way. In 1978, 314 fish were recovered at Dworshak and Pahsimeroi Hatcheries and at the Hells Canyon fish trap operated by Idaho Power Company. (See Appendix Table 32).

## Returns to Indian Fisheries and Commercial Fisheries

In 1977, NMFS began an intensive sampling effort to recover tagged adult steelhead trout (fish that were tagged as juveniles and transported to below Bonneville Dam or released as controls in the Snake River) from the Indian set net fishery in Zone 6 Bonneville pool area). In 1978, this effort was intensified further by interagency sampling and an exchange of data among the cooperating agencies.

In 1978, the Indian fishing began on 25 August and ended on 3 October. The period of fishing was arranged to allow a substantial harvest of fall chinook salmon—a species that is abundant in the lower Columbia River because of intensive hatchery productions. The period also coincides with timing of the "B" steelhead trout run, and because "B" steelhead are large (most are 2 or 3-ocean fish), they are landed along with chinook salmon in substantial numbers.

This year the estimated Indian landing of steelhead trout was 16,000 fish of which 6172 or 38.6% were sampled for marks. We recovered 367 2-ocean fish that were transported from the Snake River or released as controls in 1976.

These recoveries, together with 1-ocean recoveries from the 1976 releases are summarized in Table 23. From the 1976 releases, over 400 marked fish were recovered in the net fishery, and when expanded to total landings the number is

Table 23.--Adult steelhead trout recovered in Indian set net fishery in 1977-78 from transport and control releases of juveniles from Lower Granite and Little Goose Dams in 1976. (Estimated total recovery by expansion.)

| Year of recovery | Lower Granite Dam | | Little Goose Dam | |
|---|---|---|---|---|
| | Control | Transport groups | Control | Transport groups |
| 1977 1/ | 2(15) | 19(143) | 2(15) | 18(136) |
| 1978 2/ | 37(96) | 192(497) | 16(41) 3 | 122(316) |
| Totals | 39(111) | 211(640) | 18(56) | 140(452) |

1/ Sampling level of 3848 or 13.3% of estimated catch of 29,000 fish (f=7.53).

2/ Sampling level of 6172 or 38.6% of estimated catch of 16,000 fish (f=2.59).

3/ Not adjusted for control fish which were transported in the mass transport program at Little Goose and Lower Granite Dams.

over 1250. It is interesting that more fish from operations at Lower Granite Dam were taken in the fishery than were taken from the operations at Little Goose Dam. In all comparable groups (except Bonneville boat ramp saltwater) a higher percent return of adults from smolts released was realized from Lower Granite Dam groups (Table 24). The benefit of transportation among fish landed was excellent whether transported from Little Goose Dam or Lower Granite Dam; however, the best benefits were realized for those fish transported from Little Goose Dam.

The recovery of marked (wire tagged) fish from the Indian fishery is efficient because heads can be taken from the dead fish, and through laboratory procedures recovery of all wire tags is assured. In 1978, 6.24% of the fish sampled carried wire tags from NMFS Snake River transport studies. At the Lower Granite Dam adult collector, only 3.99% of the run (24,500) were detected to be carrying wire tags. Although the Indian fishery may have selectively removed the larger, 2-ocean fish, the selectivity probably had little effect on the total percentage recovery of tagged fish at Lower Granite Dam. Therefore, at the most, the collector was 64% efficient ($\frac{3.99}{6.24} = 0.64$). This represents a maximum efficiency because: 1) the Lower Granite collector operated throughout the run so that virtually 100% of the fish should have passed through it and 2) a portion of the Indian fishery sample (6172) and the estimated total harvest (16,000) would have homed to streams other than the Snake River. For example, if 2,000 of the 16,000 fish in the estimated harvest were non-Snake River stocks, then the mark recovery efficiency at Lower Granite Dam would be reduced to 56%. Only straying of Snake River fish would result in increasing the efficiency of mark recovery at Lower Granite Dam. This will be addressed later in the report.

Table 24.-- A comparison between transport and nontransport groups of 2-ocean age steelhead based on numbers of transported and nontransported juvenile fish from Little Goose and Lower Granite Dams in 1976 that were recaptured as adults in the Indian fishery in the lower Columbia River from 25 August to 3 October, 1978.

| Release site and experimental group | Little Goose Dam | | | | Lower Granite Dam | | | |
|---|---|---|---|---|---|---|---|---|
| | Number smolts released 1/ | Number adults recovered | % of smolt released | % transport benefit | Number smolts released 1/ | Number adults recovered | % of smolt released | % transport benefit |
| Control 2/ | 7,135 | 5 | 0.070 | - | 16,791 | 15 | 0.089 | |
| Bonneville Boat Ramp | | | | | | | | |
| Freshwater (transport) | 10,666 | 19 | 0.178 | + 154 | 7,304 | 14 | 0.192 | +116 |
| Saltwater (transport) 3/ | 11,677 | 22 | 0.188 | + 169 | 16,504 | 28 | 0.170 | + 91 |
| Control 2/ | 22,279 | 7 | 0.031 | - | 17,114 | 12 | 0.070 | - |
| Bonneville Powerhouse | | | | | | | | |
| Freshwater (transport) 4/ | 32,621 | 27 | 0.083 | +168 | 47,392 | 68 | 0.143 | +104 |
| Saltwater (transport) 3/ | 42,197 | 54 | 0.128 | +313 | 52,641 | 82 | 0.156 | +123 |
| Totals | 126,575 | 134 | | | 157,746 | 219 | | |

1/ Adjusted for initial tag loss.

2/ Adjusted for control fish which were transported in the mass transport program at Little Goose and Lower Granite Dams.

3/ 10 ppt salt water at Little Goose Dam and 5 ppt salt water at Lower Granite Dam.

4/ 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.

The number of Snake River chinook salmon and steelhead trout marked by NMFS and recovered in the ocean fisheries has been nil. However, in 1978 new stocks, primarily of Mid-Columbia River origin, were wire tagged and transported from McNary Dam. Coho salmon from the McNary Dam studies began entering the ocean fisheries by late summer of 1978. To date 34 coho salmon, 29 transports and 5 controls, have been recovered in ocean sport and commercial fisheries. This preliminary data for jacks indicate a transport benefit ratio of 5.8 to 1 (Appendix Table 35). Return of adults to the fishery and up river collection points in 1979 should provide more conclusive evidence regarding the success of McNary Dam transport operations.

## Return to Bonneville Dam

In July 1978 an adult collector system similar to the one used at Lower Granite Dam was installed in the north fishway at Bonneville Dam. The primary purpose of the installation is to provide a lower river sampling point for adult salmonids returning from groups of fish marked and released for homing-imprint studies financed by the Bonneville Power Administration. The unit will also provide some useful information on adults returning from our transportation studies.

The initial test operation of the Bonneville Dam adult collector began on 16 August and ended on 30 October 1978. This provided an opportunity to sample the "B" steelhead trout run which passed over Bonneville Dam during the period.

During the test period, seven adult seelhead trout from 1977 Lower Granite Dam test releases were detected. In addition, 14 coho salmon from the 1978 McNary Dam releases were captured. Most returns, however, were from releases of juvenile steelhead trout transported from Lower Granite and Little Goose Dams in 1976 (Table 25).

Table 25.--Preliminary returns to Bonneville Dam of 2-ocean age adult steelhead trout from control and transport releases of smolts from Lower Granite and Little Goose Dams in 1976. Recoveries were from 17 August 1978 to 30 October 1978.

| | Little Goose Dam | | | Lower Granite Dam | | |
|---|---|---|---|---|---|---|
| Release site and experimental groups | Number released 1/ | Number | Percent | Number released 1/ | Number | Percent |
| Control 2/ | 7,135 | 0 | 0.000 | 16,791 | 6 | 0.036 |
| Bonneville Boat Ramp 4/ | | | | | | |
| Freshwater (transport) | 10,666 | 6 | 0.056 | 7,304 | 1 | 0.014 |
| Saltwater (transport) 3/ | 11,677 | 3 | 0.026 | 16,504 | 3 | 0.018 |
| Control 2/ | 22,279 | 4 | 0.018 | 17,114 | 5 | 0.029 |
| Bonneville Powerhouse | | | | | | |
| Freshwater (transport) | 32,621 | 8 | 0.025 | 47,392 | 14 | 0.030 |
| Saltwater (transport) 3/ | 42,197 | 14 | 0.033 | 52,641 | 10 | 0.019 |
| Total | 126,575 | 35 | | 157,746 | 39 | |

1/ Adjusted for initial tag loss.
2/ Adjusted for control fish which were transported in the mass transport program at Little Goose and Lower Granite Dams.
3/ 10 ppt salt water at Little Goose Dam and 5 ppt salt water at Lower Granite Dam.

4/ 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.

We estimated that about 3300 steelhead trout passed through the collector facility (about 8% of the run at Bonneville Dam). Of these 81 (74 2-ocean fish and 7 1-ocean fish were from NMFS Snake River transport studies. Therefore, only 2.45% of the fish sampled were detected to be wire tagged. In our Indian fishery sampling, 6.24% of the fish were wire tagged by NMFS. We conclude that we either overestimated the number of fish subjected to detection or that the collector was inefficient in detecting the presence of tags. We believe the latter to be true.

We are, therefore, concerned that we are failing to recover significant numbers of tags at both adult collector facilities (Lower Granite and Bonneville Dams). The data generated from these collectors will continue to be useful; however, evidence is increasing that the number of observed returns we report is very conservative, and our estimated returns are much more realistic.

## Straying

We believe that straying of adult chinook salmon and steelhead trout following transportation as juveniles is minimal and of no practical concern. Throughout the progress of our studies, we have attempted to alert personnel from various agencies to be aware of our specially marked fish, and to report the presence of these fish found in areas other than the true homing locations. Appendix Table 36 indicates recoveries of steelhead trout and chinook salmon recovered in 1978 for all locations not previously covered in the report.

A total of 8 adult steelhead trout from juvenile releases in 1976 were reported from mid-Columbia River locations in 1978. Similar returns reported from the Klickitat and Deschutes Rivers may be strays however, there is evidence that up-river stocks move into lower tributaries for a short time and then proceed upriver. For example, sport fishing for steelhead in Draino Lake, near the mouth of the Little White Salmon River is excellent at times, although the river has little if any steelhead production. Also in special studies in the Deschutes River where steelhead trout have been tagged, some of these fish have been observed later at Dworshak Hatchery in Idaho.

It would appear that, based on the reported number of steelhead trout strays and the number of observed returns to Lower Granite Dam, that straying accounts for only 1-2% of the adult returns. Chinook salmon straying may be about the same level (one fish was reported for 1976 releases). Straying reported to date does not appear to be of significant consequence.

## SUMMARY

1. In 1978, 2,978,508 steelhead trout and chinook salmon were transported from Lower Granite and Little Goose Dams to safe release sites in the Columbia River below Bonneville Dam. We estimate that 64% of the steelhead and 51% of the chinook salmon that arrived at Lower Granite Dam were transported.

2. At Lower Granite Dam most smolts were mass transported. However, 180,558 chinook salmon and 91,669 steelhead trout were marked for transport tests and 54,343 chinook salmon and 55,669 steelhead were marked as controls. Delayed mortality for chinook salmon measured after transport to Bonneville Dam ranged from 4.1 to 17.1%, depending upon test treatment. Chinook salmon transported by barge had the lowest delayed mortality (4.1%). Delayed mortality for steelhead trout was insignificant.

3. In special load density tests conducted at Lower Granite Dam, in which a small container with simplified life support systems was used, results were mixed. Chinook salmon collected from gatewells in the fall had relatively high mortalities at densities of 1.0 to 1.5 lb of fish per gallon. In winter tests, when chinook salmon (parr) from Rapid River Hatchery were tested at densities of 2.0 to 3.0 lb per gallon, mortalities were low.

4. At Little Goose Dam most smolts were mass transported by truck to Bonneville Dam (520,642 unmarked fish). In addition, 136,029 chinook salmon and 99,973 steelhead trout were marked for mass transport (truck) experiments. Delayed mortalities of marked and unmarked transported groups of chinook salmon ranged from 6.6 to 13.1% (average by group). The lowest delayed mortality was shown for unmarked fish transported in 10ppt salt water. Delayed mortality for steelhead trout was low--0.2 to 2.6%.

5. A special configuration of two orifices whose diameters could be varied from 8 to 12 inches was tested in unit one (A slot) at Little Goose Dam. Pertinent findings were: a) lights must be used with orifices and b) a complete orifice system could be constructed which entails the use of north and south 12-inch diameter lighted orifices in the upstream wall of each bulkhead slot. To conserve water 8 or 10-inch diameter inserts could be used at specified times while maintaining adequate fish passage.

6. Evaluation of transportation of fingerlings from McNary Dam began in 1978. A total of 122,482 fingerlings were marked and transported by truck to below Bonneville Dam, and 111,924 fish were marked and released as controls at McNary Dam. Spring chinook salmon, sockeye salmon, coho salmon, summer/fall chinook salmon, and steelhead trout were transported. Delayed mortalities after transport were least for summer/fall chinook salmon (9.7%) and greatest for sockeye salmon (33.4%).

7. Traveling screens were used and tested for the first time at McNary Dam. In tests using spring chinook salmon, guidance efficiencies of more than 70% were achieved at screen angles of 60 or 65$^{o}$. Turbine load differences of 70 or 80 megawatts did not appear to affect guiding efficiencies, nor did the use of lights behind the screen. Descaling was relatively low in all tests, but least descaling occurred when the unit was operated at 80 megawatts.

8. Adults returns from juveniles transported from Lower Granite Dam in 1975 are complete. Transportation (by truck) provided benefits of 62.5 to 158.4% for chinook salmon depending on test group. Benefits for steelhead trout ranged from 197 to 254%. Although all fish benefited from excellent river conditions in 1975, the fact that transportation further increased survival illustrates the effectiveness of the transport concept.

9. Adults returning following transportation from Lower Granite and Little Goose Dams in 1976 are incomplete. Steelhead trout returns (nearly complete) indicate transport benefits of 191 to 601% and up to 104% for Little Goose Dam and Lower Granite Dam releases, respectively.

10. Returns of adults from transport studies were monitored at the spawning grounds and hatcheries above Lower Granite Dam. A total of 60 chinook salmon was recovered at Rapid River and Kooskia Hatcheries and on the spawning grounds. At hatcheries, 314 steelhead trout were recovered.

11. In 1978 NMFS together with other fishery agencies intensively sampled the Indian set net fishery. The fishery landed about 16,000 steelhead trout (Oregon Department of Fish and Wildlife estimate) of which 6,172 fish were sampled for marks. Over 400 marked fish from NMFS transport studies were recovered in the fishery.

12. Coho salmon from the McNary Dam studies (spring 1978) began entering the ocean fisheries by the late summer of 1978; to date, 29 transported fish and 5 control fish have been recovered. The preliminary transport benefit ratio for these jacks is 5.8 to 1.

13. A few steelhead trout (8) from 1976 transport and control releases were recovered at either hatcheries or from sport fisheries in the mid-Columbia region. These strays are few in number, and we do not believe they represent any serious impediment to transport operations.

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# APPENDIX

TABLES 1 to 36

Appendix Table 1.--Numbers of juvenile chinook salmon counted, trucked, barged, released as controls, mortality in collection and returned to Snake River by date at Lower Granite Dam, 1978.

| Date | Number counted | Trucked to Bonneville | | | | Barged to Bonneville | | Daily totals transported | Controls | Mortality in collection | Returned to river |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Salt water marked | Salt water unmarked | Fresh water marked | Fresh water unmarked | marked | unmarked | | | | |
| 4-4 | 35,477** | -- | -- | -- | 26,581 | -- | -- | 26,581 | -- | 115 | -- |
| 4-5 | 19,582 | -- | -- | -- | -- | -- | -- | -- | 2214 | 137 | 2064 |
| 4-6 | 13,775 | -- | -- | 3732 | 23,177 | -- | -- | 26,909 | -- | 197 | 53 |
| 4-7 | 16.786 | -- | -- | 4451 | 11,562 | -- | -- | 16,013 | -- | 256 | 21 |
| 4-8 | 15,166 | -- | -- | -- | 11,104 | -- | -- | 11,104 | 3364 | 242 | 2049 |
| 4-10 | 42,437* | -- | -- | 3320 | 380 | -- | -- | 3700 | 3405 | 125 | 547 |
| 4-11 | 18,274 | -- | -- | -- | -- | 8704 | 32,769 | 41,473 | -- | 251 | 25 |
| 4-12 | 20,613 | -- | -- | 3240 | 424 | -- | -- | 3664 | 2169 | 110 | 641 |
| 4-13 | 20,792 | -- | -- | 5198 | 1026 | 8710 | 3513 | 18,447 | -- | 245 | 209 |
| 4-14 | 28,851 | 7372 | 1202 | 2851 | 12,182 | -- | -- | 23,607 | -- | 464 | 201 |
| 4-15 | 21,854 | -- | -- | 6658 | 25,046 | -- | -- | 31,704 | 3148 | 606 | 789 |
| 4-17 | 40,735* | -- | -- | -- | -- | 8024 | 26,650 | 34,674 | -- | 552 | 42 |
| 4-18 | 16,591 | 6385 | 827 | -- | -- | -- | -- | 7212 | 3258 | 625 | 863 |
| 4-19 | 19,572 | -- | -- | 3113 | 405 | 4646 | 16,913 | 25,077 | -- | 359 | 15 |
| 4-20 | 23,990 | -- | -- | 4740 | 812 | -- | 15,528 | 21,080 | 3336 | 775 | 676 |
| 4-21 | 20,955 | -- | -- | 3173 | 648 | 5147 | 1035 | 10,003 | -- | 541 | 25 |
| 4-22 | 18,449 | 4712 | 836 | -- | -- | -- | 16,912 | 22,460 | 2488 | 415 | 740 |
| -24 | 32,641* | -- | -- | 2280 | 587 | -- | -- | 2867 | -- | 312 | 18 |
| -25 | 19,477 | -- | -- | 4348 | 1142 | -- | -- | 5490 | 2828 | 215 | 720 |
| -26 | 20,450 | -- | -- | 7481 | 3472 | -- | -- | 10,953 | -- | 215 | 15 |
| -27 | 34,660 | 5006 | 916 | -- | -- | -- | 58,416 | 64,338 | 7234 | 752 | 1518 |

* Indicates a combined total for 2 consecutive days.

* Indicates a combined total for 3 consecutive days.

Appendix Table 1.--continued--Numbers of juvenile chinook salmon counted, trucked, barged, released as controls, mortality in collection and returned to Snake River by date at Lower Granite Dam, 1978.

| Date | Number counted | Trucked to Bonneville: Salt water marked | Salt water unmarked | Fresh water marked | Fresh water unmarked | Barged to Bonneville: marked | unmarked | Daily totals transported | Controls | Mortality in collection | Returned to river |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-28 | 43,648 | -- | -- | -- | -- | 6400 | 3515 | 9915 | -- | 609 | 17 |
| 4-29 | 88,260 | -- | -- | 11,855 | 2382 | -- | 90,488 | 104,725 | 4200 | 1214 | 923 |
| 4-30 | 91,701 | -- | -- | -- | -- | -- | 78,764 | 78,764 | -- | 2100 | -- |
| 5-1 | 30,002 | -- | -- | 194 | 1634 | -- | 51,483 | 53,311 | -- | 1100 | 25 |
| 5-2 | 15,355 | 3915 | 1541 | -- | -- | -- | -- | 5456 | 2749 | 732 | 1725 |
| 5-3 | 15,177 | -- | -- | 307 | 880 | 4199 | 10,452 | 15,838 | -- | 487 | 26 |
| 5-4 | 7634 | -- | -- | -- | -- | -- | 2194 | 2194 | 1856 | 151 | 1520 |
| 5-5 | 6886 | -- | -- | 522 | 1400 | -- | 6798 | 8720 | -- | 86 | 70 |
| 5-6 | 6790 | -- | -- | 2426 | 667 | -- | 5480 | 8573 | -- | 54 | 6 |
| 5-8 | 14,607* | -- | -- | 518 | 225 | -- | 10,606 | 11,349 | 2066 | 107 | 346 |
| 5-9 | 8475 | -- | -- | -- | 376 | 1707 | 6580 | 8663 | -- | 110 | 5 |
| 5-10 | 8035 | -- | -- | 561 | 146 | -- | -- | 707 | 1934 | 111 | 474 |
| 5-11 | 9549 | -- | -- | -- | -- | 2186 | 12,359 | 14,545 | -- | 81 | 49 |
| 5-12 | 6559 | -- | -- | 1290 | 165 | -- | 4787 | 6242 | 1084 | 81 | 383 |
| 5-15 | 26,085** | -- | -- | 1220 | 1281 | -- | 23,826 | 26,327 | -- | 108 | 9 |
| 5-16 | 10,776 | -- | -- | -- | -- | 1450 | 7166 | 8616 | 1486 | 98 | 348 |
| 5-17 | 10,173 | -- | -- | 1356 | 303 | -- | -- | 1659 | -- | 78 | 7 |
| 5-18 | 7,071 | -- | -- | -- | -- | 822 | 15,027 | 15,849 | 797 | 112 | 183 |
| 5-19 | 10,209 | -- | -- | 1357 | 762 | -- | 6874 | 8993 | -- | 106 | 7 |
| 5-22 | 32,539** | -- | -- | 1383 | 367 | -- | 31,401 | 33,151 | -- | 38 | -- |
| 5-23 | 7548 | 5507 | 1137 | -- | -- | -- | 9787 | 16,431 | 1104 | 83 | 216 |
| 5-24 | 17,214 | -- | -- | -- | -- | 1579 | 4214 | 5793 | -- | 41 | 4 |

* Indicates a combined total for 2 consecutive days.

** Indicates a combined total for 3 consecutive days.

Appendix Table 1.--continued--Numbers of juvenile chinook salmon counted, trucked, barged, released as controls, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1978.

| Date | Number counted | Trucked to Bonneville | | | | Barged to Bonneville | | Daily totals transported | Number of controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Salt water marked | Salt water unmarked | Fresh water marked | Fresh water unmarked | marked | unmarked | | | | |
| 5-25 | 7859 | 8190 | 7057 | -- | -- | -- | -- | 15,247 | 1466 | 159 | 316 |
| 5-26 | 6100 | -- | -- | -- | -- | 1735 | 13,909 | 15,644 | -- | 78 | 11 |
| 5-27 | 3498 | -- | -- | -- | -- | -- | 2646 | 2646 | -- | 15 | -- |
| 5-30 | 11,162** | -- | -- | 3845 | 711 | -- | -- | 4556 | 1275 | 74 | 302 |
| 5-31 | 3175 | -- | -- | 1034 | 221 | 1237 | 14,869 | 17,361 | -- | 111 | 7 |
| 6-1 | 6128 | -- | -- | -- | -- | -- | -- | -- | 882 | 71 | 698 |
| 6-2 | 913 | -- | -- | 472 | 73 | -- | -- | 545 | -- | 51 | 2 |
| 6-5 | 4045** | -- | -- | -- | -- | -- | 9673 | 9673 | -- | -- | -- |
| 6-7 | 8596* | -- | -- | -- | 11,943 | -- | -- | 11,943 | -- | -- | 7 |
| 6-9 | 12,112* | -- | -- | -- | 12,784 | -- | -- | 12,784 | -- | 73 | 10 |
| 6-12 | 20,376** | -- | -- | -- | 21,343 | -- | -- | 21,343 | -- | 105 | 5 |
| 6-14 | 16,731* | -- | -- | -- | 20,491 | -- | -- | 20,491 | -- | 92 | 22 |
| 6-16 | 6695* | -- | -- | -- | 7360 | -- | -- | 7360 | -- | 75 | -- |
| 6-19 | 4502** | -- | -- | -- | 5499 | -- | -- | 5499 | -- | 55 | -- |
| 6-21 | 4259* | -- | -- | -- | 4736 | -- | -- | 4736 | -- | 65 | -- |
| TOTALS | 1,091,571 | 41,087 | 13,516 | 82,925 | 214,297 | 56,546 | 594,634 | 1,003,005 | 54,343 | 16,220 | 18,954 |

* Indicates a combined total for 2 consecutive days.

** Indicates a combined total for 3 consecutive days.

ppendix Table 2.--Numbers of juvenile steelhead trout counted, trucked, barged, released as controls, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1978.

| ate | Number counted | Number trucked to Bonneville | | | Number barged to Bonneville | | Daily totals transported | Number of controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Salt water Unmarked | Fresh water Marked | Fresh water Unmarked | Marked | Unmarked | | | | |
| -4 | 2967 | -- | -- | 1978 | -- | -- | 1978 | -- | 31 | -- |
| -5 | 1703 | -- | -- | -- | -- | -- | -- | -- | 23 | 389 |
| -6 | 3024 | -- | 181 | 4160 | -- | -- | 4341 | -- | 31 | 394 |
| -7 | 2289 | -- | 229 | 2024 | -- | -- | 2253 | -- | 27 | 60 |
| -8 | 2267 | -- | -- | 2232 | -- | -- | 2232 | 281 | 17 | 506 |
| -10 | 4109 | -- | 427 | 29 | -- | -- | 456 | 383 | 15 | 56 |
| -11 | 2731 | -- | -- | -- | 593 | 4908 | 5501 | -- | 25 | 25 |
| -12 | 3080 | -- | 402 | 120 | -- | -- | 522 | 358 | 12 | 66 |
| -13 | 3107 | -- | -- | 499 | 1107 | 1988 | 3594 | -- | 12 | 142 |
| -14 | 4697 | 542 | 353 | 2056 | -- | -- | 2951 | -- | 5 | 24 |
| -15 | 3857 | -- | -- | 2716 | -- | -- | 2716 | 486 | 11 | 195 |
| -17 | 5555* | -- | -- | -- | 1100 | 6162 | 7262 | -- | 21 | 0 |
| -18 | 6136 | 819 | -- | -- | -- | -- | 819 | 694 | 27 | 849 |
| -19 | 5203 | -- | 394 | 115 | 1377 | 3799 | 5685 | -- | 23 | 17 |
| -20 | 4914 | -- | -- | 685 | -- | 4638 | 5323 | 678 | 68 | 163 |
| -21 | 4600 | -- | 783 | 203 | 1032 | 203 | 2221 | -- | 16 | 22 |
| -22 | 6149 | 993 | -- | -- | -- | 8259 | 9252 | 748 | 15 | 2 |
| -24 | 8160* | -- | 563 | 140 | -- | -- | 703 | -- | 7 | 9 |
| -25 | 3710 | -- | -- | 498 | -- | -- | 498 | 518 | 12 | 159 |
| -26 | 4489 | -- | 1314 | 1026 | -- | -- | 2340 | -- | 21 | 62 |
| -27 | 6117 | 474 | -- | -- | -- | 12,335 | 12,809 | 1436 | 127 | 468 |
| -28 | 12,311 | -- | -- | -- | 1472 | 3997 | 5469 | -- | 41 | 40 |

* Indicates a combined total for 2 consecutive days.

Appendix Table 2.--continued--Numbers of juvenile steelhead trout counted, trucked, barged, released as controls, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1978.

| Date | Number counted | Number trucked to Bonneville | | | Number barged to Bonneville | | Daily totals transported | Number of controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Salt water Unmarked | Fresh water Marked | Fresh water Unmarked | Marked | Unmarked | | | | |
| 4-29 | 69,348 | -- | -- | 2119 | -- | 55,609 | 57,728 | 3274 | 510 | 736 |
| 4-30 | 49,377 | -- | -- | -- | -- | 42,613 | 42,613 | -- | 300 | -- |
| 5-1 | 51,084 | -- | 7276 | 271 | 7065 | 84,418 | 99,030 | -- | 530 | 52 |
| 5-2 | 31,172 | 5926 | -- | -- | -- | -- | 5926 | 7943 | 303 | 1267 |
| 5-3 | 28,186 | -- | 2563 | 880 | 7295 | 40,033 | 50,771 | -- | 393 | 28 |
| 5-4 | 32,543 | -- | -- | -- | -- | 8252 | 8252 | 10,590 | 197 | 3595 |
| 5-5 | 29,357 | -- | 3770 | 4339 | -- | 40,873 | 48,982 | -- | 144 | 154 |
| 5-6 | 30,933 | -- | -- | 6535 | -- | 31,314 | 37,849 | -- | 67 | 10 |
| 5-8 | 51,790* | -- | 2694 | 807 | -- | 41,230 | 44,731 | 6356 | 174 | 1270 |
| 5-9 | 21,792 | -- | -- | 3379 | 5312 | 19,360 | 28,051 | -- | 125 | 42 |
| 5-10 | 22,868 | -- | 2588 | 612 | -- | -- | 3200 | 4415 | 164 | 1251 |
| 5-11 | 22,281 | -- | -- | -- | 4495 | 27,932 | 32,427 | -- | 159 | 223 |
| 5-12 | 20,771 | -- | 4299 | 726 | -- | 12,513 | 17,538 | 2646 | 127 | 1530 |
| 5-15 | 71,769** | -- | 4307 | 3474 | -- | 60,438 | 68,219 | -- | 174 | 42 |
| 5-16 | 25.143 | -- | -- | -- | 3013 | 17,525 | 20,538 | 2899 | 194 | 1128 |
| 5-17 | 27,503 | -- | 3365 | 1143 | -- | -- | 4508 | -- | 171 | 28 |
| 5-18 | 26,600 | -- | -- | -- | 2743 | 42,729 | 45,472 | 2896 | 132 | 1003 |
| 5-19 | 24,996 | -- | 3640 | 1620 | -- | 18,213 | 23,473 | -- | 134 | 21 |
| 5-22 | 78,556** | -- | 3037 | 1001 | -- | 67,078 | 71,116 | -- | 64 | 9 |
| 5-23 | 23,903 | 7730 | -- | -- | -- | 18,014 | 25,744 | 3355 | 121 | 906 |

* Indicates a combined total for 2 consecutive days.

** Indicates a combined total for 3 consecutive days.

Appendix Table 2.--continued--Numbers of juvenile steelhead trout counted, trucked, barged, released as controls, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1978.

| Date | Number counted | Number trucked to Bonneville | | | Number barged to Bonneville | | Daily totals transported | Number of controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Salt water Unmarked | Fresh water Marked | Fresh water Unmarked | Marked | Unmarked | | | | |
| 5-24 | 30,602 | -- | -- | -- | 2486 | 13,685 | 16,171 | -- | 32 | 12 |
| 5-25 | 11,310 | 7614 | -- | -- | -- | -- | 7614 | 2018 | 104 | 531 |
| 5-26 | 8777 | -- | -- | -- | 2296 | 23,435 | 25,731 | -- | 42 | 3 |
| 5-27 | 13,157 | -- | -- | -- | | 10,029 | 10,029 | -- | 20 | -- |
| 5-30 | 32,616** | -- | -- | 2061 | -- | -- | 2061 | 2074 | 67 | 457 |
| 5-31 | 6446 | -- | 2197 | 522 | 2384 | 29,308 | 34,411 | -- | 73 | 8 |
| 6-1 | 12,443 | -- | -- | -- | | -- | -- | 1621 | 46 | 1524 |
| 6-2 | 6698 | -- | 3517 | 392 | -- | -- | 3909 | -- | 32 | 51 |
| 6-5 | 20,290** | -- | -- | -- | -- | 32,532 | 32,532 | -- | -- | -- |
| 6-7 | 5154 | -- | -- | 9772 | -- | -- | 9772 | -- | -- | 6 |
| 6-9 | 8256* | -- | -- | 7193 | -- | -- | 7193 | -- | 72 | 4 |
| 6-12 | 9123** | -- | -- | 6731 | -- | -- | 6731 | -- | 35 | 10 |
| 6-14 | 5284* | -- | -- | 2816 | -- | -- | 2816 | -- | 10 | 18 |
| 6-16 | 2438* | -- | -- | 2418 | -- | -- | 2418 | -- | 15 | -- |
| 6-19 | 1636** | -- | -- | 1086 | -- | -- | 1086 | -- | 10 | -- |
| 6-21 | 1298* | -- | -- | 1184 | -- | -- | 1184 | -- | 20 | -- |
| TOTALS | 1,016,675 | 24,098 | 47,899 | 79,562 | 43,770 | 783,422 | 978,751 | 55,669 | 5348 | 19,567 |

* Indicates a combined total for 2 consecutive days.

** Indicates a combined total for 3 consecutive days.

Appendix Table 3.--Numbers of juvenile chinook salmon counted, trucked, released as controls, mortality in collection, and returned to Snake River by date at Little Goose Dam, 1978.

| Date | Number counted | Trucked to Bonneville: Fresh water marked | Fresh water unmarked | Salt water marked | Salt water unmarked | Daily totals transported | Number controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|
| 4-6 | 6206 | -- | 6156 | -- | -- | 6156 | -- | 50 | -- |
| 4-8 | 8661* | -- | 8355 | -- | -- | 8355 | -- | 306 | -- |
| 4-10 | 11,448* | 5827 | 5246 | -- | -- | 11,073 | -- | 375 | -- |
| 4-11 | 3989 | -- | -- | -- | -- | -- | 3151 | 88 | 750 |
| 4-12 | 6632 | -- | -- | 2705 | 3881 | 6586 | -- | 46 | -- |
| 4-13 | 2358 | -- | -- | -- | -- | -- | 2329 | 29 | -- |
| 4-14 | 8167 | -- | -- | 4342 | 3751 | 8093 | -- | 74 | -- |
| 4-15 | 17,979 | -- | 17,834 | -- | -- | 17,834 | -- | 145 | -- |
| 4-17 | 30,077* | -- | -- | 7504 | 20,261 | 27,765 | 1925 | 387 | -- |
| 4-18 | 9414 | 6292 | 3028 | -- | -- | 9320 | -- | 94 | -- |
| 4-19 | 12,099 | -- | -- | 5320 | 5027 | 10,347 | -- | 116 | 1636 |
| 4-20 | 9186 | -- | -- | -- | -- | -- | 8872 | 314 | -- |
| 4-21 | 19,484 | 6650 | 11,252 | -- | -- | 17,902 | 899 | 683 | -- |
| 4-22 | 15,375 | -- | -- | -- | 15,143 | 15,143 | -- | 232 | -- |
| 4-24 | 28,387* | 6956 | 18,136 | -- | -- | 25,092 | 2721 | 524 | 50 |
| 4-25 | 17,283 | -- | -- | 6868 | 8,030 | 14,898 | 1801 | 584 | -- |
| 4-26 | 9052 | 4797 | 3987 | -- | -- | 8784 | -- | 268 | -- |
| 4-27 | 12,161 | -- | -- | 5989 | 6061 | 12,050 | -- | 111 | -- |
| 4-28 | 10,891 | 1445 | 4202 | -- | -- | 5647 | 5147 | 97 | -- |
| 4-29 | 8791 | -- | -- | -- | 8675 | 8675 | -- | 116 | -- |
| 5-1 | 31,617* | -- | -- | 4065 | 24,435 | 28,500 | 2690 | 427 | -- |
| 5-2 | 63,743 | 2832 | 35,643 | 1054 | 22,629 | 62,158 | 785 | 800 | -- |
| 5-3 | 63,137 | 4700 | 27,388 | 2166 | 28,12[illegible] | 62,375 | -- | 762 | -- |

* Indicates a combined total for 2 consecutive days.

Appendix Table 3.--continued--Numbers of juvenile chinook salmon counted, trucked, released as controls, mortality in collection, and returned to Snake River by date at Little Goose Dam, 1978.

| Date | Number counted | Trucked to Bonneville: Fresh water marked | Fresh water unmarked | Salt water marked | Salt water unmarked | Daily totals transported | Number controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|
| 5-4 | 36,535 | 46 | 14,654 | 4762 | 15,949 | 35,411 | 620 | 504 | -- |
| 5-5 | 18,105 | 3309 | 10,367 | 495 | 3783 | 17,954 | -- | 151 | -- |
| 5-6 | 6245 | 2109 | 3650 | -- | -- | 5759 | 414 | 72 | -- |
| 5-7 | 9485 | -- | -- | -- | 9420 | 9420 | -- | 65 | -- |
| 5-8 | 7716 | 3653 | 3511 | -- | -- | 7164 | 374 | 178 | -- |
| 5-9 | 7226 | -- | -- | 2270 | 3881 | 6151 | 1002 | 73 | -- |
| 5-10 | 7675 | 517 | 6893 | -- | -- | 7410 | 5 | 260 | -- |
| 5-11 | 6224 | -- | -- | 214 | 5924 | 6138 | 2 | 84 | -- |
| 5-12 | 4640 | 208 | 4378 | -- | -- | 4586 | 2 | 52 | -- |
| 5-13 | 9064 | -- | -- | -- | 9004 | 9004 | -- | 60 | -- |
| 5-15 | 19,340* | 1633 | 17,574 | -- | -- | 19,207 | -- | 133 | -- |
| 5-16 | 9780 | -- | -- | 331 | 9409 | 9740 | -- | 40 | -- |
| 5-17 | 9948 | -- | 9920 | -- | -- | 9920 | -- | 28 | -- |
| 5-18 | 7844 | -- | -- | 519 | 6615 | 7134 | 680 | 30 | -- |
| 5-19 | 1550 | -- | -- | -- | -- | -- | 1512 | 38 | -- |
| 5-20 | 8218 | -- | 8194 | -- | -- | 8194 | -- | 24 | -- |
| 5-22 | 6339* | -- | -- | 7 | 6230 | 6237 | 40 | 34 | 28 |
| 5-23 | 250 | -- | -- | -- | -- | -- | 233 | 17 | -- |
| 5-25 | 4541* | -- | 4521 | -- | -- | 4521 | -- | 20 | -- |
| 5-27 | 7261* | -- | -- | -- | 7246 | 7246 | -- | 15 | -- |
| 5-30 | 5557** | 1 | 5437 | -- | -- | 5438 | -- | 17 | 102 |
| 6-2 | 17,418** | -- | -- | 3 | 16,013 | 16,016 | 1236 | 166 | -- |

* Indicates a combined total for 2 consecutive days.

** Indicates a combined total for 3 consecutive days.

Appendix Table 3.--continued--Numbers of juvenile chinook salmon counted, trucked, released as controls, mortality in collection, and returned to Snake River by date at Little Goose Dam, 1978.

| Date | Number counted | Trucked to Bonneville: Fresh water marked | Fresh water unmarked | Salt water marked | Salt water unmarked | Daily totals transported | Number controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|
| 6-5 | 92 | -- | -- | -- | -- | -- | -- | 92 | -- |
| 6-8 | 15,183** | -- | 15,061 | -- | -- | 15,061 | -- | 122 | -- |
| 6-12 | 24,033*** | -- | -- | -- | 23,838 | 23,838 | -- | 195 | -- |
| 6-15 | 11,966** | -- | 11,929 | -- | -- | 11,929 | -- | 37 | -- |
| TOTALS | 668,372 | 50,975 | 257,316 | 48,614 | 263,326 | 620,231 | 36,440 | 9135 | 2566 |

* Indicates a combined total for 2 consecutive days.

** Indicates a combined total for 3 consecutive days.

*** Indicates a combined total for 4 consecutive days.

Appendix Table 4.--Numbers of juvenile steelhead trout counted, trucked, released as controls, mortalities in collection, and returned to the Snake River by date at Little Goose Dam, 1978.

| Date | Number counted | Trucked to Bonneville: Fresh water marked | Fresh water unmarked | Salt water marked | Salt water unmarked | Daily totals | Number controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|
| 4-6 | 2100 | -- | 2072 | -- | -- | 2072 | -- | 28 | -- |
| 4-8 | 1988* | -- | 1964 | -- | -- | 1964 | -- | 24 | -- |
| 4-10 | 2420* | 1364 | 1035 | -- | -- | 2399 | -- | 21 | -- |
| 4-11 | 610 | -- | -- | -- | -- | -- | 559 | 8 | 43 |
| 4-12 | 1689 | -- | -- | 709 | 977 | 1686 | -- | 3 | -- |
| 4-13 | 390 | -- | -- | -- | -- | -- | 382 | 8 | -- |
| 4-14 | 1795 | -- | -- | 747 | 1021 | 1768 | -- | 27 | -- |
| 4-15 | 3027 | -- | 3017 | -- | -- | 3017 | -- | 10 | -- |
| 4-17 | 2843* | -- | -- | 1900 | 731 | 2631 | 123 | 80 | -- |
| 4-18 | 1542 | 900 | 627 | -- | -- | 1527 | -- | 15 | -- |
| 4-19 | 1047 | -- | -- | 730 | 248 | 978 | -- | 35 | 34 |
| 4-20 | 1566 | -- | -- | -- | -- | -- | 1265 | 42 | -- |
| 4-21 | 2276 | 509 | 1068 | -- | -- | 1577 | 648 | 51 | -- |
| 4-22 | 2125 | -- | -- | -- | 2112 | 2112 | -- | 13 | -- |
| 4-24 | 3580* | 809 | 1386 | -- | -- | 2195 | 1275 | 90 | 20 |
| 4-25 | 2778 | -- | -- | 968 | 909 | 1877 | 844 | 57 | -- |
| 4-26 | 1397 | 868 | 485 | -- | -- | 1353 | -- | 44 | -- |
| 4-27 | 1331 | -- | -- | 793 | 511 | 1304 | -- | 27 | -- |
| 4-28 | 1095 | 629 | 402 | -- | -- | 1031 | 45 | 19 | -- |
| 4-29 | 1431 | -- | -- | -- | 1885 | 1885 | -- | 13 | -- |
| 5-1 | 7627* | -- | -- | 1097 | 5839 | 6936 | 610 | 81 | -- |
| 5-2 | 29,311 | 2145 | 4522 | 2590 | 18,715 | 27,972 | 1114 | 225 | -- |

* Indicates a combined total for 2 consecutive days.

Appendix Table 4.--continued--Numbers of juvenile steelhead trout counted, trucked, released as controls, mortalities in collection, and returned to the Snake River by date at Little Goose Dam, 1978.

| Date | Number counted | Trucked to Bonneville: Fresh water marked | Fresh water unmarked | Salt water marked | Salt water unmarked | Daily totals | Number controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|
| 5-3 | 46,999 | 3087 | 4095 | 1366 | 38,219 | 46,767 | -- | 232 | -- |
| 5-4 | 32,411 | 3253 | 17,650 | 859 | 9580 | 31,342 | 966 | 103 | -- |
| 5-5 | 32,909 | 2800 | 19,028 | 4219 | 6754 | 32,801 | -- | 108 | -- |
| 5-6 | 22,554 | 1190 | 19,558 | -- | -- | 20,748 | 1743 | 63 | -- |
| 5-7 | 23,782 | -- | -- | -- | 23,610 | 23,610 | -- | 172 | -- |
| 5-8 | 16,924 | 2905 | 11,164 | -- | -- | 14,069 | 2558 | 297 | -- |
| 5-9 | 13,531 | -- | -- | 2038 | 9740 | 11,778 | 1524 | 229 | -- |
| 5-10 | 11,074 | 4154 | 4990 | -- | -- | 9144 | 1755 | 175 | -- |
| 5-11 | 9040 | -- | -- | 3397 | 4112 | 7509 | 1354 | 177 | -- |
| 5-12 | 7593 | 2243 | 4235 | -- | -- | 6478 | 993 | 122 | -- |
| 5-13 | 10,295 | -- | -- | -- | 10,139 | 10,139 | -- | 156 | -- |
| 5-15 | 18,822* | 4281 | 14,249 | -- | -- | 18,530 | -- | 292 | -- |
| 5-16 | 11,708 | -- | -- | 4305 | 73 .3 | 11,618 | -- | 90 | -- |
| 5-17 | 6345 | 2641 | 3622 | -- | -- | 6263 | -- | 82 | -- |
| 5-18 | 9264 | -- | -- | 2124 | 2159 | 4283 | 4821 | 160 | -- |
| 5-19 | 1395 | -- | -- | -- | -- | -- | 1317 | 78 | -- |
| 5-20 | 9440 | -- | 9323 | -- | -- | 9323 | -- | 117 | -- |
| 5-22 | 4700* | -- | -- | 1547 | 1721 | 3268 | 769 | 92 | 571 |
| 5-23 | 1079 | -- | -- | -- | -- | -- | 1041 | 38 | -- |
| 5-25 | 3535* | 1124 | 2339 | -- | -- | 3463 | -- | 72 | -- |
| 5-27 | 4168* | -- | -- | -- | 4143 | 4143 | -- | 25 | -- |
| 5-30 | 4034** | 1976 | 1756 | -- | -- | 3732 | -- | 98 | 204 |

* Indicates a combined total for 2 consecutive days.

** Indicates a combined total for 3 consecutive days.

Appendix Table 4.--continued--Numbers of juvenile steelhead trout counted, trucked, released as controls, mortalities in collection, and returned to the Snake River by date at Little Goose Dam, 1978.

| Date | Number counted | Trucked to Bonneville: Fresh water marked | Fresh water unmarked | Salt water marked | Salt water unmarked | Daily totals | Number controls | Mortality in collection | Number returned to river |
|---|---|---|---|---|---|---|---|---|---|
| 6-2 | 13,542** | -- | -- | 3342 | 6464 | 9806 | 3288 | 448 | -- |
| 6-5 | 1572** | -- | -- | -- | -- | -- | 1370 | 202 | -- |
| 6-8 | 5567** | -- | 5340 | -- | -- | 5340 | -- | 227 | -- |
| 6-12 | 11,638*** | -- | -- | -- | 11,304 | 11,304 | -- | 334 | -- |
| 6-15 | 4898** | -- | 4779 | -- | -- | 4779 | -- | 119 | -- |
| TOTALS | 412,787 | 36,878 | 138,706 | 32,731 | 168,206 | 376,521 | 30,364 | 5229 | 872 |

* Indicates a combined total for 2 consecutive days.

** Indicates a combined total for 3 consecutive days.

*** Indicates a combined total for 4 consecutive days.

Appendix Table 5.--List of color codes used on magnetic wire tags with standardized abbreviations adopted by the Pacific Marine Fisheries Commission.

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

Appendix Table 6.-- Date, brand postion, wire tag code, initial tag loss, and numbers of juvenile chinook salmon and steelhead trout marked and transported by truck in fresh water from Lower Granite Dam to Bonneville Dam, 1978 (Test #1).

| Date | Position[1/] and brand | Wire tag code | Chinook salmon | Initial tag loss | Steelhead trout | Initial tag loss |
|---|---|---|---|---|---|---|
| 4-6 | RA-W | WH-RD-GN | 3732 | 93 | 181 | 0 |
| 4-7 | " | " " " | 4451 | 151 | 229 | * |
| 4-10 | " | " " " | 3320 | 23 | 427 | * |
| 4-12 | " | " " " | 3240 | 81 | 402 | * |
| 4-14 | " | " " " | 2851 | 0 | 353 | * |
| 4-19 | " | " " " | 3113 | 0 | 394 | * |
| 4-21 | " | " " " | 3173 | 29 | 783 | * |
| 4-24 | " | " " " | 2280 | 23 | 563 | 0 |
| 4-26 | " | " " " | 7481 | 0 | 1314 | * |
| | | Sub-totals | 33,641 | 400 | 4,646 | 0 |
| Total fish released with tags | | | 33,241 | | 4,646 | |
| 5-1 | RA-< | WH-RD-BL | 194 | * | 7276 | * |
| 5-3 | " | " " " | 307 | 0 | 2563 | 205 |
| 5-5 | " | " " " | 522 | * | 3770 | 0 |
| 5-8 | " | " " " | 518 | 0 | 2694 | 0 |
| 5-10 | " | " " " | 561 | 0 | 2588 | 0 |
| 5-12 | " | " " " | 1290 | 0 | 4299 | 0 |
| 5-15 | " | " " " | 1220 | 0 | 4307 | 0 |
| 5-17 | " | " " " | 1356 | 0 | 3365 | 0 |
| 5-19 | " | " " " | 1357 | * | 3640 | 0 |
| 5-22 | " | " " " | 1383 | 0 | 3037 | 0 |
| 5-31 | " | " " " | 1034 | 0 | 2197 | 55 |
| 6-2 | " | " " " | 472 | 0 | 3517 | 67 |
| | | Sub-totals | 10,214 | 0 | 43,253 | 327 |
| Total fish released with tags | | | 10,214 | | 42,926 | |

1/ RA indicates brand position-right anterior

* No tag loss sample obtained or sample too small for reliable estimate.

Appendix Table 7.--Date, brand position, wire tag code, initial tag loss, and numbers of juvenile chinook salmon and steelhead trout marked and transported by barge from Lower Granite Dam to Bonneville Dam, 1978 (Test #2).

| Date | Position[1/] and brand | Wire tag code | Chinook salmon | Initial tag loss | Steelhead trout | Initial tag loss |
|---|---|---|---|---|---|---|
| 4-11 | RA- M | WH-RD-RD | 8704 | 0 | 593 | 0 |
| 4-13 | " | " " " | 8710 | 96 | 1107 | 0* |
| 4-17 | " | " " " | 8024 | 104 | 1100 | 0* |
| 4-19 | " | " " " | 4646 | 0* | 1377 | 0* |
| 4-21 | " | " " " | 5147 | 0* | 1032 | 0* |
| 4-28 | " | " " " | 6400 | 0* | 1472 | 0* |
| | | Sub-totals | 41,631 | 200 | 6,681 | 0 |
| Total fish released with tags | | | 41,431 | | 6,681 | |
| 5-1 | RA- 3 | WH-RD-RD-OR | 0 | 0 | 7065 | 0 |
| 5-3 | " | " " " " | 4199 | 0 | 7295 | 0 |
| 5-9 | " | " " " " | 1707 | 0* | 5312 | 0* |
| 5-11 | " | " " " " | 2186 | 0* | 4495 | 0* |
| 5-16 | " | " " " " | 1450 | 0* | 3013 | 0* |
| 5-18 | " | " " " " | 822 | 0 | 2743 | 0* |
| 5-24 | " | " " " " | 1579 | 0* | 2486 | 0* |
| 5-26 | " | " " " " | 1735 | 0* | 2296 | 0* |
| 5-31 | " | " " " " | 1237 | 0* | 2384 | 0* |
| | | Sub-totals | 14,915 | 0 | 37,089 | 0 |
| Total fish released with tags | | | 14,915 | | 37,089 | |

1/ RA indicates brand position-right anterior

* No tag loss sample obtained, or sample too small for reliable estimate.

Appendix Table 8.--Date, brand position, wire tag code, initial tag loss, and number of juvenile chinook salmon held for a 24-hour period prior to marking, marked, and transported in fresh water by truck from Lower Granite Dam to Bonneville Dam, 1978 (Test #3).

| Date | Position 1/ and brand | Wire tag color | Chinook salmon | Initial tag loss |
|---|---|---|---|---|
| 4-13 | RA- IS | WH-OR-BL | 5198 | 109 |
| 4-15 | " | " " " | 6658 | 0 |
| 4-20 | " | " " " | 4740 | 109 |
| 4-25 | " | " " " | 4348 | 48 |
| 4-29 | " | " " " | 11855 | 0 |
| 5-6 | " | " " " | 2426 | 0 |
| 5-30 | " | " " " | 3845 | 119 |
| | | Subtotal | 39,070 | 385 |
| Total fish released with tags | | | 38,685 | |

1/ RA indicates brand position-right anterior

Appendix Table 9.--Date, brand position, wire tag code, initial tag loss, and number of juvenile chinook salmon treated in 10 ppt salt water for 2 hours, held for 24 hours, marked, and transported in 10 ppt salt water by truck from Lower Granite Dam to Bonneville Dam, 1978 (Test #4).

| Date | Position[1/] and brand | Wire tag color | Chinook salmon | Initial tag loss |
|---|---|---|---|---|
| 4-14 | RA-$\overline{S}$ | WH-OR-OR | 7372 | 103 |
| 4-18 | " | " " " | 6385 | 83 |
| 4-22 | " | " " " | 4712 | 0 |
| 4-27 | " | " " " | 5006 | 60 |
| 5-2 | " | " " " | 3915 | 0 |
| 5-23 | " | " " " | 5507 | 0 |
| 5-25 | " | " " " | 8190 | 0 |
| | | Subtotals | 41,087 | 246 |
| | Total fish released with tags | | 40,841 | |

1/ RA indicates brand position-right anterior

Appendix Table 10--Date, brand position, wire tag code, and numbers of juvenile chinook salmon and steelhead trout marked and released as controls in the Lower Granite Dam forebay at Clarkston, WA, 1978.

| Date | Position[1/] and brand | Wire tag color | Chinook salmon | Steelhead trout |
|---|---|---|---|---|
| 4-15 | LA-P | WH-RD-WH | 2214 | 0 |
| 4-8 | " | " " " | 3364 | 281 |
| 4-10 | " | " " " | 3405 | 383 |
| 4-12 | " | " " " | 2169 | 358 |
| 4-15 | " | " " " | 3148 | 486 |
| | | Subtotals | 14,300 | 1,508 |
| 4-18 | LA-b | WH-RD-WH | 3258 | 694 |
| 4-20 | " | " " " | 3336 | 678 |
| 4-22 | " | " " " | 2488 | 748 |
| 4-25 | " | " " " | 2828 | 518 |
| 4-27 | " | " " " | 3322 | 990 |
| | | Subtotals | 15,232 | 3,628 |
| 4-29 | LA-d | WH-RD-WH | 2144 | 2388 |
| | | Subtotals | 2,144 | 2,388 |
| 5-2 | LA-a | WH-RD-WH-RD | 2088 | 5226 |
| 5-4 | " | " " " " | 1501 | 6284 |
| 5-8 | " | " " " " | 1601 | 4273 |
| 5-10 | " | " " " " | 1134 | 2286 |
| 5-12 | " | " " " " | 1084 | 2646 |
| 5-16 | " | " " " " | 1486 | 2899 |
| 5-18 | " | " " " " | 797 | 2896 |
| 5-23 | " | " " " " | 1104 | 3355 |
| 5-25 | " | " " " " | 1466 | 2018 |
| 5-30 | " | " " " " | 1275 | 2074 |
| 6-1 | " | " " " " | 882 | 1621 |
| | | Subtotals | 14,418 | 35,578 |
| | | TOTALS | 46,094 | 43,102 |

1/ LA indicates brand position-left anterior

Appendix Table 11--Date, brand position, wire tag code, and numbers of juvenile chinook salmon and steelhead trout marked and released as controls in the Lower Granite Dam tailrace, 1978.

| Date | Position[1/] and brand | Wire tag color | Chinook salmon | Steelhead trout |
|---|---|---|---|---|
| 4-27 | LA-S1 | WH-PK-PK | 3912 | 446 |
| 4-29 | " | " " " | 2056 | 886 |
| | | Subtotals | 5,968 | 1,332 |
| 5-2 | LA-[illegible]1101 | WH-OR-YW | 661 | 2717 |
| 5-4 | " | " " " | 355 | 4306 |
| 5-8 | " | " " " | 465 | 2083 |
| 5-10 | " | " " " | 800 | 2129 |
| | | Subtotals | 2,281 | 11,235 |
| | | TOTALS | 8,249 | 12,567 |

1/ LA indicates brand position-left anterior

Appendix Table 12.--Percent descaling of juvenile chinook salmon by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1978.

| Date | Unit 1[1/] | Unit 2 slot A | Unit 2 slot B | Unit 2 slot C | Unit 3 slot A | Unit 3 slot B | Unit 3 slot C[2/] | Unit 4 slot A | Unit 4 slot B | Unit 4 slot C | Unit 5 slot A | Unit 5 slot B | Unit 5 slot C | Unit 6 slot A | Unit 6 slot B | Unit 6 slot C | Fish marking facility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-5 | -- | 5 | 5 | 4 | 5 | 7 | -- | 4 | 3 | 2 | -- | -- | -- | -- | -- | -- | -- |
| 4-6 | -- | 2 | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4-7 | -- | 5 | 3 | 2 | 3 | 1 | -- | 2 | 2 | 2 | -- | -- | -- | -- | -- | -- | -- |
| 4-10 | -- | 3 | 5 | 3 | 2 | 3 | -- | 6 | 4 | 2 | -- | -- | -- | -- | -- | -- | -- |
| 4-11 | -- | 3 | 4 | 2 | 3 | 3 | -- | 2 | 1 | 0 | -- | -- | -- | -- | -- | -- | -- |
| 4-12 | -- | 3 | 1 | 2 | 3 | 2 | -- | 4 | 2 | 0 | -- | -- | -- | -- | -- | -- | -- |
| 4-13 | -- | 3 | 3 | 2 | 3 | 3 | -- | 3 | 3 | 0 | -- | -- | -- | -- | -- | -- | -- |
| 4-14 | -- | 1 | 3 | 2 | 1 | 3 | -- | 5 | 5 | 4 | -- | -- | -- | -- | -- | -- | -- |
| 4-17 | -- | 3 | 1 | 4 | 4 | 3 | -- | 1 | 4 | 3 | -- | -- | -- | -- | -- | -- | -- |
| 4-18 | -- | 2 | 5 | 1 | 1 | 3 | -- | 13 | 6 | 3 | 4 | 1 | 4 | -- | -- | -- | -- |
| 4-19 | -- | 6 | 7 | 6 | 3 | 1 | -- | 12 | 10 | 3 | 0 | 1 | 3 | -- | -- | -- | -- |
| 4-20 | -- | 2 | 1 | 0 | 4 | 6 | -- | 5 | 7 | 3 | 3 | 5 | 0 | -- | -- | -- | -- |
| 4-21 | -- | 1 | 3 | 2 | 5 | 3 | -- | 8 | 9 | 4 | 2 | 3 | 2 | -- | -- | -- | 31 |
| 4-24 | -- | 4 | 5 | 4 | * | 3 | -- | 3 | 3 | 0 | * | * | * | -- | -- | -- | -- |
| 4-25 | -- | 3 | 3 | 5 | 4 | 10 | -- | 2 | 5 | 5 | 5 | 6 | * | -- | -- | -- | -- |
| 4-26 | -- | 12 | 12 | 8 | 8 | 7 | -- | 7 | 4 | 1 | * | * | * | -- | -- | -- | -- |
| 4-27 | -- | 5 | 7 | 7 | 18 | 11 | -- | 6 | 5 | 4 | 4 | 3 | 5 | -- | -- | -- | 43 |
| 4-28 | -- | 9 | 8 | 6 | 4 | 5 | -- | 12 | 9 | 5 | 5 | 8 | 6 | -- | -- | -- | 16 |
| 5-1 | -- | 8 | 5 | 4 | * | 5 | -- | 1 | 3 | 1 | 5 | 2 | 1 | -- | -- | -- | 7 |
| 5-2 | -- | 3 | 4 | 2 | * | 4 | -- | 2 | 1 | 2 | 2 | 2 | 1 | -- | -- | -- | 3 |

1/ Unit 1 did not operate during this time period.

2/ Gatewell slot C of unit 3 was used as a release site for sample fish from all other gatewells and, therefore, was not sampled.

* Indicates number of fish in sample is too small for accurate estimate - less than 50.

ppendix Table 12.--continued--Percent descaling of juvenile chinook salmon by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1978.

| ate | Unit 1[1] | Unit 2 slot A | Unit 2 slot B | Unit 2 slot C | Unit 3 slot A | Unit 3 slot B | Unit 3 slot C[2] | Unit 4 slot A | Unit 4 slot B | Unit 4 slot C | Unit 5 slot A | Unit 5 slot B | Unit 5 slot C | Unit 6 slot A | Unit 6 slot B | Unit 6 slot C | Fish marking facility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -3 | -- | 4 | 3 | 2 | * | 0 | -- | 3 | 4 | 3 | 6 | 1 | 5 | -- | -- | -- | 11 |
| -4 | -- | 2 | 5 | 3 | * | * | -- | 3 | 6 | * | 0 | 0 | * | -- | -- | -- | 12 |
| -5 | -- | 3 | 11 | 2 | * | 7 | -- | 1 | 8 | 2 | 4 | * | 4 | -- | -- | -- | 6 |
| -8 | -- | 6 | 5 | 4 | * | * | -- | 2 | 2 | 2 | 1 | 3 | * | -- | -- | -- | 6 |
| -9 | -- | 2 | 5 | * | * | 1 | -- | 4 | 1 | 1 | 0 | 4 | 2 | -- | -- | -- | 3 |
| -10 | -- | 2 | 3 | 1 | 2 | * | -- | 2 | 2 | 1 | 4 | 0 | 1 | -- | -- | -- | 7 |
| -11 | -- | 3 | 1 | 6 | 2 | 3 | -- | 1 | * | 1 | 3 | 4 | 4 | -- | -- | -- | 6 |
| -12 | -- | 5 | 7 | 0 | * | 3 | -- | 2 | * | 3 | 5 | 1 | * | -- | -- | -- | 3 |
| -15 | -- | 1 | 7 | 1 | * | 3 | -- | 5 | 1 | 12 | 0 | 3 | 6 | 1 | 2 | * | 2 |
| -16 | -- | 2 | 6 | 4 | 0 | 3 | -- | 2 | 4 | * | 1 | * | 3 | 1 | 14 | * | 7 |
| -17 | -- | 4 | 4 | 7 | * | * | -- | 5 | 4 | 3 | * | * | * | * | 9 | * | 8 |
| -18 | -- | 6 | 4 | 13 | * | 5 | -- | 12 | 4 | * | 9 | * | 9 | 10 | 16 | * | 5 |
| -19 | -- | 10 | 4 | 7 | * | 0 | -- | 1 | 2 | 7 | 5 | 0 | 1 | 2 | 15 | 9 | 4 |
| -22 | -- | 4 | 3 | 1 | * | * | -- | 3 | 3 | 2 | 0 | 2 | 6 | 1 | 8 | 19 | 1 |
| -23 | -- | 8 | 1 | 4 | * | 1 | -- | 6 | 12 | 0 | 4 | 4 | 7 | 5 | 4 | 3 | 0 |
| -24 | -- | 4 | 3 | 2 | * | 3 | -- | 6 | 2 | 9 | 5 | 1 | 7 | 12 | 15 | 12 | 5 |
| -25 | -- | 2 | 3 | 3 | * | 3 | -- | * | * | * | 2 | 9 | 3 | 5 | 5 | 5 | 2 |
| -26 | -- | 5 | 1 | 1 | * | 2 | -- | * | * | * | 0 | 2 | 5 | 2 | 2 | * | 1 |
| -30 | -- | 5 | 9 | 9 | * | 1 | -- | 2 | 2 | 10 | 6 | 5 | 5 | 1 | 1 | * | 1 |
| -31 | -- | 7 | 7 | 3 | * | * | -- | * | 4 | 3 | 1 | 6 | * | * | * | * | 1 |
| -1 | -- | * | 7 | 6 | * | 5 | -- | 4 | 7 | 18 | 17 | 8 | * | 1 | 6 | * | 5 |

/ Unit 1 did not operate during this time period.

/ Gatewell slot C of unit 3 was used as a release site for sample fish from all other gatewells and, therefore, was not sampled.

Indicates number of fish in sample is too small for accurate estimate - less than 50.

Appendix Table 13.--Percent descaling of juvenile steelhead trout by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1978.

| Date | Unit 1[1/] | Unit 2 slot A | Unit 2 slot B | Unit 2 slot C | Unit 3 slot A | Unit 3 slot B | Unit 3 slot C[2/] | Unit 4 slot A | Unit 4 slot B | Unit 4 slot C | Unit 5 slot A | Unit 5 slot B | Unit 5 slot C | Unit 6 slot A | Unit 6 slot B | Unit 6 slot C | Fish marking facility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-5 | -- | * | * | 4 | * | * | -- | 0 | * | * | -- | -- | -- | -- | -- | -- | -- |
| 4-6 | -- | 0 | * | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4-7 | -- | * | 2 | 0 | 3 | 1 | -- | 4 | 2 | * | -- | -- | -- | -- | -- | -- | -- |
| 4-10 | -- | * | * | * | * | * | -- | 3 | * | * | -- | -- | -- | -- | -- | -- | -- |
| 4-11 | -- | 5 | * | * | * | * | -- | * | * | * | -- | -- | -- | -- | -- | -- | -- |
| 4-12 | -- | * | * | * | * | * | -- | * | * | * | -- | -- | -- | -- | -- | -- | -- |
| 4-13 | -- | * | * | * | * | * | -- | * | * | * | -- | -- | -- | -- | -- | -- | -- |
| 4-14 | -- | * | * | * | * | * | -- | * | * | * | -- | -- | -- | -- | -- | -- | -- |
| 4-17 | -- | 0 | 4 | 2 | 3 | 2 | -- | 5 | 1 | 3 | -- | -- | -- | -- | -- | -- | -- |
| 4-18 | -- | 0 | 1 | 3 | 2 | 4 | -- | 4 | 6 | 3 | 2 | 2 | 3 | -- | -- | -- | -- |
| 4-19 | -- | 4 | 7 | 5 | 4 | 5 | -- | 3 | 4 | 5 | 5 | 5 | 1 | -- | -- | -- | -- |
| 4-20 | -- | * | * | * | 2 | 4 | -- | 12 | 5 | * | 2 | * | 3 | -- | -- | -- | -- |
| 4-21 | -- | 4 | * | 2 | * | 11 | -- | 4 | 7 | 6 | 5 | 4 | 4 | -- | -- | -- | 24 |
| 4-24 | -- | 2 | 4 | 0 | * | * | -- | 0 | 2 | 4 | * | * | * | -- | -- | -- | -- |
| 4-25 | -- | 4 | * | 2 | * | * | -- | * | 5 | 8 | 7 | 2 | * | -- | -- | -- | -- |
| 4-26 | -- | 9 | 7 | 4 | * | 15 | -- | 6 | 5 | 7 | * | * | * | -- | -- | -- | -- |
| 4-27 | -- | 5 | 7 | 9 | 4 | 10 | -- | 5 | 3 | 2 | 4 | 4 | * | -- | -- | -- | 18 |
| 4-28 | -- | 3 | 1 | 2 | 4 | 8 | -- | 5 | 6 | 4 | 5 | 4 | 7 | -- | -- | -- | 27 |
| 5-1 | -- | 2 | 0 | 2 | 1 | 2 | -- | 2 | 2 | 0 | 2 | 0 | 1 | -- | -- | -- | 1 |
| 5-2 | -- | 1 | 1 | 2 | 1 | 2 | -- | 2 | 1 | 1 | 2 | 1 | 0 | -- | -- | -- | 1 |

1/ Unit 1 did not operate during this time period.

2/ Gatewell slot C of unit 3 was used as a release site for sample fish from all other gatewells and, therefore, was not sampled.

* Indicates number of fish in sample is too small for accurate estimate - less than 50.

ppendix Table 13.--continued--Percent descaling of juvenile steelhead trout by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1978.

| ate | Unit 1[1/] | Unit 2 slot A | Unit 2 slot B | Unit 2 slot C | Unit 3 slot A | Unit 3 slot B | Unit 3 slot C[2/] | Unit 4 slot A | Unit 4 slot B | Unit 4 slot C | Unit 5 slot A | Unit 5 slot B | Unit 5 slot C | Unit 6 slot A | Unit 6 slot B | Unit 6 slot C | Fish marking facility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -3 | -- | 2 | 1 | 1 | 4 | 2 | -- | 4 | 2 | 1 | 3 | 1 | 0 | -- | -- | -- | 1 |
| -4 | -- | 2 | 4 | 2 | * | 2 | -- | 2 | 3 | 1 | 2 | 1 | 1 | -- | -- | -- | 1 |
| -5 | -- | 2 | 3 | 2 | * | 4 | -- | 3 | 5 | 5 | 6 | 3 | 4 | -- | -- | -- | 2 |
| -8 | -- | 5 | 4 | 4 | 4 | 4 | -- | 4 | 4 | 7 | 7 | 6 | 6 | -- | -- | -- | 4 |
| -9 | -- | 2 | 7 | 1 | 7 | 4 | -- | 7 | 6 | 5 | 2 | 5 | 4 | -- | -- | -- | 4 |
| -10 | -- | 3 | 4 | 6 | 2 | 1 | -- | 3 | 5 | 3 | 3 | 2 | 3 | -- | -- | -- | 3 |
| -11 | -- | 2 | 0 | 2 | 3 | 3 | -- | 5 | 4 | 3 | 4 | 2 | 2 | -- | -- | -- | 3 |
| -12 | -- | 2 | 3 | 4 | * | 5 | -- | 5 | 6 | 2 | 4 | 7 | 1 | -- | -- | -- | 3 |
| -15 | -- | 4 | 2 | 2 | * | 1 | -- | 5 | 3 | 7 | 3 | 1 | 4 | 2 | 2 | * | 2 |
| -16 | -- | 9 | 3 | 1 | 3 | 4 | -- | 3 | 3 | 4 | 2 | 1 | 2 | 6 | 3 | 4 | 6 |
| -17 | -- | 2 | 3 | 5 | * | 1 | -- | 3 | 8 | 4 | 6 | 7 | 5 | 4 | 4 | 4 | 5 |
| -18 | -- | 4 | 3 | 8 | * | 6 | -- | 9 | 6 | 6 | 9 | 4 | 9 | 5 | 7 | 10 | 8 |
| -19 | -- | 3 | 7 | 6 | * | 7 | -- | 7 | 11 | 5 | 7 | 8 | 7 | 8 | 6 | 2 | 4 |
| -22 | -- | 10 | 5 | 5 | * | * | -- | 5 | 4 | 6 | 7 | 4 | 4 | 5 | 5 | 3 | 3 |
| -23 | -- | 2 | 1 | 4 | * | 4 | -- | 4 | 4 | 5 | 5 | 4 | 5 | 6 | 2 | 1 | 5 |
| -24 | -- | 2 | 1 | 4 | * | 2 | -- | 3 | 2 | 4 | 8 | 2 | 2 | 0 | 0 | 1 | 6 |
| -25 | -- | 4 | 5 | 3 | * | 2 | -- | * | * | * | 1 | 3 | 2 | 2 | 2 | 1 | 5 |
| -26 | -- | 1 | 4 | 4 | * | 2 | -- | * | * | * | 3 | 1 | 5 | 3 | 4 | 1 | 6 |
| -30 | -- | 4 | 5 | 2 | * | 7 | -- | 5 | 4 | 5 | 3 | 3 | 4 | 3 | 4 | 3 | 4 |
| -31 | -- | 1 | 4 | 3 | * | 4 | -- | 5 | 4 | 3 | 5 | 2 | 1 | 3 | 2 | 1 | 2 |
| -1 | -- | 1 | 4 | 1 | * | 2 | -- | 4 | 4 | 4 | 7 | 4 | 2 | 2 | 4 | 8 | 4 |

' Unit 1 did not operate during this time period.

' Gatewell slot C of unit 3 was used as a release site for sample fish from all other gatewells and, therefore, was not sampled.

Indicates number of fish in sample is too small for accurate estimate - less than 50.

Appendix Table 14.--Date, test condition, transport system water quality data, delayed mortality, and tag loss of marked and unmarked juvenile chinook salmon and steelhead trout after transport from Lower Granite Dam to Bonneville Dam, 1978.

| Date | Test cond.[1/] | Water quality | | | | Delayed mortality and tag loss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Chinook salmon | | | | | Steelhead trout | | | | |
| | | | | | | Marked | | | Unmarked | | Marked | | | Unmarked | |
| | | Temp. | $O_2$ (ppm) | $CO_2$ (ppm) | pH | No. held | % mort. | Tag loss% | No. held | % mort. | No. held | % mort. | Tag loss% | No. held | % mort. |
| 4-6 | 1 | 7.8 | 17.3 | 7.7 | -- | 80 | 15.0 | 2.5 | 206 | 31.0 | 2 | 0.0 | 0.0 | 36 | 0.0 |
| 4-7 | 1 | 7.8 | 17.8 | 6.3 | -- | 135 | 18.5 | 3.4 | 105 | 16.0 | -- | -- | -- | 11 | 0.0 |
| 4-10 | 1 | 10.0 | 22.5 | 6.0 | -- | 265 | 11.3 | 0.7 | 24 | 33.3 | 3 | 0.0 | 0.0 | 1 | 0.0 |
| 4-12 | 1 | 13.1 | 17.3 | 2.5 | 6.9 | 121 | 16.5 | 2.5 | 13 | 7.7 | -- | -- | -- | -- | -- |
| 4-12 | 2 | 10.0 | 11.1 | 1.0 | 6.7 | 81 | 3.7 | 0.0 | 87 | 1.1 | 3 | 0.0 | 0.0 | 4 | 0.0 |
| 4-13 | 3 | 12.2 | 19.4 | 2.0 | 6.8 | 187 | 4.3 | 2.1 | 35 | 8.6 | 2 | 0.0 | 0.0 | 6 | 0.0 |
| 4-14 | 4 | 10.0 | 14.7 | 2.0 | 7.0 | 143 | 2.8 | 1.4 | 56 | 0.0 | 2 | 0.0 | 0.0 | 5 | 0.0 |
| 4-14 | 1 | 12.0 | 19.2 | 4.0 | 6.8 | 55 | 9.1 | 0 | 61 | 34.4 | -- | -- | -- | 7 | 0.0 |
| 4-15 | 2 | 10.1 | 11.1 | 1.5 | 7.0 | 85 | 0.0 | 1.1 | 33 | 0.0 | -- | -- | -- | 0 | 0.0 |
| 4-15 | 3 | 12.2 | 21.9 | 6.0 | 6.8 | 128 | 16.4 | 0 | 38 | 7.9 | -- | -- | -- | 9 | 0.0 |
| 4-18 | 4 | 11.6 | 15.7 | 2.5 | 7.2 | 229 | 2.6 | 1.3 | 24 | 4.2 | -- | -- | -- | 20 | 0.0 |
| 4-18 | 2 | 10.0 | 11.0 | 1.5 | 7.0 | 55 | 10.9 | 0 | 128 | 0.8 | -- | -- | -- | 4 | 0.0 |
| 4-19 | 1 | 12.2 | 24.4 | 2.3 | 7.0 | 131 | 30.5 | -- | 20 | 45.0 | 2 | 0.0 | 0.0 | 1 | 0.0 |
| 4-20 | 3 | 11.0 | 17.5 | 3.1 | 6.9 | 128 | 12.5 | 2.3 | 8 | 12.5 | -- | -- | -- | 3 | 0.0 |

1/ Test Conditions

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

2 - Transported by barge in fresh water.

3 - Held in raceway for 24 h prior to marking, marked, and transported by truck in fresh water--marked and unmarked chinook and unmarked steelhead only.

4 - Held in 10 ppt salt water for 2 h, then held for 24 h in raceway prior to marking, marked, and transported by truck in 10 ppt salt water -- marked and unmarked chinook and unmarked steelhead only.

Appendix Table 14.--continued--Date, test condition, transport system water quality data, delayed mortality, and tag loss of marked and unmarked juvenile chinook salmon and steelhead trout after transport from Lower Granite Dam to Bonneville Dam, 1978.

| Date | Test[1/] cond. | Water quality | | | | Delayed mortality and tag loss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Chinook salmon | | | | | Steelhead trout | | | | |
| | | | | | | Marked | | | Unmarked | | Marked | | | Unmarked | |
| | | Temp. | $O_2$ (ppm) | $CO_2$ (ppm) | pH | No. held | % mort. | Tag loss% | No. held | % mort. | No. held | % mort. | Tag loss% | No. held | % mort. |
| 4-21 | 1 | 11.1 | 15.8 | 1.7 | 6.95 | 102 | 21.5 | 0.9 | 11 | 27.2 | -- | -- | -- | 2 | 0.0 |
| 4-22 | 4 | 12.5 | 12.8 | 2.1 | 7.0 | 131 | 5.2 | 0 | 56 | 5.4 | -- | -- | -- | 14 | 0.0 |
| 4-23 | 2 | 10.0 | 11.2 | 0.9 | 7.0 | 79 | 6.3 | 1.3 | -- | -- | 4 | 0.0 | 25.0 | -- | -- |
| 4-23 | 2 | -- | -- | -- | -- | -- | -- | -- | 142 | 0.0 | -- | -- | -- | 35 | 0.0 |
| 4-24 | 1 | 10.0 | 10.4 | 2.0 | 6.7 | 91 | 27.8 | 4.0 | 9 | 55.6 | 21 | 0.0 | 0.0 | 1 | 0.0 |
| 4-25 | 3 | 11.9 | 21.3 | 2.4 | 7.1 | 182 | 7.1 | 1.1 | 24 | 12.5 | -- | -- | -- | 12 | 0.0 |
| 4-26 | 1 | 12.2 | 22.2 | 4.5 | 7.0 | 139 | 14.4 | 0.0 | 15 | 13.3 | 4 | 0.0 | 0.0 | 5 | 0.0 |
| 4-27 | 4 | 9.0 | 18.2 | 2.5 | 7.5 | 165 | 5.4 | 1.2 | 16 | 6.2 | -- | -- | -- | 7 | 0.0 |
| 4-28 | 2 | 10.5 | 10.8 | 1.5 | 8.0 | -- | -- | -- | 157 | 1.9 | -- | -- | -- | 17 | 0.0 |
| 4-29 | 3 | 11.5 | 20.1 | 8.5 | 6.8 | 145 | 16.6 | 0.0 | 25 | 8.0 | 7 | 0.0 | 0.0 | 12 | 0.0 |
| 5-1 | 2 | 10.5 | 9.0 | 2.0 | 7.3 | -- | -- | -- | 215 | 1.4 | -- | -- | -- | 97 | 0.0 |
| 5-1 | 1 | 9.0 | 16.8 | 2.5 | 7.3 | -- | -- | -- | 40 | 15.0 | 68 | 0.0 | 0.0 | 5 | 0.0 |
| 5-2 | 4 | 13.0 | 31.8 | 9.0 | 7.0 | 60 | 1.7 | 0.0 | 26 | 0.0 | 3 | 0.0 | 0.0 | 37 | 0.0 |
| 5-3 | 1 | 12.5 | 15.6 | 2.2 | 7.8 | 22 | 27.3 | 0.0 | 6 | 33.3 | 112 | 0.9 | 8.0 | 10 | 0.0 |

1/ Test Conditions

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

2 - Transported by barge in fresh water.

3 - Held in raceway for 24 h prior to marking, marked, and transported by truck in fresh water-- marked and unmarked chinook and unmarked steelhead only.

4 - Held in 10 ppt salt water for 2 h, then held for 24 h in raceway prior to marking, marked, and transported by truck in 10 ppt salt water-- marked and unmarked chinook and unmarked steelhead only.

Appendix Table 14.--continued--Date, test condition, transport system water quality data, delayed mortality, and tag loss of marked and unmarked juvenile chinook salmon and steelhead trout after transport from Lower Granite Dam to Bonneville Dam, 1978.

| | | | | | | Delayed mortality and tag loss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Chinook salmon | | | | | Steelhead trout | | | | |
| Date | Test[1/] cond. | Water quality | | | | Marked | | | Unmarked | | Marked | | | Unmarked | |
| | | Temp. | $O_2$ (ppm) | $CO_2$ (ppm) | pH | No. held | % mort. | Tag loss% | No. held | % mort. | No. held | % mort. | Tag loss% | No. held | % mort. |
| 5-5 | 1 | 8.9 | 22.5 | 24.0 | 6.6 | -- | -- | -- | 18 | 27.8 | 37 | -- | -- | 66 | 0.0 |
| 5-6 | 3 | 11.0 | 20.4 | 2.5 | 7.35 | 70 | 15.7 | 0.0 | 18 | 12.5 | -- | -- | -- | 30 | 2.3 |
| 5-8 | 2 | 12.0 | 10.5 | 2.0 | 7.55 | 10 | 0.0 | 0.0 | 40 | 2.5 | 18 | 0.0 | 0.0 | 148 | 0.0 |
| 5-8 | 1 | 13.5 | 45.9 | 5.0 | 7.15 | 21 | 28.6 | 0.0 | 5 | 40.0 | 62 | 1.6 | 0.0 | 12 | 0.0 |
| 5-9 | 1 | 13.0 | 18.8 | 2.5 | 7.5 | -- | -- | -- | -- | -- | -- | -- | -- | 83 | 0.0 |
| 5-10 | 1 | 13.0 | 28.1 | 3.5 | 7.2 | 23 | 21.7 | 0.0 | -- | -- | 73 | 0.0 | 0.0 | 36 | 0.0 |
| 5-10 | 2 | 12.0 | 10.9 | 1.5 | 7.85 | 36 | 0.0 | 0.0 | 47 | 4.2 | 53 | 1.8 | 0.0 | 121 | 0.0 |
| 5-12 | 1 | 12.0 | 26.0 | 6.5 | 7.2 | 24 | 29.0 | 0.0 | -- | -- | 97 | 4.1 | 0.0 | 17 | 0.0 |
| 5-13 | 2 | 13.0 | 10.4 | 2.0 | 7.85 | 15 | 6.7 | 0.0 | 40 | 7.5 | 8 | 0.0 | 0.0 | 69 | 0.0 |
| 5-15 | 1 | 11.0 | 19.1 | 4.0 | 7.15 | 32 | 43.7 | 0.0 | 48 | 20.8 | 24 | 4.2 | 0.0 | 74 | 0.0 |
| 5-17 | 1 | 12.0 | 38.9 | 9.0 | 6.9 | 36 | 19.4 | 0.0 | 9 | 0.0 | 63 | 0.0 | 0.0 | 31 | 0.0 |
| 5-18 | 2 | 14.2 | 9.9 | 1.7 | [illegible].7 | [illegible]5 | 0.0 | 0.0 | 89 | 1.1 | 4 | 0.0 | 0.0 | 80 | 0.0 |
| 5-19 | 1 | 14.1 | 17.2 | 3.0 | 7.2 | 15 | 6.7 | 0.0 | 11 | 9.1 | 43 | 0.0 | 0.0 | 22 | 0.0 |
| 5-21 | 2 | 14.0 | 10.2 | 2.0 | 7.75 | -- | -- | -- | 66 | 0.0 | -- | -- | -- | 71 | 0.0 |

1/ Test Conditions

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

2 - Transported by barge in fresh water.

3 - Held in raceway for 24 h prior to marking, marked, and transported by truck in fresh water-- marked and unmarked chinook and unmarked steelhead only.

4 - Held in 10 ppt salt water for 2 h, then held for 24 h in raceway prior to marking, marked, and transported by truck in 10 ppt salt water-- marked and unmarked chinook and unmarked steelhead only.

Appendix Table 14.--continued--Date, test condition, transport system water quality data, delayed mortality, and tag loss of marked and unmarked juvenile chinook salmon and steelhead trout after transport from Lower Granite Dam to Bonneville Dam, 1978.

| Date | Test cond.[1/] | Water quality | | | | Delayed mortality and tag loss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Chinook salmon | | | | | Steelhead trout | | | | |
| | | | | | | Marked | | | Unmarked | | Marked | | | Unmarked | |
| | | Temp. | $O_2$ (ppm) | $CO_2$ (ppm) | pH | No. held | % mort. | Tag loss% | No. held | % mort. | No. held | % mort. | Tag loss% | No. held | % mort. |
| 5-22 | 1 | 12.0 | 12.6 | 3.0 | 7.2 | 92 | 6.5 | 0.0 | 10 | 10.0 | 66 | 0.0 | 0.0 | 19 | 0.0 |
| 5-23 | 4 | 11.0 | 14.4 | 3.0 | 7.1 | 97 | 3.1 | 0.0 | 21 | 9.5 | -- | -- | -- | 97 | 0.0 |
| 5-25 | 4 | 13.0 | 17.2 | 8.5 | 7.0 | 122 | 12.2 | 0.0 | 49 | 6.1 | 20 | 0.0 | 0.0 | 93 | 0.0 |
| 5-25 | 2 | 14.0 | 9.4 | 1.5 | 7.7 | 23 | 0.0 | 0.0 | 82 | 0.0 | 5 | 0.0 | 0.0 | 58 | 0.0 |
| 5-28 | 2 | 14.5 | 10.6 | 1.5 | 8.1 | -- | -- | -- | 241 | 1.7 | -- | -- | -- | 27 | 0.0 |
| 5-30 | 3 | 13.0 | 40.8 | 3.0 | 7.3 | 96 | 5.2 | 3.1 | 8 | 0.0 | 8 | 0.0 | 0.0 | 67 | 0.0 |
| 5-31 | 1 | 12.2 | 13.9 | 2.8 | 7.4 | 140 | 8.6 | 0.0 | -- | -- | 40 | 0.0 | 2.5 | 7 | 0.0 |
| 6-1 | 2 | 15.2 | 10.0 | 1.5 | 8.05 | -- | -- | -- | 71 | 1.4 | -- | -- | -- | 52 | 0.0 |
| 6-2 | 1 | 11.5 | 25.4 | 7.5 | 7.25 | 56 | 10.7 | 0.0 | 7 | 22.2 | -- | -- | -- | 26 | 0.0 |
| 6-6 | 2 | 15.5 | 9.8 | 1.5 | 7.75 | -- | -- | -- | 44 | 2.2 | -- | -- | -- | 43 | 0.0 |
| 6-9 | 1 | 10.5 | 14.0 | 5.0 | 7.2 | -- | -- | -- | 77 | 14.3 | -- | -- | -- | 66 | 0.0 |
| 6-12 | 1 | 11.1 | 13.2 | 9.0 | 7.25 | -- | -- | -- | 281 | 5.3 | -- | -- | -- | 81 | 0.0 |
| 6-14 | 1 | 13.2 | 15.4 | 11.5 | 7.15 | -- | -- | -- | 224 | 5.1 | -- | -- | -- | 35 | 0.0 |
| 6-16 | 1 | 14.5 | 8.1 | 4.0 | 7.1 | -- | -- | -- | 278 | 1.8 | -- | -- | -- | 9 | 0.0 |
| 6-19 | 1 | 14.4 | 14.6 | 3.9 | 7.0 | -- | -- | -- | 156 | 1.3 | -- | -- | -- | 23 | 0.0 |
| 6-21 | 1 | 14.4 | 12.3 | 4.5 | 7.3 | -- | -- | -- | 205 | 2.9 | -- | -- | -- | 25 | 0.0 |

1/ Test Conditions

1 - Transported by truck in fresh water (traditional manner) 2 - Transported by barge in fresh water

3 - Held in raceway for 24 h prior to marking, marked, and transported by truck in fresh water-- marked and unmarked chinook and unmarked steelhead only.

4 - Held in 10 ppt salt water for 2 h, then held for 24 h in raceway prior to marking, marked, and transported by truck in 10 ppt salt water marked and unmarked chinook and unmarked steelhead only.

Appendix Table 15.--Delayed mortality of marked and unmarked chinook salmon smolts prior to transport in fresh water (Test #1) at Lower Granite Dam, 1978.

| | Marked | | Unmarked | |
|---|---|---|---|---|
| Date | No. held | No. mortalities | No. held | No. mortalities |
| 4-06 | 50 | 2 | -- | -- |
| 4-12 | 50 | 4 | -- | -- |
| 4-19 | 51 | 10 | 8 | 1 |
| 4-24 | 69 | 16 | 11 | 2 |
| 4-26 | 153 | 24 | 12 | 2 |
| 5-22 | 56 | 3 | 3 | 2 |
| TOTALS | 429 | 59 | 34 | 7 |

Appendix Table 16.--Results of water quality tests in chinook salmon density studies conducted during 1977-78. Means and standard deviations are presented where appropriate.

| Density lb/gal.) | Number of replicates | Water quality parameters | Hours in container 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Temp. (°F) | 50.4±2.7 | 51.3±2.7 | 51.4±2.5 | 52.0±2.0 | 52.0±2.0 | 52.2±2.0 | 52.5±2.3 | 52.3±2.0 | 52.5±2.2 |
| | | pH | 7.1±0.1 | 7.0±0.1 | 7.0±0.1 | 7.0±0.1 | 7.0±0.1 | 7.0±0.1 | 7.0±0.1 | 7.0±0.1 | 7.0±0.1 |
| | | $CO_2$ (ppm) | 25.7±5.4 | 30.5±5.0 | 30.5±6.4 | 32.0±5.1 | 32.7±4.8 | 31.3±4.7 | 36.7±8.7 | 38.3±10.1 | 38.3±9.1 |
| **1.0 | 6 | *$NH_3$ (ppb) | --- | 5.0±2.2 | 6.6±2.7 | 7.7±1.9 | 11.5±3.6 | 14.1±5.0 | 14.5±4.2 | 16.5±5.0 | 18.8±7.6 |
| | | Temp. (°F) | 54.5±0.7 | 53.8±0.2 | 54.5±0.7 | 54.9±0.4 | 55.0±0.0 | 55.0±0.7 | 55.2±0.2 | 55.2±0.2 | 55.0±0.7 |
| | | pH | 6.9±0.1 | 6.9±0.1 | 6.8±0.1 | 6.9±0.1 | 6.9±0.1 | 7.0±0.1 | 6.9±0.1 | 6.9±0.1 | 7.0±0.1 |
| | | $CO_2$ (ppm) | 41.0±1.4 | 48.0±5.7 | 57.0±4.2 | 50.0±5.7 | 53.0±10.0 | 63.0±1.4 | 70.0±5.7 | 71.0±4.2 | 68.0±5.7 |
| **1.5 | 2 | *$NH_3$ (ppb) | --- | --- | --- | 19.0±3.2 | 22.2±4.4 | 35.9±1.9 | 36.5±7.9 | 43.6±10.3 | 43.2±6.9 |
| | | Temp. (°F) | 47.8±1.8 | 48.6±1.4 | 48.7±1.1 | 48.9±0.9 | 49.1±0.9 | 49.5±0.7 | 49.3±0.7 | 49.5±0.5 | 49.1±0.9 |
| | | pH | 7.2±0.1 | 7.3±0.1 | 7.3±0.1 | 7.2±0.1 | 7.2±0.0 | 7.2±0.1 | 7.2±0.1 | 7.2±0.1 | 7.2±0.1 |
| | | $CO_2$ (ppm) | 11.3±2.3 | 10.7±1.2 | 12.0±2.0 | 13.3±2.3 | 14.7±1.2 | 15.3±2.3 | 15.3±1.2 | 17.3±1.2 | 18.0±2.0 |
| 2.0 | 3 | *$NH_3$ (ppb) | --- | 13.3±1.7 | 18.6±3.9 | 18.7±1.7 | 21.3±2.5 | 22.7±4.0 | 28.5±3.0 | 29.4±3.2 | 33.7±4.3 |
| | | Temp. (°F) | 49.1 | 48.6 | 49.1 | 50.0 | 50.0 | 50.4 | 50.4 | 50.0 | 50.4 |
| | | pH | 7.2 | 7.3 | 7.2 | 7.1 | 7.1 | 7.0 | 7.0 | 7.1 | 7.1 |
| | | $CO_2$ (ppm) | 14.0 | 16.0 | 16.0 | 22.0 | 22.0 | 26.0 | 28.0 | 22.0 | 26.0 |
| 2.5 | 1 | *$NH_3$ (ppb) | --- | 21.1 | 25.5 | 23.9 | 26.7 | 25.6 | 31.8 | 43.5 | 51.0 |
| | | Temp. (°F) | 47.3 | 48.2 | 48.6 | 50.0 | 50.0 | 50.4 | 50.9 | 51.8 | 51.8 |
| | | pH | 7.2 | 7.2 | 7.0 | 7.0 | 6.8 | 6.9 | 6.8 | 6.8 | 6.9 |
| | | $CO_2$ (ppm) | 16.0 | 18.0 | 24.0 | 26.0 | 36.0 | 34.0 | 36.0 | 36.0 | 36.0 |
| 3.0 | 1 | *$NH_3$ (ppb) | --- | 14.0 | 15.0 | 19.4 | 15.7 | 24.8 | 22.8 | 28.5 | 38.4 |

* Un-ionized ammonia.

** No agitator used during experiment.

Appendix Table 17.--Mortalities in chinook salmon tested in loading densities of 1.0 to 3.0 lb of fish per gal of water.

| Test condition | Source of fish | No. of fish | Mortality in test | Delayed mortality 16 h | 110 h | 136 h |
|---|---|---|---|---|---|---|
| 1.0 lb /gal | Snake River | 113 | 8.0% | 12.4% | 22.1% | ----- |
| Control | Snake River | 100 | ----- | ----- | 4.0% | ----- |
| 1.0 lb /gal | Snake River | 120 | 3.3% | 5.0% | 13.3% | ----- |
| Control | Snake River | 100 | ----- | ----- | 4.0% | ----- |
| 1.0 lb /gal | Snake River | 90 | 25.6% | 28.9% | 33.3% | ----- |
| Control | Snake River | 103 | ----- | ----- | 14.0% | ----- |
| 1.0 lb /gal | Snake River | 95 | 16.8% | 17.9% | 20.0% | ----- |
| Control | Snake River | 103 | ----- | ----- | 14.0% | ----- |
| 1.0 lb /gal | Snake River | 90 | 28.9% | 34.4% | ----- | 42.2% |
| Control | Snake River | 100 | ----- | ----- | ----- | 12.0% |
| 1.0 lb /gal | Snake River | 86 | 9.3% | 19.8% | 33.7% | ----- |
| Control | Snake River | 100 | ----- | ----- | ----- | 12.0% |
| 1.5 lb /gal | Snake River | 238 | 6.7% | 7.1% | ----- | 12.2% |
| Control | Snake River | 100 | ----- | ----- | ----- | 1.0% |
| 1.5 lb /gal | Snake River | 245 | 5.3% | ----- | ----- | 15.1% |
| Control | Snake River | 100 | ----- | ----- | ----- | 2.0% |
| 1.5 lb /gal | Snake River | 248 | 7.3% | 9.3% | 14.1% | ----- |
| Control | Snake River | 100 | ----- | ----- | 2.0% | ----- |
| 2.0 lb /gal | Rapid River Hatchery | 462 | 0.0% | 0.0% | * | ----- |
| Control | Rapid River Hatchery | 100 | ----- | ----- | 0.0% | ----- |
| 2.0 lb /gal | Rapid River Hatchery | 462 | 0.0% | 0.0% | 0.0% | ----- |
| Control | Rapid River Hatchery | 100 | ----- | ----- | 0.0% | ----- |
| 2.0 lb /gal | Rapid River Hatchery | 459 | 0.0% | 0.0% | 0.0% | ----- |
| Control | Rapid River Hatchery | 100 | ----- | ----- | 0.0% | ----- |
| 2.0 lb /gal | Rapid River Hatchery | 406 | 0.0% | 0.0% | 0.0% | ----- |
| Control | Rapid River Hatchery | 100 | ----- | ----- | 0.0% | ----- |
| 2.5 lb /gal | Rapid River Hatchery | 489 | 0.0% | 0.0% | 0.2% | ----- |
| Control | Rapid River Hatchery | 100 | ----- | ----- | 0.0% | ----- |
| 3.0 lb /gal | Rapid River Hatchery | 561 | 0.0% | 0.0% | 0.0% | ----- |
| Control | Rapid River Hatchery | 100 | ----- | ----- | 0.0% | ----- |

* Water supply accidentally shut off resulting in a large mortality.

Appendix Table 18.--Date, brand position, wire tag code, and initial tag loss, and numbers of juvenile chinook salmon and steelhead trout marked and transported by truck in fresh water from Little Goose Dam to Bonneville Dam, 1978.

| Date | Position[1/] and brand | Wire tag code | Chinook salmon transported (No.) | Initial tag loss (No.) | Steelhead trout transported (No.) | Initial tag loss (No.) |
|---|---|---|---|---|---|---|
| 4-10 | RA- J | WH-RD-OR | 5827 | 93 | 1364 | 46 |
| 4-18 | " | " " " | 6292 | 145 | 900 | * |
| 4-21 | " | " " " | 6650 | 133 | 509 | * |
| 4-24 | " | " " " | 6956 | 271 | 809 | * |
| 4-26 | " | " " " | 4797 | 197 | 868 | * |
| 4-28 | " | " " " | 1445 | 61 | 629 | * |
| 5-2 | " | " " " | 2832 | 113 | 2145 | * |
| 5-3 | " | " " " | 4700 | 66 | 3087 | * |
| 5-4 | " | " " " | 46 | * | 3253 | 150 |
| 5-5 | " | " " " | 3309 | 473 | 2800 | * |
| 5-6 | " | " " " | 2109 | 32 | 1190 | 43 |
| | | Subtotals | 44,963 | 1,584 | 17,554 | 239 |
| Total fish released with tags | | | 43,379 | | 17,315 | |
| 5-8 | RA J | WH-RD-OR | 3653 | * | 2905 | 0 |
| 5-10 | " | " " " | 517 | * | 4154 | 0 |
| 5-12 | " | " " " | 208 | * | 2243 | 76 |
| | | Subtotals | 4378 | 0 | 9302 | 76 |
| Total fish released with tags | | | 4378 | | 9226 | |

1/ RA indicates a right-anterior position of brand.

* No tag loss sample obtained or sample to small for reliable estimate.

Appendix Table 18.--continued--Date, brand position, wire tag code, and initial tag loss, and numbers of juvenile chinook salmon and steelhead trout marked and numbers of juvenile chinook salmon and steelhead trout marked and transported by truck in fresh water from Little Goose Dam to Bonneville Dam, 1978.

| Date | Position[1/] and brand | Wire tag code | Chinook salmon transported (No.) | Initial tag loss (No.) | Steelhead trout transported (No.) | Initial tag loss (No.) |
|---|---|---|---|---|---|---|
| 5-15 | RA- ⌐ | WH-RD | 1633 | 0 | 4281 | * |
| 5-17 | " | " " | 0 | * | 2641 | 66 |
| 5-25 | " | " " | 0 | * | 1124 | 0 |
| 5-30 | " | " " | 1 | * | 1976 | 622 |
| | | Subtotals | 1634 | 0 | 10,022 | 688 |
| Total fish released with tags | | | 1634 | | 9,334 | |

1/ RA indicates a right-anterior position of brand.

* No tag loss sample obtained or sample to small for reliable estimate.

Appendix Table 19.--Date, brand position, wire tag code, and initial tag loss, and numbers of juvenile chinook salmon and steelhead trout marked and transported by truck in 10 ppt salt water from Little Goose Dam to Bonneville Dam, 1978.

| Date | Position[1/] and brand | Wire tag code | Chinook salmon | Initial tag loss | Steelhead trout | Initial tag loss |
|---|---|---|---|---|---|---|
| 4-12 | RA- ⊣ | WH-RD-LG | 2705 | 65 | 709 | 0 |
| 4-14 | " | " " " | 4342 | 82 | 747 | 28 |
| 4-17 | " | " " " | 7504 | 0 | 1900 | 0 |
| 4-19 | " | " " " | 5320 | 122 | 730 | * |
| 4-25 | " | " " " | 6868 | 69 | 968 | * |
| 4-27 | " | " " " | 5989 | 264 | 793 | * |
| 5-1 | " | " " " | 4065 | 0 | 1097 | * |
| 5-2 | " | " " " | 1054 | * | 2590 | * |
| 5-3 | " | " " " | 2166 | 152 | 1366 | * |
| 5-4 | " | " " " | 4762 | 71 | 859 | * |
| 5-5 | " | " " " | 495 | * | 4219 | 0 |
| | | Subtotals | 45,270 | 825 | 15,978 | 28 |
| Total fish released with tags | | | 44,445 | | 15,950 | |
| 5-9 | RA- ⊢ | WH-RD-LG | 2270 | 118 | 2038 | 124 |
| 5-11 | " | " " " | 214 | * | 3397 | 265 |
| | | Subtotals | 2484 | 118 | 5435 | 389 |
| Total fish released with tags | | | 2366 | | 5046 | |
| 5-16 | RA- ⊢ | WH-OR-GN-YW | 331 | 10 | 4305 | 0 |
| 5-18 | " | " " " " | 519 | * | 2124 | 144 |
| 5-22 | " | " " " " | 7 | * | 1547 | 0 |
| 6-2 | " | " " " " | 3 | * | 3342 | 0 |
| | | Subtotals | 860 | 10 | 11,318 | 144 |
| Total fish released with tags | | | 850 | | 11,174 | |

1/ RA indicates a right-anterior position of brand.

* No tag loss sample obtained or sample to small for reliable estimate.

Appendix Table 20.--Date, brand position, wire tag code, and numbers of juvenile chinook salmon, coho salmon, sockeye salmon, and steelhead trout marked and released as controls in the Little Goose Dam tailrace, 1978.

| Date | Position[1/] and brand | Wire tag code | Chinook salmon | Coho salmon | Sockeye salmon | Steelhead trout |
|---|---|---|---|---|---|---|
| 4-11 | LA- | WH-OR-PK | 3151 | -- | 63 | 559 |
| 4-13 | " | " " " | 2329 | -- | 51 | 382 |
| 4-7 | " | " " " | 1925 | -- | 106 | 123 |
| 4-20 | " | " " " | 8872 | -- | 143 | 1265 |
| 4-21 | " | " " " | 899 | -- | 18 | 648 |
| | | Subtotals | 17,176 | -- | 381 | 2,977 |
| 4-24 | LA- | WH-OR-PK | 2721 | -- | 37 | 1275 |
| 4-25 | " | " " " | 1801 | -- | 33 | 844 |
| 4-28 | " | " " " | 5147 | -- | 47 | 45 |
| | | Subtotals | 9,669 | -- | 117 | 2,164 |
| 5-1 | LA- | WH-YW-BR-BR | 2690 | 11 | 88 | 610 |
| 5-2 | " | " " " " | 785 | 7 | 3 | 1114 |
| 5-4 | " | " " " " | 620 | 3 | 2 | 966 |
| 5-6 | " | " " " " | 414 | 22 | 21 | 1743 |
| | | Subtotals | 4,509 | 43 | 114 | 4,433 |
| 5-8 | LA- | WH-YW-BR-BR | 374 | 41 | 14 | 2558 |
| 5-9 | " | " " " " | 1002 | 14 | 28 | 1524 |
| 5-10 | " | " " " " | 5 | 2 | 5 | 1755 |
| 5-11 | " | " " " " | 2 | 3 | 4 | 1354 |
| 5-12 | " | " " " " | 2 | 3 | 1 | 993 |
| | | Subtotals | 1,385 | 63 | 52 | 8,184 |
| 5-18 | LA- | WH-OR-GN-RD | 680 | 25 | 43 | 4821 |
| 5-19 | " | " " " " | 1513 | 44 | 81 | 1317 |
| 5-22 | " | " " " " | 40 | 12 | 8 | 769 |
| 5-23 | " | " " " " | 233 | 12 | 48 | 1041 |
| 6-2 | " | " " " " | 1236 | 20 | 113 | 3288 |
| 6-5 | " | " " " " | -- | 1 | 52 | 1370 |
| | | Subtotals | 3,702 | 114 | 345 | 12,606 |
| | | TOTALS | 36,441 | 220 | 1009 | 30,364 |

1/ LA indicates brand position-left anterior.

Appendix Table 21.--Date, test condition, transport system water quality data, delayed mortality, and tag loss of marked and unmarked juvenile chinook salmon and steelhead trout after transport from Little Goose Dam to Bonneville Dam, 1978.

| Date | Test cond.[1/] | Water quality | | | | Delayed mortality and tag loss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Chinook salmon | | | | | Steelhead trout | | | | |
| | | | | | | Marked | | | Unmarked | | Marked | | | Unmarked | |
| | | Temp. (C°) | $O_2$ (ppm) | $CO_2$ (ppm) | pH | No. held | % mort. | Tag loss% | No. held | % mort. | No. held | % mort. | Tag loss% | No. held | % mort. |
| 4-10 | F | 17 | 15.7 | 9.0 | -- | 186 | 20.4 | 1.6 | 13 | 7.7 | 29 | 0.0 | 3.4 | 5 | 0.0 |
| 4-12 | S | 10 | 31.4 | 5.0 | 6.9 | 135 | 2.2 | 2.4 | 16 | 6.2 | 22 | 0.0 | 0.0 | 2 | 0.0 |
| 4-14 | S | 11 | 21.4 | 3.0 | 6.9 | 161 | 13.0 | 1.9 | 35 | 14.3 | 27 | 0.0 | 3.7 | 2 | 0.0 |
| 4-15 | F | 10 | 20.8 | 4.0 | 6.9 | -- | -- | -- | 219 | 1.4 | -- | -- | -- | -- | -- |
| 4-17 | S | 10 | 18.3 | 4.5 | 6.9 | 50 | 4.0 | 0.0 | 14 | 0.0 | 24 | 0.0 | 0.0 | 3 | 0.0 |
| 4-18 | F | 11 | 18.5 | 3.0 | 6.8 | 129 | 18.6 | 2.3 | 18 | 22.2 | 10 | 0.0 | 0.0 | -- | -- |
| 4-19 | S | 10 | 20.1 | 3.5 | 7.0 | 88 | 18.2 | 2.3 | 18 | 33.3 | 12 | 0.0 | 0.0 | 5 | 0.0 |
| 4-19 | S | 10 | 20.1 | 3.5 | 7.0 | -- | -- | -- | 120 | 18.3 | -- | -- | -- | 7 | 14.3 |
| 4-21 | F | 11 | 17.9 | 2.9 | 6.8 | 100 | 39.0 | 2.0 | 48 | 41.7 | 7 | 0.0 | 0.0 | -- | -- |
| 4-22 | S | 11 | 14.2 | 2.9 | 7.0 | -- | -- | -- | 131 | 5.3 | -- | -- | -- | 23 | 0.0 |
| 4-24 | F | 12 | 13.7 | 3.5 | 7.2 | 77 | 5.2 | 3.9 | 82 | 3.6 | 5 | 0.0 | 0.0 | 3 | 0.0 |
| 4-25 | S | -- | -- | -- | -- | 97 | 7.2 | 1.0 | 26 | 7.7 | 6 | 0.0 | 0.0 | -- | -- |
| 4-25 | S | -- | -- | -- | -- | -- | -- | -- | 109 | 7.3 | -- | -- | -- | 14 | 0.0 |
| 4-26 | F | 11 | 39.9 | 7.0 | 7.1 | 97 | 26.8 | 4.1 | 27 | 14.8 | 11 | 8.3 | 0.0 | 3 | 0.0 |
| 4-27 | S | 12 | 13.2 | 2.9 | 7.6 | 90 | 20.0 | 4.4 | 30 | 36.7 | 11 | 0.0 | 0.0 | 4 | 0.0 |
| 4-28 | F | 11 | 32.7 | 3.5 | 7.3 | 48 | 25.0 | 4.2 | 26 | 34.6 | 19 | 0.0 | 0.0 | 4 | 0.0 |
| 4-29 | S | 11 | 15.9 | 2.5 | 7.9 | -- | -- | -- | 77 | 8.7 | -- | -- | -- | 23 | 0.0 |
| 5-1 | S | 10 | 26.1 | 9.0 | 7.2 | 42 | 2.9 | 0.0 | 79 | 2.5 | 6 | 0.0 | 0.0 | -- | -- |

1/ Test Conditions

F - Freshwater transports

S - Saltwater transports

Appendix Table 21.--continued--Date, test condition, transport system water quality data, delayed mortality, and tag loss of marked and unmarked juvenile chinook salmon and steelhead trout after transport from Little Goose Dam to Bonneville Dam, 1978.

| Date | Test cond.[1/] | Water quality | | | | Delayed mortality and tag loss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Chinook salmon | | | | | Steelhead trout | | | | |
| | | | | | | Marked | | | Unmarked | | Marked | | | Unmarked | |
| | | Temp. (C°) | $O_2$ (ppm) | $CO_2$ (ppm) | pH | No. held | % mort. | Tag loss% | No. held | % mort. | No. held | % mort. | Tag loss% | No. held | % mort. |
| 5-2 | F | 11 | 19.1 | 10.0 | 7.05 | 25 | 52.0 | 4.0 | 101 | 28.7 | 17 | 5.9 | 0.0 | 6 | 0.0 |
| 5-2 | S | 11 | 19.9 | 11.1 | 7.4 | 13 | 23.0 | 0.0 | 67 | 13.4 | 16 | 0.0 | 0.0 | 30 | 0.0 |
| 5-3 | S | 10.5 | 25.7 | 9.0 | 7.35 | -- | -- | -- | 62 | 14.5 | -- | -- | -- | 70 | 0.0 |
| 5-3 | F | 11.5 | 20.5 | 5.5 | 7.75 | 72 | 13.9 | 1.4 | 132 | 14.4 | 15 | 0.0 | 0.0 | 11 | 0.0 |
| 5-3 | S | 11 | 18.5 | 4.5 | 7.7 | 43 | 7.0 | 7.0 | 44 | 13.6 | 11 | 0.0 | 0.0 | 36 | 0.0 |
| 5-4 | F | 9 | 22.1 | 5.5 | 7.4 | 14 | 21.4 | 0.0 | 63 | 20.6 | 20 | 0.0 | 4.6 | 43 | 0.0 |
| 5-4 | S | 10.5 | 19.3 | 5.0 | 7.35 | 64 | 1.5 | 1.5 | 88 | 3.4 | 4 | 0.0 | 0.0 | 43 | 0.0 |
| 5-5 | F | 13 | 10.1 | 4.0 | 7.5 | 35 | 8.6 | 14.3 | 27 | 7.4 | 17 | 0.0 | 5.9 | 27 | 0.0 |
| 5-5 | S | 12.2 | 16.8 | 6.5 | 7.3 | 6 | 0.0 | 0.0 | 14 | 7.1 | 34 | 0.0 | 0.0 | 42 | 0.0 |
| 5-6 | F | 10.5 | 31.9 | 4.0 | 7.0 | 67 | 11.9 | 1.5 | 39 | 30.8 | 28 | 3.6 | 3.6 | 8 | 0.0 |
| 5-7 | S | 11 | 28.4 | 8.0 | 7.0 | -- | -- | -- | 61 | 4.9 | -- | -- | -- | 50 | 0.0 |
| 5-8 | F | 11.5 | 20.7 | 8.5 | 7.1 | 66 | 15.2 | 0.0 | 15 | 6.7 | 29 | 0.0 | 0.0 | 17 | 0.0 |
| 5-9 | S | 12 | 19.6 | 4.0 | 7.9 | 77 | 9.1 | 5.2 | 40 | 2.5 | 33 | 3.0 | 6.1 | 28 | 0.0 |
| 5-10 | F | 12.1 | 20.9 | 4.0 | 7.5 | 8 | 12.5 | 0.0 | 24 | 4.2 | 39 | 0.0 | 0.0 | 41 | 0.0 |
| 5-11 | S | 12.2 | 15.9 | 3.5 | 7.5 | 13 | 15.4 | 7.7 | 29 | 3.4 | 51 | 0.0 | 7.8 | 11 | 0.0 |
| 5-12 | F | 12.2 | 19.2 | 3.5 | 7.4 | 18 | 5.5 | 0.0 | 53 | 13.2 | 29 | 3.4 | 3.4 | 26 | 3.8 |
| 5-13 | S | 12 | 18.3 | 6.0 | 7.6 | -- | -- | -- | 82 | 0.0 | -- | -- | -- | 46 | 0.0 |
| 5-15 | F | 13 | 16.2 | 12.5 | 6.9 | 38 | 13.2 | 0.0 | 241 | 17.4 | 11 | 0.0 | 0.0 | 35 | 2.9 |

1/ Test Conditions

F - Freshwater transports

S - Saltwater transports

Appendix Table 21.--continued--Date, test condition, transport system water quality data, delayed mortality, and tag loss of marked and unmarked juvenile chinook salmon and steelhead trout after transport from Little Goose Dam to Bonneville Dam, 1978.

| Date | Test cond.[1/] | Water quality | | | | Delayed mortality and tag loss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Chinook salmon | | | | | Steelhead trout | | | | |
| | | | | | | Marked | | | Unmarked | | Marked | | | Unmarked | |
| | | Temp. | $O_2$ (ppm) | $CO_2$ (ppm) | pH | No. held | % mort. | Tag loss% | No. held | % mort. | No. held | % mort. | Tag loss% | No. held | % mort. |
| 5-16 | S | 12 | 15.0 | 5.0 | 7.15 | 32 | 0.0 | 3.1 | 81 | 1.2 | 58 | 0.0 | 0.0 | 17 | 0.0 |
| 5-17 | F | 12.5 | 18.2 | 4.8 | 7.2 | 17 | 5.9 | 5.9 | 48 | 14.3 | 44 | 6.8 | 2.5 | 27 | 0.0 |
| 5-18 | S | 12 | 12.9 | 3.5 | 7.4 | 11 | 0.0 | 0.0 | 15 | 0.0 | 43 | 0.0 | 6.8 | 26 | 0.0 |
| 5-20 | F | 13 | 14.8 | 3.5 | 7.3 | -- | -- | -- | 45 | 6.7 | -- | -- | -- | 88 | 1.1 |
| 5-22 | S | 12 | 16.4 | 2.5 | 7.4 | 11 | 0.0 | 0.0 | 32 | 0.0 | 46 | 0.0 | 0.0 | 23 | 0.0 |
| 5-25 | F | 12.5 | 17.6 | 2.5 | 7.2 | -- | -- | -- | 14 | 14.3 | 47 | 2.1 | 0.0 | 50 | 0.0 |
| 5-27 | S | 12.2 | 18.0 | 3.0 | 7.4 | -- | -- | -- | 116 | 3.4 | -- | -- | -- | 51 | 2.0 |
| 5-30 | F | 13 | 16.2 | 2.5 | 7.2 | 7 | 0.0 | 0.0 | 13 | 7.7 | 92 | 4.3 | 31.5 | 39 | 0.0 |
| 6-2 | S | 12.5 | 16.3 | 8.0 | 7.2 | 17 | 0.0 | 0.0 | 187 | 4.5 | 35 | 0.0 | 0.0 | 26 | 0.0 |
| 6-8 | F | 13 | 16.3 | 5.1 | 7.25 | -- | -- | -- | 102 | 3.9 | -- | -- | -- | 45 | 0.0 |
| 6-12 | S | 13 | 17.5 | 11.5 | 6.8 | -- | -- | -- | 152 | 1.3 | -- | -- | -- | 47 | 0.0 |
| 6-15 | F | 13 | 14.1 | 3.5 | 7.3 | -- | -- | -- | 153 | 3.3 | -- | -- | -- | 33 | 0.0 |

1/ Test Conditions

F - Freshwater transports

S - Saltwater transports

Appendix Table 22.--Date, brand positions, wire tag code, initial tag loss, and number of steelhead trout, spring chinook salmon, coho salmon, and sockeye salmon transported from McNary Dam to Bonneville Dam, 1978.

| Date | Position[1/] and brand | Wire tag color | Steelhead trout | Initial tag loss | Spring chinook salmon | Initial tag loss | Coho salmon | Initial tag loss | Sockeye salmon | Initial tag loss |
|---|---|---|---|---|---|---|---|---|---|---|
| 4-21 | RA-V | WH-GM-WH | 132 | * | 1298 | 0 | 2480 | 55 | 145 | * |
| 4-24 | " | " " " | 235 | * | 1126 | 37 | 2931 | 67 | 118 | * |
| 4-27 | " | " " " | 179 | * | 1324 | 0 | 2609 | 34 | 178 | * |
| 4-28 | " | " " " | 75 | * | 1035 | 0 | 2029 | 0 | 487 | 0 |
| 5-1 | " | " " " | 319 | * | 1627 | * | 1341 | * | 657 | * |
| 5-2 | " | " " " | 791 | 23 | 881 | 0 | 665 | 0 | 87 | 0 |
| 5-3 | " | " " " | 408 | 0 | 1002 | * | 796 | 0 | 173 | * |
| 5-4 | " | " " " | 910 | 0 | 1455 | 0 | 370 | 0 | 335 | * |
| 5-5 | " | " " " | 378 | 0 | 1370 | 0 | 300 | 0 | 242 | 0 |
| 5-8 | " | " " " | 826 | 0 | 1482 | 0 | 356 | 0 | 204 | * |
| 5-9 | " | " " " | 609 | 15 | 1002 | 0 | 252 | 0 | 46 | * |
| 5-10 | " | " " " | 657 | 12 | 929 | 0 | 373 | 24 | 33 | * |
| 5-11 | " | " " " | 719 | 47 | 1116 | 0 | 243 | 0 | 48 | * |
| 5-12 | " | " " " | 853 | 21 | 1428 | 0 | 299 | 12 | 10 | * |
| 5-15 | " | " " " | 1414 | 0 | 1547 | 34 | 218 | 8 | 43 | * |
| 5-16 | " | " " " | 868 | 0 | 1016 | 31 | 367 | 20 | 108 | * |
| 5-17 | " | " " " | 1037 | 18 | 1066 | 0 | 476 | 21 | 84 | * |
| 5-18 | " | " " " | 866 | 21 | 1207 | 0 | 458 | 0 | 42 | * |
| 5-19 | " | " " " | 839 | 0 | 980 | 0 | 328 | * | 39 | * |
| | | Subtotals | 12,115 | 157 | 22,891 | 102 | 16,891 | 241 | 3,079 | 0 |
| | | Total fish released with tags | 11,958 | | 22,789 | | 16,650 | | 3,079 | |

1/ RA indicates brand position - right anterior.

* No tag loss sample obtained or sample to small for reliable estimate.

Appendix Table 22--continued--Date, brand position, wire tag code, initial tag loss, and number of steelhead trout, spring chinook salmon, coho salmon, and sockeye salmon transported from McNary Dam to Bonneville Dam, 1978.

| Date | Position[1/] and brand | Wire tag color | Steelhead trout | Initial tag loss | Spring chinook Salmon | Initial tag loss | Coho salmon | Initial tag loss | Sockeye salmon | Initial tag loss |
|---|---|---|---|---|---|---|---|---|---|---|
| 5-22 | RA-< | WH-PU-YW-YW | 1102 | 15 | 1300 | 83 | 378 | 9 | 159 | * |
| 5-23 | " | " " " " | 669 | * | 581 | * | 319 | * | 157 | * |
| 5-24 | " | " " " " | 722 | 0 | 524 | 0 | 647 | 0 | 116 | * |
| 5-25 | " | " " " " | 725 | 0 | 555 | 21 | 515 | 0 | 224 | * |
| 5-26 | " | " " " " | 372 | 35 | 378 | 0 | 661 | 0 | 170 | * |
| 5-30 | " | " " " " | 2098 | 25 | 1243 | * | 717 | 0 | 699 | 0 |
| 5-31 | " | " " " " | 564 | 9 | 458 | 0 | 262 | * | 313 | 0 |
| 6-2 | " | " " " " | 500 | 0 | 814 | 15 | 401 | 0 | 862 | 0 |
| 6-5 | " | " " " " | 732 | 0 | 1138 | 0 | 235 | 0 | 643 | 0 |
| 6-6 | " | " " " " | 373 | 111 | 1322 | 49 | 423 | 43 | 211 | 0 |
| 6-8 | " | " " " " | 313 | 17 | 943 | 23 | 909 | 0 | 198 | * |
| | | Subtotals | 8,670 | 212 | 9,256 | 191 | 5,467 | 52 | 3,752 | 0 |
| | Total fish released with tags | | 8,458 | | 9,065 | | 5,415 | | 3,752 | |

1/ RA indicates brand positions-right anterior.

* No tag loss sample obtained or sample to small for reliable estimate.

Appendix Table 23.--Date, brand position, wire tag code and number of steelhead trout, spring chinook, coho salmon, and sockeye salmon released as controls at McNary Dam, 1978.

| Date | Position[1/] and brand | Wire tag code | Steelhead trout | Spring chinook salmon | Coho salmon | Sockeye salmon |
|---|---|---|---|---|---|---|
| 4-17 | LA-H | WH-RD-YW-RD | 80 | 1294 | 2178 | 58 |
| 4-19 | " | " " " " | 100 | 329 | 634 | 58 |
| 4-21 | " | " " " " | 145 | 1069 | 2163 | 119 |
| 4-24 | " | " " " " | 116 | 1462 | 2248 | 193 |
| 4-27 | " | " " " " | 44 | 1030 | 1075 | 45 |
| 4-28 | " | " " " " | 201 | 638 | 2488 | 227 |
| 5-1 | " | " " " " | 229 | 309 | 494 | 11 |
| 5-2 | " | " " " " | 171 | 1126 | 703 | 178 |
| 5-3 | " | " " " " | 123 | 1148 | 500 | 178 |
| 5-4 | " | " " " " | 310 | 1306 | 349 | 37 |
| 5-5 | " | " " " " | 334 | 799 | 302 | 71 |
| | | Subtotals | 1,853 | 10,510 | 13,134 | 1,175 |
| 5-8 | LA-H | WH-RD-YW-RD | 1083 | 1200 | 345 | 178 |
| 5-9 | " | " " " " | 1091 | 875 | 217 | 18 |
| 5-10 | " | " " " " | 720 | 796 | 265 | 41 |
| 5-11 | " | " " " " | 783 | 1392 | 264 | 116 |
| 5-12 | " | " " " " | 985 | 1345 | 199 | 27 |
| 5-15 | " | " " " " | 608 | 983 | 212 | 58 |
| 5-16 | " | " " " " | 730 | 1181 | 515 | 78 |
| 5-17 | " | " " " " | 813 | 925 | 612 | 60 |
| 5-18 | " | " " " " | 763 | 1114 | 615 | 315 |
| 5-19 | " | " " " " | 488 | 794 | 373 | 82 |
| | | Subtotals | 8,064 | 10,605 | 3,617 | 973 |

1/ Indicates brand position-left anterior.

Appendix Table 23.--continued--Date, brand position, wire tag code and number of steelhead trout, spring chinook, coho salmon, and sockeye salmon released as controls at McNary Dam, 1978.

| Date | Position[1/] and brand | Wire tag code | Steelhead trout | Spring chinook salmon | Coho salmon | Sockeye salmon |
|---|---|---|---|---|---|---|
| 5-22 | LA-S | WH-RD-OR-RD | 792 | 366 | 234 | 25 |
| 5-23 | " | " " " " | 881 | 599 | 528 | 73 |
| 5-24 | " | " " " " | 551 | 572 | 426 | 276 |
| 5-25 | " | " " " " | 897 | 814 | 762 | 514 |
| 5-26 | " | " " " " | 363 | 469 | 423 | 335 |
| 5-30 | " | " " " " | 999 | 1602 | 598 | 258 |
| 6-1 | " | " " " " | 394 | 719 | 410 | 548 |
| | | Subtotals | 4,877 | 5,141 | 3,381 | 2,029 |
| 6-5 | LA-ω | WH-RD-OR-RD | 551 | 1046 | 291 | 364 |
| 6-7 | " | " " " " | 48 | 748 | 193 | 142 |
| 6-9 | " | " " " " | 192 | 981 | 626 | 126 |
| 6-12 | " | " " " " | 0 | 2345 | 525 | 250 |
| | | Subtotals | 791 | 5,120 | 1,635 | 882 |
| | | TOTALS | 15,585 | 31,376 | 21,767 | 5,059 |

1/ Indicates brand position-left anterior.

Appendix Table 24.--Date, brand position, wire tag code, and number of fall chinook salmon transported from McNary Dam to Bonneville Dam, 1978.

| Date | Position[1/] and brand | Wire tag code | Fall chinook salmon | Initial tag loss |
|---|---|---|---|---|
| 6-28 | RA-IC | WH-OR-GN-LG | 3394 | 54 |
| 6-30 | " | " " " " | 1329 | 17 |
| 7-6 | " | " " " " | 3134 | * |
| 7-10 | " | " " " " | 3040 | * |
| 7-12 | " | " " " " | 3037 | 0 |
| 7-13 | " | " " " " | 3054 | 0 |
| | | Subtotals | 16,988 | 71 |
| | Total fish released with tags | | 16,917 | |
| 7-19 | RA-OI | WH-LG | 3140 | 0 |
| 7-27 | " | " " | 4194 | * |
| 7-31 | " | " " | 993 | 23 |
| 8-2 | " | " " | 668 | * |
| 8-11 | " | " " | 2067 | * |
| 8-21 | " | " " | 2485 | * |
| 8-23 | " | " " | 3966 | * |
| 8-28 | " | " " | 4047 | * |
| 8-30 | " | " " | 1813 | * |
| | | Subtotals | 23,373 | 23 |
| | Total fish released with tags | | 23,350 | |

1/ Indicates brand position-right anterior

* No tag loss sample obtained or sample to small for reliable estimate

Appendix Table 25.--Date, brand position, wire tag code, and number of fall chinook salmon released as controls at McNary Dam, 1978.

| Date | Position[1/] and brand | Wire tag code | Fall chinook salmon |
|---|---|---|---|
| 6-29 | LA-IF | WH-PU-GN-BL | 3038 |
| 7-5 | " | " " " " | 1084 |
| 7-7 | " | " " " " | 4053 |
| 7-11 | " | " " " " | 2845 |
| 7-14 | " | " " " " | 4072 |
| | | Subtotal | 15,092 |
| 7-17 | LA-IF | WH-YW-XY-GN | 3169 |
| 7-26 | " | " " " " | 3822 |
| 7-28 | " | " " " " | 4114 |
| 8-10 | " | " " " " | 3191 |
| 8-24 | " | " " " " | 2125 |
| 8-25 | " | " " " " | 4088 |
| 8-31 | " | " " " " | 1833 |
| 9-1 | " | " " " " | 703 |
| | | Subtotal | 23,045 |
| | | TOTAL | 38,137 |

1/ Indicates brand position-left anterior

Appendix Table 26.--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead trout counted; mortality in collection; and returned to Columbia River by date at McNary Dam, 1978.1/

| Date | Numbers counted | | | | | Mortality in collection | | | | | Returned to river | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fall chinook | Spring chinook | Coho | Sockeye | Steelhead trout | Fall chinook | Spring chinook | Coho | Sockeye | Steelhead trout | Fall chinook | Spring chinook | Coho | Sockeye | Steelhead trout |
| 4-17 | -- | 1294 | 2173 | 58 | 80 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4-19 | -- | 460 | 734 | 90 | 140 | -- | -- | -- | -- | -- | -- | 131 | 100 | 32 | 40 |
| 4-21 | -- | 3424 | 5703 | 330 | 357 | -- | 34 | 2 | -- | 4 | -- | 1023 | 1058 | 66 | 76 |
| 4-24 | -- | 4095 | 7133 | 449 | 639 | -- | 169 | 118 | 8 | 6 | -- | 1338 | 1836 | 130 | 282 |
| 4-27 | -- | 4139 | 6135 | 696 | 417 | -- | 148 | 145 | 58 | 14 | -- | 1637 | 2306 | 423 | 180 |
| 4-28 | -- | 3857 | 6291 | 1203 | 465 | -- | 78 | 62 | 60 | 12 | -- | 2106 | 1712 | 487 | 177 |
| 5-1 | -- | 3650 | 2520 | 1316 | 1102 | -- | 59 | 27 | 76 | 6 | -- | 1655 | 658 | 632 | 548 |
| 5-2 | -- | 5013 | 2053 | 1144 | 1413 | -- | 70 | 71 | 20 | 14 | -- | 2936 | 614 | 859 | 437 |
| 5-3 | -- | 4941 | 1740 | 1370 | 1030 | -- | 96 | 12 | 45 | 5 | -- | 2695 | 432 | 979 | 494 |
| 5-4 | -- | 7033 | 1629 | 1442 | 2162 | -- | 30 | 25 | 12 | 14 | -- | 4242 | 885 | 1058 | 928 |
| 5-5 | -- | 4172 | 856 | 967 | 1292 | -- | 12 | 35 | 9 | 11 | -- | 1991 | 219 | 645 | 569 |
| 5-8 | -- | 4592 | 1050 | 1352 | 3314 | -- | 9 | 2 | 2 | 8 | -- | 1901 | 347 | 968 | 1397 |
| 5-9 | -- | 3372 | 714 | 1345 | 2944 | -- | 49 | 32 | 79 | 98 | -- | 1447 | 213 | 1202 | 1143 |
| 5-10 | -- | 3064 | 762 | 982 | 2226 | -- | 8 | 12 | 6 | 18 | -- | 1331 | 112 | 902 | 831 |
| 5-11 | -- | 4471 | 760 | 1026 | 2354 | -- | 16 | 12 | 13 | 10 | -- | 1947 | 241 | 849 | 842 |
| 5-12 | -- | 6829 | 896 | 1033 | 2359 | -- | 53 | 33 | 31 | 26 | -- | 4003 | 365 | 965 | 495 |
| 5-15 | -- | 7688 | 1058 | 798 | 3084 | -- | 31 | 60 | 64 | 18 | -- | 5127 | 568 | 633 | 1044 |
| 5-16 | -- | 9258 | 1331 | 871 | 2052 | -- | 72 | 55 | 31 | 29 | -- | 6989 | 394 | 654 | 425 |
| 5-17 | -- | 8362 | 1406 | 995 | 2481 | -- | 32 | 27 | 22 | 12 | -- | 6289 | 291 | 829 | 619 |
| 5-18 | -- | 10,197 | 1402 | 1740 | 2726 | -- | 29 | 17 | 33 | 21 | -- | 7847 | 312 | 1350 | 1076 |
| 5-19 | -- | 6502 | 1299 | 1355 | 2531 | -- | 25 | 4 | 14 | 15 | -- | 4753 | 594 | 1220 | 1189 |
| 5-22 | -- | 4651 | 884 | 940 | 2610 | -- | 14 | 4 | 8 | 11 | -- | 2971 | 268 | 748 | 705 |
| 5-23 | -- | 2945 | 1088 | 985 | 1986 | -- | 17 | 3 | 9 | 15 | -- | 1748 | 238 | 746 | 421 |
| 5-24 | -- | 3092 | 1445 | 1481 | 1981 | -- | 10 | 6 | 17 | 24 | -- | 1986 | 366 | 1072 | 684 |

1/ Numbers of fingerlings trucked to Bonneville Dam or released as controls are listed in appendix tables 22 to 25.

Appendix Table 26.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead trout counted; mortality in collection; and returned to Columbia River by date at McNary Dam, 1978.[1/]

| Date | Numbers counted | | | | | Mortality in collection | | | | | Returned to river | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fall chinook | Spring chinook | Coho | Sockeye | Steelhead trout | Fall chinook | Spring chinook | Coho | Sockeye | Steelhead trout | Fall chinook | Spring chinook | Coho | Sockeye | Steelhead trout |
| 5-25 | -- | 2892 | 1560 | 1644 | 2412 | -- | 17 | 5 | 10 | 14 | -- | 1506 | 278 | 896 | 776 |
| 5-26 | -- | 2083 | 1606 | 1403 | 2450 | -- | 12 | 9 | 13 | 21 | -- | 1224 | 513 | 885 | 1194 |
| 5-30 | -- | 5371 | 2042 | 2211 | 5166 | -- | 99 | 22 | 163 | 149 | -- | 2427 | 705 | 1091 | 1920 |
| 5-31 | -- | 807 | 387 | 565 | 922 | -- | 16 | 16 | 18 | 26 | -- | 333 | 109 | 234 | 332 |
| 6-1 | -- | 1050 | 529 | 1038 | 769 | -- | 9 | 6 | 32 | 12 | -- | 322 | 113 | 458 | 363 |
| 6-2 | -- | 1428 | 642 | 1465 | 918 | -- | 12 | 3 | 10 | 14 | -- | 602 | 238 | 593 | 404 |
| 6-5 | -- | 4232 | 1287 | 2332 | 2427 | -- | 48 | 25 | 107 | 43 | -- | 2000 | 736 | 1218 | 1117 |
| 6-6 | -- | 2325 | 821 | 490 | 1129 | -- | 40 | 3 | 13 | 100 | -- | 963 | 395 | 266 | 656 |
| 6-7 | -- | 1547 | 429 | 388 | 454 | -- | 49 | 7 | 20 | 36 | -- | 750 | 229 | 226 | 370 |
| 6-8 | -- | 1830 | 1238 | 352 | 665 | -- | 10 | 1 | 8 | 11 | 84 | 793 | 328 | 146 | 341 |
| 6-9 | -- | 2180 | 1528 | 429 | 586 | -- | 76 | 21 | 21 | 20 | 103 | 998 | 881 | 282 | 374 |
| 6-12 | -- | 3815 | 969 | 639 | 362 | -- | 106 | 44 | 45 | 65 | 200 | 1164 | 400 | 344 | 297 |
| 6-27 | 1035 | 667 | 27 | 19 | 21 | 4 | -- | -- | -- | -- | 1035 | 667 | 27 | 19 | 21 |
| 6-28 | 6744 | 861 | 53 | 37 | 33 | 9 | -- | -- | -- | -- | 3350 | 861 | 53 | 37 | 33 |
| 6-29 | 7729 | 569 | 47 | 17 | 19 | 12 | -- | -- | -- | -- | 4691 | 569 | 47 | 17 | 19 |
| 6-30 | 2153 | 254 | 8 | 7 | 6 | 5 | -- | -- | -- | -- | 824 | 254 | 8 | 7 | 6 |
| 7-5 | 2098 | 240 | 4 | 9 | 6 | 260 | -- | -- | -- | -- | 1014 | 240 | 4 | 9 | 6 |
| 7-6 | 5655 | 301 | 15 | 33 | 6 | 119 | -- | -- | -- | -- | 2521 | 301 | 15 | 33 | 6 |
| 7-7 | 7896 | 365 | 14 | 9 | 6 | 170 | -- | -- | -- | -- | 3843 | 365 | 14 | 9 | 6 |
| 7-10 | 3312 | 283 | 2 | 23 | 23 | 192 | -- | -- | -- | -- | 272 | 283 | 2 | 23 | 23 |
| 7-11 | 3641 | 168 | -- | 3 | 7 | 299 | -- | -- | -- | -- | 796 | 168 | -- | 3 | 7 |
| 7-12 | 3855 | 69 | -- | 6 | -- | 803 | -- | -- | -- | -- | 818 | 69 | -- | -- | 6 |
| 7-13 | 3679 | 55 | 1 | -- | -- | 854 | -- | -- | -- | -- | 625 | 55 | 1 | -- | -- |
| 7-14 | 4763 | 43 | -- | -- | -- | 567 | -- | -- | -- | -- | 691 | 43 | -- | -- | -- |

1/ Numbers of fingerlings trucked to Bonneville Dam or released as controls are listed in appendix tables 22 to 25.

Appendix Table 26.--continued--Numbers of juvenile fall chinook, spring chinook, coho, and sockeye salmon and steelhead trout counted; mortality in collection; and returned to Columbia River by date at McNary Dam, 1978.[1/]

| Date | Numbers counted | | | | | Mortality in collection | | | | | Returned to river | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fall chinook | Spring chinook | Coho | Sockeye | Steelhead trout | Fall chinook | Spring chinook | Coho | Sockeye | Steelhead trout | Fall chinook | Spring chinook | Coho | Sockeye | Steelhead trout |
| 7-17 | 3905 | 119 | 1 | 28 | -- | 237 | -- | -- | -- | -- | 590 | 119 | 1 | -- | 28 |
| 7-19 | 3703 | 64 | 2 | 59 | 1 | 193 | -- | -- | -- | -- | 443 | 64 | 2 | 1 | 59 |
| 7-26 | 5197 | 107 | 1 | 208 | -- | 104 | -- | -- | -- | -- | 1183 | 107 | 1 | -- | 208 |
| 7-27 | 5133 | 73 | 3 | 94 | -- | 272 | -- | -- | -- | -- | 778 | 73 | 3 | 94 | -- |
| 7-28 | 5065 | 35 | 2 | 147 | -- | 78 | -- | -- | -- | -- | 816 | 35 | 2 | 147 | -- |
| 7-31 | 1160 | 14 | -- | 50 | -- | 36 | -- | -- | -- | -- | 106 | 14 | -- | 50 | -- |
| 8-2 | 801 | 14 | 1 | 31 | -- | -- | -- | -- | -- | -- | 94 | 14 | 1 | 31 | -- |
| 8-10 | 3408 | 136 | 20 | 78 | 2 | 156 | -- | -- | -- | -- | 182 | 136 | 20 | 78 | 2 |
| 8-11 | 2323 | 10 | -- | 39 | -- | 73 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 8-21 | 2766 | -- | 7 | 56 | -- | 21 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 8-23 | 4320 | -- | -- | 23 | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 8-24 | 2342 | -- | 2 | 30 | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 8-25 | 4710 | -- | -- | 21 | -- | 40 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 8-28 | 4932 | -- | -- | 54 | -- | 19 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 8-30 | 1980 | -- | -- | 14 | -- | 16 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 8-31 | 1963 | -- | -- | 19 | -- | 19 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 9-1 | 807 | -- | -- | 23 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| TOTALS | 107,075 | 151,108 | 64,310 | 38,061 | 60,135 | 4577 | 1605 | 926 | 1077 | 902 | 25,059 | 85,612 | 19,255 | 24,646 | 23,176 |

1/ Numbers of fingerlings trucked to Bonneville Dam or released as controls are listed in appendix tables 22 to 25.

Appendix Table 27.--Percent descaling of juvenile chinook salmon by date, unit number and gatewell slot designation or fish marking facility at McNary Dam, 1978.

| Date | Unit 4 slot A | Unit 4 slot B | Unit 4 slot C | Unit 7 slot A | Unit 7 slot B | Unit 7 slot C | Unit 8 slot A | Unit 8 slot B | Unit 8 slot C | Fish marking facility |
|---|---|---|---|---|---|---|---|---|---|---|
| 5-2 | 11 | 10 | 3 | -- | -- | -- | -- | -- | -- | -- |
| 5-4 | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 |
| 5-6 | 9 | 4 | -- | 3 | -- | -- | 9 | -- | 6 | -- |
| 5-7 | -- | 6 | -- | 10 | -- | -- | 12 | -- | 7 | -- |
| 5-8 | -- | 9 | -- | -- | -- | -- | -- | -- | -- | 15 |
| 5-9 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-10 a.m. | -- | 10 | -- | -- | -- | -- | -- | -- | -- | 18 |
| 5-10 p.m. | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-11 a.m. | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-11 p.m. | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-12 | 4 | 6 | 7 | -- | 4 | -- | 4 | 4 | 4 | -- |
| 5-13 | 3 | 4 | 2 | -- | 4 | -- | -- | 7 | -- | -- |
| 5-15 a.m. | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-15 p.m. | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-16 a.m. | -- | 8 | -- | -- | -- | -- | -- | -- | -- | 12 |
| 5-16 p.m. | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-17 a.m. | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-17 p.m. | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-18 | -- | 7 | -- | -- | -- | -- | -- | -- | -- | 9 |
| 5-20 a.m. | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-20 p.m. | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-21 | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-24 | 9 | 15 | 6 | -- | 6 | -- | 5 | -- | 10 | 15 |
| 5-25 | 7 | 4 | 5 | -- | -- | -- | 14 | -- | * | 3 |
| 5-26 | 9 | 9 | 4 | -- | 9 | -- | 4 | -- | 7 | 2 |
| 5-27 | 7 | 4 | 4 | -- | 0 | -- | 1 | 1 | -- | -- |
| 5-30 | 6 | 4 | -- | -- | * | -- | -- | -- | -- | 5 |
| 5-31 | 5 | 3 | 3 | -- | 1 | -- | -- | 2 | -- | -- |
| 6-1 | -- | 5 | -- | -- | * | -- | -- | 3 | -- | 6 |

* Indicates number of fish in sample is too small for accurate estimate - less than 50.

Appendix Table 28.--Percent descaling of juvenile steelhead trout by date, unit number and gatewell slot designation or fish marking facility at McNary Dam, 1978.

| Date | Unit 4 slot A | Unit 4 slot B | Unit 4 slot C | Unit 7 slot A | Unit 7 slot B | Unit 7 slot C | Unit 8 slot A | Unit 8 slot B | Unit 8 slot C | Fish marking facility |
|---|---|---|---|---|---|---|---|---|---|---|
| 5-2 | 3 | 0 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-4 | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 |
| 5-7 | -- | -- | -- | -- | -- | -- | 4 | -- | 4 | -- |
| 5-8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 |
| 5-10 | -- | 11 | -- | -- | -- | -- | -- | -- | -- | 11 |
| 5-11 | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-16 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5-24 | 4 | 3 | 6 | -- | -- | -- | 4 | -- | 7 | -- |
| 5-25 | 5 | 4 | 6 | -- | -- | -- | * | -- | * | 5 |
| 5-26 | 7 | 4 | 4 | -- | * | -- | 7 | -- | 3 | * |
| 5-27 | 7 | 4 | 5 | -- | * | -- | 2 | 3 | -- | -- |
| 5-30 | 3 | 5 | 3 | -- | * | -- | -- | -- | -- | 5 |
| 5-31 | 0 | 3 | 1 | -- | * | -- | -- | 3 | -- | -- |
| 6-1 | -- | 1 | -- | -- | * | -- | -- | * | -- | * |

* Indicates number of fish in sample is too small for accurate estimate - less than 50.

Appendix Table 29.--Date; transport system water quality data; delayed mortality; and tag loss of marked spring chinook, fall chinook, coho, and sockeye salmon and steelhead trout after transport from McNary Dam to Bonneville Dam, 1978.

| Date | Water quality | | | | Delayed mortality and tag loss | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Spring chinook salmon | | | Coho salmon | | | Sockeye salmon | | | Steelhead trout | | |
| | Temp. C° | $O_2$ (ppm) | $CO_2$ (ppm) | pH | No. held | % mort. | Tag loss | No. held | % mort. | Tag loss | No. held | % mort. | Tag loss | No. held | % mort. | Tag loss |
| 4-21 | 9.0 | 26.1 | 2.0 | 6.75 | 27 | 25.9 | 0 | 89 | 28.9 | 2.2 | -- | -- | -- | -- | -- | -- |
| 4-24 | 9.4 | 27.0 | 2.1 | 6.7 | 30 | 56.7 | 3.3 | 89 | 24.1 | 2.3 | -- | -- | -- | -- | -- | -- |
| 4-27 | 9.4 | 21.3 | 2.9 | 7.2 | 22 | 54.5 | 0 | 77 | 22.0 | 1.3 | 6 | 33.3 | 0 | -- | -- | -- |
| 4-28 | 9.0 | 29.0 | 2.5 | 7.6 | 29 | 13.8 | 0 | 93 | 20.4 | 0 | 27 | 14.8 | -- | -- | -- | -- |
| 5-2 | 11.0 | 24.8 | 3.5 | 7.45 | 25 | 60.0 | 0 | 52 | 36.5 | 0 | 13 | 53.8 | 0 | 35 | 2.7 | 2.9 |
| 5-3 | 10.1 | 27.5 | 2.5 | 7.5 | 14 | 28.6 | 0 | 51 | 29.4 | 0 | 5 | 60.0 | 0 | 20 | 15.0 | 0 |
| 5-4 | 10.5 | 26.0 | 2.2 | 7.5 | 27 | 29.6 | 0 | 23 | 30.4 | 0 | 5 | 20.0 | 0 | 43 | 2.3 | 0 |
| 5-5 | 10.0 | 29.9 | 3.0 | 7.6 | 33 | 15.1 | 0 | 40 | 42.5 | 0 | 27 | 40.7 | 0 | 35 | 5.7 | 0 |
| 5-8 | 9.5 | 27.1 | 2.2 | 7.55 | 38 | 4.3 | 0 | 30 | 10.0 | 0 | 11 | 9.1 | 0 | 37 | 0 | 0 |
| 5-9 | 10.0 | 26.3 | 2.0 | 7.65 | 37 | 16.2 | 0 | 28 | 25.0 | 0 | 12 | 16.7 | 0 | 41 | 4.9 | 2.4 |
| 5-10 | 10.0 | 20.8 | 2.0 | 7.6 | 66 | 12.1 | 0 | 31 | 29.0 | 6.4 | -- | -- | -- | 53 | 0 | 1.9 |
| 5-11 | 12.2 | 19.3 | 2.1 | 7.45 | 59 | 8.5 | 0 | 21 | 14.3 | 0 | -- | -- | -- | 46 | 4.3 | 6.5 |
| 5-12 | 11.1 | 17.5 | 2.5 | 7.4 | 76 | 10.5 | 0 | 25 | 8.0 | 4.0 | -- | -- | -- | 46 | 7.5 | 2.5 |
| 5-15 | 12.2 | 21.5 | 3.0 | 7.2 | 45 | 8.9 | 2.2 | 27 | 0 | 3.7 | -- | -- | -- | 74 | 0 | 0 |
| 5-16 | 12.2 | 18.9 | 2.5 | 7.15 | 64 | 15.6 | 3.1 | 37 | 21.6 | 5.4 | 8 | 75.0 | 0 | 50 | 10.0 | 0 |
| 5-17 | 11.0 | 22.4 | 2.2 | 7.3 | 40 | 20.0 | 0 | 22 | 9.1 | 4.5 | -- | -- | -- | 59 | 0 | 1.7 |
| 5-18 | 12.3 | 24.5 | 2.3 | 7.35 | 27 | 25.9 | 0 | 25 | 12.0 | 0 | -- | -- | -- | 42 | 14.3 | 2.4 |
| 5-19 | 12.2 | 26.4 | 2.5 | 7.5 | 44 | 29.5 | 0 | 19 | 10.5 | 0 | -- | -- | -- | 46 | 6.5 | 0 |
| 5-22 | 12.2 | 25.3 | 2.5 | 7.15 | 40 | 10.0 | 7.5 | 42 | 2.4 | 2.4 | 10 | 40.0 | 0 | 72 | 0 | 1.4 |
| 5-24 | 12.5 | 27.8 | 2.5 | 7.4 | 29 | 37.9 | 0 | 38 | 28.9 | 0 | 8 | 50.0 | 0 | 61 | 6.5 | 0 |
| 5-25 | 13.0 | 25.4 | 2.0 | 7.3 | 26 | 30.8 | 3.8 | 32 | 18.7 | 0 | -- | -- | -- | 42 | 4.8 | 0 |
| -26 | 12.2 | 23.7 | 2.5 | 7.5 | 20 | 40.0 | 0 | 35 | 28.6 | 0 | 14 | 50.0 | 0 | 74 | 1.3 | 4.0 |

Appendix Table 29.--continued--Date, transport system water quality data; delayed mortality; and tag loss of marked spring chinook, fall chinook, coho, and sockeye salmon and steelhead trout after transport from McNary Dam to Bonneville Dam, 1978.

| Date | Water quality | | | | Delayed mortality and tag loss | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Spring Chinook salmon | | | Coho salmon | | | Sockeye salmon | | | Steelhead trout | | |
| | Temp. C° | $O_2$ (ppm) | $CO_2$ (ppm) | pH | No. held | % mort. | Tag loss | No. held | % mort. | Tag loss | No. held | % mort. | Tag loss | No. held | % mort. | Tag loss |
| 5-30 | 10.0 | 15.7 | 2.5 | 7.15 | 19 | 0 | 0 | 26 | 0 | 0 | 44 | 15.9 | 0 | 81 | 0 | 1.2 |
| 5-31 | 13.5 | 25.0 | 2.2 | 7.3 | 30 | 23.3 | 0 | 14 | 7.1 | 0 | 31 | 35.5 | 0 | 62 | 1.6 | 1.6 |
| 6-2 | 13.3 | 24.6 | 3.0 | 7.35 | 54 | 14.8 | 1.8 | 33 | 9.1 | 0 | 30 | 50.0 | 0 | 54 | 0 | 0 |
| 6-5 | 14.0 | 21.7 | 3.0 | 7.3 | 37 | 13.5 | 0 | 35 | 8.6 | 0 | 36 | 22.2 | 0 | 42 | 0 | 0 |
| 6-6 | 14.3 | 19.5 | 3.0 | 7.5 | 54 | 5.5 | 3.7 | 39 | 2.6 | 10.2 | 29 | 27.5 | 0 | 37 | 2.7 | 29.7 |
| 6-8 | 14.5 | 20.6 | 2.0 | 7.55 | 84 | 14.3 | 2.4 | 56 | 9.8 | 0 | 18 | 61.1 | 0 | 38 | 0.0 | 5.3 |

| | | | | | Fall Chinook salmon | | |
|---|---|---|---|---|---|---|---|
| | | | | | No. Held | % Mort. | Tag Loss |
| 6-28 | 15.5 | 13.4 | 3.5 | 7.65 | 123 | 13.0 | 1.6 |
| 6-30 | 15.6 | 30.7 | 3.0 | -- | 155 | 2.6 | 1.3 |
| 7-12 | -- | 30.9 | 3.0 | -- | 260 | 2.7 | 0 |
| 7-13 | -- | 20.0 | -- | -- | 189 | 3.7 | -- |
| 7-19 | -- | -- | -- | -- | 145 | 29.9 | 0 |
| 7-31 | 22.0 | 19.7 | 2.5 | 7.75 | 132 | 15.1 | 2.3 |

Appendix Table 30.--Experimental design for tests of guiding efficiency and descaling of spring chinook salmon subjected to a traveling screen in unit 4B at McNary Dam, 1978. Variables tested include turbine load, screen angle, and light condition.

| Test number | Turbine load | Screen angle | Light condition | Replicates | Number of chinook per replicate |
|---|---|---|---|---|---|
| 1 | 80MW | 50° | on | 3 | 150 |
| 2 | 80MW | 55° | on | 3 | 150 |
| 3 | 70MW | 65° | off | 3 | 150 |
| 4 | 70MW | 55° | off | 3 | 150 |
| 5 | 80MW | 50° | off | 3 | 150 |
| 6 | 80MW | 45° | off | 3 | 150 |
| 7 | 70MW | 50° | off | 3 | 150 |
| 8 | 70MW | 60° | on | 3 | 150 |
| 9 | 80MW | 60° | on | 3 | 150 |
| 10 | 80MW | 65° | on | 3 | 150 |
| 11 | 70MW | 45° | on | 3 | 150 |
| 12 | 80NW | 45° | on | 3 | 150 |
| 13 | 70MW | 50° | on | 3 | 150 |
| 14 | 70MW | 45° | off | 3 | 150 |
| 15 | 80MW | 60° | off | 3 | 150 |
| 16 | 80MW | 65° | off | 3 | 150 |
| 17 | 70MW | 65° | on | 3 | 150 |
| 18 | 70MW | 60° | off | 3 | 150 |
| 19 | 70MW | 55° | on | 3 | 150 |
| 20 | 80MW | 55° | off | 3 | 150 |

Appendix Table 31.--Date; unit and slot designation; number and percent descaling of juvenile chinook, coho, and sockeye salmon and steelhead trout during designated 24 h accumulation periods at McNary Dam, 1978.

| Date | Unit and slot | No. chinook | % descaling | No. coho | % descaling | No. sockeye | % descaling | No. steelhead | % descaling |
|---|---|---|---|---|---|---|---|---|---|
| 5-26, 27 | 4B | 543 | 4 | 286 | 5 | 266 | 19 | 451 | 4 |
| " | 7B | 69 | * | 6 | * | 45 | * | 11 | * |
| " | 8B | 203 | 1 | 55 | * | 69 | * | 106 | 3 |
| 5-29, 30 | 4B | 530 | 4 | 83 | 4 | 62 | * | 207 | 5 |
| " | 7B | 55 | * | 6 | * | 18 | * | 25 | * |
| " | 8B | 84 | * | 5 | * | 44 | * | 61 | * |
| 5-30, 31 | 4B | 205 | 3 | 28 | * | 97 | 5 | 121 | 3 |
| " | 7B | 81 | 1 | 9 | * | 5 | * | 28 | * |
| " | 8B | 147 | 2 | 35 | * | 42 | * | 164 | 3 |
| 5-31, 6-1 | 4B | 236 | 5 | 51 | * | 102 | 3 | 78 | 1 |
| " | 7B | 31 | * | 1 | * | 5 | * | 12 | * |
| " | 8B | 93 | 3 | 12 | * | 80 | 1 | 42 | * |

* Indicates number of fish in sample is too small for accurate estimate - less than 75.

Appendix Table 32.--Recovery of adult steelhead trout at Dworshak Hatchery, Pahsimeroi Hatchery, and Hells Canyon Dam in 1978 that were tagged as juveniles and transported and released below Bonneville Dam or released as controls at Lower Granite and Little Goose Dams (1975-76).

| Originating dam and year of release | Test condition | Adults recovered: Number with jaw tag & wire tag | Adults recovered: Number with wire tag only | Adults recovered: Total |
|---|---|---|---|---|
| Dworshak Hatchery | | | | |
| Lower Granite 1975 | Transport | 70 | 65 | 135 |
| Lower Granite 1975 | Control | 23 | 28 | 51 |
| Lower Granite 1976 | Transport | 1 | 5 | 6 |
| Lower Granite 1976 | Control | 0 | 1 | 1 |
| Little Goose 1976 | Transport | 3 | 2 | 5 |
| Little Goose 1976 | Control | 1 | 0 | 1 |
| Subtotals | | 98 | 101 | 199 |
| Pahsimeroi Hatchery | | | | |
| Lower Granite 1975 | Transport | 4 | 0 | 4 |
| Lower Granite 1976 | Transport | 34 | 6 | 40 |
| Lower Granite 1976 | Control | 8 | 3 | 11 |
| Little Goose 1976 | Transport | 36 | 3 | 39 |
| Little Goose 1976 | Control | 7 | 2 | 9 |
| Subtotals | | 89 | 14 | 103 |
| Hells Canyon Dam | | | | |
| Lower Granite 1975 | Transport | 1 | 1 | 2 |
| Lower Granite 1976 | Transport | 3 | 4 | 7 |
| Little Goose 1976 | Transport | 2 | 0 | 2 |
| Little Goose 1976 | Control | 1 | 0 | 1 |
| Subtotals | | 7 | 5 | 12 |
| TOTALS | | 194 | 120 | 314 |

Appendix Table 33.--Recovery of adult chinook salmon in 1978 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 and Little Goose Dams (1975 to 77).

| Originating dam and year of release | Test condition | Adults recovered: Number jaw tag[1/] and wire tag | Number wire tag only | Total |
|---|---|---|---|---|
| Kooskia Hatchery | | | | |
| Lower Granite 1975 | Transport | 1 | 0 | 1 |
| Lower Granite 1976 | Transport | 0 | 3 | 3 |
| Lower Granite 1976 | Control | 2 | 2 | 4 |
| Little Goose 1976 | Transport | 2 | 0 | 2 |
| Little Goose 1976 | Control | 1 | 1 | 2 |
| Unknown | | 0 | 1 | 1 |
| Subtotals | | 6 | 7 | 13 |
| Rapid River Hatchery | | | | |
| Lower Granite 1975 | Transport | 2 | 4 | 6 |
| Lower Granite 1975 | Control | 0 | 2 | 2 |
| Lower Granite 1976 | Transport | 3 | 7 | 10 |
| Lower Granite 1976 | Control | 1 | 1 | 2 |
| Lower Granite 1977 | Transport | 1 | 0 | 1 |
| Little Goose 1976 | Transport | 1 | 0 | 1 |
| Little Goose 1976 | Control | 0 | 2 | 2 |
| Subtotals | | 8 | 16 | 24 |
| TOTALS | | 14 | 23 | 37 |

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

Appendix Table 34.--Spawning ground recoveries of adult chinook salmon that were marked as juveniles and transported and released below Bonneville Dam or released as controls from Lower Granite and Little Goose Dams (1975-76).

| Tag code | Originating dam and release year | Adults recovered: Number with jaw tag[1/] & wire tag | Adults recovered: Number with wire tag only | Adults recovered: Total |
|---|---|---|---|---|
| WH-OR-BR | Lower Granite 1975 | 6 | 7 | 13 |
| WH-YW-XY-LG | " " " | 1 | 1 | 2 |
| WH-YW-XY-GR | " " " | 0 | 1 | 1 |
| WH-OR-XR | " " " | 0 | 4 | 4 |
| WH-YW-XY-PK | " " " | 1 | 1 | 2 |
| GR Stripe | Little Goose 1976 | 1 | 0 | 1 |
| | TOTALS | 9 | 14 | 23 |

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

Appendix Table 35.--Preliminary recovery in ocean sport and commercial fisheries and at Bonneville Dam of 1-ocean age (jack) coho salmon from juveniles tagged and transported to Below Bonneville Dam or released as controls at McNary Dam in 1978 (recoveries as of 1 February 1979).

| Recovery area | Number of transported fish | Number of control fish | Benefit ratio |
|---|---|---|---|
| Ocean sport and commercial fisheries | 29 | 5 | 5.8:1 |
| Bonneville Dam (adult separator) | 8 | 6 | 1.33:1 |
| Totals | 37 | 11 | 3.36:1 |

Appendix Table 36.--Miscellaneous recoveries of adult steelhead trout and chinook salmon ( ) in 1978 that were tagged as juveniles and transported and released below Bonneville Dam or released as controls from Lower Granite and Little Goose Dams (1976-77).

| Area of recovery | 1976 | | | | 1977 | |
|---|---|---|---|---|---|---|
| | Lower Granite transport test (No.) | Lower Granite control (No.) | Little Goose transport test (No.) | Little Goose control (No.) | Lower Granite transport test (No.) | Little Goose transport test (No.) |
| Lower Columbia (sport) | | | 2 | | 1 | |
| Klickitat River (sport) | | | | 1 | | |
| Lower Columbia & Ocean (commercial) | 2 | | | | 2 (1) | |
| Deschutes River (sport) | 3 (1) | | 1 | | 1 | |
| Upper Columbia sport & hatchery | 2 | | 5 | 1 | | |
| Bonneville trap | 28 | 10 | 31 | 4 | | |