CZES Coastal Zone and Estuarine Studies

TRANSPORTATION OPERATIONS ON THE SNAKE AND COLUMBIA RIVERS 1979

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INTRODUCTION

During the past several years at Lower Granite and Little Goose Dams on the Snake River and more recently at McNary Dam on the Columbia River, the National Marine Fisheries Service (NMFS) under contract to the U.S. Army Corps of Engineers (CofE) has been conducting research to improve the survival of valuable upriver stocks of anadromous salmonids during the downstream migration phase (smolt phase) of their life cycle. The major objectives of this research have been: (1) to develop, improve, and refine facilities and equipment for the efficient collection and transportation of a maximum number of smolts without compromising their physical condition; (2) to mark test and control groups of fish to determine the best combinations of release sites and transport modes; and (3) to develop an effective mass transportation system capable of moving large numbers of fish in a timely and orderly manner around or through hazardous areas associated with dams to safe release sites.

With the exception of some incomplete adult return data, the research designed to evaluate fish protective facilities and transport methods has been completed at Lower Granite and Little Goose Dams and the emphasis in 1979 shifted entirely to mass transportation operations. At McNary Dam, research designed to evaluate fish protective facilities and transport methods was again emphasized in 1979. However, mass transportation operations were initiated concurrently and information germane to these mass transportation operations will be included in this report.

MASS TRANSPORT OF SMOLTS

Generally cool weather prevailed in March and April, causing a gradual and somewhat delayed seaward migration of fingerlings from all river systems. Chinook salmon arrived at Lower Granite Dam in sufficient numbers

to warrant the initiation of truck transport operations on 11 April; at Little Goose Dam, the first fish were hauled by truck 17 April. All fingerlings collected were hauled by truck until daily collection reached about 25,000 fingerlings at Lower Granite Dam on 23 April when barging operations began. The last barge load of smolts departed Lower Granite Dam on 31 May. Trucks were used to haul the remaining smolts from then until the end of the migration on 4 July.

To provide maximum use of the barges this year, a second tug was added--providing each barge with a tug. To further maximize the use of the barges, fingerlings collected at Little Goose and McNary Dams were loaded into the barges as they stopped briefly at these dams while enroute from Lower Granite Dam to the release site below Bonneville Dam. When barges were not available at Little Goose or McNary Dams, smolts were routinely trucked on a daily basis.

Although all turbine units at the two collector dams on the Snake River were fully screened, 100% of the potential smolt collection was not realized. In brief, the major reasons were as follows: (1) a massive accumulation of debris on the upper 1/3 of the trash racks at Lower Granite Dam resulted in lower collection of chinook salmon; (2) one generator unit at Lower Granite Dam was out of service for the entire season for extensive mechanical repairs. Consequently, many fish passed over the spill that was required between 23 and 27 May because of the lower powerhouse capacity; and (3) the traveling screens at Little Goose Dam did not operate in a fully acceptable manner. These problems will be addressed in greater detail later in this report.

At McNary Dam, the collection potential was enhanced by the addition of vertical barrier screens in all turbine gatewells and by the use of two

additional bar screens. These devices provided a three-fold increase in the number of fish collected at this dam over the previous year (assuming equal recruitment).

Although some collection problems existed, over 5 million salmonids were collected at the three dams. Table 1 shows that 5,080,258 salmonids were transported to safe release sites below Bonneville Dam. About 60% of this total were transported by barge and the remainder were hauled by truck. However, at Lower Granite Dam, barging accounted for 83% of the transport total.

Sims et al. (1980) estimated that 4,270,000 chinook salmon and 2,550,000 steelhead arrived at Lower Granite Dam in 1979. We transported 49% of the available chinook salmon and 67% of the steelhead from the two Snake River dams (Table 2). (See Appendix Tables 1 to 4 and 13 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.)

TABLE 1.--Number of juvenile chinook, coho, and sockeye salmon and steelhead transported from Lower Granite, Little Goose, and McNary Dams and released below Bonneville Dam, 1979.

	Chinook	Coho	Sockeye	Steelhead	Total
Lower Granite Dam					
Truck	193,980	56	1,073	203,982	399,091
Barge	976,918	533	10,404	992,565	1,980,420
Subtotal	1,170,898	589	11,477	1,196,547	2,379,511
Little Goose Dam					
Truck	555,045	----	-----	292,624	847,669
Barge	382,668	----	-----	223,290	605,958
Subtotal	937,713	----	-----	515,914	1,453,627
McNary Dam					
Truck	596,545	27,057	95,460	66,547	785,609
Barge	202,096	55,620	102,229	101,566	461,511
Subtotal	798,641	82,677	197,689	168,113	1,247,120
Grand total transported	2,907,252	83,266	209,166	1,880,574	5,080,258

a/ This total includes those fish marked and transported for experimental purposes.

TABLE 2.--Number of chinook salmon and steelhead smolts and percent of total Snake River outmigration transported below Bonneville Dam 1971-1979 (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 1972-1980.)

	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
1979	4,270	2,109	49	2,550	1,712	67

TRANSPORT OPERATIONS -- LOWER GRANITE DAM

Collection and Transportation

About 1.3 million chinook salmon and 1.3 million steelhead were collected at Lower Granite Dam in 1979. Of these totals, 1,170,898 chinook salmon and 1,196,547 steelhead were transported from Lower Granite Dam to safe release sites below Bonneville Dam. (Incidental numbers of coho and sockeye salmon were also transported.)

About 27,336 chinook salmon and 30,495 steelhead transported by barge were marked to provide an index to the success of the transport operations in subsequent years. Similarly, 70,628 chinook salmon and 66,146 steelhead were marked and released as control fish in the forebay or tailrace of the dam. Marked fish released in the forebay also enabled us to determine the magnitude of steelhead and chinook salmon populations arriving at the dam. All marked fish had excised adipose fins and received distinctive freeze brands and coded wire tags. Table 3 and Appendix Tables 5 to 8 contain detailed summaries of all marked release groups.

Although over 2.6 million chinook salmon and steelhead were collected at Lower Granite Dam in 1979, the maximum collection potential of the system was not attained. Only 31% of the available chinook salmon were collected compared to 50% of the available steelhead. Chinook salmon collection should have been higher if everything was operating correctly. As previously mentioned, a massive debris accumulation that developed on the trash racks during the peak of the chinook salmon outmigration was the primary factor responsible. Using the relative amount of gatewell drawdown (the difference between the water level in a gatewell and the water level in the forebay) as an indicator, it was estimated that the upper third of the trash racks in front of Units 1 and 2 were almost completely covered by debris. Although much less severely, debris also accumulated on the upper areas of the trash racks in front of Units 4, 5, and 6.

TABLE 3.--Summary of marked and unmarked chinook salmon and steelhead at Lower Granite Dam by release sites, 1979. (Includes controls that were marked but not actually transported.)

Release Sites	Marked		Unmarked	
	Chinook	Steelhead	Chinook	Steelhead
Trucked Bonneville Dam	--	--	193,980	203,982
Barged Bonneville Dam	27,336	30,495	949,582	962,070
Lower Granite Forebay (control)	24,467	17,319	--	--
Clarkston, WA (control)	20,629	27,777	--	--
Lower Granite Tailrace (control)	25,532	21,050	--	--
Totals	97,964	96,641	1,143,562	1,166,052

A debris blockage of this magnitude on the trash racks would have two major effects. First, many smolts that normally enter the turbine intakes in the upper portion of the water mass would be diverted to lower levels, thereby allowing them passage under the traveling screens and, consequently, through the turbines. (This is a theoretical explanation, indicating why smolts failed to be guided into gatewells.) Second, the water velocity through the open portion of the trash racks would be increased substantially, resulting in higher descaling and injury rates for those fish that encounter the trash racks in these areas.

This condition was first detected and brought to the attention of CofE project personnel by NMFS on 1 May. They took immediate and sustained actions in an attempt to rectify the problem. Unfortunately, the CofE had no permanent debris removal equipment at Lower Granite Dam; however, a privately owned, barge mounted crane was located in Lewiston, Idaho, and towed downriver. The towing operation alone took nearly 1 full working day. After arrival at the dam, a mechanical problem developed and the crane was unable to operate under the weight of the large, steel H-beam used to scrape the trash racks. Repeated attempts to repair the crane were unsuccessful. Finally, 5 days after the debris problem was first noted, the crane was successfully repaired and the trash racks cleared. If permanent trash rack cleaning equipment had been available, this unfortunate situation could have been avoided.

Because of the unpredictable nature of smolt movements, it is impossible to accurately estimate the number of fish that were diverted under the traveling screens prior to debris removal. As previously indicated, the lower percentage of chinook salmon vs steelhead collected at Lower Granite Dam meant substanial numbers of chinook salmon were escaping under the traveling screen. A comparison of the collection data between Little

Goose and Lower Granite Dams provides further evidence that a substantial number of chinook salmon smolts failed to be guided at Lower Granite Dam. During the entire season, we collected approximately 26% more chinook salmon at Lower Granite Dam than at Little Goose Dam. However, at Lower Granite Dam, we collected approximately 60% more steelhead than at Little Goose Dam. Again, the trash racks had been cleaned prior to the steelhead peak, and it would appear from the higher percent collected that this species may have been less affected by the debris accumulation. Also, after the trash racks were cleared on 5 May, the number of chinook salmon smolts collected at Lower Granite Dam dropped gradually by approximately 10,000 fish per day for 4 to 5 days. At Little Goose Dam, the impact of debris removal from the Lower Granite Dam trash racks was much more pronounced. Approximately 4 days after the trash racks were cleared, the numbers of chinook salmon smolts collected at this dam dropped by 20,000 to 30,000 fish per day for 2 consecutive days. These data indicate that although the run was declining at both dams during the respective time periods, the collection efficiency at Lower Granite Dam had increased substantially after the debris removal operation; therefore, fewer fish would have been available for collection at Little Goose Dam.

The other factor that had a minor effect on the collection efficiency at Lower Granite Dam, was the unavailability of Unit 3 during the entire smolt outmigration. As water flows surpassed the maximum capacity of the powerhouse, spilling was required for a brief time (23 to 27 May); thereby, allowing a portion of the smolts (mostly steelhead) to pass over the spillways. If Unit 3 had been in service, no spilling would have been necessary in 1979.

On several occasions during the past few years, NMFS has verbally requested that the CofE install permanent debris removal equipment at Lower Granite Dam. In this regard, we feel that the preceding discussion provides ample justification for the following actions: (1) permanent debris removal equipment should be installed at Lower Granite Dam prior to the 1980 smolt outmigration; (2) in future years, trash racks should be cleared of debris in advance of the smolt outmigration with periodic inspection and debris removal operations conducted during the smolt outmigration as deemed necessary by NMFS and CofE project personnel; and (3) whenever possible, long term turbine outages for repairs and maintenance should not be scheduled to coincide with the smolt outmigration. We feel the implementation of these actions would enhance the collection potential at Lower Granite Dam, thereby providng more fish in better physical condition for transport and, ultimately, more adult fish returning in future years.

Descaling, Delayed Mortality, and Water Quality Measurements

As in past years, the average descaling measured on chinook salmon at the fish marking faciltiy during the marking process was used to index the general condition of transported. The average daily descaling rate for chinook salmon of 5.3% (range 1 to 12%) was the lowest ever recorded at the Lower Granite marking facility. The rate of descaling for steelhead of 5.7% (range 0 to 15.5%) was comparable to the 5.8% measured in 1978. (See Appendix Tables 9 and 10 for additional detail.)

Descaling and injury of fingerlings in gatewells where traveling screens were operating were monitored throughout the season. The average descaling data by gatewell are presented in Table 4. The data indicate that traveling screens operated satisfactorily in 1979 based on the low

TABLE 4.--Average percent descaling for naturally migrating juvenile chinook salmon and steelhead collected from turbine intake gatewells at Lower Granite Dam, 1979.

	Descaling - chinook salmon				
Unit	1	2	4	5	6
Gatewell	A B C (%)	A B C (%)	A B C (%)	A B C (%)	A B C (%)
Average by gatewell	7 7 4	4 5 4	2 2 3	2 2 2	1 2 2
Average by turbine unit	6	4	2	2	1

Combined average for entire season 4%.

	Descaling - steelhead				
Unit	1	2	4	5	6
Gatewell	A B C (%)	A B C (%)	A B C (%)	A B C (%)	A B C (%)
Average by gatewell	4 4 5	5 4 5	2 5 7	4 4 5	4 5 5
Average by turbine unit	4	5	5	4	5

Combined average for entire season 5%.

combined average descaling rate of 4% for chinook salmon and 5% for steelhead. However, the average descaling rate for chinook salmon by turbine unit was substantially higher in Units 1 and 2 than in any of the other three units; whereas, the average descaling rate for steelhead by turbine unit was nearly equal for all five units. We feel that the increased descaling rate for chinook salmon measured in Units 1 and 2 was due to the much heavier debris load on the trash racks in front of these two units. The nearly equal descaling rate for steelhead measured in all five units further substantiates our conclusion because the majority of the steelhead migrated after the trash racks were cleared.

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 11 lists these measurements by date and transport method. Delayed mortality measurements for marked chinook salmon and steelhead were also taken at Lower Granite Dam prior to barge transport. All delayed mortality samples were held for 48 h. The averages for all groups are given in Table 5. (Individual test data are shown in Appendix Table 12.) As expected, the average delayed mortality was higher for unmarked chinook salmon after truck transport than after barge transport. Also, for marked chinook salmon, the delayed mortality average was slightly higher (5.0 vs 3.5%) for fish held at Lower Granite Dam prior to barge transport than for fish held at Bonneville Dam after barge transport. Delayed mortality averages for all groups of steelhead were insignificant.

TABLE 5.--Summary of 48-h delayed mortality of chinook salmon and steelhead smolts before barge transport (marked only) and after barge and truck transport (marked and unmarked) to Bonneville Dam from Lower Granite Dam, 1979.

	Chinook						Steelhead					
	Marked			Unmarked			Marked			Unmarked		
	No. Held	No. Mort.	% Mort.	No. Held	No. Mort.	% Mort.	No. Held	No. Mort.	% Mort.	No. Held	No. Mort.	% Mort.
Before barge transport (at Lower Granite Dam)	357	18	5.0	---	---	---	290	2	0.68	---	---	---
After barge transport (at Bonneville Dam)	708	22	3.1	1485	86	5.8	284	1	0.4	777	5	0.6
After truck transport (at Bonneville Dam)	---	---	---	2952	296	10.0	---	---	---	1464	24	1.6

TRANSPORT OPERATIONS - LITTLE GOOSE DAM

Collection and Transportation

A special collection and transportation operation was conducted by NMFS at Little Goose Dam in 1979. Normally, fish diverted into the gatewells exit through the orifice-bypass system and are collected in holding raceways located just downstream from the tailrace deck. From here, they are easily loaded into transport tankers. However in 1979, a new orifice-bypass system scheduled for completion prior to the smolt outmigration was not finished on time. Since the old system had already been dismantled, it was necessary to load the fish into transport tankers directly from the gatewells. This was accomplished using a crane and dip net basket (Swan et al. 1979). The system was essentially a salvage operation and as such was successful.

Two portable fingerling observation shacks were installed on the intake deck and samples of fish dipped from the gatewells were processed through them to determine descaling percentages, fish weights, and species compositions. A weight displacement method utilizing the fish weight and species composition information was developed to estimate numbers of fish transported (See Appendix A for a detailed explanation of this method).

In total, 937,713 chinook salmon and 515,914 steelhead were collected and transported by truck or barge from Little Goose Dam. Table 2 and Appendix Table 13 further detail numbers and methods of transport. No fish were marked at Little Goose Dam in 1979.

The traveling screens at Little Goose Dam operated unsatisfactorily in 1979. We inspected the screens after they were removed from the gatewells at the end of the season and concluded that 9 of 18 screens were not functioning properly. Some screen panels were torn and others were in such

poor condition that it was obvious they could not operate as designed. Operation of traveling screens under these circumstances would tend to increase descaling and injury and decrease guiding efficiency. We feel that this situation resulted from inadequate maintenance prior to the field season together with insufficient inspections during the field season. In future years, we strongly urge that the CofE at Little Goose Dam take appropriate actions to resolve this problem.

Descaling, Delayed Mortality, and Water Quality Measurements

Descaling measurements were taken from all gatewells during the loading operation and are summarized in Table 6 and detailed by gatewell in Appendix Tables 14 and 15. The average rate of descaling measured was 8.1% for chinook salmon; much higher than the 5.7% measured at Lower Granite Dam. The rate of 5.7% for steelhead was essentially the same at both dams. The higher ratio of chinook salmon descaling resulted from the aforementioned debris problem that occurred at Lower Granite Dam. Prior to the cleaning of the trash rack at Lower Granite Dam (17 April to 10 May), the rate of descaling on chinook salmon recovered at Little Goose Dam averaged 12% in Turbine Units 1, 2, and 4. Since May 10, the average rate of descaling decreased by 6.0% to 6.0% (Table 7). Even with the debris problem, the overall rates of descaling for both chinook salmon and steelhead were much lower than the rates measured during the previous year when enviornmental conditions were similar. However, in 1978 the measurements were taken at the fish marking facility after the fingerlings had passed through the entire bypass system. This information suggests that much of the descaling in previous years may have occurred while fingerlings were passing through the old orifice-bypass system.

TABLE 6.--Average percent descaling for naturally migrating juvenile chinook salmon and steelhead collected from turbine intake gatewells at Little Goose Dam, 1979.

	Descaling - chinook salmon				
Unit	1	2	3[a]	4	5
Gatewell	A B C (%)	A B C (%)	A B C (%)	A B C (%)	A B C (%)
Average by gatewell	9 10 6	10 12 7	7 5 6	9 8 7	6 5 7
Average by turbine unit	9	10	6	8	6

Combined average for entire season 8%.

	Descaling - steelhead				
Unit	1	2	3	4	5
Gatewell	A B C (%)	A B C (%)	A B C (%)	A B C (%)	A B C (%)
Average by gatewell	6 6 5	6 6 6	6 5 6	4 6 6	5 6 6
Average by turbine unit	6	6	6	6	5

Combined average for entire season 6%.

a/ Insufficient measurements taken to compare.

TABLE 7.--Average percent descaling for naturally migrating chinook salmon from Turbine Units 1, 2, and 4 (data from Units 3, 5 and 6 insufficient for comparison) at Little Goose Dam before and after trash rack cleaning at Lower Granite Dam

	Descaling - chinook salmon		
Unit	1	2	4
Gatewell	A B C (%)	A B C (%)	A B C (%)
Before cleaning (17 April to 10 May)	11 14 8	14 17 9	12 12 10
Average by turbine	11	13	11
Combined average		12	
After cleaning (11 May to 2 June)	7 8 5	5 7 5	5 5 4
Average by turbine	7	6	
Combined average		6	

Delayed mortality and water quality parameters including temperature, O_2, CO_2, and pH were measured after transport to Bonneville Dam and are given for each load in Appendix Table 16. The delayed mortality averages for unmarked chinook salmon hauled by truck and barge measured 19.8 and 7.0%, respectively. The average noted for the trucked group is significantly higher than the average measured for a comparable group transported in 1978 (12.7%). We speculate that the higher mortality was the result of the succession of stresses resulting from encounters with the debris plugged trash racks at Lower Granite Dam, the poor performance of traveling screens at Little Goose Dam, and the somewhat cumbersome dipping and loading operation. Delayed mortality averages for unmarked steelhead trout hauled by truck or barge were low (0.8% and 1.8%, respectively).

TRANSPORT OPERATIONS - McNARY DAM

At McNary Dam, 1979 marked the second year of collection and transportation operations. During the previous year, only those fish marked for research purposes were transported to safe release sites below Bonneville Dam. All fish collected in excess of research requirements were returned to the river in 1978.

In 1979, the addition of vertical barrier screens in all gatewell slots together with the addition of two bar screens, substantially increased the collection capability of the facility. A total of 1,593,208 salmonids were collected. This was approximately three times the number of fish collected during the previous year and provided a large surplus over the requirements for research purposes. To provide these fish with maximum protection, nearly all were transported along with marked fish. Including marked fish, a total of 1,247,120 salmonids were transported. Specifics of collection, marking, test groups, and disposition of all fish handled at McNary Dam

will be addressed in one report, "Transportation Research on the Columbia and Snake Rivers - 1979," (Park et al 1980).

BARGE OPERATIONS

Between 20 April and 31 May 1979, two tugboats and two barges transported over 3 million juvenile salmonids from Lower Granite, Little Goose, and McNary Dams. (See Appendix Tables 1 to 4 and 13 for additional details on numbers of barged smolts). Two NMFS personnel -- a diesel engine mechanic and a biologist -- were responsible for the operation of each barge. We monitored water pressure in the spray bars on a 24-h basis and periodically checked oxygen levels and temperatures in the fish holding compartments.

The 1979 barging program was a success; however, we did experience some problems. One of the barges developed several major mechanical problems -- two broken pump shafts (the same pump) and sticking valves in two diesel engines. We feel the performance of one of the tugboats was marginal. The tugboat maneuvered poorly during the release of fish below Bonneville Dam. (The tugboat backs into the current during a normal release.) Also, during heavy spill periods increased river velocities near the dams slowed the tug's upstream progress considerably due to a lack of sufficient engine power.

By implementing the following recommendations, the CofE could improve the 1980 fish barging program. First, all the diesel engines and pumps should be properly serviced and tested prior to the spring salmonid outmigrations. (The sticking valves in the engines may have resulted from improper storage of the diesels.) Second, tugboats used to push the barges should have adequate power to average at least 9 mph traveling upstream on the Columbia and Snake Rivers. Also, the tugboats should be maneuverable and powerful enough to maintain a steady position in the river current while releasing fish below Bonneville Dam.

In the near future, both increased smolt production and enhanced collection potential (especially at McNary Dam) will greatly increase the number of smolts available for transport. Accordingly, we expect barging to further increase its role in the transportation process. With this in mind, together with the fact that some barges were filled to capacity during this year's operations, NMFS recommends that a third and fourth barge be added to the transport fleet in 1981 and 1982, respectively.

SUMMARY

1. In 1979, 3,833,138 salmonids were transported from Lower Granite and Little Goose Dams. We estimate that 49% of the chinook salmon and 67% of the steelhead that arrived at Lower Granite Dam were transported. An additional 1,247,120 salmonids were transported from McNary Dam, bringing the total fish transported in 1979 to 5,080,258.

2. Of the total transported at Lower Granite Dam, 27,336 chinook salmon and 30,495 steelhead were marked to provide an index to the success of the transportation operations in future years. In addition, 70,628 chinook salmon and 66,146 steelhead were marked for various control releases. Delayed mortality averages for chinook salmon ranged from 3.1 to 10.0% depending upon transport method and whether they were marked or unmarked. Marked chinook salmon transported by barge had the lowest delayed mortality (3.1%). Marked chinook salmon held at Lower Granite Dam prior to barge transport averaged 5.0%. Delayed mortality measurements for steelhead were insignificant.

3. At Lower Granite Dam, a massive debris accumulation on the upper 1/3 of the trash racks during the peak of the chinook salmon outmigration resulted in failure to collect a substantial number of fingerlings and resulted in injury to an unknown number of them.

4. Because the new orifice-bypass system was not finished on schedule at Little Goose Dam, smolts were dipnetted directly from gatewells into the transport tankers. A total of 1,453,627 salmonids were transported by truck and barge. Delayed mortality averages of unmarked chinook salmon transported by truck and barge were 19.8 and 7.0%, respectively. Delayed mortality averages for steelhead were low (0.8 and 1.8%, respectively. No fingerlings were marked in 1979.

5. In 1979, mass transportation operations were initiated concurrently with ongoing research operations at McNary Dam. Vertical barrier screens in all gatewells, three traveling screens, and three bar screens provided a large surplus of smolts over the requirements for research purposes. Including marked fish, a total of 1,247,120 salmonids were transported.

6. In 1979, the fish barging operation was expanded to include Little Goose and McNary Dams and a second tug was added providing each barge with a tug.

RECOMMENDATIONS

(1) Install permanent debris removal equipment at Lower Granite Dam. Clean trash racks at all dams prior to and during the smolt outmigration period as deemed necessary by NMFS and CofE project personnel.

(2) Inspect and test traveling screens at all dams prior to the smolt outmigration. Install meters on all screens to monitor performance during smolt migration period.

(3) Service and test all diesel engines and pumps in barges prior to the smolt outmigration.

(4) Tugboats for the barges must have adequate power to average at least 9 mph traveling upstream.

(5) Add one barge to the operations in 1981 and a second in 1982 for a total of four barges.

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APPENDIX A

This appendix is made up of two parts: (I) a description of the method used to estimate the numbers of fish loaded in the transport tankers at Little Goose Dam, and (II) 16 tables providing details about our 1979 Transport Operations Program.

PART I

METHODS USED TO CALCULATE NUMBERS OF FISH IN TANKS

The displacement method used to estimate the numbers of juvenile chinook salmon and steelhead loaded into transport tankers at Little Goose Dam is described below. Since fish weight is the same as a given volume of water (Haskell, 1959), we determined that each 1/16-inch rise of water measured from a given mark on a sight glass tube attached to the transport tankers would equal 45 pounds of fish. Therefore, each 1/16-inch unit of increase multiplied by 45 pounds equaled the total weight of fish added to the tank. We then multiplied the percentages of each species by weight by the total weight added to determine the total weight of each species contained in the tank. Finally, the numbers of fish per pound of each species were multiplied by the total weight of each species to derive the total number of each species that was loaded into a tanker. Although a water dissipator was used when dipping (loading) fish into the truck, we estimated that each dip net load of fish also contributed approximately 1/2 gallon of water to the transport tanker. By multiplying the total number of dips by 1/2 gallon and then multiplying the number of gallons by 8.3 pounds and dividing this number by 45 (the number of pounds of water in 1/16 inch) we calculated the number of 1/16-inch units to be subtracted from the total displacement at the end of the loading process.

Sample Calculation

During the loading process, 34 dip nets of fish are loaded into the transport tanker resulting in a total gain of 3 15/16 inches on the sight glass tube. Assume for this sampling period that: (1) the composition by weight is 32% for chinook salmon and 68% for steelhead, and (2) the weights are 26 fish per pound and 6 fish per pound, respectively.

STEP 1

Calculate the amount of excess water placed in the transport tanker:

34 dips x 1/2 gallon/dip = 17 gallon water into tanker.

17 gallon water x 8.3 pounds/gallon = 141.1 pounds

141.1 pounds ÷ 45 pounds per 1/16-inch on gauge = 3 (rounded off).

Therefore, 3/16 inch is to be subtracted from total inches gained on the sight tube leaving 3 12/16 inches of net total gain.

STEP 2

Calculate net total poundage:

3 12/16 or 60/16 inches x 45 pounds per 1/16 inch equals 2700 pounds.

STEP 3

Calculate total weights by species:

2700 pounds x 32% = 864 pounds of chinook salmon

2700 pounds 68% = 1,836 pounds of steelhead

STEP 4

Calculate total numbers of each species loaded into tanker:

864 pounds x 26 fish per pound = 22,464 chinook salmon

1,836 pounds x 6 fish per pound = 11,016 steelhead

TOTAL IN LOAD 33,480

PART II

TABLES

Appendix Table 1.--Numbers of juvenile steelhead counted, trucked, barged, released as controls, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville		Daily totals transported	Controls	Mortality in collection	Returned to river
			marked	unmarked				
4-3	77	--	--	--	--	--	--	77
4-4	51	--	--	--	--	--	--	51
4-5	109	108	--	--	108	--	1	--
4-6	27	26	--	--	26	--	1	--
4-8	367	--	--	--	--	342	5	20
4-9	1,696	609	--	--	609	--	7	--
4-10	3,145	3,541	--	--	3,541	1,047	20	118
4-11	5,440	5,185	--	--	5,185	--	26	3
4-13	9,522	8,378	--	--	8,378	1,373	200	159
4-15	17,241	11,410	--	--	11,410	--	165	2
4-16	7,200	5,303	--	--	5,303	3,466	118	272
4-17	8,401	4,552	--	--	4,552	--	82	45
4-18	6,616	5,564	--	--	5,564	1,971	60	182
4-19	5,545	4,540	--	--	4,540	--	72	21
4-20	6,768	--	--	--	--	1,757	106	276
4-21	6,582	--	--	--	--	--	--	--
4-22	8,765	--	1,134	23,342	24,476	--	78	4
4-23	7,606	--	--	--	--	1,217	58	314
4-24	4,247	--	--	--	--	754	50	182
4-25	7,902	--	--	--	--	782	59	213
4-26	7,666	--	--	--	--	1,013	128	279
4-27	15,753	--	1,214	38,363	39,577	--	301	13
4-28	7,194	--	--	--	--	--	--	--
4-29	8,010	--	--	15,802	15,802	725	383	250
4-30	12,022	--	--	--	--	994	141	258
5-1	15,049	--	1,122	1,234	2,356	1,149	154	303
5-2	22,411	--	1,679	45,099	46,778	--	242	5
5-3	32,901	--	--	158	158	3,432	478	400
5-4	34,066	--	--	62,454	62,454	--	320	17
5-5	61,226	--	--	--	--	--	--	--
5-6	52,654	12,585	2,416	119,472	134,473	--	805	4
5-7	75,972	--	--	--	--	2,941	296	6,105
5-8	76,839	--	3,552	109,554	113,106	2,920	237	529
5-9	57,955	--	4,329	23,073	27,402	--	204	9
5-10	45,784	--	--	--	--	7,253	255	2,316
5-11	47,823	--	3,122	72,299	75,421	--	115	7

Appendix Table 1.--Continued--Numbers of juvenile steelhead counted, trucked, barged, released as controls, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville		Daily totals transported	Controls	Mortality in collection	Returned to river
			marked	unmarked				
5-12	28,528	--	--	--	--	--	--	--
5-13	33,760	--	--	--	--	2,849	199	689
5-14	13,005	--	5,657	41,581	47,238	--	103	8
5-15	12,786	--	--	--	--	4,868	172	855
5-16	14,446	--	4,895	14,796	19,691	--	115	--
5-17	21,240	--	--	--	--	5,715	140	2,775
5-18	27,062	--	1,375	50,908	52,283	--	87	4
5-19	36,900	--	--	--	--	--	--	--
5-20	48,516	--	--	93,154	93,154	4,292	175	1,760
5-21	51,955	46,349	--	--	46,349	--	215	8
5-22	67,758	--	--	--	--	2,961	147	1,335
5-23	54,877	--	--	117,970	117,970	--	150	7
5-24	31,296	--	--	--	--	2,778	151	1,181
5-25	24,029	--	--	--	--	2,059	160	1,501
5-26	22,967	--	--	63,948	63,948	--	--	--
5-27	24,750	--	--	--	--	3,243	187	1,532
5-28	19,255	--	--	37,667	37,667	--	125	--
5-29	15,959	--	--	--	--	1,504	87	2,594
5-30	11,018	--	--	--	--	--	100	26
5-31	10,361	--	--	31,196	31,196	--	97	4
6-1	9,738	7,602	--	--	7,602	1,553	90	528
6-2	7,976	6,178	--	--	6,178	--	--	--
6-3	6,228	5,175	--	--	5,175	1,188	93	281
6-4	7,844	9,742	--	--	9,742	--	102	--
6-5	9,833	--	--	--	--	--	--	--
6-6	9,196	17,478	--	--	17,478	--	230	--
6-7	10,273	--	--	--	--	--	--	--
6-8	5,915	17,336	--	--	17,336	--	199	--
6-9	4,186	--	--	--	--	--	--	--
6-10	3,261	7,212	--	--	7,212	--	119	75
6-11	4,327	--	--	--	--	--	--	--
6-12	3,794	6,906	--	--	6,906	--	181	--
6-13	2,420	--	--	--	--	--	--	--
6-14	2,789	5,009	--	--	5,009	--	127	--
6-15	2,398	--	--	--	--	--	--	--
6-16	2,546	4,673	--	--	4,673	--	83	--

Appendix Table 1.--continued--Numbers of juvenile steelhead counted, trucked, barged, released as controls, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville		Daily totals transported	Controls	Mortality in collection	Returned to river
			marked	unmarked				
6-17	1,258	--	--	--	--	--	--	--
6-18	1,433	2,533	--	--	2,533	--	58	--
6-19	1,560	--	--	--	--	--	--	--
6-20	962	2,252	--	--	2,252	--	80	--
6-21	243	--	--	--	--	--	--	--
6-22	356	634	--	--	634	--	45	--
6-23	302	--	--	--	--	--	--	--
6-24	555	839	--	--	839	--	46	--
6-25	377	--	--	--	--	--	--	--
6-26	462	918	--	--	918	--	51	--
6-27	441	--	--	--	--	--	--	--
6-28	344	792	--	--	792	--	39	--
6-29	136	--	--	--	--	--	--	--
6-30	105	175	--	--	175	--	26	--
7-1	82	--	--	--	--	--	--	--
7-2	154	--	--	--	--	--	23	--
7-3	89	--	--	--	--	--	--	--
7-4	108	378	--	--	378	--	41	--
TOTALS	1,352,791	203,982	992,565		1,196,547	66,146	9210	27,597

Appendix Table 2.--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, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville		Daily totals transported	Controls	Mortality in collection	Returned to River
			marked	unmarked				
4-3	361	--	--	--	--	--	32	329
4-4	292	--	--	--	--	--	18	274
4-5	379	--	--	--	--	--	17	362
4-6	1,801	--	--	--	--	--	56	1,745
4-8	2,359	--	--	--	--	2,102	203	54
4-9	4,562	--	--	--	--	--	143	1,592
4-10	3,832	4,315	--	--	4,315	1,275	146	143
4-11	5,594	5,242	--	--	5,242	--	124	4
4-13	19,931	17,536	--	--	17,536	2,572	400	432
4-15	12,201	7,956	--	--	7,956	--	361	11
4-16	6,461	4,759	--	--	4,759	2,719	423	389
4-17	8,169	4,301	--	--	4,301	--	275	48
4-18	9,009	7,577	--	--	7,577	2,658	314	163
4-19	9,032	7,370	--	--	7,370	--	323	11
4-20	12,172	--	--	--	--	3,206	472	291
4-21	11,094	--	--	--	--	--	--	--
4-22	14,773	--	2,304	38,875	41,179	--	664	2
4-23	15,514	--	--	--	--	2,576	421	569
4-24	19,348	--	--	--	--	3,441	510	732
4-25	32,168	--	--	--	--	3,243	585	610
4-26	35,892	--	--	--	--	4,762	867	1,037
4-27	45,962	--	3,759	131,620	135,379	--	918	10
4-28	36,630	--	--	--	--	--	--	--
4-29	40,782	--	--	80,454	80,454	3,855	1,386	1,017
4-30	43,579	--	--	--	--	3,469	1,171	778
5-1	54,553	--	3,884	2,539	6,423	6,035	1,703	908
5-2	58,708	--	4,879	141,858	146,737	--	1,330	9
5-3	62,925	--	--	118	118	6,471	1,911	783
5-4	81,412	--	--	134,600	134,600	--	1,333	16
5-5	75,303	--	--	--	--	--	--	--
5-6	64,760	12,915	1,827	147,806	162,548	--	2,263	8
5-7	46,048	--	--	--	--	2,696	1,003	2,580
5-8	56,660	--	1,855	80,188	82,043	3,354	657	351
5-9	27,946	--	2,258	10,850	13,108	--	383	7
5-10	11,619	--	--	--	--	2,088	460	259
5-11	26,552	--	1,771	29,268	31,039	--	290	10
5-12	8,356	--	--	--	--	--	--	--
5-13	9,892	--	--	--	--	1,092	307	187

Appendix Table 2.--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, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville		Daily totals transported	Controls	Mortality in collection	Returned to River
			marked	unmarked				
5-14	7,312	--	2,853	13,336	16,189	--	256	20
5-15	5,199	--	--	--	--	2,490	269	225
5-16	3,463	--	1,446	3,988	5,434	--	145	--
5-17	4,815	--	--	--	--	1,221	175	701
5-18	5,611	--	500	10,646	11,146	--	88	4
5-19	9,869	--	--	--	--	--	--	--
5-20	12,975	--	--	24,843	24,843	1,380	200	175
5-21	12,320	6,744	--	--	6,744	--	116	10
5-22	22,831	--	--	--	--	1,437	144	36
5-23	15,771	--	--	37,383	37,383	--	250	--
5-24	13,200	--	--	--	--	1,662	190	55
5-25	11,654	--	--	--	--	1,551	400	68
5-26	7,522	--	--	25,574	25,574	--	--	--
5-27	8,107	--	--	--	--	1,460	628	56
5-28	10,101	--	--	19,704	19,704	--	383	7
5-29	6,079	--	--	--	--	295	159	737
5-30	7,013	--	--	--	--	--	170	12
5-31	5,747	--	--	15,932	15,932	--	364	8
6-1	4,070	3.177	--	--	3,177	723	212	75
6-2	4,583	3,550	--	--	3,550	--	--	--
6-3	3,578	2,938	--	--	2,938	795	262	58
6-4	2,660	3,302	--	--	3,302	--	210	--
6-5	4,121	--	--	--	--	--	--	--
6-6	3,854	7,272	--	--	7,272	--	420	--
6-7	6,105	--	--	--	--	--	--	--
6-8	3,515	10,265	--	--	10,265	--	310	--
6-9	5,703	--	--	--	--	--	--	--
6-10	4,443	9,754	--	--	9,754	--	380	66
6-11	4,596	--	--	--	--	--	--	--
6-12	4,030	7,313	--	--	7,313	--	410	--
6-13	2,872	--	--	--	--	--	--	--
6-14	3,310	5,894	--	--	5,894	--	384	--
6-15	2,169	--	--	--	--	--	--	--
6-16	2,303	4,195	--	--	4,195	--	140	--
6-17	2,498	--	--	--	--	--	--	--
6-18	2,845	5,018	--	--	5,018	--	127	--
6-19	4,952	--	--	--	--	--	--	--

Appendix Table 2.--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, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville		Daily totals transported	Controls	Mortality in collection	Returned to River
			marked	unmarked				
6-20	3,054	7,133	--	--	7,133	--	217	--
6-21	2,449	--	--	--	--	--	--	--
6-22	3,594	6,391	--	--	6,391	--	210	--
6-23	2,930	--	--	--	--	--	--	--
6-24	5,386	8,204	--	--	8,204	--	221	--
6-25	3,631	--	--	--	--	--	--	--
6-26	4,446	8,750	--	--	8,750	--	300	--
6-27	4,451	--	--	--	--	--	--	--
6-28	3,469	7,905	--	--	7,905	--	300	--
6-29	3,985	--	--	--	--	--	--	--
6-30	3,080	5,118	--	--	5,118	--	191	--
7-1	2,413	--	--	--	--	--	--	--
7-2	4,512	--	--	--	--	--	201	--
7-3	2,137	--	--	--	--	--	--	--
7-4	2,587	9,086	--	--	9,086	--	162	--
TOTALS	1,270,551	193,980	976,918		1,170,898	70,628	30,063	18,034

Appendix Table 3.--Numbers of juvenile sockeye salmon counted, trucked, barged, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville	Daily totals transported	Returned to river	Mortality in collection
4-3	9	--	--	--	8	1
4-4	7	--	--	--	7	--
4-5	18	--	--	--	18	--
4-6	26	--	--	--	26	--
4-8	26	--	--	--	23	3
4-9	31	--	--	--	12	--
4-10	41	32	--	32	8	1
4-11	22	22	--	22	--	1
4-13	110	104	--	104	6	--
4-15	17	17	--	17	--	--
4-16	28	20	--	20	10	--
4-17	8	8	--	8	--	--
4-18	16	14	--	14	2	--
4-19	15	15	--	15	--	--
4-20	19	--	--	--	4	--
4-21	18	--	--	--	--	--
4-22	24	--	62	62	--	--
4-23	--	--	--	--	--	--
4-24	--	--	--	--	--	--
4-25	--	--	--	--	--	--
4-26	--	--	--	--	--	--
4-27	62	--	57	57	--	--
4-28	47	--	--	--	--	--
4-29	52	--	96	96	3	--
4-30	55	--	--	--	--	1
5-1	70	--	5	5	--	--
5-2	81	--	188	188	--	--
5-3	96	--	--	--	3	--
5-4	--	--	90	90	--	--
5-5	137	--	--	--	--	--
5-6	118	36	261	297	--	--
5-7	110	--	--	--	9	--
5-8	134	--	191	191	8	--
5-9	86	--	41	41	--	--
5-10	115	--	--	--	27	--
5-11	1,056	--	958	958	--	10
5-12	223	--	--	--	--	--
5-13	264	--	--	--	27	--
5-14	436	--	643	643	--	25
5-15	500	--	--	--	258	31
5-16	574	--	697	697	--	29
5-17	642	--	--	--	276	13
5-18	297	--	927	927	--	--
5-19	858	--	--	--	--	--
5-20	1,128	--	2,135	2,135	167	6
5-21	913	87	--	87	--	15
5-22	1,381	--	--	--	94	4
5-23	714	--	2,194	2,194	--	9
5-24	359	--	--	--	47	5
5-25	396	--	--	--	55	6
5-26	184	--	1,210	1,210	--	--
5-27	199	--	--	--	44	1

Appendix Table 3.--continued--Numbers of juvenile sockeye salmon counted, trucked, barged, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville	Daily totals transported	Returned to river	Mortality in collection
5-28	237	--	460	460	--	2
5-29	66	--	--	--	13	--
5-30	91	--	--	--	--	1
5-31	81	--	189	189	--	1
6-1	69	54	--	54	16	--
6-2	89	69	--	69	--	--
6-3	69	57	--	57	17	2
6-4	11	13	--	13	--	--
6-5	14	--	--	--	--	--
6-6	13	26	--	26	--	--
6-7	17	--	--	--	--	--
6-8	10	28	--	28	--	--
6-9	30	--	--	--	--	--
6-10	24	53	--	53	--	--
6-11	36	--	--	--	--	--
6-12	34	58	--	58	--	--
6-13	27	--	--	--	--	--
6-14	30	54	--	54	--	1
6-15	9	--	--	--	--	--
6-16	10	18	--	18	--	--
6-17	11	--	--	--	--	--
6-18	13	23	--	23	--	--
6-19	126	--	--	--	--	--
6-20	78	184	--	184	--	--
6-21	5	--	--	--	--	--
6-22	8	15	--	15	--	1
6-23	13	--	--	--	--	--
6-24	24	38	--	38	--	--
6-25	4	--	--	--	--	--
6-26	5	11	--	11	--	--
6-27	10	--	--	--	--	--
6-28	8	17	--	17	--	--
6-29	--	--	--	--	--	--
6-30	--	--	--	--	--	--
7-1	--	--	--	--	--	--
7-2	--	--	--	--	--	--
7-3	--	--	--	--	--	--
7-4	--	--	--	--	--	--
TOTALS	12,994	1,073	10,404	11,477	1,188	169

Appendix Table 4.--Numbers of juvenile coho salmon counted, trucked, barged, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville	Daily totals transported	Returned to river	Mortality in collection
4-3	1	--	--	--	1	--
4-4	--	--	--	--	--	--
4-5	--	--	--	--	--	--
4-6	--	--	--	--	--	--
4-8	--	--	--	--	--	--
4-9	--	--	--	--	--	--
4-10	--	--	--	--	--	--
4-11	--	--	--	--	--	--
4-13	--	--	--	--	--	--
4-15	--	--	--	--	--	--
4-16	--	--	--	--	--	--
4-17	2	2	--	2	--	--
4-18	--	--	--	--	--	--
4-19	--	--	--	--	--	--
4-20	--	--	--	--	--	--
4-21	--	--	--	--	--	--
4-22	--	--	--	--	--	--
4-23	--	--	--	--	--	--
4-24	--	--	--	--	--	--
4-25	40	--	--	--	--	--
4-26	--	--	--	--	--	--
4-27	--	--	35	35	--	--
4-28	--	--	--	--	--	--
4-29	--	--	--	--	--	--
4-30	--	--	--	--	--	--
5-1	--	--	--	--	--	--
5-2	--	--	--	--	--	--
5-3	--	--	--	--	--	--
5-4	--	--	--	--	--	--
5-5	--	--	--	--	--	--
5-6	--	--	--	--	--	--
5-7	12	--	--	--	--	--
5-8	--	--	--	--	--	--
5-9	--	--	--	--	--	--
5-10	--	--	--	--	--	--
5-11	--	--	--	--	--	--
5-12	37	--	--	--	--	--
5-13	44	--	--	--	2	--
5-14	21	--	55	55	--	--
5-15	18	--	--	--	2	--
5-16	37	--	38	38	--	--
5-17	53	--	--	--	9	--
5-18	33	--	87	87	--	--
5-19	48	--	--	--	--	--
5-20	62	--	118	118	3	--
5-21	--	--	--	--	--	--
5-22	92	--	--	--	4	--
5-23	--	--	98	98	--	--
5-24	46	--	--	--	1	--
5-25	--	--	--	--	--	--
5-26	31	--	47	47	--	--
5-27	33	--	--	--	1	--

Appendix Table 4.--continued--Numbers of juvenile coho salmon counted, trucked, barged, mortality in collection, and returned to Snake River by date at Lower Granite Dam, 1979.

Date	Number counted	Trucked to Bonneville	Barged to Bonneville	Daily totals transported	Returned to river	Mortality in collection
5-28	30	--	55	55	--	--
5-29	--	--	--	--	--	--
5-30	--	--	--	--	--	--
5-31	--	--	--	--	--	--
6-1	14	11	--	11	1	--
6-2	13	10	--	10	--	--
6-3	10	8	--	8	2	--
6-4	--	--	--	--	--	--
6-5	--	--	--	--	--	--
6-6	--	--	--	--	--	--
6-7	16	--	--	--	--	--
6-8	9	25	--	25	--	--
6-9	--	--	--	--	--	--
6-10	--	--	--	--	--	--
6-11	--	--	--	--	--	--
6-12	--	--	--	--	--	--
6-13	--	--	--	--	--	--
6-14	--	--	--	--	--	--
6-15	--	--	--	--	--	--
6-16	--	--	--	--	--	--
6-17	--	--	--	--	--	--
6-18	--	--	--	--	--	--
6-19	--	--	--	--	--	--
6-20	--	--	--	--	--	--
6-21	--	--	--	--	--	--
6-22	--	--	--	--	--	--
6-23	--	--	--	--	--	--
6-24	--	--	--	--	--	--
6-25	--	--	--	--	--	--
6-26	--	--	--	--	--	--
6-27	--	--	--	--	--	--
6-28	--	--	--	--	--	--
6-29	--	--	--	--	--	--
6-30	--	--	--	--	--	--
7-1	--	--	--	--	--	--
7-2	--	--	--	--	--	--
7-3	--	--	--	--	--	--
7-4	--	--	--	--	--	--
TOTALS	702	56	533	589	26	0

Appendix Table 5.--Date, brand position and orientation, wire tag code, and numbers of juvenile chinook salmon and steelhead marked and transported by barge from Lower Granite Dam to Bonneville Dam, 1979.

Date	Wire tag color	Position[a] and brand	Brand orientation[b]	Chinook salmon	Steelhead
4-23	WH-RD-YW-OR	RA-F	1	2,304	1,134
4-28	" " " "	"	"	3,759	1,214
5-2	" " " "	"	"	3,884	1,122
5-3	" " " "	"	"	4,879	1,679
5-7	" " " "	"	"	1,827	2,416
	Subtotals			16,653	7,565
5-9	WH-RD-YW-OR	RA-F	2	1,855	3,552
5-10	" " " "	"	"	2,258	4,329
5-12	" " " "	"	"	1,771	3,122
5-14	" " " "	"	"	840	2,711
5-15	" " " "	"	"	2,013	2,946
5-16	" " " "	"	"	418	1,122
5-17	" " " "	"	"	1,028	3,773
5-19	" " " "	"	"	500	1,375
	Subtotals			10,683	22,930
	TOTALS			27,336	30,495

a/ Indicates brand position - right anterior.

b/ Orientation 1 means symbol in normal readable position (F). Orientation 2 the symbol is rotated 90° clockwise (ꟻ).

Appendix Table 6.--Date, brand position and orientation, and numbers of juvenile chinook salmon and steelhead marked and released in the Lower Granite Dam forebay at Clarkston, WA, 1979.

Date	Position[a] and brand	Brand orientation[b]	Chinook salmon	Steelhead
4-9	LA-IN	1	2,102	342
4-11	" "	"	1,275	1,047
4-14	" "	"	2,572	1,373
4-17	" "	"	2,719	3,466
4-19	" "	"	2,658	1,971
	Subtotals		11,326	8,199
5-21	LA-IN	2	1,380	4,292
5-23	" "	"	1,437	2,961
5-25	" "	"	1,662	2,778
5-26	" "	"	1,551	2,059
5-28	" "	"	1,460	3,243
5-30	" "	"	295	1,504
6-2	" "	"	723	1,553
6-4	" "	"	795	1,188
	Subtotals		9,303	19,578
	TOTALS		20,629	27,777

a/ Indicates brand position - left anterior.

b/ Orientation 1 means symbol in normal readable position (IN). Orientation 2 the symbol is rotated 90° clockwise (IN).

Appendix Table 7.--Date, brand position and orientation, wire tag code, and numbers of juvenile chinook salmon and steelhead marked and released as controls by barge in the Lower Granite forebay, 1979.

Date	Wire tag color	Position[a] and brand	Brand Orientation[a]	Chinook salmon	Steelhead trout
4-21	WH-RD-YW-GM	LA-K	1	3,206	1,757
4-27	" " " "	"	"	4,762	1,013
5-2	" " " "	"	"	6,035	1,149
5-4	" " " "	"	"	3,295	1,614
	Subtotals			17,298	5,533
5-9	WH-RD-YW-GM	LA-K	2	3,354	2,920
5-11	" " " "	"	"	1,233	3,419
5-14	" " " "	"	"	1,092	2,849
5-16	" " " "	"	"	1,490	2,598
	Subtotals			7,169	11,786
	TOTALS			24,467	17,319

a/ Indicates brand position - left anterior.

b/ Orientation 1 means symbol in normal readable position (K). Orientation 2 the symbol is rotated 90° clockwise (⋊).

Appendix Table 8.--Date, brand position and orientation, wire tag code, and numbers of juvenile chinook salmon and steelhead marked and released as controls in the Lower Granite tailrace, 1979.

Date	Wire tag color	Position[a] and brand	Brand Orientation[b]	Chinook salmon	Steelhead trout
4-24	WH-RD-YW-LB	LA-K	3	2,576	1,217
4-25	" " " "	"	"	3,441	754
4-26	" " " "	"	"	3,243*	782
4-30	" " " "	"	"	3,855	725
5-1	" " " "	"	"	3,469	994
5-4	" " " "	"	"	3.176	1,818
	Subtotals			19,760	6,290
5-8	WH-RD-YW-LB	LA-K	4	2,696	2,941
5-11	" " " "	"	"	855	3,834
5-16	" " " "	"	"	1,000	2,270
5-18	" " " "	"	"	1,221	5,715
	Subtotals			5,772	14,760
	TOTALS			25,532	21,050

a/ Indicates brand position - left anterior.

b/ Orientation - 3. The symbol is rotated 180° clockwise ( ).
Orientation - 4. The symbol is rotated 270° clockwise ( ).

* Indicates 265 of this number were branded with LA-F.

Appendix Table 9.--Percent descaling of juvenile chinook salmon by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1979.

Date	Unit 1 slot A	Unit 1 slot B	Unit 1 slot C	Unit 2 slot A	Unit 2 slot B	Unit 2 slot C	Unit 3[a]	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
4-12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.8
4-13	4	5.2	1.8	10.1	2.5	1.6	--	--	--	--	2.9	3.9	--	1.0	2.3	--	--
4-14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.0
4-17	5.6	3.9	1.8	3.9	2.5	2.7	--	.7	--	--	1.3	1.7	*	*	*	*	--
4-17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.9
4-18	3.4	4.8	6.7	.9	4.9	3.5	--	1.5	2.5	*	2.2	*	*	*	*	*	2.0
4-19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.0
4-20	3.4	4.6	3.3	.9	4.0	1.8	--	.9	1.6	*	2.4	2.2	2.8	*	*	*	2.0
4-23	4.7	5.7	4.8	6.0	5.9	1.0	--	2.0	1.0	*	.9	*	*	*	*	*	10.0
4-25	6.5	4.8	2.9	7.8	1.0	2.0	--	2.0	1.0	*	3.3	*	3.0	*	*	*	--
4-26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0
4-27	6.0	8.9	2.0	4.4	9.9	6.6	--	.6	3.3	*	3.0	1.3	1.9	--	*	*	12.0
4-28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.9
4-30	9.4	9.6	7.0	3.8	3.8	5.6	--	2.6	--	*	1.3	2.6	.6	1.4	*	*	10.8
5-1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.0
5-2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.0

[a] Unit 3 did not operate during this time period.

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

Appendix Table 9.--continued--Percent descaling of juvenile chinook salmon by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1979.

Date	Unit 1 slot A	Unit 1 slot B	Unit 1 slot C	Unit 2 slot A	Unit 2 slot B	Unit 2 slot C	Unit 3[a]	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
5-3	11.2	15	5.1	--	5.3	5.2	--	**	.7	--	2.0	2.0	4.6	.4	1.9	2.0	9.0
5-4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0
5-5	14.2	6.0	6.0	8.0	11.3	6.8	--	**	3.7	4.0	3.4	3.6	2.0	.7	--	.6	3.0
5-7	4.9	3.7	3.3	1.4	2.6	2.0	--	**	3.8	3.6	3.2	1.3	2.8	2.0	1.3	2.8	4.0
5-8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.0
5-9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0
5-10	7.5	3.6	4.7	3.1	1.9	2.1	--	**	2.9	3.4	2.7	*	*	*	*	*	3.0
5-11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0
5-12	5.6	4.5	.9	1.3	3.2	3.8	--	**	4.7	1.9	2.0	1.8	*	*	*	*	1.0
5-14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.0
5-15	*	*	*	4.0	2.9	--	--	**	--	*	*	*	*	*	*	*	4.0
5-16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0
5-17	*	*	*	*	*	*	--	**	*	*	*	*	*	*	*	*	4.0
5-18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12.0
5-21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.6
5-22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

[a] Unit 3 did not operate during this time period.

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

** Indicates no sample taken due to excess oil or debris in gatewell or traveling screen obstruction.

Appendix Table 9.--continued--Percent descaling of juvenile chinook salmon by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1979.

Date	Unit 1 slot A	Unit 1 slot B	Unit 1 slot C	Unit 2 slot A	Unit 2 slot B	Unit 2 slot C	Unit 3[a]	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
5-23	*	*	*	*	*	*	--	**	*	*	*	*	*	*	*	*	6.0
5-24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0
5-25	*	8.1	5.6	*	*	.8	--	**	*	*	*	*	*	*	*	*	4.0
5-26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.1
5-28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.0
5-29	*	*	*	--	8.9	*	--	**	*	--	**	*	*	*	3.0	*	3.0
5-30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.0
5-31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.6
6-1	*	*	*	*	7.6	4.2	--	**	**	*	*	*	1.0	--	*	*	5.0
6-2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0
6-4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0
6-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0
6-7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0
6-9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.0
6-13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0
6-15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.2
6-17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.0

a/ Unit 3 did not operate during this time period.

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

** Indicates no sample taken due to excess oil or debris in gatewell or traveling screen obstruction.

Appendix Table 10.--Percent descaling of juvenile steelhead by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1979.

Date	Unit 1 slot A	Unit 1 slot B	Unit 1 slot C	Unit 2 slot A	Unit 2 slot B	Unit 2 slot C	Unit 3[a]	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
4-12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.4
4-13	2.0	1.9	2.0	--	1.2	1.2	--	--	--	--	1.9	2.8	1.8	1.5	3.6	2.0	--
4-14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.0
4-17	.7	2.1	--	1.7	3.0	2.8	--	1.6	--	--	--	--	*	*	*	*	--
4-17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.5
4-18	--	.9	6.7	1.0	1.0	1.0	--	1.9	2.6	*	3.2	*	*	*	*	*	2.0
4-19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0
4-20	4.1	1.0	2.9	4.3	2.0	--	--	2.6	2.6	*	--	2.9	1.9	*	*	*	--
4-23	2.0	2.8	4.0	5.0	3.0	.9	--	1.0	2.0	*	3.5	*	*	*	*	*	6.0
4-25	1.8	2.0	2.9	2.0	3.0	1.0	--	2.0	1.0	*	6.3	*	3.3	*	*	*	--
4-26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0
4-27	.9	2.7	4.3	5.9	--	4.6	--	--	--	*	*	3.3	2.0	3.2	*	*	2.0
4-28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.0
4-30	--	5.9	2.9	2.2	3.9	2.0	--	5.0	1.0	*	.9	3.0	5.0	12.9	*	*	2.0
5-1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.0
5-2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0

a/ Unit 3 did not operate during this time period.

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

Appendix Table 10.--continued--Percent descaling of juvenile steelhead by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1979.

Date	Unit 1 slot A	Unit 1 slot B	Unit 1 slot C	Unit 2 slot A	Unit 2 slot B	Unit 2 slot C	Unit 3[a]	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
5-3	5.5	2.0	.9	--	--	7.7	--	**	1.1	--	3.0	00	5.0	1.6	6.1	--	3.0
5-4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0
5-5	4.9	4.0	*	*	*	*	--	**	8.1	8.6	9.0	8.7	12.7	3.0	5.9	7.0	6.0
5-7	4.4	10.0	9.3	7.5	1.0	10.4	--	**	4.8	*	8.9	9.0	6.6	*	--	5.7	9.0
5-8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0
5-9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.8
5-10	3.1	3.8	4.1	7.0	3.0	9.2	--	**	8.0	6.7	4.3	3.4	6.1	5.5	2.3	*	10.3
5-11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0
5-12	1.6	2.3	3.0	3.8	11.5	6.5	--	**	9.4	8.6	6.5	5.3	5.2	4.2	*	*	12.0
5-14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0
5-15	2.7	5.8	4.3	6.0	7.0	4.2	--	**	6.9	6.0	3.9	3.0	3.7	6.7	3.0	*	7.0
5-16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.0
5-17	5.2	5.2	5.3	7.2	2.9	4.0	--	**	*	7.4	*	5.1	5.9	4.2	4.3	2.5	5.0
5-18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.7
5-21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.0
5-22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.5
5-23	15.0	6.0	7.9	10.4	11.6	8.0	--	**	8.0	7.0	*	*	13.2	7.8	10.0	7.8	15.5

a/ Unit 3 did not operate during this time period.

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

** Indicates no sample taken due to excess oil or debris in gatewell or traveling screen obstruction.

Appendix Table 10.--continued--Percent descaling of juvenile steelhead by date, unit number and gatewell slot designation or fish marking facility at Lower Granite Dam, 1979.

Date	Unit 1 slot A	Unit 1 slot B	Unit 1 slot C	Unit 2 slot A	Unit 2 slot B	Unit 2 slot C	Unit 3[a]	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
5-24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.0
5-25	12.0	9.8	6.5	10.5	7.8	13.2	--	**	12.3	7.7	*	*	5.2	6.0	8.4	7.9	7.0
5-26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14.7
5-28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0
5-29	3.0	4.7	3.9	3.0	4.0	*	--	**	4.0	2.9	**	3.0	2.0	4.0	6.0	6.7	3.0
5-30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0
5-31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.6
6-1	4.0	7.9	9.4	2.9	7.0	4.0	--	**	**	*	*	*	3.2	2.1	*	*	5.0
6-2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11.0
6-4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.0
6-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.0
6-7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.9
6-9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.9
6-13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.0
6-15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0
6-17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0

a/ Unit 3 did not operate during this time period.

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

** Indicates no sample taken due to excess oil or debris in gatewell or traveling screen obstruction.

Appendix Table 11.--Date, test condition, transport system water quality data, and delayed mortality of marked and unmarked juvenile chinook salmon and steelhead after tranport from Lower Granite Dam to Bonenville Dam, 1979.

Date	Test cond.[a]	Water quality				Delayed Mortality							
						Chinook marked		Chinook unmarked		Steelhead marked		Steelhead unmarked	
		Temp. (°C)	O_2 (ppm)	CO_2 (ppm)	pH	No. held	% mort.	No. held	% mort.	No. held	% mort.	No. held	% mort.
4-11	1	8.9	13.9	7.5	7.4	--	--	--	--	--	--	--	--
4-12	1	8.9	14.2	5.0	7.8	--	--	97	13.4	--	--	54	0.0
4-14	1	8.9	16.0	8.7	7.4	--	--	84	15.4	--	--	86	0.0
4-16	1	9.4	13.7	9.1	7.4	--	--	75	32.0	--	--	151	0.7
4-17	1	11.0	15.4	4.2	7.4	--	--	64	20.3	--	--	97	0.0
4-18	1	9.5	16.4	4.0	7.4	--	--	166	6.6	--	--	73	0.0
4-19	1	10.0	17.4	4.1	7.5	--	--	217	16.6	--	--	137	0.0
4-20	1	10.0	14.1	4.1	7.4	--	--	206	11.6	--	--	95	0.0
4-24	2	10.0	13.2	1.5	7.6	49	6.1	249	2.4	34	2.9	37	0.0
4-29	2	11.1	10.7	1.2	7.9	109	8.2	91	3.3	1	0.0	3	0.0
5-1	2	10.5	10.4	1.2	7.6	--	--	215	1.4	--	--	36	0.0
5-4	2	12.2	10.4	1.5	7.7	160	2.5	102	7.8	56	0.0	24	4.2
5-6	2	12.2	9.2	1.2	7.4	--	--	87	2.3	--	--	26	3.8
5-9	2	12.2	9.1	1.0	7.3	67	1.4	105	15.2	23	0.0	88	1.1
5-11	2	12.0	9.6	1.1	7.3	17	0.0	52	1.9	11	0.0	51	0.0
5-13	2	13.5	10.3	1.7	7.6	33	0.0	72	1.4	29	0.0	59	0.0
5-16	2	13.8	9.4	2.5	7.3	57	1.7	60	5.0	15	0.0	28	0.0
5-18	2	14.0	9.9	1.5	7.3	89	1.1	117	4.3	26	0.0	38	0.0
5-20	2	14.0	9.6	1.0	7.2	109	2.7	105	0.9	14	0.0	85	0.0
5-22	1	13.9	24.3	26.5	6.6	--	--	12	33.3	--	--	99	4.2
5-22	1	12.8	26.6	29.5	6.5	--	--	20	20.0	--	--	99	0.0
5-23	2	14.8	10.2	1.5	7.7	9	0.0	50	6.0	17	0.0	100	0.0
5-25	2	15.4	9.9	2.0	7.3	9	0.0	22	9.1	54	0.0	27	0.0

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

Appendix Table 11.--continued--Date, test condition, transport system water quality data, and delayed mortality of marked and unmarked juvenile chinook salmon and steelhead after transport from Lower Granite Dam to Bonneville Dam, 1979.

Date	Test[a] cond.	Water quality				Delayed Mortality							
						Chinook marked		Chinook unmarked		Steelhead marked		Steelhead unmarked	
		Temp. (°C)	O_2 (ppm)	CO_2 (ppm)	pH	No. held	% mort.	No. held	% mort.	No. held	% mort.	No. held	% mort.
5-28	2	12.2	9.4	1.5	7.1	--	--	32	12.5	4	0.0	17	0.0
5-30	2	15.2	10.2	0.9	7.3	--	--	36	38.9	--	--	98	2.0
6-2	2	15.4	9.2	1.1	7.2	--	--	90	15.5	--	--	60	0.0
6-2	1	14.4	26.6	2.6	6.7	--	--	40	32.5	--	--	79	10.1
6-3	1	12.8	16.8	2.2	6.8	--	--	50	10.0	--	--	49	0.0
6-5	1	12.8	34.2	4.4	6.9	--	--	154	7.8	--	--	84	1.2
6-7	1	12.2	26.3	18.0	6.6	--	--	88	34.1	--	--	79	6.3
6-11	1	14.4	31.0	7.6	6.6	--	--	257	3.1	--	--	104	0.0
6-13	1	15.2	34.2	13.5	6.6	--	--	204	8.3	--	--	97	1.0
6-15	1	15.2	33.5	9.4	6.7	--	--	84	4.8	--	--	48	2.1
6-17	1	16.1	33.4	6.5	6.7	--	--	127	3.1	--	--	27	0.0
6-19	1	16.1	34.7	4.5	6.9	--	--	106	16.5	--	--	21	4.8
6-21	1	16.1	28.8	5.2	6.7	--	--	102	3.9	--	--	26	0.0
6-23	1	16.1	30.4	4.5	6.8	--	--	106	4.7	--	--	1	0.0
6-25	1	16.7	30.1	7.5	6.7	--	--	139	2.1	--	--	20	10.0
6-27	1	16.1	29.4	4.5	6.7	--	--	143	9.1	--	--	24	0.0
6-29	1	18.3	28.5	5.5	6.5	--	--	179	2.8	--	--	14	0.0
7-1	1	18.3	29.5	3.4	6.7	--	--	96	4.2	--	--	--	--
7-5	1	15.5	33.4	3.9	6.7	--	--	136	7.3	--	--	--	--

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

Appendix Table 12.--48-h. delayed mortality of marked chinook salmon and steelhead prior to barge transport from Lower Granite Dam, 1979.

	CHINOOK			STEELHEAD		
Date	No. held	No. mort.	% mort.	No. held	No. mort.	% mort.
4-25	67	5	7.5	29	0	0.0
4-30	70	2	2.9	27	1	3.7
5-5	32	1	3.1	19	0	0.0
5-12	53	2	3.7	58	0	0.0
5-14	56	5	8.9	54	0	0.0
5-16	47	2	4.3	52	0	0.0
5-19	32	1	3.1	51	1	2.0

Appendix Table 13.--Numbers of juvenile chinook salmon and steelhead counted, trucked and barged to below Bonneville Dam from Little Goose Dam, 1979.

Date	Chinook			Steelhead		
	Number trucked	Number barged	Daily total[a]	Number trucked	Number barge	Daily total[a]
4-17	11,673	--	11,673	6,555	--	6,555
4-19	12,006	--	12,006	5,589	--	5,589
4-21	12,403	--	12,403	9,108	--	9,108
4-23	--	9,675	9,675	--	5,908	5,908
4-24	2,876	--	2,876	1,668	--	1,668
4-26	16,313	--	16,313	6,682	--	6,682
4-27	15,157	--	15,157	5,814	--	5,814
4-28	--	19,562	19,562	--	4,496	4,496
4-29	29,342	--	29,342	4,921	--	4,921
4-30	--	47,817	47,817	--	8,019	8,019
5-1	44,557	--	44,557	7,628	--	7,628
5-2	42,383	--	42,383	7,108	--	7,108
5-3	--	43,700	43,700	--	6,230	6,230
5-4	34,808	16,380	51,188	8,997	4,234	13,231
5-5	--	54,990	54,990	--	14,214	14,214
5-6	54,462	--	54,462	16,196	--	16,196
5-7	21,380	63,863	85,243	7,869	23,920	31,789
5-8	65,555	--	65,555	23,420	--	23,420
5-9	35,486	--	35,486	20,396	--	20,396
5-10	--	23,238	23,238	--	12,851	12,851
5-11	24,234	--	24,234	23,827	--	23,827
5-12	--	12,999	12,999	--	12,274	12,274
5-13	7,452	--	7,452	9,108	--	9,108
5-14	10,512	--	10,512	11,391	--	11,391
5-15	--	11,754	11,754	--	12,744	12,744
5-16	7,044	--	7,044	5,737	--	5,737
5-17	--	5,340	5,340	--	4,550	4,550
5-18	5,767	--	5,767	5,062	--	5,062
5-19	--	6,264	6,264	--	5,847	5,847
5-20	--	7,093	7,093	--	9,267	9,267
5-21	--	3,441	3,441	--	4,224	4,224
5-22	--	9,480	9,480	--	13,719	13,719
5-23	10,233	4,833	15,066	16,022	7,566	23,588
5-24	--	13,155	13,155	--	24,453	24,453
5-25	11,538	--	11,538	23,903	--	23,903
5-26	5,930	2,022	7,952	12,490	3,978	16,468
5-27	--	6,912	6,912	--	14,904	14,904
5-28	6,536	--	6,536	14,012	--	14,012
5-29	--	7,652	7,652	--	15,415	15,415
5-30	6,534	--	6,534	9,773	--	9,773
5-31	--	5,247	5,247	--	6,718	6,718
6-1	--	7,251	7,251	--	7,759	7,759
6-4	18,445	--	18,445	7,711	--	7,711
6-6	10,975	--	10,975	4,896	--	4,896
6-8	8,282	--	8,282	6,347	--	6,347

a/ All fish handled at Little Goose Dam were either trucked or barged.

Appendix Table 13.--continued--Numbers of juvenile chinook salmon and steelhead counted, trucked and barged to below Bonneville Dam from Little Goose Dam, 1979.

Date	Chinook			Steelhead		
	Number trucked	Number barged	Daily total[a/]	Number trucked	Number barge	Daily total[a/]
6-11	7,579	--	7,579	5,634	--	5,634
6-15	5,708	--	5,708	2,257	--	2,257
6-20	9,875	--	9,875	2,503	--	2,503
TOTALS	555,045	382,668	937,713	292,624	223,290	515,914

a/ All fish handled at Little Goose Dam were either trucked or barged.

Appendix Table 14.--Percent descaling of juvenile chinook salmon by date, unit number, and gatewell slot designation at Little Goose Dam, 1979.

DATE	UNIT 1			UNIT 2			UNIT 3			UNIT 4			UNIT 5			UNIT 6 a/		
	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C
4-17	3.1	---	6.2	10.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4-19	---	21.5	---	---	7.9	*	7.9	---	---	---	---	---	---	---	---	---	---	---
4-21	7.3	22.4	11.3	18.8	---	5.2	---	---	---	---	---	---	---	---	---	---	---	---
4-23	8.0	5.9	5.7	11.0	19.5	14.7	11.4	---	---	4.3	---	---	---	---	---	---	---	---
4-24	---	---	---	---	10.6	6.7	---	---	---	*	3.8	6.7	---	---	---	---	---	---
4-26	---	---	---	7.3	7.3	---	6.0	4.0	---	7.7	13.7	---	---	---	---	---	---	---
4-27	---	---	---	12.9	12.6	8.7	---	---	---	24.1	21.7	---	---	---	---	---	---	---
4-28	---	---	---	---	---	---	---	---	---	18.8	8.6	8.1	---	9.4	---	---	---	---
4-29	---	---	---	---	---	---	---	---	---	---	---	---	---	7.1	7.5	---	---	---
4-30	---	---	---	21.5	18.9	11.7	3.6	4.2	---	---	---	---	11.0	---	---	---	---	---
5-1	---	---	---	---	---	---	---	---	10.5	10.6	12.3	10.6	---	---	---	---	---	---
5-2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	14.1	10.4	---
5-3	18.6	---	---	21.7	35.2	13.5	14.7	---	---	---	---	---	---	---	---	---	11.9	---
5-4	---	---	---	---	---	---	---	10.4	7.9	8.0	13.4	12.7	---	---	---	---	---	---
5-5	17.1	16.0	14.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5-6	---	---	---	18.6	*	7.5	9.0	---	---	---	---	---	---	---	---	---	---	---
5-7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	10.9	12.7

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

a/ Unit 6 was not sampled adequately due to small numbers of fish present throughout the season.

Appendix Table 14.--continued--Percent descaling of juvenile chinook salmon by date, unit number, and gatewell slot designation at Little Goose Dam, 1979.

DATE	UNIT 1 slot A	UNIT 1 slot B	UNIT 1 slot C	UNIT 2 slot A	UNIT 2 slot B	UNIT 2 slot C	UNIT 3 slot A	UNIT 3 slot B	UNIT 3 slot C	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 a/ slot A	UNIT 6 a/ slot B	UNIT 6 a/ slot C
5-8	21.0	6.9	6.2	---	20.1	8.8	4.8	9.2	8.4	---	---	---	---	---	---	---	---	---
5-9	6.7	11.3	6.6	9.9	18.8	9.9	---	---	---	---	---	---	---	---	---	---	---	---
5-10	9.0	13.6	5.0	11.1	13.5	5.2	---	---	---	---	---	---	---	---	---	---	---	---
5-11	---	---	---	5.1	6.0	---	5.5	4.6	5.0	---	---	---	---	---	---	---	---	---
5-12	4.6	7.6	6.9	---	---	---	---	---	---	5.2	---	---	---	---	---	---	---	---
5-13	---	---	---	5.2	5.3	4.6	3.8	4.0	---	---	---	---	---	---	---	---	---	---
5-14	9.5	12.5	6.2	---	---	---	---	---	---	---	---	---	3.1	9.4	9.4	---	---	---
5-15	---	---	---	4.0	7.3	4.1	---	---	3.5	7.1	4.2	---	---	---	---	---	---	---
5-16	8.4	9.6	2.2	---	---	---	1.9	6.6	---	---	---	---	---	---	---	---	---	---
5-17	---	---	---	---	---	---	---	---	13.3	*	4.8	4.1	4.7	*	---	---	---	---
5-18	10.6	6.5	6.2	---	---	---	9.2	6.7	3.6	---	---	---	---	---	---	---	---	---
5-21	---	---	---	11.6	6.5	6.1	---	---	---	4.6	8.0	4.6	---	---	---	---	---	---
5-23	*	7.5	3.3	---	---	---	3.8	7.5	1.2	---	---	---	---	---	---	---	---	---
5-24	---	---	---	6.7	*	5.0	---	---	---	---	---	---	7.4	1.8	---	---	---	---
5-25	---	---	---	---	---	---	---	---	---	3.3	4.5	1.8	---	---	3.9	---	---	---
5-26	3.7	4.6	5.3	---	---	---	3.8	2.6	---	---	---	---	---	---	---	---	---	---
5-28	---	---	---	4.2	5.7	3.6	---	---	4.7	4.8	---	---	---	---	---	---	---	---
5-29	---	---	---	---	---	---	---	---	---	---	2.2	3.7	6.3	2.3	9.4	---	---	---

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

a/ Unit 6 was not sampled adequately due to small numbers of fish present throughout the season.

Appendix Table 14.--continued--Percent descaling of juvenile chinook salmon by date, unit number, and gatewell slot designation at Little Goose Dam, 1979.

DATE	UNIT 1			UNIT 2			UNIT 3			UNIT 4			UNIT 5			UNIT 6 a/		
	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C
5-30	4.9	6.8	5.3	---	---	---	2.5	3.7	---	---	---	---	---	---	---	---	---	---
5-31	---	---	---	7.3	6.9	10.5	---	---	3.0	4.3	---	---	---	---	---	---	---	---
6-1	---	---	---	---	---	---	---	---	3.6	---	3.1	---	---	---	---	---	---	---
6-4	---	---	---	---	---	---	---	---	---	---	---	---	3.2	1.6	4.1	---	---	---
6-6	4.7	6.0	3.1	---	---	---	11.0	1.6	4.1	---	---	---	---	---	---	---	---	---
6-8	---	---	---	3.5	9.3	2.8	---	---	---	---	---	---	---	---	---	---	---	---
6-15	---	---	7.0	5.7	---	4.4	---	---	---	---	---	---	---	---	---	---	---	---
6-20	---	7.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

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

a/ Unit 6 was not sampled adequately due to small numbers of fish present throughout the season.

Appendix Table 15.--Percent descaling of juvenile steelhead by date, unit number, and gatewell slot designation at Little Goose Dam, 1979.

DATE	UNIT 1			UNIT 2			UNIT 3			UNIT 4			UNIT 5			UNIT 6 a/		
	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C
4-17	4.0	---	4.3	2.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4-19	---	9.6	---	---	1.1	*	5.7	---	---	---	---	---	---	---	---	---	---	---
4-21	5.1	5.9	5.8	8.0	---	4.3	---	---	---	---	---	---	---	---	---	---	---	---
4-23	7.1	3.8	2.5	3.1	8.9	13.6	*	---	---	7.5	---	---	---	---	---	---	---	---
4-24	---	---	---	---	9.6	7.7	---	---	---	*	6.9	*	---	---	---	---	---	---
4-26	---	---	---	4.4	4.3	---	5.3	3.9	---	*	5.9	---	---	---	---	---	---	---
4-27	---	---	---	4.4	1.7	5.9	---	---	---	*	7.4	---	---	---	---	---	---	---
4-28	---	---	---	---	---	---	---	---	---	3.4	10.6	5.3	---	*	---	---	---	---
4-29	---	---	---	---	---	---	---	---	---	---	---	---	---	*	*	---	---	---
4-30	---	---	---	*	*	*	*	*	---	---	---	---	3.1	---	---	---	---	---
5-1	---	---	---	---	---	---	---	---	6.0	3.6	7.0	4.2	---	---	---	---	---	---
5-2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	*	*	---
5-3	5.3	---	---	4.5	6.5	5.8	5.2	---	---	---	---	---	---	---	---	---	4.2	---
5-4	---	---	---	---	---	---	---	4.1	4.7	0.0	2.5	*	---	---	---	---	---	---
5-5	3.0	2.8	0.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5-6	---	---	---	8.5	5.4	4.6	2.9	---	---	---	---	---	---	---	---	---	---	---
5-7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.5	5.5
5-8	7.8	5.7	7.8	---	4.5	5.7	6.3	8.4	13.0	---	---	---	---	---	---	---	---	---

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

a/ Unit 6 was not sampled adequately due to small numbers of fish present throughout the season.

Appendix Table 15.--continued--Percent descaling of juvenile steelhead by date, unit number, and gatewell slot designation at Little Goose Dam 1979.

DATE	UNIT 1 slot A	UNIT 1 slot B	UNIT 1 slot C	UNIT 2 slot A	UNIT 2 slot B	UNIT 2 slot C	UNIT 3 slot A	UNIT 3 slot B	UNIT 3 slot C	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 [a] slot A	UNIT 6 [a] slot B	UNIT 6 [a] slot C
5-9	4.5	8.4	2.6	7.9	6.7	5.4	---	---	---	---	---	---	---	---	---	---	---	---
5-10	9.6	1.5	6.1	6.1	5.8	4.4	---	---	---	---	---	---	---	---	---	---	---	---
5-11	---	---	---	0.0	3.2	---	4.4	3.0	4.8	---	---	---	---	---	---	---	---	---
5-12	6.0	6.0	4.8	---	---	---	---	---	---	4.3	---	---	---	---	---	---	---	---
5-13	---	---	---	3.7	4.1	8.0	5.4	---	---	---	---	---	---	---	---	---	---	---
5-14	4.7	*	3.6	---	---	---	---	---	---	---	---	---	3.6	2.7	2.7	---	---	---
5-15	---	---	---	4.9	2.5	3.5	---	---	5.8	2.5	1.3	---	---	---	---	---	---	---
5-16	4.4	6.2	8.6	---	---	---	7.2	3.4	---	---	---	---	---	---	---	---	---	---
5-17	---	---	---	---	---	---	---	---	4.5	0.8	6.7	9.9	3.3	3.5	---	---	---	---
5-18	7.7	7.5	4.8	---	---	---	8.2	5.2	4.2	---	---	---	---	---	---	---	---	---
5-21	---	---	---	10.9	11.7	6.1	---	---	---	7.0	8.8	5.4	---	---	---	---	---	---
5-23	8.4	7.9	10.6	---	---	---	9.3	10.1	7.1	---	---	---	---	---	---	---	---	---
5-24	---	---	---	12.1	6.3	9.7	---	---	---	---	---	---	7.8	11.8	---	---	---	---
5-25	---	---	---	---	---	---	---	---	---	6.9	8.3	6.4	---	---	9.9	---	---	---
5-26	5.1	8.5	10.4	---	---	---	4.4	7.1	---	---	---	---	---	---	---	---	---	---
5-28	---	---	---	4.4	3.3	4.7	---	---	6.7	7.6	---	---	---	---	---	---	---	---
5-29	---	---	---	---	---	---	---	---	---	---	6.8	3.9	6.9	4.9	3.0	---	---	---
5-30	7.9	8.8	5.0	---	---	---	8.0	3.5	---	---	---	---	---	---	---	---	---	---

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

a/ Unit 6 was not sampled adequately due to small numbers of fish present throughout the season.

Appendix Table 15.--continued--Percent descaling of juvenile steelhead by date, unit number, and gatewell slot designation at Little Goose Dam 1979.

DATE	UNIT 1			UNIT 2			UNIT 3			UNIT 4			UNIT 5			UNIT 6 a/		
	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C	slot A	slot B	slot C
5-31	---	---	---	6.3	7.3	4.0	---	---	4.0	5.1	---	---	---	---	---	---	---	---
6-1	---	---	---	---	---	---	---	---	5.9	---	3.4	---	---	---	---	---	---	---
6-4	---	---	---	---	---	---	---	---	---	---	---	---	4.5	4.7	3.0	---	---	---
6-6	3.5	3.0	3.4	---	---	---	4.4	2.7	4.1	---	---	---	---	---	---	---	---	---
6-8	---	---	---	3.0	5.8	4.3	---	---	---	---	---	---	---	---	---	---	---	---
6-15	---	---	4.0	4.9	---	5.3	---	---	---	---	---	---	---	---	---	---	---	---
6-20	---	7.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

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

a/ Unit 6 was not sampled adequately due to small numbers of fish present throughout the season.

Appendix Table 16.--Date, test condition, transport system water quality data, and delayed mortality of unmarked juvenile chinook salmon and steelhead after transport from Little Goose Dam, 1979.

Date	Test[a/] cond.	Water quality				Delayed mortality			
						Chinook unmarked		Steelhead ummarked	
		Temp. (°C)	O_2 (ppm)	CO_2 (ppm)	pH	No. held	% mort	No. held	% mort
4-17	1	8.9	21.0	5.5	7.5	137	33.6	106	0.9
4-19	1	8.3	14.8	3.2	7.5	105	49.5	142	4.2
4-21	1	10.0	14.1	4.5	7.5	158	50.6	167	4.8
4-24	1	10.5	25.8	3.7	7.5	103	23.3	48	1.7
4-24	2	10.0	13.2	1.5	7.6	111	13.5	21	0.0
4-26	1	10.0	22.9	6.5	7.1	169	26.0	61	0.0
4-27	1	10.0	17.1	6.5	7.4	212	16.5	30	6.7
4-29	1	9.5	26.1	6.7	7.3	162	19.1	54	0.0
4-29	2	11.1	10.7	1.2	7.9	145	1.4	21	0.0
5-1	1	11.1	17.2	6.0	7.3	253	13.8	33	0.0
5-1	1	12.8	24.2	3.6	7.4	239	11.3	66	0.0
5-1	2	10.5	10.4	1.2	7.6	215	1.4	36	0.0
5-2	1	11.1	15.2	8.0	7.3	261	10.6	58	0.0
5-4	1	11.1	24.0	14.0	7.1	101	26.7	86	2.3
5-4	2	12.2	10.4	1.5	7.7	102	7.8	24	4.2
5-6	1	11.1	19.2	10.0	7.1	107	22.4	99	1.0
5-6	1	9.4	21.8	10.8	7.1	133	33.8	71	1.4
5-6	2	12.2	9.2	1.2	7.4	172	5.2	13	0.0
5-8	1	10.5	19.7	8.6	6.9	117	31.6	92	2.2
5-8	1	10.0	20.4	8.5	6.7	87	34.5	86	1.2
5-9	2	12.2	9.1	1.0	7.3	105	15.2	88	1.1
5-9	1	--	21.6	11.0	6.8	79	19.0	46	0.0
5-9	1	11.1	17.4	3.6	7.0	122	33.6	63	1.6
5-9	1	10.5	11.6	11.0	6.9	102	34.3	101	0.0
5-10	1	10.5	21.5	7.5	7.0	98	11.2	76	2.6
5-11	1	12.2	22.3	18.0	6.7	83	21.7	62	0.0
5-11	2	12.0	9.6	1.1	7.3	79	8.9	29	0.0
5-13	1	--	27.4	6.5	---	43	18.6	41	0.0
5-13	2	13.5	10.3	1.7	7.6	72	1.4	59	0.0
5-14	1	12.2	21.8	6.5	6.7	202	7.9	58	0.0
5-16	1	11.1	29.2	7.0	6.8	101	3.0	91	1.1
5-16	2	13.8	9.4	2.5	7.3	39	12.8	26	0.0
5-18	1	10.0	21.1	4.6	6.8	61	14.7	113	1.8
5-18	2	14.0	9.9	1.5	7.3	89	4.5	35	0.0
5-20	2	14.0	9.6	1.0	7.2	27	3.7	68	0.0
5-23	2	14.8	10.2	1.5	7.7	50	6.0	100	0.0
5-23	1	14.0	22.0	7.6	6.8	44	18.2	51	2.0

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

Appendix Table 16.--continued--Date, test condition, transport system water quality data, and delayed mortality of unmarked juvenile chinook salmon and steelhead after transport from Little Goose Dam, 1979.

Date	Test cond.[a/]	Water quality				Delayed mortality			
						Chinook unmarked		Steelhead unmarked	
		Temp. (°C)	O_2 (ppm)	CO_2 (ppm)	pH	No. held	% mort	No. held	% mort
5-25	1	11.1	26.5	17.5	6.7	27	3.7	63	1.6
5-25	2	15.4	9.9	2.0	7.3	22	9.1	27	0.0
5-28	2	14.4	9.4	1.5	7.1	28	0.0	38	0.0
5-28	1	12.2	18.5	4.0	6.8	28	32.1	53	1.9
5-30	1	12.2	14.1	2.6	6.9	115	25.2	75	0.0
5-30	2	15.2	10.2	0.9	7.3	36	38.9	98	2.0
6-2	2	15.4	9.2	1.1	7.2	103	8.7	60	3.3
6-4	1	16.5	30.0	13.0	6.5	219	11.4	62	3.2
6-6	1	17.3	21.2	4.0	7.1	115	11.3	67	0.0
6-8	1	16.1	33.0	9.5	6.6	126	9.5	32	3.1
6-15	1	15.0	13.1	2.7	7.2	95	14.7	45	8.9
6-20	1	16.7	32.5	4.5	6.8	154	3.9	15	0.0

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