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Evaluation of Transportation and Related Research on Columbia and Snake Rivers, 1982

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February 1983

COASTAL ZONE AND ESTUARINE STUDIES

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

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

February 1983

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INTRODUCTION

In 1982, the National Marine Fisheries Service (NMFS) conducted research under contract to the U.S. Army Corps of Engineers (CofE) relating to the transportation of juvenile salmonids at Lower Granite and McNary Dams.

Major research objectives were to: (1) continue marking juvenile fall chinook salmon for truck transport tests at McNary Dam; (2) evaluate the relative survival of marked vs unmarked fall chinook salmon transported to Bonneville Dam compared to marked and unmarked fish not transported (released at McNary Dam); (3) continue evaluation of previous transport efforts by recovery of adults tagged as juveniles in the various fisheries, at hatcheries, from spawning areas, and at dams; (4) determine relative stresses to spring chinook salmon in collection and transport systems at Lower Granite and McNary Dams; and (5) measure stress on spring chinook salmon and steelhead during transportation in trucks at four specific load densities.

FALL CHINOOK SALMON MARKING - MCNARY DAM

Continuation Study for Evaluation of Truck Transport

In July and August, 39,693 juvenile fall chinook salmon were marked and subsequently released at Bonneville Dam as test fish for standard truck transport evaluation (Appendix Table 1). An additional 38,683 fish were marked and subsequently released in the tailrace at McNary Dam as controls. Evaluation of this test will be based on future recovery of marked adults.

Relative Survival of Marked vs Unmarked and Transported vs Nontransported Fall Chinook Salmon

Since 1978, millions of summer/fall chinook salmon smolts have been transported from McNary Dam to below Bonneville Dam. Several hundred thousand of these were marked to evaluate the effects of transportation. Nearly equal numbers of marked fish were released at McNary Dam to determine survival of nontransported fish (controls for comparison to transported lots).

It is generally believed that marking/handling of smolts limits the survival capability of the fish following this stressful activity. There have been questions raised as to whether marked fall chinook salmon at McNary Dam survive at the same rate as the unmarked population transported from the dam.

During the 1982 transport season, the NMFS conducted a test to measure the relative survival of marked vs unmarked fish and transported vs nontransported fish at McNary Dam.

Methods

Transported fish were hauled in two truck systems: (1) a standard 3,500-gallon CofE tanker and (2) a smaller 250-gallon tanker. The smaller tanker was constructed and operated in a manner duplicating conditions in the larger unit. Oxygen levels, temperature, and fish density were controlled and matched between units used for paired transportation tests.

The smaller tanker provided backup in the event a sufficiently large sample of marked fish could not be obtained from the larger unit. While this problem did not develop, it was shown that the smaller unit did provide reliable duplication of results obtained from the CofE tanker.

Tests were conducted from mid-July through August using fish marked for ongoing transport evaluation. Fish were marked by excising the adipose fin, applying a freeze brand, and inserting a coded wire tag into the nose (detailed marking procedures are described by Park et al. 1981). After marking, fish were loaded directly into a tanker and transported to Bonneville Dam. Fish density did not exceed 0.5 lb per gallon on any trip.

Upon arrival at Bonneville Dam, a mixed sample of marked and unmarked fish was taken by vertical net sampler (described in the section on stress studies) from the CofE tanker. This group was then held in river water in flow-through holding tanks at a density no greater than 0.1 lb per gallon static volume. All fish from the smaller tanker were held in similar tanks.

The nontransported portion of this experiment was conducted entirely at McNary Dam. Marked fish were selected from groups being marked concurrently for other experiments. Unmarked fish were sampled from a raceway using a vertical net sampler. Fish were then held in flow-through tanks similar to those at Bonneville Dam.

Evaluation of the experiment was based on 5-d delayed mortality. Each day, dead fish were removed from the holding tanks. Analysis was based on contingency tables from live vs dead fish counts (X^2 statistic). Significance was desired at $P<0.05$, df = 1.

It should be mentioned that during normal sampling operations at McNary Dam, selected fish were anesthetized and examined for brands, descaling, etc. These fish were then returned to the raceways. This group of handled fish was segregated from fish used in this experiment and were not transported at the same time. Also, the terms "marked" and "unmarked" as used in this section refer only to the handling of fish at McNary Dam. Fish marked upriver from the collection site were treated as unmarked for purposes of this experiment.

Results

Ten trials (replicates) were run during the experiment. In the first trial, there were mechanical problems with the small tanker which resulted in excessive mortality to fish (Appendix Table 2). In the seventh trial, there was unexplained excessive mortality in most groups; therefore, these data are not included in our analysis.

The test data indicate that marking/handling alone does not cause substantial mortality to fall chinook salmon smolts, but there may be a compounding effect of marking plus transportation. Among the nontransported fish, mortality to unmarked fish was actually slightly higher than mortality to marked fish (no significant difference). In the CofE tanker group, mortality of marked fish was somewhat higher than mortality of unmarked fish (4.6% vs 3.0%), but the difference was not significant (Figure 1). However, the marked groups transported in the experimental tanker had significantly higher mortality than their nontransported counterpart ($P<0.01$, df = 1).

The data from these tests indicate that marking fish followed by truck transportation will cause them to die at slightly higher rates than those marked and released at McNary Dam (e.g., a typical transport/control test).

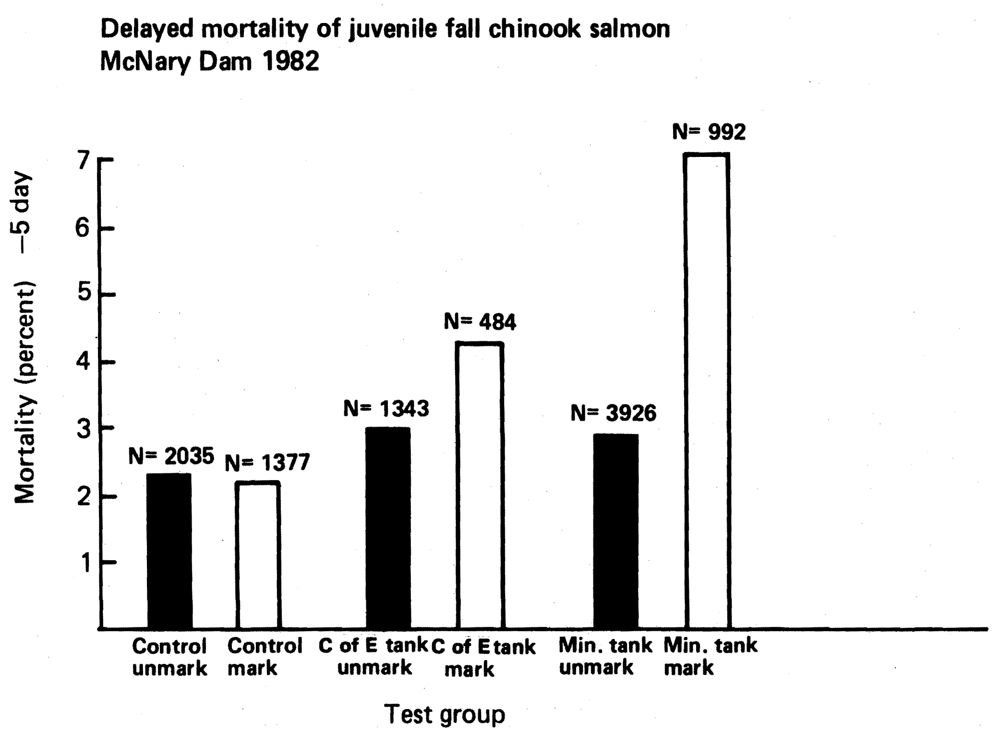

Figure 1.--Delayed mortality of juvenile fall chinook salmon, McNary Dam 1982.

Adult return data from previous truck transport tests (e.g., 1978) show that marked transported fish survive at higher rates than marked fish released as controls. In fact, transport benefit ratios are high (4.1:1 to 9.6:1 as shown in the following section of this report). This is easily explained because smolts released at McNary Dam (marked or unmarked) suffer extremely high mortality during their migration from McNary Dam to Bonneville Dam--a mortality far greater than the transport induced mortality.

In summary, we found that for fall chinook salmon smolts:

1. Marking alone did not induce significant mortality within a 5-d holding period.

2. Transportation alone did not induce significant mortality within a 5-d holding period.

3. The combined effects of marking and transportation in the experimental tanker did lead to significant ($P<0.01$, df = 1) mortality within a 5-d holding period.

ADULT RETURNS TO THE COLUMBIA AND SNAKE RIVERS

Adult salmonids that were tagged as juveniles to evaluate transport from dams were recovered on their upstream migration by operating tag detection equipment in fishways at Bonneville, McNary, and Lower Granite Dams. At Bonneville Dam, these facilities were operated 1 April to 15 October 1982 (5 d per week, 8 h each day). At McNary and Lower Granite Dams, operations were continuous 1 May to 24 November and 1 March to 30 November, respectively. In addition, tags were recovered from fish spawned in Columbia and Snake River hatcheries, sport fisheries, various commercial fishing catches (including ocean fisheries), and natal spawning areas.

Altogether, over 600 tagged fish were recovered in 1982. The recoveries of tagged adults were nearly equal in three major areas: dams, hatcheries, and fisheries. Recoveries by species were dominated by steelhead followed by fall chinook salmon; only a few spring chinook salmon were recovered.

Steelhead

Transport to control benefit ratios for smolts barged to below Bonneville Dam from Lower Granite Dam in 1978-1980 are shown in Figure 2. These data are based on adults that returned to the adult collection facility at Lower Granite Dam. (Complete data for recoveries by year and area are shown in Appendix Tables 3.1 to 3.9.) Smolts transported by truck in 1978 returned at rates comparable with barged fish. Also, fish transported by truck from Little Goose Dam in 1978 returned at rates comparable with the barged group from Lower Granite Dam.

Results from transportation of steelhead at Lower Granite Dam continue to be impressive. Somewhat lower ratios observed for 1979-1980 are not disturbing since it is likely many controls released for these tests were subsequently transported at McNary Dam (Park et al. 1982).

Likewise, transportation of steelhead by barge and truck from McNary Dam to below Bonneville Dam is extremely encouraging. Transport to control benefit ratios have exceeded 1.5:1 for both barged and trucked fish since 1978 (Figure 3). (Appendix Tables 3.10 to 3.17 show complete return data.) The data used for the benefit ratio analysis for tests at McNary Dam represent combined adult recoveries at Bonneville, McNary, and Lower Granite Dams. Whereas transport to control benefit ratios provide an index for following the progress of transportation successes on a specific test situation, total adults returning to the river provide a better insight to

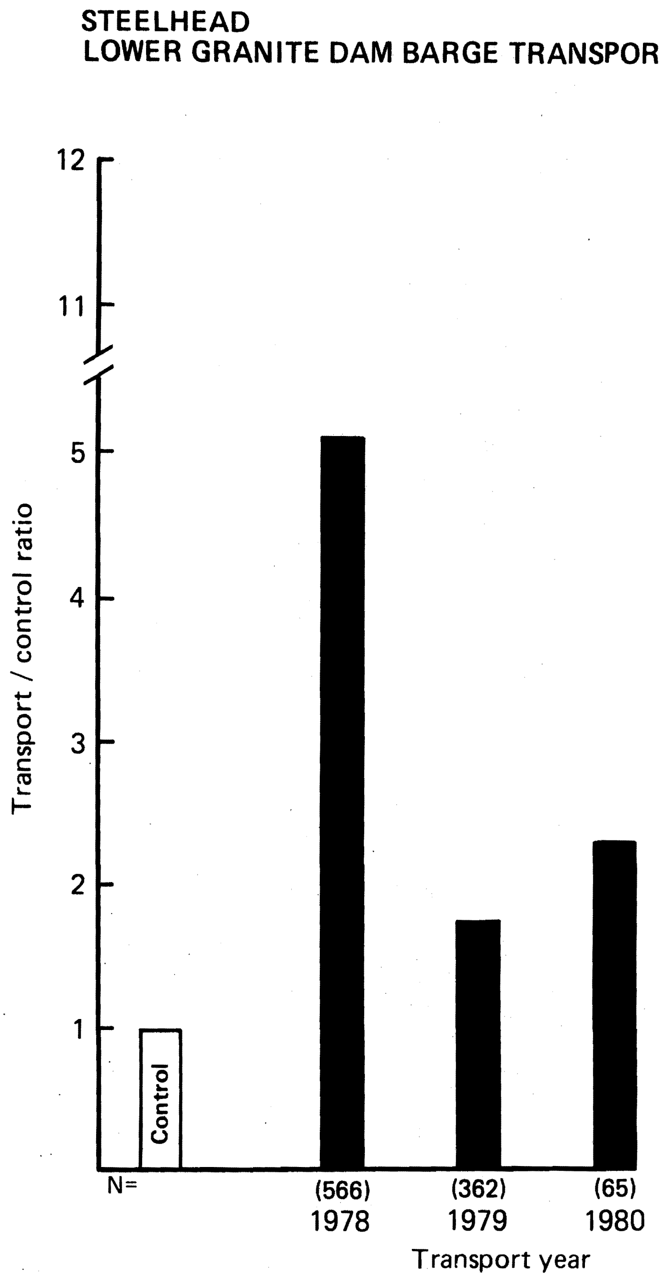

Figure 2.--Transport/control ratios for Lower Granite Dam barge transportation tests with steelhead, 1978-1980.

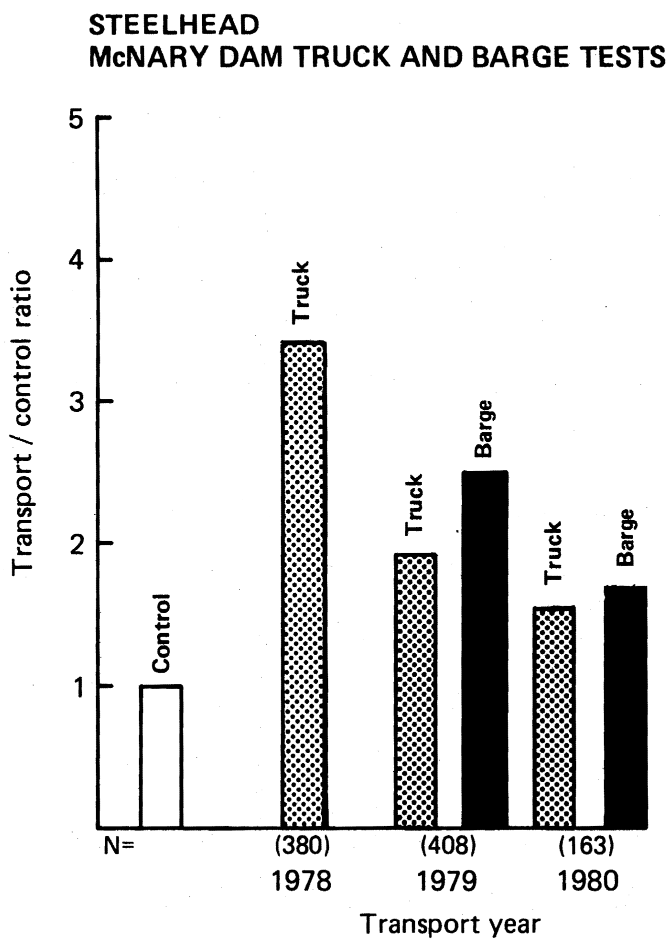

Figure 3.--Transport/control ratios for McNary Dam truck and barge transportation tests with steelhead, 1978-1980.

the current status of net benefits to the species as a result of continued recent transport efforts.

The 1982 steelhead escapement at Ice Harbor and Priest Rapids Dams (over 70,000 fish and 10,000 fish, respectively) were both near records. Besides survival enhancement from transportation, there are several reasons why this dramatic turnaround from record low runs just a few years ago to the present high 1982 run occurred: (1) increased hatchery production that emphasizes quality smolts, e.g., Dworshak National Fish Hatchery (NFH); (2) properly timed hatchery release schedules that tend to enhance smolt survival; (3) reduced losses of adults on their upstream migration; and (4) increased enforcement activities in relation to commercial, sport, and tribal fisheries.

The positive influence of transportation for Snake River steelhead is shown in Figure 4. As can be seen, except for the returns from the drought years, returns of adults from each of the outmigration years, 1975 to present, have provided a sport fishery.

Through NMFS recommendations that were fully supported by the CofE, increased screening of turbine intakes coupled with mass transportation of steelhead was begun in 1975. The number of fish transported was dramatically increased in 1978 and has continued (Table 1) (Park 1980). These actions have coincided precisely with larger steelhead runs returning to the Columbia and Snake Rivers. Later, similar actions were taken at McNary Dam which further benefited Snake River runs and, for the first time, added protection for mid-Columbia River stocks as well.

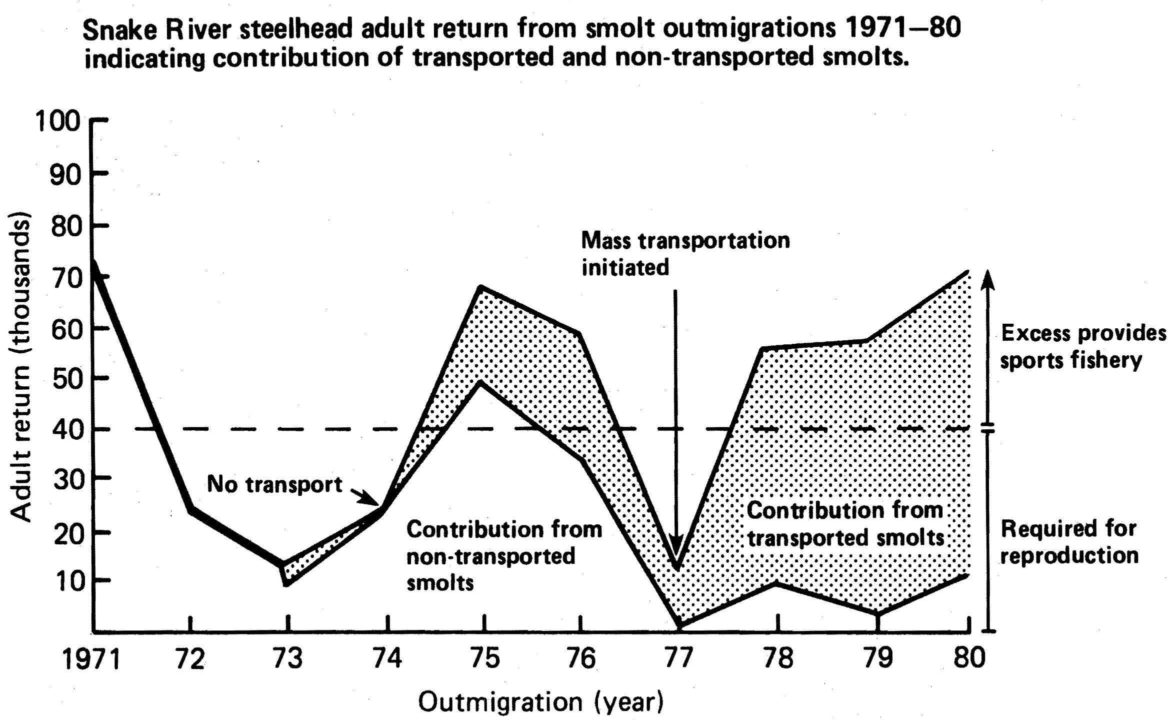

Figure 4.--Adult steelhead that have returned to the Snake River from each outmigration year (1971-80), indicating the contribution of transported and nontransported fish.

Table 1.--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).

		Chinook smolts			Steelhead smolts		
Year	No. of turbine units screened	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	3	4,000	109	3	5,500	154	3
1972	3	5,000	360	7	2,500	227	9
1973	9[a]	5,000	247	5	5,500	176	3
1974	0	3,500	0	0	5,000	0	0
Transport from Lower Granite and Little Goose Dams combined							
1975	9	4,000	414	10	3,200	549	17
1976	10	5,000	751	15	3,200	435	14
1977	15	2,000	1,365	68	1,400	895	64
1978	30	3,180	1,623	51	2,120	1,355	64
1979	33	4,270	2,109	49	2,550	1,712	67
1980	36	5,400	3,254	60	3,600	2,860	79

a/ Nine screens were used only until 11 May 1973 - thereafter, three were used for duration of the outmigration.

In 1975, the NMFS predicted that the Snake River run (including Lower Columbia River harvest) could reach in excess of 120,000 fish annually if remedial protection measures (including transportation) were implemented (Collins et al. 1975; Ebel et al. 1979). Assumptions in Collins' model required an outmigration of 4.6 million smolts reaching Lower Granite Dam and a collection efficiency for the Snake River projects of 90% in low flow years. It seems likely that current research aimed at improving collection efficiency (79% of the steelhead smolts were collected and transported in 1980) could result in achieving 90% collection in future years. If so, adult steelhead runs could easily top 100,000 fish annually in the near future.

Another way of assessing the 1982 Snake River steelhead run is to place a monetary value on each returning fish. A recent study by Meyer (1982) shows that each escaping steelhead spawner is worth $359 (Figure 5). From Meyer's model it can be seen that each escaping fish is twice as valuable as each harvested fish, or expressed another way, the total value of escaping fish is equal to the total value of fish caught.

To determine the value of the run in 1982, we estimated that 80,000 fish of Snake River origin returned to the Columbia River. The estimate is based on the following:

1) 70,000 fish counted at Ice Harbor Dam from 1 July to 1 November.

2) 4,000 fish in Columbia River sport catch.

3) 4,000 fish in Columbia River commercial catch.

4) 2,000 fish during winter-spring passage period at Ice Harbor Dam.

We believe that estimates in items 2-4 above are conservative, and it is likely that more fish are involved in all these areas. Based on Meyer's

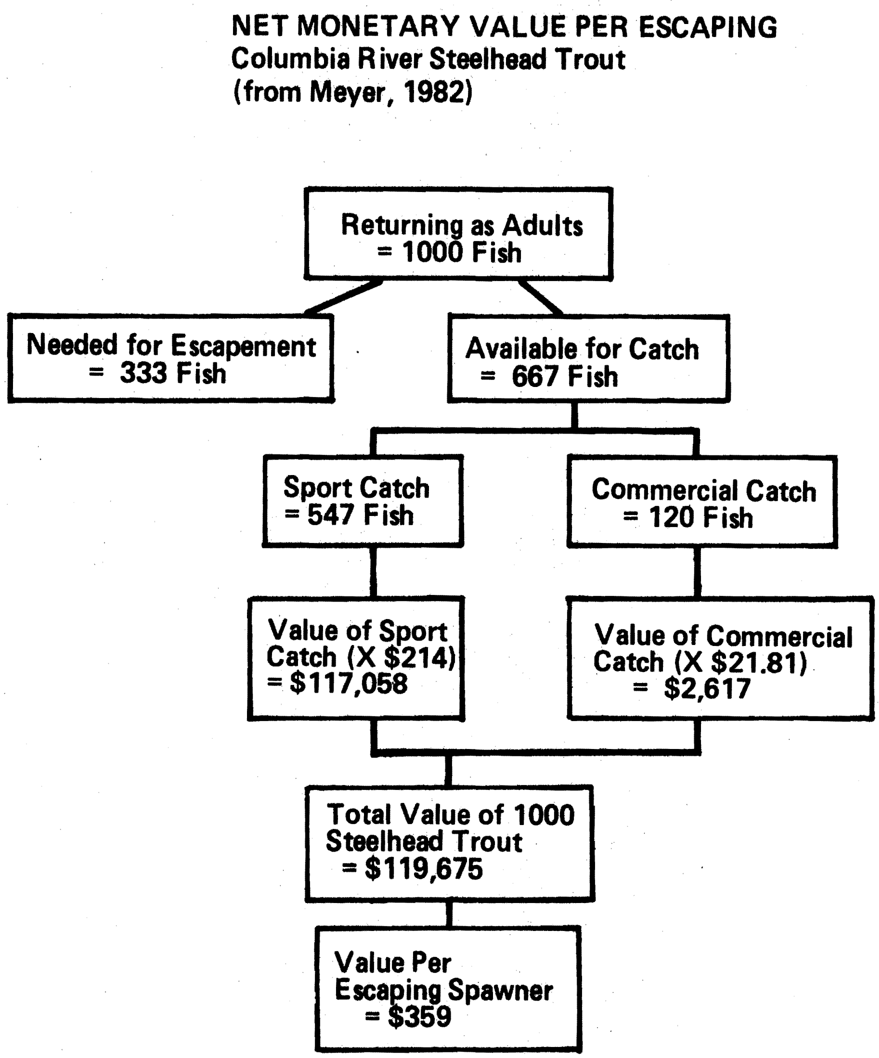

Figure 5.--Net monetary value per escaping Columbia River steelhead spawner (Meyer 1982).

assumptions such as escapement and harvest estimates, we placed 80,000 into his model for analysis (Figure 6). The resulting total net monetary value of the run exceeds $9.5 million. Since this calculation is based on harvested fish (real value), the escapement has an equal value but only as a potential or future value since progeny of spawners will bring future value to the various fisheries communities.

We neither laud nor defend Meyer's analysis. However, if we accept his assumptions there can be little argument that we have an extremely valuable resource based on just 1 year's return. It is also clear that the investments made in research and implementation of protection measures (i.e., traveling screens, trucks, and barges) are paying excellent dividends for steelhead.

Fall Chinook Salmon

Transport of fall chinook salmon smolts by truck from McNary Dam to below Bonneville Dam is showing very promising benefits. Preliminary returns indicate that transport benefits ranged from 4.1:1 to 9.6:1 depending on area of recovery and year of transport (Figure 7). Although tests began in 1978, recovery data are not quite complete since 1982 ocean and Columbia River fisheries harvest data are not reported. (Appendix Tables 4.1 to 4.8 show return data to date.)

It appears that transported fish contribute to fisheries and return to the river at significantly higher rates than the nontransported control fish. For example, the 1978 test data (most complete) when placed in contingency tables (X^2 statistic) show a highly significant ($P<0.01$, df = 1) return rate and contribution rate for transported fish.

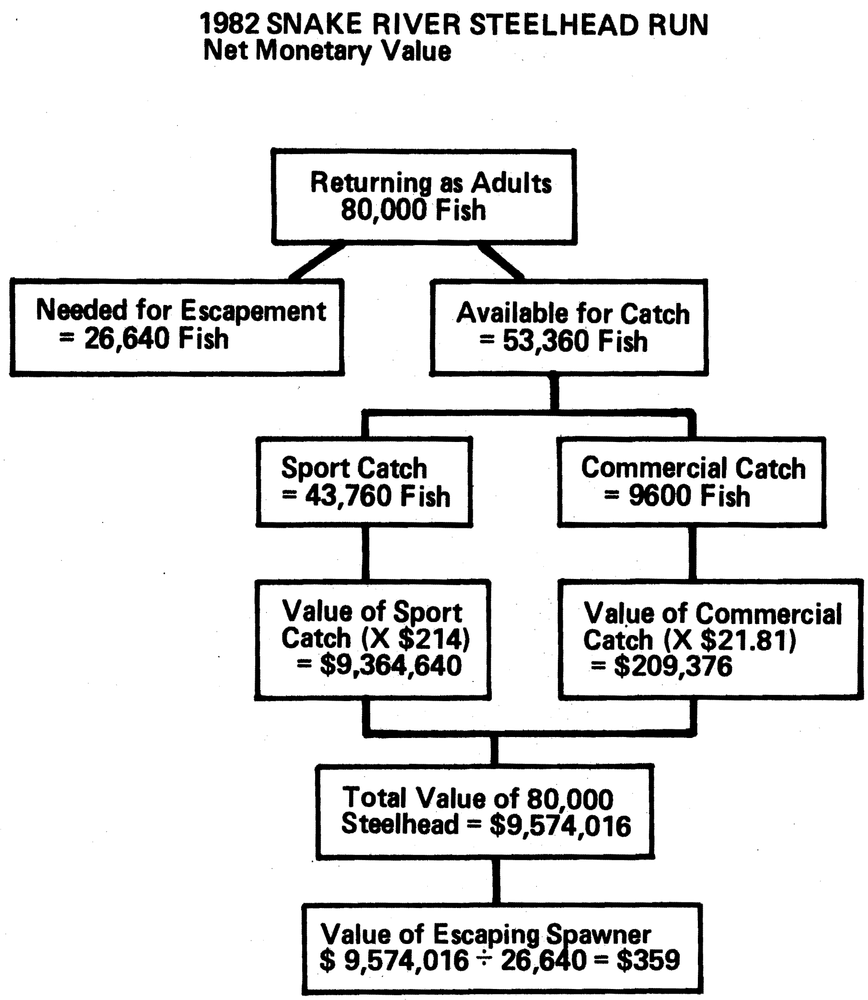

Figure 6.--Net monetary value for the 1982 Snake River steelhead run.

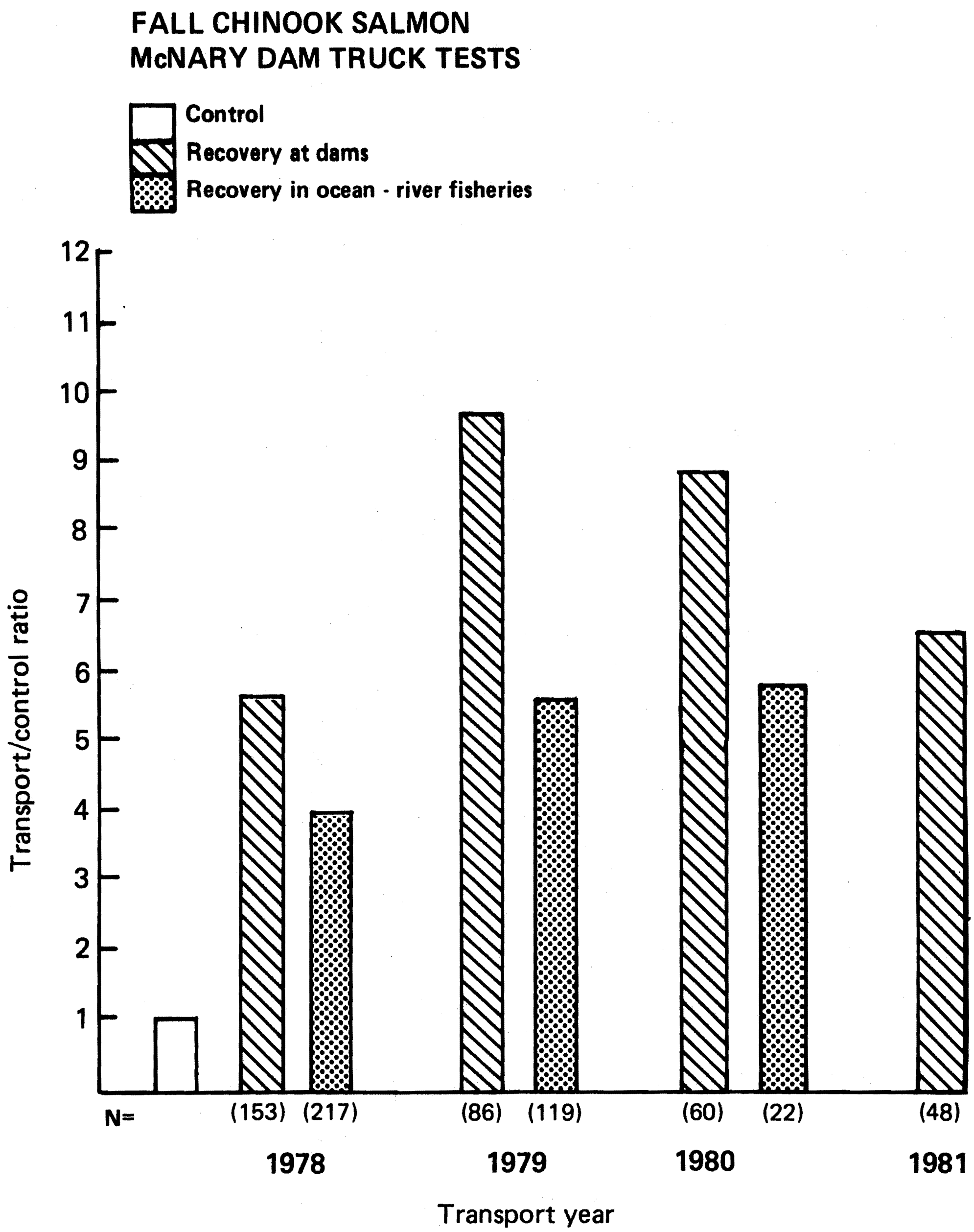

Figure 7.--Transport/control ratios for McNary Dam truck transportation tests with fall chinook salmon, 1978-81.

In another comparison of fisheries contribution of fall chinook salmon smolts released in 1978, we examined the ocean harvest rate of: (1) fish transported from McNary Dam, (2) fish released in the tailrace at McNary Dam, and (3) fish released from Washington Department of Fisheries hatcheries at Ringold and Priest Rapids. Ocean harvest data are preliminary, however, data to date should be comparable because most fall chinook salmon transported or released as controls at McNary Dam are represented by mid-Columbia River smolts--including a substantial number of fish from Ringold and Priest Rapids Hatcheries. Therefore, we may reasonably expect fish from all of the above groups to enter the various ocean fisheries at near equal rates.

From the data in Table 2, significantly more transported fish were harvested (based on the number of smolts released) than fish released from hatcheries or from the group released below McNary Dam ($P<0.01$, df = 1). Fish released from the hatcheries apparently are exposed to much higher river mortality factors than transported fish, and contributions are more nearly parallel to the McNary Dam control group (no significant difference in harvest rate). The adult data from returns to the Columbia River and from fisheries harvest data are depicting a clear and impressive picture of transport benefits. Evidence is accumulating that demonstrates transportation is providing juvenile fall chinook salmon protection at McNary Dam.

Spring Chinook Salmon

The results of transportation tests at Lower Granite and McNary Dams 1978-80 are summarized in Table 3. (All recoveries for spring chinook salmon experiments, including Little Goose Dam, are included in Appendix Tables 5.1 to 5.21.) None of the data provide cause for optimism

Table 2.--A comparison of ocean harvest rates of three groups of Columbia River fall chinook salmon released as smolts in 1978.

Release group	Number released	Released site	Ocean harvest[a]	Percent of smolt release
McNary Dam transport (truck)	40,361	Tailrace Bonneville Dam	583[b]	1.444
Priest Rapids and Ringold Hatcheries	299,229	Hatchery	1094[c]	0.366
McNary Dam control	38,137	Tailrace McNary Dam	132[b]	0.346

a/ Based on harvest data available through 13 December 1982. Harvest data were not complete and assumption was made that harvest report was equal for all groups.

b/ Number was estimated based on a 21.3% sampling rate in the ocean fisheries.

c/ Number was estimated based on information compiled by the Washington Department of Fisheries, including establishing the sampling rate already noted.

Table 3.--Summary of adult spring chinook salmon returns to dams, Snake and mid-Columbia River hatcheries, and to fisheries from transportation tests originating from Lower Granite and McNary Dams, 1978-80.

Group	No. smolts released	No. adult returns to dams[a/]	No. adult returns to Snake River hatcheries and spawning grounds	No. adult returns to mid-Columbia River hatcheries and spawning grounds	No. adult returns to ocean and Columbia River fisheries	Transport to control benefit ratio
Lower Granite Dam						
1978 Truck	43,855	33	7	0	3	5.49:1
Barge	56,546	66	12	0	5	8.52:1
24 h Fresh water	38,685	5	5	0	0	<1:1
24 h Salt water	40,841	5	2	0	1	<1:1
Control (Little Goose tailrace)	36,441	5	6	0	0	- -
1979 Barge	27,336	12	13	0	3	3.75:1
Control (Lower Granite tailrace)	25,532	3	0	0	0	- -
1980 Barge	40,719	1	0	0	0	nil
Truck	32,772	0	0	0	0	0
Control (Little Goose tailrace)	21,876	0	0	0	0	- -
McNary Dam						
1978 Truck	31,956	20	6	2	11	2.80:1
Control	31,376	7	2	5	5	- -
1979 Truck	42,748	12	1	11	66	<1:1
Barge	40,126	10	0	5	26	<1:1
Control	31,229	13	1	16	39	- -
1980 Truck	40,938	8	0	2	16	4.53:1
Barge	44,023	4	0	2	8	2.09:1
Control	46,585	2	0	2	6	- -

a/ For Lower Granite Dam tests, the number represents those fish that returned to Lower Granite Dam. For McNary Dam tests, the number represents those fish that returned to Bonneville, McNary, and Lower Granite Dams combined.

concerning the status of upriver stocks of spring chinook salmon. Only the barge and truck groups transported from Lower Granite Dam in 1978 show a strong benefit ratio (8.52 and 5.49 to 1, respectively). This positive factor is undermined by low percentage adult returns based on smolts released. Unfortunately, the returns for 1979-80 groups are abysmally low.

Although no fish transported from the Snake River were recovered at mid-Columbia River hatcheries, there were five fish from 1978-79 transport groups recovered at Deschutes River hatcheries, indicating some straying occurred.

Results of transporting spring chinook salmon at McNary Dam are vague. We should point out that the recoveries at dams noted in Table 3 represent combined returns to traps at Bonneville, McNary, and Lower Granite Dams. It appears then that rates of return for smolts transported from McNary and Lower Granite Dams are essentially the same.

Evaluation of transporting spring chinook salmon at McNary Dam has been hampered by our failure to properly identify spring chinook salmon at the time of marking (Park et al. 1981). Consequently, many fall chinook salmon have been inadvertently marked and released as spring fish. This explains in part why many so-called spring chinook salmon are recovered in ocean fisheries. This was especially true for the 1979 test groups when 131 recoveries were observed in ocean and Columbia River fisheries. This represents a mixture of spring chinook and fall chinook salmon. For the 1978-80 test groups from Lower Granite Dam, no fish were recovered in the ocean, and only 12 fish were recovered in Lower Columbia River fisheries. On the other hand, relatively large numbers of spring chinook salmon appeared in ocean and Columbia River fisheries from the McNary Dam tests in 1979. We believe these fish were primarily Cowlitz River stock spring fish released at Ringold Hatchery (Park et al. 1981). Apparently this stock has a propensity to enter coastal fisheries--a behavior quite unnatural for native upriver stocks. It is also apparent that the Cowlitz River stock survived and contributed to all fisheries at substantially higher rates than native upriver stocks.

In general, a great deal of care must be used when planning marking experiments for chinook salmon at McNary Dam when adult evaluation is required. We believe that future marking for spring chinook salmon should be terminated no later than 1 June. Conversely, marking for fall chinook salmon should begin no earlier than 1 July.

The current status of upriver spring chinook salmon runs is alarming and perplexing. There may be several reasons for poor survival in recent years: (1) poor ocean survival, (2) smolts may be unfit for ocean entry because of disease or other hatchery related causes, or (3) smolts may be stressed enough in collection and transport systems that survival after release below Bonneville Dam is questionable. Because stress is related to collection and transportation, its potential as a problem was addressed in the 1982 research.

STRESS STUDIES - COLLECTION AND TRANSPORT SYSTEMS

Preliminary research by Park et al. (1981) has shown that a secondary challenge to seawater would result in an indication of the relative primary stress levels of spring chinook salmon smolts at different points within the collection and transport system at Lower Granite Dam. The seawater challenge test is a type of secondary performance test which is commonly used within the fisheries community to measure relative primary stress levels. However, this test is unique in that secondary performance tests such as severe confinement, thermal shock, and disease challenge used by other researchers were conducted in fresh water.

The seawater challenge test takes advantage of stress induced osmoregulatory disturbances which upset water and ion balance in fish (Maetz 1974; Pic et al. 1974 and 1975; Mazeaud et al. 1977; Girard and Payan 1980). The effects of these disturbances on euryhaline fish are much more pronounced in full strength seawater than in fresh water, primarily because the osmoregulatory demand is much greater in the seawater environment. For example, the ion exchange rate between a smolted salmon and its environment in seawater can be as high as 10 times greater than in fresh water (Potts et al. 1970). The net result of this highly complicated phenomenon is that the higher the stress level of a group of smolts, the less capable individuals within the group are of osmoregulation in seawater, resulting in increased mortality.

The reader is cautioned that when interpreting results of these tests, mortality following the secondary seawater challenge has no known relationship to long-term survival. The data are useful in determining where primary stresses occur so that action may be taken to reduce collection and transport stresses to smolts and hence provide for maximum long-term survival.

In 1982, the seawater challenge tests were expanded to further isolate areas of stress within the collection and transport system at Lower Granite Dam; similar tests were initiated at McNary Dam. In addition, a series of transport density tests were designed and conducted to determine the effects of various transport densities on chinook salmon smolts transported alone, chinook salmon smolts transported with steelhead smolts, and steelhead smolts transported alone.

Methods

The reliability of the test data is, to a large degree, dependent upon capturing smolts from the various sample areas and transferring them into the seawater test chambers without adding additional handling stresses. Basically, this means that smolts have to be sampled from the freshwater test areas and transferred in a live car to the seawater test chambers without removing the smolts from water. To sample shallow or confined areas such as the gatewell dip basket, we dipped fish with a sanctuary dip net as described by Park et al. (1981). To sample deeper or less confined areas such as raceways, trucks, or barges, we designed and built a vertical net sampler. This device has an expandable upper frame, a middle area of netting in the shape of a fyke, and a lower sanctuary bag area with a removable plug. This device was lowered to the bottom of a sample area, allowed to remain there for a period of time, then pulled up quickly through the water column thereby capturing any fish in the vertical column of water above the net. As the sampler was pulled out of the water, any fish that had been captured remained in the watertight sanctuary bag below the net. Once captured and maintained in water in either the sanctuary dip nets or the vertical net sampler, the fish and water were placed into a 24-gallon plastic can for transfer to the seawater test chambers.

The test chambers at all facilities were standard 10-gallon glass aquaria set in a water bath of flow-through river water to maintain ambient river temperatures within the aquaria. The aquaria were covered to eliminate possible external interferences, and water quality was sustained by O_2 injection.

A stock solution of artifical seawater (Marine Environment)1/ was mixed at 54 ppt in Living Stream Model 700 recirculating holding systems. These systems cycled the stock solution approximately once every 5-7 minutes to provide continuous mixing and were equipped with refrigeration units for temperature control.

To start a test, 5 gallons of the seawater stock solution were poured into a test aquarium. A piece of duct tape which covered a screened rectangular opening near the bottom of the 24-gallon transfer container was removed allowing the water to drain down to exactly 4.2 gallons. Once at this level, the 4.2 gallons of water containing the test fish were poured from the transfer container into the test aquarium containing the seawater stock solution instantly bringing the salinity within the aquarium to the test salinity (30 ppt).

To ensure adequate test sensitivity prior to testing, we determined the highest seawater concentration, up to 30 ppt, which allowed 90% survival of control fish. This was accomplished by exposure of 15 control fish each to seawater concentrations of 15, 20, 25, and 30 ppt for 48 h. Survival in all of these groups exceeded 90%; therefore, we chose 30 ppt as the seawater concentration for the first test replicate.

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

Thereafter, survival of control fish in the previous replicate was used as the indicator for the appropriate seawater concentration in the replicate to follow. If control fish survival was less than 90% during the previous replicate, control fish would again be challenged to the aforementioned concentrations before replication continued. This did not occur, and 30 ppt was determined to be the appropriate seawater concentration for all test replicates during the entire study.

Each test group of approximately 20-30 smolts was exposed to artificial seawater for 48 h. Mortalities were removed at 24 h and at the end of the test period. All mortalities were weighed and measured to fork length (mm), and abnormalities such as injury, descaling, or obvious disease symptoms were noted. These data were also recorded for all survivors at the end of the 48-h test period. Upon completion of a test replicate, all live fish were released.

Live and dead fish counts were used in a contingency table analysis utilizing the chi-square statistic for significance. Significance was established at ($P<0.05$, df = 1) for comparisons between groups.

Collection and Transport Systems, Lower Granite and McNary Dams

To isolate areas of stress to chinook salmon smolts within the collection and transport systems at Lower Granite and McNary Dams, we sampled groups of smolts designated as follows:

1. Freshwater and seawater controls. The intake gatewells were the first area where fish were available for sampling after they entered the collection system. These groups of fish at both dams were sampled from C-Slot Intake Gatewells. Our rationale for selecting control fish from

these gatewells was that they are generally less crowded and descaled than are fish in either of the other two gatewells within the same unit. This phenomenon occurs because the C-Slot Intakes provide the least amount of water to a turbine unit; hence, the water velocities within these intakes are less than in either of the other two intakes.

2. Gatewell group. These fish were sampled from A-Slot Intake Gatewells at both dams. Since the A-Slot Intake provides the most water (highest velocity) to a turbine unit, descaling and crowding are generally the highest in these gatewells. Also, within these intakes, fish are more likely to be exposed to undesirable velocity situations which may result in fatigue or swimming impairment.

3. Preseparator group. These fish were sampled immediately prior to entering the fish separator at both dams. The fish had passed through the submerged gatewell orifices, the bypass channel (flume at McNary Dam) and pipe, the upwell area, and over the perforated porosity plate.

4. Raceway + 45 min group. These fish were sampled from a holding raceway no later than 45 min after passing through the fish separator and associated flume distribution system at Lower Granite Dam but not at McNary Dam. A group of chinook salmon smolts was also challenged from this area at Little Goose Dam for comparative stress measurements.

5. Raceway + 10 to 12 h group. These fish were sampled after remaining in a concrete holding raceway for approximately 10 to 12 h or just before they were loaded into a truck or barge at both dams. A similar group was sampled from the plastic holding raceways at McNary Dam. In addition, groups of steelhead smolts were sampled from this area at both Lower Granite and Little Goose Dams for comparative stress measurements.

6. Truck during loading group. These fish were sampled from a transport truck as they were loaded from a holding raceway at Lower Granite Dam only. Fish were not sampled from trucks at McNary Dam because the chinook salmon outmigration did not arrive in sufficient numbers for sampling before barging operations began.

7. Truck 20 to 30 min post-loading. These fish were sampled from a transport truck at Lower Granite Dam approximately 20 to 30 min after they were loaded from a holding raceway.

8. Barge post-loading group. These fish were sampled from a barge immediately after they were loaded from a holding raceway at both dams.

9. Truck post-transport group. These fish were sampled immediately upon arrival at Bonneville Dam after transport from Lower Granite Dam only.

10. Delayed challenge trucked groups. These fish were sampled from lots of fish matched to the previous group (truck post-transport) and were challenged to seawater at 24-h intervals beginning at 24 h post-transport and continuing through 144 h post-transport.

11. Barge post-transport. These fish were sampled from a transport barge and challenged to seawater immediately upon arrival at Bonneville Dam.

Handling and Marking Test Groups, Lower Granite Dam

To isolate areas of stress within our traditional handling and marking procedures, we sampled the designated groups as follows:

1. Upwell box (control). These fish were sampled from the upwell box within the marking facility immediately after removal from the outside sample tank. The fish had previously passsed through the gatewell orifices,

the bypass channel and pipe, and the fingerling separator and associated counting tank.

2. Traditional handling and marking group. These fish were sampled after they had passed through standard marking procedures used during past transport experiments. These procedures include dipping from the upwell box into the anesthetic sorting trough using a standard (netted) dip net, sorting by species, adipose fin clipping, freeze branding, and coded wire tagging.

3. Standard dip net group. These fish were sampled after they had passed through the procedure described above for the traditional handling and marking group except they were dipped from the upwell box with a sanctuary dip net rather than a standard dip net. The difference in stress levels between these two groups would indicate the amount of stress incurred by dipping fish from the upwell box into the anesthetic trough using a standard dip net.

4. Benzocaine + traditional handling and marking group. These fish were sampled after they had been dipped from the upwell box with a sanctuary dip net, anesthetized with benzocaine, and handled and marked in the traditional manner including dipping with a standard dip net after anesthetizing with benzocaine.

5. Unbuffered MS-222 group. These fish were sampled after they were dipped with a sanctuary dip net from the upwell box and exposed to unbuffered MS-222 only.

6. Traditional handling and marking in 10 ppt seawater group. These fish were sampled after they had passed through our traditional handling and marking procedures as previously described with 10 ppt seawater added to the anesthetic bath.

Results

Collection System and Transport Tests, Lower Granite Dam

Since fish populations and numbers of fish entering the system change as the season progresses, it is appropriate to separate these test results into phases--an early or truck phase and a later or barge phase.

Truck Phase.--Figure 8 (and Appendix Table 6) illustrates the test results during this phase of the study. Pertinent findings are summarized as follows:

1. There was no significant difference in the stress levels of chinook salmon smolts between the C-Slot Gatewells (controls) and the A-Slot Gatewells.

2. There was a significant increase in the stress level of chinook salmon smolts between the gatewell groups and the preseparator group ($P<0.01$, df = 1).

3. A comparison of the results between the preseparator group and the raceway + 45 min group isolates the separator complex. Although the average percent mortality nearly doubled between these groups (6.9 vs 11.3%), there was no statistically significant difference.

4. There was a significant decrease in the stress levels of chinook salmon smolts between the raceway + 45 min group and the raceway + 10- to 12-h group.

5. There was a significant increase in the stress levels of chinook salmon smolts between the raceway prior to loading group (+ 10 to 12 h) and the truck post-transport group. Nearly all of this increase was attributed to truck transport operations.

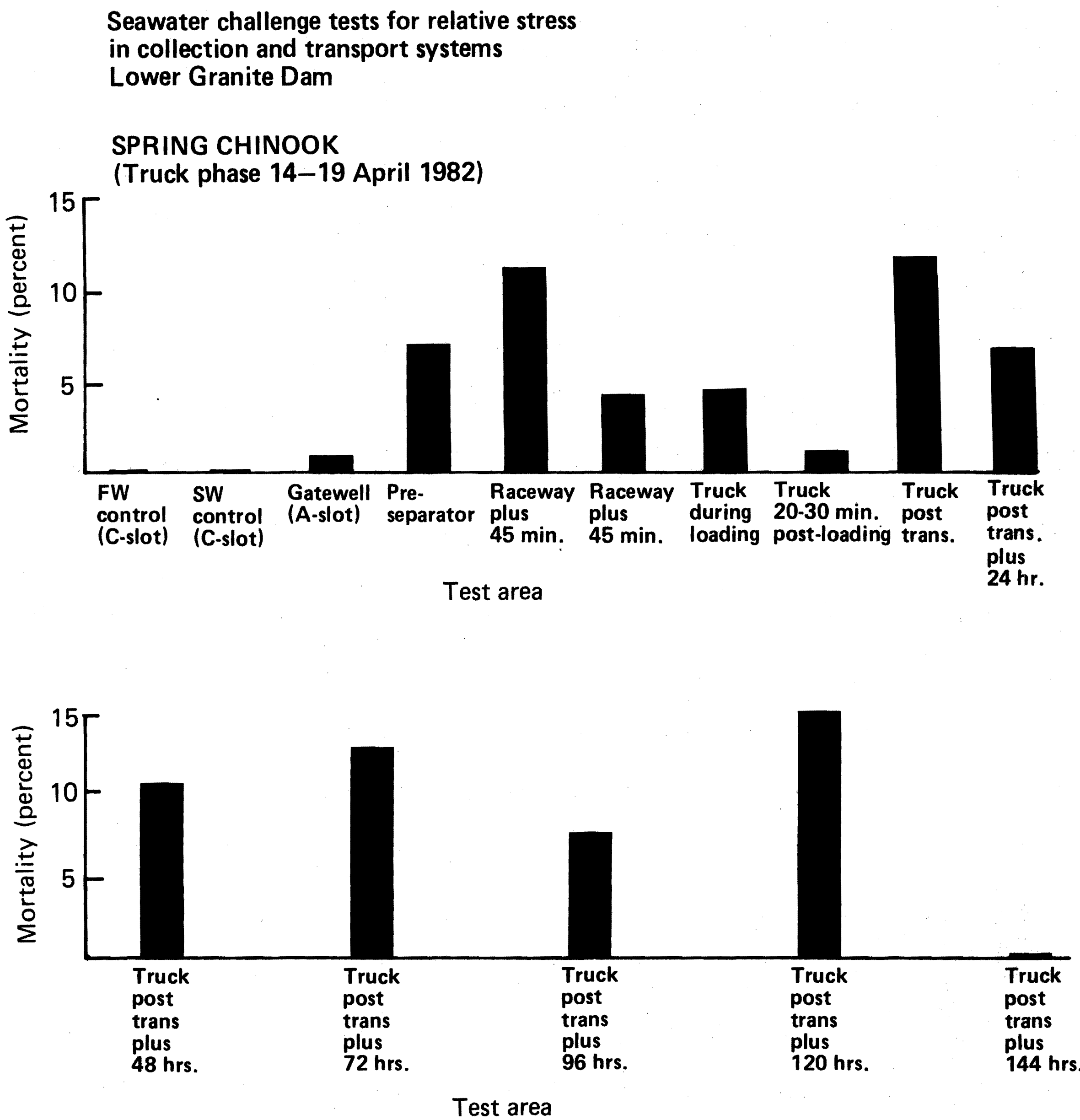

Figure 8.--Seawater challenge tests for relative stress to spring chinook salmon in collection and transport systems at Lower Granite Dam (truck phase, 14-19 April 1982).

6. Sampling a transport truck in marginal light conditions and estimating fish numbers in large sample groups accurately without introducing additional stresses proved to be very difficult. As a result, the test data from the truck post-transport delayed challenge test groups were insufficient for a reliable analysis. However, as was noted in 1981, the stress levels appeared to drop considerably after a 24-h post-transport rest period.

7. At Little Goose Dam, the average percent mortality of the test group of chinook salmon sampled from the raceways (+ 45 min) was 10.8%. This stress level was nearly identical to the comparable group at Lower Granite Dam.

Barge Phase.--Figure 9 illustrates the test results during this phase of the study. Pertinent findings are summarized as follows:

1. There was no significant difference in the stress levels of chinook salmon smolts between the C-Slot Gatewells and the A-Slot Gatewells.

2. There was no significant difference in the stress levels of chinook salmon smolts between the gatewell groups and the preseparator group during this phase. However, the truck phase replicates and the barge phase replicates combined indicated a highly significant increase in stress levels between these areas ($P<0.01$, df = 1).

3. There was no significant difference in stress levels of chinook salmon smolts between the preseparator group and the raceway + 45 min group, although the average percent mortality was again somewhat higher for the latter group.

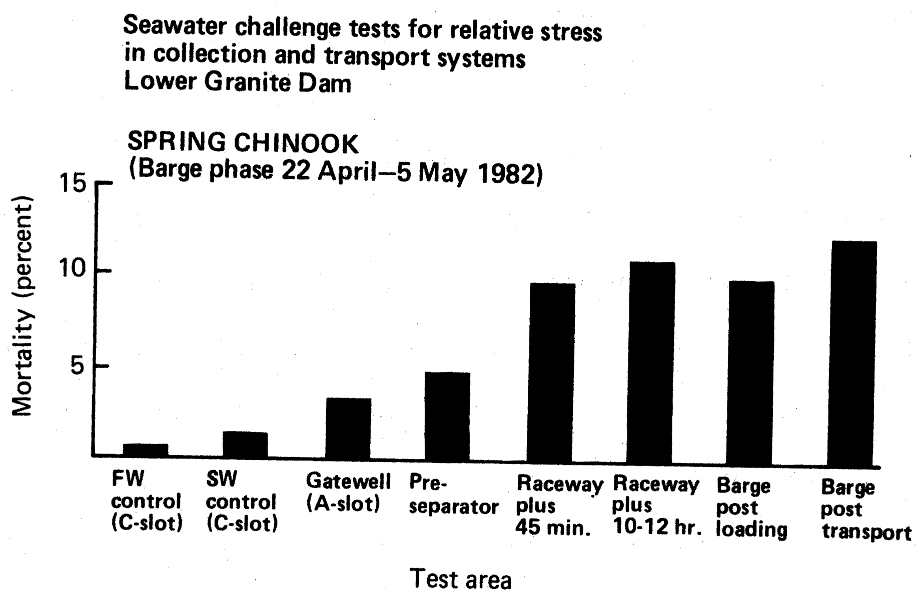

Figure 9.--Seawater challenge tests for relative stress of spring chinook salmon in collection and transport systems at Lower Granite Dam (barge phase, 22 April-5 May 1982).

4. No reduction in stress levels of chinook salmon smolts was noted after the fish had been held in a raceway for 10 to 12 h.

5. The barge loading and transport operations did not significantly increase the stress level of chinook salmon smolts above the level of the raceway prior to loading group (+ 10 to 12 h).

6. The average percent mortality of groups of steelhead smolts that were held in a raceway for 10 to 12 h prior to seawater challenge at Lower Granite and Little Goose Dams was 21.4 and 2.2%, respectively. However, we do not believe that the relative stress levels between these groups were accurately reflected. Since the majority of the mortality (75%) occurred during the second of three replicates in the Lower Granite Dam tests, it was more likely that some unknown event influenced these results.

Our anlaysis of the data from the Lower Granite Dam system's stress tests indicates there was no difference in the stress levels of chinook salmon smolts between the C and A-Slot Gatewells, but a significant increase in stress occurred between the gatewell and preseparator areas. In addition, there may have been another lesser increase (not statistically significant) in stress during passage through the separator complex (including distribution flumes).

Holding chinook salmon smolts in a raceway at relatively low densities for up to 12 h did not increase stress levels. In fact, a reduction in the stress level was noted during the early replicates (truck phase) but not during the later replicates (barge phase). We believe this phenomenon may be due to an increased presence of steelhead smolts in the raceways during the latter period. The results of the density studies lend support to this contention as will be discussed later.

Truck transport appeared to significantly increase stress levels, whereas barge transport did not. However, the fish were at a higher stress level in the raceways prior to loading during the barge phase than during the truck phase.

Our data indicate that the truck and barge loading operations did not influence the stress levels of chinook salmon smolts. Prior to this year's smolt outmigration, the CofE designed and installed a new loading system at Lower Granite Dam. Although we have no data from previous years for confirmation, it appears that this new system provided the desired result of minimizing stresses.

Handling and Marking Tests, Lower Granite Dam

Figure 10 and Appendix Table 6 detail the results of the handling and marking stress tests conducted at Lower Granite Dam in 1982. Pertinent findings include:

1. There was a highly significant increase in the stress level of chinook salmon smolts between the controls (upwell box) and the traditional handling and marking group ($P<0.01$, df = 1).

2. Although the average percent mortality figures indicate substantial reductions in stress levels in chinook salmon smolts that were dipped with a sanctuary dip net or anesthetized with benzocaine prior to dipping with a standard dip net, the differences were not statistically significant at $P<0.05$, df = 1.

3. Only chinook salmon smolts exposed to unbuffered MS-222 did not increase stress levels.

4. The addition of 10 ppt seawater to the anesthetic bath clearly did not reduce the stress level of chinook salmon smolts.

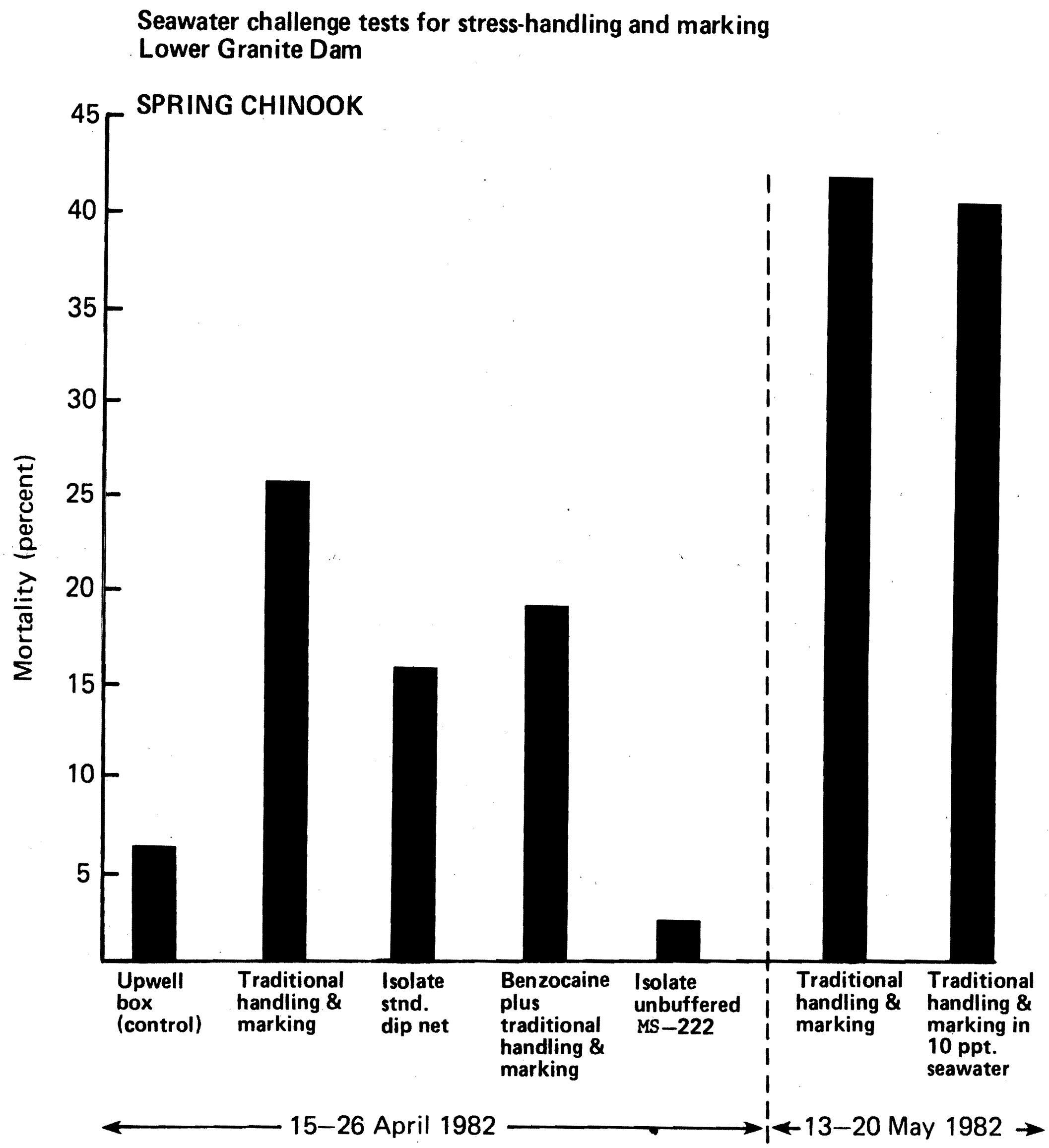

Figure 10.--Seawater challenge tests for stress during handling and marking of spring chinook salmon at Lower Granite Dam.

These results show the same basic patterns as the results from similar tests conducted in 1981 although overall mortalities were lower in 1982. We believe the majority of the handling amd marking stress was incurred when fish were dipped with a standard (fabric) dip net and released into the shallow, well-illuminated anesthetic trough. Once smolts were anesthetized, further sorting and marking procedures probably caused little, if any, increase in stress.

Currently, NMFS and CofE field personnel are collaborating on the design of a system that will allow fish to be anesthetized prior to the dipping process. The system is scheduled to be installed at Lower Granite Dam for field testing during the 1983 smolt outmigration. We are strongly optimistic that this procedure will greatly reduce the stresses associated with handling and marking procedures.

Collection System and Transport Tests, McNary Dam

The results of the McNary Dam collection and transport systems test are shown in Figure 11 and Appendix Table 7. Pertinent findings include:

1. There was no significant difference in the stress levels of chinook salmon smolts between the C-Slot Gatewell group and the A-Slot Gatewell group.

2. There was a highly significant difference in the stress levels of chinook salmon smolts between the gatewell groups and the preseparator group ($P<0.01$, $df = 1$).

3. There was no significant difference in the stress levels of chinook salmon smolts among the preseparator, plastic or concrete raceway, barge post-loading, and barge post-transport groups.

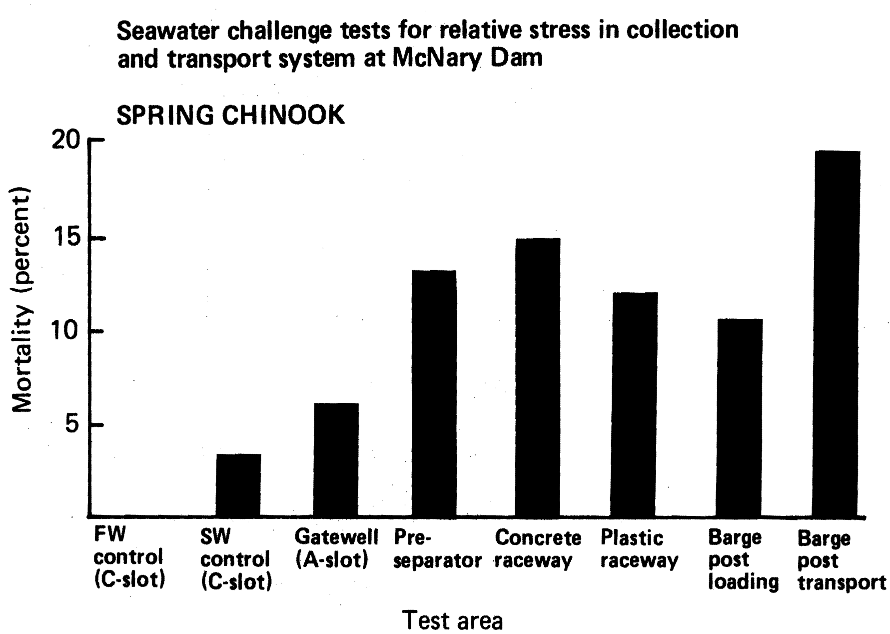

Figure 11.--Seawater challenge tests for relative stress to spring chinook salmon in collection and transport systems at McNary Dam.

The stress patterns prior to transport at McNary Dam were similar to the patterns observed at Lower Granite Dam. As expected, a substantial increase in stress occurred between the gatewells and preseparator area at McNary Dam. This increase appears to be somewhat stronger at McNary Dam than was observed for the comparative area at Lower Granite Dam. Conversely, the separator complex may have added more stress at Lower Granite Dam than at McNary Dam. As at Lower Granite Dam, the loading and barging operations did not increase stress levels.

TRANSPORT DENSITY TESTS

In recent attempts to reduce stress and hopefully increase survival, concerned fisheries agencies have restricted the loading density for chinook salmon smolts to 0.50 lb per gallon of water in holding raceways and transport trucks, and 5.0 lb per gallon per minute of water flow in transport barges. Loading density criteria for steelhead smolts remained at 1.0 lb per gallon of water when only this species was present. Further separation by species (size) was discontinued at all collector dams in 1982. Whereas these restrictions may or may not increase survival of chinook salmon smolts, they will increase the total cost of the transportation program by requiring additional holding space and transport equipment.

In 1982, the NMFS conducted a series of seawater challenge tests designed to provide information on the relative stress effects of various transport densities on chinook salmon and steelhead smolts.

Methods

To test the effects of various transport densities on chinook salmon transported alone, chinook salmon transported with steelhead, and steelhead transported alone, we designed and constructed a 160-gallon simulated (model) tanker. The experimental tanker was subdivided into eight isolated compartments and was equipped with air stones, surface agitators, and lid vents to closely resemble the actual life support systems in large fish tankers of this type. The aforementioned groups of smolts were transported from Lower Granite Dam to Bonneville Dam in the "experimental tanker" at densities of 0.25, 0.50, 1.0, and 1.5 lb of fish per gallon of water.

Prior to transport, test fish were anesthetized, weighed, and randomly hand counted into the various test groups and allowed a 24-h recovery period at 0.10 lb per gallon density. A control group matching each test series was seawater challenged at Lower Granite Dam after the 24-h recovery period.

Upon arrival at Bonneville Dam, 20 to 30 fish from each test replicate were subsampled from the tanker using a sanctuary dip net. Subsequent transfer and seawater challenge procedures were the same as previously described.

Results

Figure 12 presents the results of these tests (see Appendix Tables 8 to 10). Pertinent findings are summarized as follows:

1. The stress level of controls from the chinook salmon group alone was significantly lower than the stress level of controls from the chinook salmon/steelhead mix group (chinook salmon only challenged).

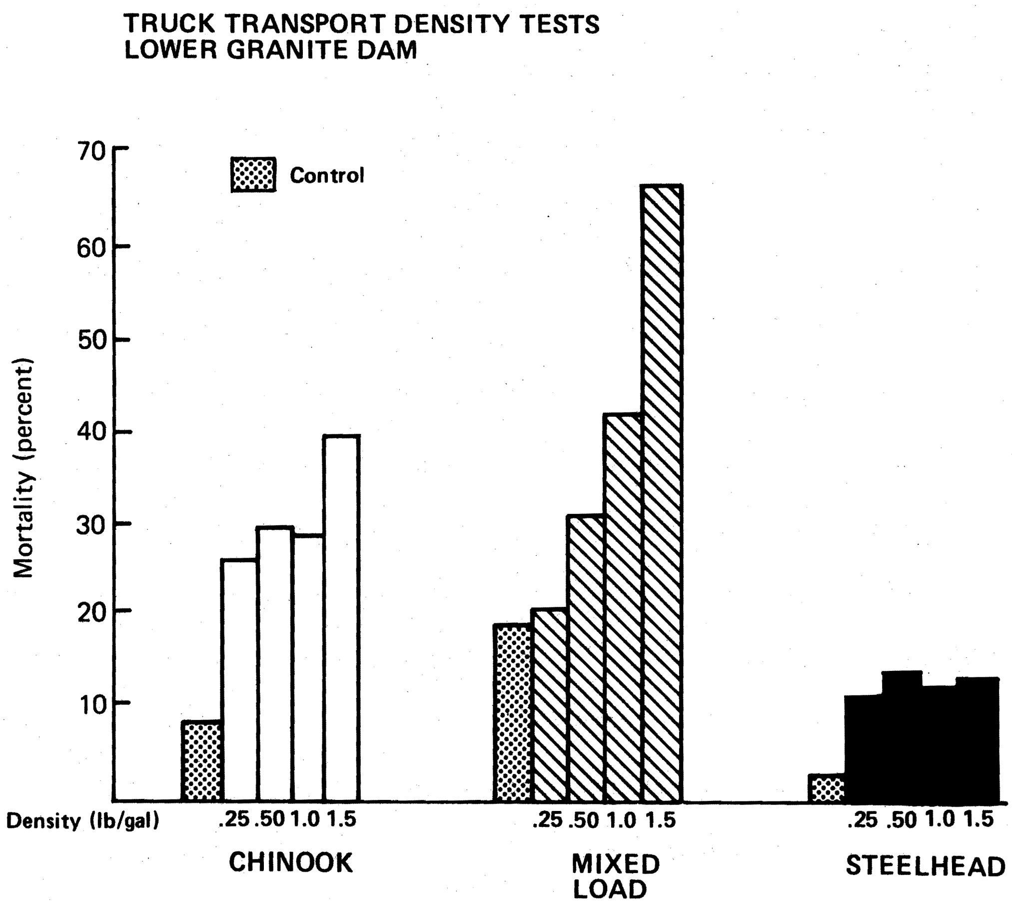

Figure 12.--Transport tests for spring chinook salmon and steelhead hauled by truck at four densities at Lower Granite Dam.

2. There was no significant difference in stress levels when chinook salmon were transported alone among any of the densities tested. However, the 1.5 lb per gallon group approached significance when compared independently to any of the other three test densities.

3. There was a highly significant difference in the stress levels of chinook salmon smolts when transported with steelhead among all of the densities tested ($P<0.01$, df = 1).

4. There was no significant difference in the stress levels of steelhead among any of the densities tested (steelhead were challenged only from the group of steelhead transported alone).

We suspect that a sampling bias may have been inadvertently introduced into the post-transport test results which favored the chinook salmon from the chinook salmon/steelhead mix groups at the 0.25 lb per gallon density, and to a lesser extent the 0.50 lb per gallon density. When chinook salmon from these groups were sampled from the experimental tanker, nearly all of the chinook salmon in the 0.25 lb per gallon tank and about 50% of the chinook salmon in the 0.50 lb per gallon tank were utilized to meet the test requirements for numbers of fish challenged. In all of the other tanks, chinook salmon smolts were simply dipped at or near the surface, since adequate numbers for test purposes were readily available. Therefore, a disproportionate number of weaker fish may have been introduced into the test samples for these groups. Even with this sample bias in favor of the chinook salmon smolts from the mixed groups at 0.25 and 0.50 lb per gallon, we believe that these data, together with the control fish data, strongly suggest a negative interaction for chinook salmon smolts when held or transported with steelhead smolts. We do not know at this time if this is an interspecific interaction or simply due to the fact that steelhead smolts are generally larger than chinook salmon smolts. These test results do indicate, however, that both chinook salmon and steelhead smolts can be transported with conspecific fish at densities up to 1.0 lb per gallon of water without increasing stresses above the levels incurred at 0.25 lb per gallon of water.

RECOMMENDATIONS

1. There are continuing problems regarding the survival of upriver stocks of spring chinook salmon. Recent research has shown that stresses occur to smolts in collection and transport systems, but it is not clear if these stresses are severe enough to substantially limit survival of smolts after their release below Bonneville Dam. In our view, we should address research immediately to determine if transported and nontransported smolts (nontransported smolts are also dying at some stage of their life following release) are capable of survival and growth following seawater entry. Predation and other environmental challenges need not be a part of the study. Results of the study would tell us much about whether further study is necessary to reduce stress to smolts in collection and transport systems. It would also provide insight into potential hatchery oriented problems such as disease, which is closely related to stress and ultimately survival.

2. From research conducted in 1982, we learned that spring chinook salmon were more severely stressed when transported with steelhead than when hauled only with conspecific fish. Therefore, we proposed tests to determine if separation of species at the dam can lead to reduction in

stress to spring chinook salmon when held in collection raceways and in transport systems. Plans are underway to conduct the study at Little Goose Dam in 1983.

SUMMARY

1. In continuation studies to evaluate the transportation of fall chinook salmon smolts at McNary Dam, 39,693 juveniles were marked and subsequently transported and released downstream from Bonneville Dam (test group). A control group of 38,683 fish was released in the McNary Dam tailrace.

2. At McNary Dam we found that marking wild fall chinook salmon smolts by itself or transportation by itself did not increase mortality. However, the combined effects of marking and transportation did lead to significant ($P<0.01$, df = 1) mortality within a 5-d holding period.

3. The 1982 adult steelhead runs at Ice Harbor and Priest Rapids Dams were near records. A number of reasons may be shown why large numbers of fish returned in 1982, however transportation effort in recent years at Lower Granite, Little Goose, and McNary Dams is one of the more likely factors.

4. Transportation of fall chinook salmon smolts in 1978-1981 by truck from McNary Dam to below Bonneville Dam is showing very promising benefits. Preliminary returns indicate that benefits have ranged from 4.1:1 to 9.6:1 depending on area of recovery. Smolts transported in 1978 have contributed about 4 times as many fish to ocean fisheries as those released as controls or that were released from Priest Rapids and Ringold Hatcheries (comparisons are adjusted for the number of smolts released from each source).

5. The number of spring chinook salmon returning from releases of transported (test) and nontransported (control) groups at Lower Granite Dam in 1978-1980 are small. Similar poor return rates for experimental groups at McNary Dam have been observed for the same period. Reasons for poor survival include: (a) poor ocean survival, (b) smolts may be unfit for ocean entry, and (c) smolts may be severely stressed in collection and transport systems. All may be true and closely related to each other.

6. In experiments (48-h seawater challenge tests) conducted to isolate areas in collection and transport systems that stress spring chinook salmon, we found that a significant ($P<0.05$, df = 1) stress increase occurs between gatewells and the fingerling sorter assembly. Truck transport also significantly increased stress; barge transport did not. However, the fish were at a higher stress level in the raceways prior to loading during the barge phase than during the truck phase.

7. In similar tests at McNary Dam, stress levels of spring chinook salmon increased sharply ($P<0.01$, df = 1) from gatewells to the separator. No tests were made for trucked fish, but, as at Lower Granite Dam, barge transport did not increase stress of spring chinook salmon.

8. In truck (simulated tanker) transport tests, we found no significant difference in stress to spring chinook salmon when transported only with conspecific fish at 0.25, 0.5, 1.0, and 1.5 lb per gallon. However, when chinook salmon were transported with steelhead, there was a significant increase in stress at all densities tested. In fact, when controls were held (no transport involved), chinook salmon were significantly more stressed when held with steelhead than when held only with conspecific fish. The data suggest a strong species interaction influencing stress during transportation and possibly during collection (e.g., in raceways) as well.

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Appendix Table 1.--Summary of brands and wire codes used to identify juvenile fall chinook salmon that were marked at McNary Dam and released as controls below McNary or transported by truck to below Bonneville Dam, 1982.

Marking period	Brand position, symbol, and orientation[a/]	Tag code	Number marked
Transport			
25 June - 02 July	RA - V, 1	23-16-10	5,381
12 July - 21 July	RA - V, 2	23-16-12	18,787
26 July - 06 Aug	RA - V, 3	23-16-14	15,525
		Sub-total	39,693
Control			
24 June	LA - H, 1	23-16-09	2,396
26 June	LA - H, 2	23-16-09	3,235
29 June	LA - IF, 1	23-16-09	2,690
01 July	LA - IF, 3	23-16-09	346
06 July	LA - 1C, 1	23-16-11	461
13 July	LA - IC, 3	23-16-11	3,055
15 July	LA - IM, 1	23-16-11	4,323
17 July	LA - IM, 3	23-16-11	4,012
20 July	LA - IF, 2	23-16-11	5,001
22 July	LA - IF, 4	23-16-11	2,012
27 July	LA - IC, 2	23-16-13	3,262
29 July	LA - IC, 4	23-16-13	4,500
03 Aug	LA - IM, 2	23-16-13	1,007
05 Aug	LA - IM, 4	23-16-13	2,383
		Sub-total	38,683

a/ Brand positions abbreviations are: RA-Right anterior and LA-Left anterior. Brand symbol is self explanatory. Brand orientation is as follows: 1-V, 2-<, 3-Λ, and 4-<.

Appendix Table 2.--Survival and mortality after 5-d holding of marked and unmarked fall chinook salmon from three groups (two transported, one nontransported) from McNary Dam.

Date/trial no.	Marked		Unmarked	
	Alive	Dead	Alive	Dead
Transported				
200-gallon experimental tanker				
1. 25 June	84	98	246	148
2. 28 June	42	18	339	32
3. 30 June	28	4	58	0
4. 12 July	37	3	127	5
5. 14 July	114	0	156	0
6. 19 July	266	8	1,702	16
7. 21 July	230	40	2,180	150
8. 26 July	191	12	900	23
9. 28 July	181	18	289	17
10. 2 Aug	63	7	243	19
Transported				
3,500-gallon CofE tanker				
1. 25 June	31	2	174	5
2. 28 June	137	4	120	2
3. 30 June	28	0	53	1
4. 12 July	33	2	127	1
5. 14 July	56	0	75	1
6. 19 July	50	5	376	6
7. 21 July	39	5	143	20
8. 26 July	42	7	166	9
9. 28 July	50	5	139	10
10. 2 Aug	31	1	73	5
Nontransported				
1. 24 June	207	1	342	4
2. 26 June	384	1	406	2
3. 29 June	182	0	324	2
4. 1 July	104	1	270	2
5. 13 July	172	3	225	21
6. 15 July	204	4	177	4
7. 20 July	185	33	262	2
8. 27 July	94	20	243	13

STEELHEAD

Appendix Tables 3.1 to 3.9 - Lower Granite and Little Goose Dams

3.10 to 3.17 - McNary Dam

Appendix Table 3.1

15 DEC 82

1978 LOWER GRANITE TRUCK

STEELHEAD

MARKS USED RAW 1 RAW 2 RDGN RDBL

NUMBER RELEASED 47899

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	20	8	1	0	29	0.060
MCNARY TRAP	0	26	9	0	0	35	0.073
LOWER GRANITE TRAP	0	336	163	15	0	514	1.073
PRIEST RAPIDS TRAP	0	1	0	0	0	1	0.002
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	1	0	0	0	1	0.002
RIVER SPORT	1	59	33	1	0	94	0.196
RIVER COMMERCIAL	0	1	0	2	0	3	0.006
INDIAN FISHERY	0	15	16	2	0	33	0.068
HATCHERIES (GENERAL)	0	2	0	0	0	2	0.004
DWORSHAK H.	0	3	40	4	0	47	0.098
PAHSIMEROI H.	0	46	8	0	0	54	0.112
HAYDEN CREEK H.	0	0	2	0	0	2	0.004
HELLS CANYON (OXBOW) H.	0	4	4	0	0	8	0.016
KOOSKIA H.	5	2	3	1	0	11	0.022
BIG CREEK H.	0	1	0	0	0	1	0.002
TOTALS	6	517	286	26	0	835	1.743
PERCENT OF RECOVERY	0.7	61.9	34.2	3.1	0.0	100.0	

Appendix Table 3.2

15 DEC 82

1978 LOWER GRANITE BARGE

STEELHEAD

MARKS USED RAW 3 RAW 4 RDRD RDRDOR

NUMBER RELEASED 43770

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	15	8	3	0	26	0.059
MCNARY TRAP	0	15	12	0	0	27	0.061
LOWER GRANITE TRAP	0	328	162	9	0	499	1.140
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	2	37	27	1	0	67	0.153
RIVER COMMERCIAL	0	1	1	0	0	2	0.004
INDIAN FISHERY	0	12	31	3	0	46	0.105
DWORSHAK H.	0	3	41	2	0	46	0.105
PAHSIMEROI H.	0	30	7	0	0	37	0.084
RAPID RIVER H.	0	2	0	0	0	2	0.004
HAYDEN CREEK H.	0	0	1	0	0	1	0.002
HELLS CANYON (OXBOW) H.	0	6	1	0	0	7	0.015
KOOSKIA H.	0	1	12	0	0	13	0.029
TOTALS	2	450	303	18	0	773	1.766
PERCENT OF RECOVERY	0.2	58.2	39.1	2.3	0.0	100.0	

Appendix Table 3.3

15 DEC 82

1978 LITTLE GOOSE CONTROLS - TAILRACE

STEELHEAD

MARKS USED LAPI1 YWBRBR LAPI2 ORGNRD LAPI3 LAPI4 ORPK NUMBER RELEASED 30364

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	2	3	1	0	6	0.019
MCNARY TRAP	0	3	2	0	0	5	0.016
LOWER GRANITE TRAP	0	48	18	1	0	67	0.220
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	5	8	0	0	13	0.042
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	3	0	0	3	0.009
DWORSHAK H.	0	0	1	0	0	1	0.003
PAHSIMEROI H.	0	3	0	0	0	3	0.009
KOOSKIA H.	0	0	2	0	0	2	0.006
TOTALS	0	61	37	2	0	100	0.329
PERCENT OF RECOVERY	0.0	61.0	37.0	2.0	0.0	100.0	

Appendix Table 3.4

15 DEC 82

1978 LITTLE GOOSE TRUCK

STEELHEAD

MARKS USED RAJ 1 RAJ 3 RDOR RD NUMBER RELEASED 35875

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	10	14	1	0	25	0.069
MCNARY TRAP	0	17	5	0	0	22	0.061
LOWER GRANITE TRAP	0	253	105	7	0	365	1.017
PRIEST RAPIDS TRAP	0	1	0	0	0	1	0.002
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	4	18	18	1	0	41	0.114
RIVER COMMERCIAL	0	0	1	1	0	2	0.005
INDIAN FISHERY	0	13	10	1	0	24	0.066
DWORSHAK H.	0	2	13	1	0	16	0.044
PAHSIMEROI H.	0	13	2	0	0	15	0.041
RAPID RIVER H.	0	1	0	0	0	1	0.002
HELLS CANYON (OXBOW) H.	0	1	0	0	0	1	0.002
KOOSKIA H.	0	0	6	0	0	6	0.016
TOTALS	4	329	174	12	0	519	1.446
PERCENT OF RECOVERY	0.7	63.3	33.5	2.3	0.0	100.0	

Appendix Table 3.5

15 DEC 82

1978 LITTLE GOOSE TRUCK - 10PPT SALT

STEELHEAD

MARKS USED RAJ 2 RAJ 4 RDLG ORGNYW NUMBER RELEASED 32170

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	10	5	1	0	16	0.049
MCNARY TRAP	0	4	9	0	0	13	0.040
LOWER GRANITE TRAP	1	216	112	5	0	334	1.038
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	2	0	0	2	0.006
RIVER SPORT	0	14	36	2	0	52	0.161
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	6	11	1	0	18	0.055
HATCHERIES (GENERAL)	0	1	0	0	0	1	0.003
DWORSHAK H.	0	3	14	4	0	21	0.065
PAHSIMEROI H.	0	12	2	0	0	14	0.043
HAYDEN CREEK H.	0	0	2	0	0	2	0.006
KOOSKIA H.	0	0	3	0	0	3	0.009
CHELAN H.	0	1	0	0	0	1	0.003
TOTALS	1	267	196	13	0	477	1.482
PERCENT OF RECOVERY	0.2	55.9	41.0	2.7	0.0	100.0	

Appendix Table 3.6

15 DEC 82

1979 LOWER GRANITE - BARGE
STEELHEAD

MARKS USED RAF 1 RAF 2 RDYWOR NUMBER RELEASED 30495

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	2	35	1	38	0.124
MCNARY TRAP	0	2	2	0	4	0.013
LOWER GRANITE TRAP	0	55	206	1	262	0.859
OCEAN SPORT	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0.000
RIVER SPORT	1	26	30	0	57	0.186
RIVER COMMERCIAL	0	0	3	0	3	0.009
INDIAN FISHERY	0	13	40	0	53	0.173
DWORSHAK H.	0	2	44	0	46	0.150
PAHSIMEROI H.	0	16	15	1	32	0.104
TOTALS	1	116	375	3	495	1.623
PERCENT OF RECOVERY	0.2	23.4	75.7	0.6	100.0	

Appendix Table 3.7

15 DEC 82

1979 LOWER GRANITE -CONTROL -TAILRACE

STEELHEAD

MARKS USED LAK 3 LAK 4 YWLB

NUMBER RELEASED 21050

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	1	11	0	12	0.057
MCNARY TRAP	0	0	1	0	1	0.004
LOWER GRANITE TRAP	0	18	82	0	100	0.475
OCEAN SPORT	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0.000
RIVER SPORT	1	3	5	0	9	0.042
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0	0.000
RAPID RIVER H.	0	1	0	0	1	0.004
TOTALS	1	23	99	0	123	0.584
PERCENT OF RECOVERY	0.8	18.6	80.4	0.0	100.0	

Appendix Table 3.8

15 DEC 82

1980 LOWER GRANITE - BARGE

STEELHEAD

MARKS USED RAW 1 RAW 2 HOPR DYPR

NUMBER RELEASED 32559

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	20	1	21	0.064
MCNARY TRAP	0	0	0	0	0.000
LOWER GRANITE TRAP	0	38	13	51	0.156
OCEAN SPORT	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0.000
RIVER SPORT	0	6	2	8	0.024
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	5	2	7	0.021
PAHSIMEROI H.	0	3	1	4	0.012
TOTALS	0	72	19	91	0.279
PERCENT OF RECOVERY	0.0	79.1	20.8	100.0	

Appendix Table 3.9

15 DEC 82

1980 LITTLE GOOSE - TAILRACE CONTROL

STEELHEAD

MARKS USED LAP 1 LAP 2 LAP 3 ER NUMBER RELEASED 19273

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	2	2	0.010
MCNARY TRAP	0	0	1	1	0.005
LOWER GRANITE TRAP	0	8	6	14	0.072
OCEAN SPORT	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0.000
RIVER SPORT	0	1	2	3	0.015
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	0	3	3	0.015
DWORSHAK H.	0	1	0	1	0.005
PAHSIMEROI H.	0	1	0	1	0.005
TOTALS	0	11	14	25	0.129
PERCENT OF RECOVERY	0.0	44.0	56.0	100.0	

Appendix Table 3.10

15 DEC 82

1978 MCNARY - TRUCK

STEELHEAD

MARKS USED RAV 1 RAV 2 GM GMWH PUYWYW NUMBER RELEASED 20416

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	15	29	8	0	52	0.254
MCNARY TRAP	0	19	45	3	0	67	0.328
LOWER GRANITE TRAP	0	111	74	2	0	187	0.915
PRIEST RAPIDS TRAP	0	21	7	0	0	28	0.137
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	1	0	0	0	1	0.004
RIVER SPORT	0	27	41	2	0	70	0.342
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	4	1	0	5	0.024
HATCHERIES (GENERAL)	0	0	1	0	0	1	0.004
DWORSHAK H.	0	0	5	1	0	6	0.029
PAHSIMEROI H.	0	1	2	0	0	3	0.014
RAPID RIVER H.	0	0	1	0	0	1	0.004
CHELAN H.	0	2	0	0	0	2	0.009
WELLS H.	0	3	0	0	0	3	0.014
RINGOLD H.	0	0	1	0	0	1	0.004
TOTALS	0	200	210	17	0	427	2.091
PERCENT OF RECOVERY	0.0	46.8	49.1	3.9	0.0	100.0	

Appendix Table 3.11

15 DEC 82

1978 MCNARY CONTROLS - TAILRACE

STEELHEAD

MARKS USED: LAH 1 RDORRD, LAH 2, LAS 1, LAS 2, RDYWRD

NUMBER RELEASED 15585

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	5	7	2	0	14	0.089
MCNARY TRAP	0	8	9	1	0	18	0.115
LOWER GRANITE TRAP	0	24	17	1	0	42	0.269
PRIEST RAPIDS TRAP	0	6	4	0	0	10	0.064
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	6	10	0	0	16	0.102
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	2	2	0	0	4	0.025
DWORSHAK H.	0	0	2	1	0	3	0.019
PAHSIMEROI H.	0	1	0	0	0	1	0.006
KOOSKIA H.	0	0	1	0	0	1	0.006
CHELAN H.	0	3	0	0	0	3	0.019
RINGOLD H.	0	0	1	0	0	1	0.006
TOTALS	0	55	53	5	0	113	0.725
PERCENT OF RECOVERY	0.0	48.6	46.9	4.4	0.0	100.0	

Appendix Table 3.12

15 DEC 82

1979 MCNARY - TRUCK

STEELHEAD

MARKS USED RA3 1 RDLGPK RA3 2 RA3 3 RA3 4 SM NUMBER RELEASED 15379

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	15	30	0	45	0.292
MCNARY TRAP	0	15	23	0	38	0.247
LOWER GRANITE TRAP	0	19	38	0	57	0.370
PRIEST RAPIDS TRAP	0	19	6	0	25	0.162
OCEAN SPORT	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0.000
RIVER SPORT	0	33	29	1	63	0.409
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERY	0	15	10	0	25	0.162
DWORSHAK H.	0	0	3	0	3	0.019
PAHSIMEROI H.	0	4	3	1	8	0.052
CHELAN H.	0	0	1	0	1	0.006
WELLS H.	0	0	7	0	7	0.045
RINGOLD H.	0	0	1	0	1	0.006
LEAVENWORTH H.	0	1	2	0	3	0.019
YAKIMA H.	0	0	11	0	11	0.071
OTHER	0	1	0	0	1	0.006
TOTALS	0	122	164	2	288	1.872
PERCENT OF RECOVERY	0.0	42.3	56.9	0.6	100.0	

Appendix Table 3.13

15 DEC 82

1979 MCNARY - BARGE

STEELHEAD

MARKS USED	RAR 1	RAR 2	RAR 3	RAR 4	RDYWLG	NUMBER RELEASED	18182
	RDPKYW	RDYWPK					

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	25	49	0	74	0.406
MCNARY TRAP	0	20	40	6	66	0.362
LOWER GRANITE TRAP	0	30	59	0	89	0.489
PRIEST RAPIDS TRAP	0	34	8	0	42	0.230
OCEAN SPORT	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0.000
RIVER SPORT	0	58	39	0	97	0.533
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERY	0	12	15	0	27	0.148
DWORSHAK H.	0	0	8	0	8	0.043
PAHSIMEROI H.	0	3	0	0	3	0.016
RAPID RIVER H.	0	0	0	1	1	0.005
CHELAN H.	0	0	1	0	1	0.005
WELLS H.	0	2	5	0	7	0.038
WINTHROP H.	0	3	0	1	4	0.021
RINGOLD H.	0	0	2	0	2	0.010
LEAVENWORTH H.	0	0	1	0	1	0.005
YAKIMA H.	0	0	19	0	19	0.104
TOTALS	0	187	246	8	441	2.425
PERCENT OF RECOVERY	0.0	42.4	55.7	1.8	100.0	

Appendix Table 3.14

15 DEC 82

1979 MCNARY - CONTROL - TAILRACE

STEELHEAD

MARKS USED	LA5 1 RDLGYW	LA5 2	LA5 3	LA5 4	PR	NUMBER RELEASED	8595

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	2	14	1	17	0.197
MCNARY TRAP	0	4	4	0	8	0.093
LOWER GRANITE TRAP	0	6	8	0	14	0.162
PRIEST RAPIDS TRAP	0	4	0	0	4	0.046
OCEAN SPORT	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	1	0	0	1	0.011
RIVER SPORT	0	8	9	0	17	0.197
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERY	0	1	3	8	12	0.139
DWORSHAK H.	0	0	3	0	3	0.034
PAHSIMEROI H.	0	0	2	0	2	0.023
HELLS CANYON (OXBOW) H.	0	0	1	0	1	0.011
CHELAN H.	0	0	1	0	1	0.011
YAKIMA H.	0	0	2	0	2	0.023
TOTALS	0	26	47	9	82	0.954
PERCENT OF RECOVERY	0.0	31.7	57.3	10.9	100.0	

Appendix Table 3.15

15 DEC 82

1980 MCNARY - TRUCK

STEELHEAD

MARKS USED RAV 1 RAV 2 NDSM DY NUMBER RELEASED 22362

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	17	4	21	0.093
MCNARY TRAP	0	3	11	14	0.062
LOWER GRANITE TRAP	0	11	6	17	0.076
PRIEST RAPIDS TRAP	0	3	0	3	0.013
OCEAN SPORT	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0.000
RIVER SPORT	0	3	5	8	0.035
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	4	0	4	0.017
DWORSHAK H.	0	1	0	1	0.004
PAHSIMEROI H.	0	1	0	1	0.004
CHELAN H.	0	1	0	1	0.004
LEAVENWORTH H.	0	2	0	2	0.008
TOTALS	0	46	26	72	0.321
PERCENT OF RECOVERY	0.0	63.8	36.1	100.0	

Appendix Table 3.16

15 DEC 82

1980 MCNARY — BARGE

STEELHEAD

MARKS USED RA2 1 RA2 2 ERPR LATB NUMBER RELEASED 30382

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	25	4	29	0.095
MCNARY TRAP	0	2	22	24	0.078
LOWER GRANITE TRAP	0	19	6	25	0.082
PRIEST RAPIDS TRAP	0	5	0	5	0.016
OCEAN SPORT	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0.000
RIVER SPORT	0	9	4	13	0.042
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	4	3	7	0.023
CHELAN H.	0	1	0	1	0.003
WELLS H.	0	1	0	1	0.003
LEAVENWORTH H.	0	2	0	2	0.006
YAKIMA H.	0	1	0	1	0.003
TOTALS	0	69	39	108	0.355
PERCENT OF RECOVERY	0.0	63.8	36.1	100.0	

Appendix Table 3.17

15 DEC 82

1980 MCNARY - TAILRACE CONTROL

STEELHEAD

MARKS USED LAH 1 LAH 2 ERLA CEND NUMBER RELEASED 21291

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	8	4	12	0.056
MCNARY TRAP	0	0	7	7	0.032
LOWER GRANITE TRAP	0	10	4	14	0.065
PRIEST RAPIDS TRAP	0	5	0	5	0.023
OCEAN SPORT	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0.000
RIVER SPORT	0	5	4	9	0.042
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	0	1	1	0.004
WELLS H.	0	1	0	1	0.004
TOTALS	0	29	20	49	0.230
PERCENT OF RECOVERY	0.0	59.1	40.8	100.0	

FALL CHINOOK SALMON

Appendix Tables 4.1 to 4.8 - McNary Dam

Appendix Table 4.1

15 DEC 82

1978 MCNARY - TRUCK

FALL CHINOOK

MARKS USED RAIC1 RAIC3 ORGNLG LG

NUMBER RELEASED 40361

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	21	4	5	2	32	0.079
MCNARY TRAP	0	59	15	11	10	95	0.235
LOWER GRANITE TRAP	0	5	0	0	0	5	0.012
OCEAN SPORT	0	0	2	0	0	2	0.004
OCEAN COMMERCIAL	0	10	17	91	4	122	0.302
RIVER SPORT	0	4	0	1	0	5	0.012
RIVER COMMERCIAL	0	6	8	5	0	19	0.047
INDIAN FISHERY	0	3	3	22	0	28	0.069
HATCHERIES (GENERAL)	0	0	0	1	0	1	0.002
DWORSHAK H.	0	0	1	0	0	1	0.002
TUCANNON H.	0	0	1	2	0	3	0.007
WELLS H.	0	4	0	11	0	15	0.037
PRIEST RAPIDS H.	0	13	0	16	0	29	0.071
STREAM SURVEY	0	0	0	2	0	2	0.004
TOTALS	0	125	51	167	16	359	0.889
PERCENT OF RECOVERY	0.0	34.8	14.2	46.5	4.4	100.0	

Appendix Table 4.2

15 DEC 82

1978 MCNARY CONTROLS - TAILRACE

FALL CHINOOK

MARKS USED LAIF1 LAIF3 PUGNBL YWXYGN NUMBER RELEASED 38137

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	4	1	4	0	9	0.023
MCNARY TRAP	0	7	2	1	1	11	0.028
LOWER GRANITE TRAP	0	1	0	0	0	1	0.002
OCEAN SPORT	0	0	1	1	0	2	0.005
OCEAN COMMERCIAL	0	2	3	20	1	26	0.068
RIVER SPORT	0	1	0	2	0	3	0.007
RIVER COMMERCIAL	0	0	3	0	0	3	0.007
INDIAN FISHERY	0	2	1	2	0	5	0.013
WELLS H.	0	1	0	1	0	2	0.005
PRIEST RAPIDS H.	0	1	0	5	0	6	0.015
TOTALS	0	19	11	36	2	68	0.178
PERCENT OF RECOVERY	0.0	27.9	16.1	52.9	2.9	100.0	

Appendix Table 4.3

15 DEC 82

1979 MCNARY - TRUCK

FALL CHINOOK

MARKS USED						NUMBER RELEASED	132919
	RA3 1	RA3 2	RA3 3	RAI+1	RAI+2		
	RAI+3	RAI+4	SM	RDLGPK	RDPKLB		
	RDPKOR	LBYWLG	RDLBYW				

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	26	9	1	36	0.027
MCNARY TRAP	0	34	5	4	43	0.032
LOWER GRANITE TRAP	0	0	0	0	0	0.000
OCEAN SPORT	0	0	4	0	4	0.003
OCEAN COMMERCIAL	0	10	42	28	80	0.060
RIVER SPORT	0	3	0	0	3	0.002
RIVER COMMERCIAL	0	2	5	0	7	0.005
INDIAN FISHERY	0	1	9	0	10	0.007
DWORSHAK H.	0	0	1	0	1	0.000
WELLS H.	0	0	5	0	5	0.003
PRIEST RAPIDS H.	0	0	21	0	21	0.015
STREAM SURVEY	0	0	1	0	1	0.000
TOTALS	0	76	102	33	211	0.158
PERCENT OF RECOVERY	0.0	36.0	48.3	15.6	100.0	

Appendix Table 4.4

15 DEC 82

1979 MCNARY - CONTROL - TAILRACE

FALL CHINOOK

MARKS USED: LA5 1, LAIM3, LBYWLB; LA5 2, LAIM4, RDLBPK; LA5 3, PR; LAIM1, RDLGYW; LAIM2, RDYWPK

NUMBER RELEASED 112718

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	4	0	0	4	0.003
MCNARY TRAP	0	2	0	1	3	0.002
LOWER GRANITE TRAP	0	0	0	0	0	0.000
OCEAN SPORT	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	1	5	4	10	0.008
RIVER SPORT	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	3	0	3	0.002
INDIAN FISHERY	0	0	2	0	2	0.001
DWORSHAK H.	0	0	1	0	1	0.000
WELLS H.	0	0	1	0	1	0.000
PRIEST RAPIDS H.	0	0	8	0	8	0.007
TOTALS	0	7	20	5	32	0.028
PERCENT OF RECOVERY	0.0	21.8	62.5	15.6	100.0	

Appendix Table 4.5

15 DEC 82

1980 MCNARY - TRUCK

FALL CHINOOK

MARKS USED RAIC1 RAIC3 LA HO

NUMBER RELEASED 80213

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	19	4	23	0.028
MCNARY TRAP	0	12	18	30	0.037
LOWER GRANITE TRAP	0	0	1	1	0.001
OCEAN SPORT	0	1	2	3	0.003
OCEAN COMMERCIAL	0	1	11	12	0.014
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	1	0	1	0.001
INDIAN FISHERY	0	4	0	4	0.004
WELLS H.	0	2	0	2	0.002
PRIEST RAPIDS H.	0	4	0	4	0.004
TOTALS	0	44	36	80	0.099
PERCENT OF RECOVERY	0.0	55.0	45.0	100.0	

Appendix Tables 4.6

15 DEC 82

1980 MCNARY - TAILRACE CONTROL

FALL CHINOOK

MARKS USED LAIF1 LAIF3 CE CEDY

NUMBER RELEASED 84587

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	4	0	4	0.004
MCNARY TRAP	0	0	1	1	0.001
LOWER GRANITE TRAP	0	1	0	1	0.001
OCEAN SPORT	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	2	2	0.002
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	1	0	1	0.001
HATCHERIES (GENERAL)	0	1	0	1	0.001
TUCANNON H.	0	2	0	2	0.002
PRIEST RAPIDS H.	0	4	0	4	0.004
TOTALS	0	13	3	16	0.018
PERCENT OF RECOVERY	0.0	81.2	18.7	100.0	

15 DEC 82

1981 MCNARY - TRUCK

FALL CHINOOK

MARKS USED RAI+1 RAI+2 RAI+3 RAI+4 031733 NUMBER RELEASED 42924

RECOVERY AREA	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	2	2	0.004
MCNARY TRAP	0	38	38	0.088
LOWER GRANITE TRAP	0	1	1	0.002
OCEAN SPORT	0	0	0	0.000
OCEAN COMMERCIAL	1	0	1	0.002
RIVER SPORT	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
TOTALS	1	41	42	0.097
PERCENT OF RECOVERY	2.3	97.6	100.0	

Appendix Table 4.8

15 DEC 82

1981 MCNARY CONTROLS - TAILRACE

FALL CHINOOK

MARKS USED LAIM1 LAIM2 LAIM3 LAIM4 031732 NUMBER RELEASED 42580

RECOVERY AREA	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	1	1	0.002
MCNARY TRAP	0	4	4	0.009
LOWER GRANITE TRAP	0	1	1	0.002
OCEAN SPORT	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0.000
RIVER SPORT	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
TOTALS	0	6	6	0.014
PERCENT OF RECOVERY	0.0	100.0	100.0	

SPRING CHINOOK SALMON

Appendix Tables 5.1 to 5.21

Appendix Table 5.1

15 DEC 82

1978 LOWER GRANITE TRUCK
SPRING/SUMMER CHINOOK

MARKS USED RAW 1 RAW 2 RDGN RDBL NUMBER RELEASED 43855

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	0	0	0.000
LOWER GRANITE TRAP	0	4	24	5	0	33	0.075
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	1	0	1	0.002
RIVER COMMERCIAL	0	0	1	0	0	1	0.002
INDIAN FISHERY	0	0	0	0	0	0	0.000
DWORSHAK H.	0	0	2	0	0	2	0.004
RAPID RIVER H.	0	2	2	0	0	4	0.009
MCCALL H.	0	0	0	1	0	1	0.002
DESCHUTES R. HATCHERIES	0	2	0	0	0	2	0.004
STREAM SURVEY	0	0	1	0	0	1	0.002
TOTALS	0	8	30	7	0	45	0.102
PERCENT OF RECOVERY	0.0	17.7	66.6	15.5	0.0	100.0	

Appendix Table 5.2

15 DEC 82

1978 LOWER GRANITE BARGE
SPRING/SUMMER CHINOOK

MARKS USED RAW 3 RAW 4 RDRD RDRDOR NUMBER RELEASED 56546

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	0	0	0.000
LOWER GRANITE TRAP	0	6	50	10	0	66	0.116
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	3	0	0	3	0.005
RIVER COMMERCIAL	0	0	0	1	0	1	0.001
INDIAN FISHERY	0	0	0	1	0	1	0.001
HATCHERIES (GENERAL)	0	0	0	1	0	1	0.001
RAPID RIVER H.	0	3	5	0	0	8	0.014
MCCALL H.	0	0	1	2	0	3	0.005
KOOSKIA H.	0	0	1	0	0	1	0.001
DESCHUTES R. HATCHERIES	0	0	0	1	0	1	0.001
TOTALS	0	9	60	16	0	85	0.150
PERCENT OF RECOVERY	0.0	10.5	70.5	18.8	0.0	100.0	

Appendix Table 5.3

15 DEC 82

1978 LOWER GRANITE TRUCK - 24HR HOLD

SPRING/SUMMER CHINOOK

MARKS USED RAIS1 ORBL

NUMBER RELEASED 38685

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	1	1	0.002
LOWER GRANITE TRAP	0	2	3	0	0	5	0.012
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0	0	0.000
RAPID RIVER H.	0	2	3	0	0	5	0.012
DESCHUTES R. HATCHERIES	0	0	1	0	0	1	0.002
TOTALS	0	4	7	0	1	12	0.031
PERCENT OF RECOVERY	0.0	33.3	58.3	0.0	8.3	100.0	

Appendix Table 5.4

15 DEC 82

1978 LOWER GRANITE TRUCK - 2HR SALT

SPRING/SUMMER CHINOOK

MARKS USED RAIS2 OROR NUMBER RELEASED 40841

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	0	0	0.000
LOWER GRANITE TRAP	0	1	4	0	0	5	0.012
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	1	0	0	1	0.002
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0	0	0.000
MCCALL H.	0	0	0	1	0	1	0.002
KOOSKIA H.	0	0	1	0	0	1	0.002
TOTALS	0	1	6	1	0	8	0.019
PERCENT OF RECOVERY	0.0	12.5	75.0	12.5	0.0	100.0	

Appendix Table 5.5

15 DEC 82

1978 LOWER GRANITE CONTROLS - TAILRACE

SPRING/SUMMER CHINOOK

MARKS USED LAIS3 LAB21 PKPK ORYW NUMBER RELEASED 8249

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	0	0	0.000
LOWER GRANITE TRAP	0	0	2	1	0	3	0.036
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0	0	0.000
TOTALS	0	0	2	1	0	3	0.036
PERCENT OF RECOVERY	0.0	0.0	66.6	33.3	0.0	100.0	

Appendix Table 5.6

15 DEC 82

1978 LITTLE GOOSE TRUCK

SPRING/SUMMER CHINOOK

MARKS USED RAJ 1 RAJ 3 RDOR RD NUMBER RELEASED 49391

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	0	0	0.000
LOWER GRANITE TRAP	0	1	2	2	0	5	0.010
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0	0	0.000
RAPID RIVER H.	0	0	2	0	0	2	0.004
MCCALL H.	0	0	0	1	0	1	0.002
TOTALS	0	1	4	3	0	8	0.016
PERCENT OF RECOVERY	0.0	12.5	50.0	37.5	0.0	100.0	

Appendix Table 5.7

15 DEC 82

1978 LITTLE GOOSE TRUCK - 10PPT SALT

SPRING/SUMMER CHINOOK

MARKS USED RAJ 2 RAJ 4 RDLG ORGNYW NUMBER RELEASED 47661

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	0	0	0.000
LOWER GRANITE TRAP	0	0	0	1	0	1	0.002
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0	0	0.000
RAPID RIVER H.	0	0	0	1	0	1	0.002
TOTALS	0	0	0	2	0	2	0.004
PERCENT OF RECOVERY	0.0	0.0	0.0	100.0	0.0	100.0	

Appendix Table 5.8

15 DEC 82

1978 LITTLE GOOSE CONTROLS - TAILRACE

SPRING/SUMMER CHINOOK

MARKS USED: LAPI1 YWBRBR; LAPI2 ORGNRD; LAPI3; LAPI4; ORPK

NUMBER RELEASED 36441

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	0	0	0.000
LOWER GRANITE TRAP	0	0	5	0	0	5	0.013
OCEAN SPORT	0	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0	0	0.000
DWORSHAK H.	0	0	1	0	0	1	0.002
RAPID RIVER H.	0	0	2	1	0	3	0.008
MCCALL H.	0	0	1	1	0	2	0.005
TOTALS	0	0	9	2	0	11	0.030
PERCENT OF RECOVERY	0.0	0.0	81.8	18.1	0.0	100.0	

Appendix Table 5.9

15 DEC 82

1979 LOWER GRANITE -CONTROL -TAILRACE

SPRING/SUMMER CHINOOK

MARKS USED LAK 3 LAK 4 YWLB NUMBER RELEASED 25532

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	1	1	2	0.007
MCNARY TRAP	0	0	0	0	0	0.000
LOWER GRANITE TRAP	0	0	3	0	3	0.011
OCEAN SPORT	0	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0	0.000
TOTALS	0	0	4	1	5	0.019
PERCENT OF RECOVERY	0.0	0.0	80.0	20.0	100.0	

Appendix Table 5.10

15 DEC 82

1979 LOWER GRANITE - BARGE

SPRING/SUMMER CHINOOK

MARKS USED RAF 1 RAF 2 RDYWOR NUMBER RELEASED 27336

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	1	0	0	0	1	0.003
MCNARY TRAP	0	0	1	0	1	0.003
LOWER GRANITE TRAP	0	4	7	1	12	0.043
OCEAN SPORT	0	0	0	0	0	0.000
OCEAN COMMERCIAL	1	0	0	0	1	0.003
RIVER SPORT	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERY	0	0	2	0	2	0.007
HATCHERIES (GENERAL)	0	0	1	0	1	0.003
RAPID RIVER H.	0	1	7	1	9	0.032
MCCALL H.	0	1	1	2	4	0.014
DESCHUTES R. HATCHERIES	0	1	0	0	1	0.003
TOTALS	2	7	19	4	32	0.117
PERCENT OF RECOVERY	6.2	21.8	59.3	12.5	100.0	

Appendix Table 5.11

15 DEC 82

1980 LOWER GRANITE - BARGE

SPRING/SUMMER CHINOOK

MARKS USED RAW 1 RAW 2 HOPR DYPR NUMBER RELEASED 40719

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	0.000
LOWER GRANITE TRAP	0	0	1	1	0.002
OCEAN SPORT	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0.000
HATCHERIES (GENERAL)	0	0	1	1	0.002
RAPID RIVER H.	0	0	1	1	0.002
MCCALL H.	0	0	1	1	0.002
TOTALS	0	0	4	4	0.009
PERCENT OF RECOVERY	0.0	0.0	100.0	100.0	

Appendix Table 5.12

15 DEC 82

1980 LOWER GRANITE - TRUCK - TRAD. MANR

SPRING/SUMMER CHINOOK

MARKS USED RA3T1 RA3T3 RA2T1 PRTB NUMBER RELEASED 32772

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	0	0.000
MCNARY TRAP	0	0	0	0	0.000
LOWER GRANITE TRAP	0	0	0	0	0.000
OCEAN SPORT	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0.000
TOTALS	0	0	0	0	0.000
PERCENT OF RECOVERY	0.0	0.0	0.0	0.0	

Appendix Table 5.13

15 DEC 82

1980 LITTLE GOOSE - TAILRACE CONTROL

SPRING/SUMMER CHINOOK

MARKS USED LAP 1 LAP 2 LAP 3 ER

NUMBER RELEASED 21876

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	1	0	1	0.004
MCNARY TRAP	0	0	0	0	0.000
LOWER GRANITE TRAP	0	0	0	0	0.000
OCEAN SPORT	0	0	0	0	0.000
OCEAN COMMERCIAL	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0.000
TOTALS	0	1	0	1	0.004
PERCENT OF RECOVERY	0.0	100.0	0.0	100.0	

Appendix Table 5.14

15 DEC 82

1978 MCNARY - TRUCK

SPRING/SUMMER CHINOOK

MARKS USED RAV 1 RAV 2 GM GMWH PUYWYW NUMBER RELEASED 31956

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	1	2	0	3	0.009
MCNARY TRAP	0	0	1	2	0	3	0.009
LOWER GRANITE TRAP	0	3	10	1	0	14	0.043
OCEAN SPORT	2	2	0	0	0	4	0.012
OCEAN COMMERCIAL	1	1	0	0	0	2	0.006
RIVER SPORT	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	1	1	1	0	3	0.009
INDIAN FISHERY	0	0	0	2	0	2	0.006
RAPID RIVER H.	0	1	4	0	0	5	0.015
HAYDEN CREEK H.	0	0	1	0	0	1	0.003
RINGOLD H.	0	1	0	0	0	1	0.003
LEAVENWORTH H.	0	0	0	1	0	1	0.003
TOTALS	3	9	18	9	0	39	0.122
PERCENT OF RECOVERY	7.6	23.0	46.1	23.0	0.0	100.0	

Appendix Table 5.15

15 DEC 82

1978 MCNARY CONTROLS - TAILRACE

SPRING/SUMMER CHINOOK

MARKS USED LAH 1 RDORRD LAH 2 LAS 1 LAS 2 RDYWRD NUMBER RELEASED 31376

RECOVERY AREA	1978	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	0	1	0	1	0.003
MCNARY TRAP	0	0	0	1	0	1	0.003
LOWER GRANITE TRAP	0	2	2	1	0	5	0.015
OCEAN SPORT	0	0	1	0	0	1	0.003
OCEAN COMMERCIAL	0	0	1	0	0	1	0.003
RIVER SPORT	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	1	0	0	0	1	0.003
INDIAN FISHERY	0	0	0	2	0	2	0.006
DWORSHAK H.	0	0	1	0	0	1	0.003
RAPID RIVER H.	0	0	1	0	0	1	0.003
RINGOLD H.	0	1	0	0	0	1	0.003
LEAVENWORTH H.	0	0	0	4	0	4	0.012
TOTALS	0	4	6	9	0	19	0.060
PERCENT OF RECOVERY	0.0	21.0	31.5	47.3	0.0	100.0	

Appendix Table 5.16

15 DEC 82

1979 MCNARY - TRUCK

SPRING/SUMMER CHINOOK

MARKS USED RA3 1 RDLGPK RA3 2 RA3 3 RA3 4 SM NUMBER RELEASED 42748

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	5	0	2	0	7	0.016
MCNARY TRAP	0	0	3	0	3	0.007
LOWER GRANITE TRAP	0	1	1	0	2	0.004
OCEAN SPORT	0	12	3	0	15	0.035
OCEAN COMMERCIAL	1	11	12	0	24	0.056
RIVER SPORT	0	2	1	1	4	0.009
RIVER COMMERCIAL	0	0	2	2	4	0.009
INDIAN FISHERY	0	0	19	0	19	0.044
RAPID RIVER H.	0	1	0	0	1	0.002
RINGOLD H.	0	0	8	0	8	0.018
LEAVENWORTH H.	0	0	2	0	2	0.004
ENTIAT H.	0	0	1	0	1	0.002
TOTALS	6	27	54	3	90	0.210
PERCENT OF RECOVERY	6.6	30.0	60.0	3.3	100.0	

Appendix Table 5.17

15 DEC 82

1979 MCNARY - BARGE

SPRING/SUMMER CHINOOK

MARKS USED RAR 1 RDPKYW RAR 2 RDYWPK RAR 3 RAR 4 RDYWLG NUMBER RELEASED 40126

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	4	1	0	0	5	0.012
MCNARY TRAP	0	0	0	0	0	0.000
LOWER GRANITE TRAP	0	3	2	0	5	0.012
OCEAN SPORT	0	9	0	0	9	0.022
OCEAN COMMERCIAL	0	4	5	0	9	0.022
RIVER SPORT	0	0	4	0	4	0.009
RIVER COMMERCIAL	1	0	1	0	2	0.004
INDIAN FISHERY	0	0	2	0	2	0.004
RINGOLD H.	1	0	2	0	3	0.007
STREAM SURVEY	0	0	2	0	2	0.004
TOTALS	6	17	18	0	41	0.102
PERCENT OF RECOVERY	14.6	41.4	43.9	0.0	100.0	

Appendix Table 5.18

15 DEC 82

1979 MCNARY - CONTROL - TAILRACE

SPRING/SUMMER CHINOOK

MARKS USED LAS 1 RDLGYW LAS 2 LAS 3 LAS 4 PR NUMBER RELEASED 31229

RECOVERY AREA	1979	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	6	0	3	0	9	0.028
MCNARY TRAP	0	0	1	0	1	0.003
LOWER GRANITE TRAP	0	1	2	0	3	0.009
OCEAN SPORT	0	8	3	0	11	0.035
OCEAN COMMERCIAL	0	3	5	0	8	0.025
RIVER SPORT	0	0	0	1	1	0.003
RIVER COMMERCIAL	1	0	4	2	7	0.022
INDIAN FISHERY	0	0	12	0	12	0.038
RAPID RIVER H.	0	0	1	0	1	0.003
RINGOLD H.	0	0	7	2	9	0.028
LEAVENWORTH H.	0	0	1	4	5	0.016
STREAM SURVEY	0	0	1	1	2	0.006
TOTALS	7	12	40	10	69	0.220
PERCENT OF RECOVERY	10.1	17.3	57.9	14.4	100.0	

Appendix Table 5.19

15 DEC 82

1980 MCNARY - TRUCK

SPRING/SUMMER CHINOOK

MARKS USED RAV 1 RAV 2 NDSM DY NUMBER RELEASED 40938

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	3	2	5	0.012
MCNARY TRAP	1	0	2	3	0.007
LOWER GRANITE TRAP	0	0	0	0	0.000
OCEAN SPORT	0	4	3	7	0.017
OCEAN COMMERCIAL	0	4	4	8	0.019
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	1	0	1	0.002
RINGOLD H.	0	2	0	2	0.004
TOTALS	1	14	11	26	0.063
PERCENT OF RECOVERY	3.8	53.8	42.3	100.0	

Appendix Table 5.20

15 DEC 82

1980 MCNARY — BARGE
SPRING/SUMMER CHINOOK

MARKS USED RA2 1 RA2 2 ERPR LATB NUMBER RELEASED 44023

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	0	2	2	0.004
MCNARY TRAP	2	0	0	2	0.004
LOWER GRANITE TRAP	0	0	0	0	0.000
OCEAN SPORT	0	3	1	4	0.009
OCEAN COMMERCIAL	0	2	1	3	0.006
RIVER SPORT	0	0	1	1	0.002
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0.000
LEAVENWORTH H.	0	0	2	2	0.004
TOTALS	2	5	7	14	0.031
PERCENT OF RECOVERY	14.2	35.7	50.0	100.0	

Appendix Table 5.21

15 DEC 82

1980 MCNARY - TAILRACE CONTROL

SPRING/SUMMER CHINOOK

MARKS USED LAH 1 LAH 2 ERLA CEND NUMBER RELEASED 46585

RECOVERY AREA	1980	1981	1982	TOTALS	PERCENT RETURN
BONNEVILLE TRAP	0	1	1	2	0.004
MCNARY TRAP	0	0	0	0	0.000
LOWER GRANITE TRAP	0	0	0	0	0.000
OCEAN SPORT	0	3	1	4	0.008
OCEAN COMMERCIAL	0	1	0	1	0.002
RIVER SPORT	0	0	1	1	0.002
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0.000
RINGOLD H.	0	1	1	2	0.004
TOTALS	0	6	4	10	0.021
PERCENT OF RECOVERY	0.0	60.0	40.0	100.0	

Appendix Table 6.--Seawater challenge test data for spring chinook salmon from Lower Granite Dam collection and transport system, including test numbers, descaling, total biomass, and average length of live and dead fish by sample area and replicate after 48 h exposure to 30 ppt artificial seawater. (Includes data from Little Goose Dam and for steelhead which were unintentionally sampled with spring chinook in some tests.)

		Dead Fish						Live Fish						
		Number nondescaled		Number descaled		Average fork length (mm)		Number nondescaled		Number descaled		Average fork length (mm)		
Replicate number	Date	Chin.	Sthd.	Chin.	Sthd.	Chin.	Sthd.	Chin.	Sthd.	Chin.	Sthd.	Chin.	Sthd.	Total biomass (gm)[a]
						Test Condition - Freshwater Controls, C slots								
1	4/14-16	0	0	0	0	--	--	35	2	0	0	120.9	177.5	736.0
2	4/16-18	0	0	0	0	--	--	23	1	1	0	116.9	170.0	468.0
3	4/17-19	0	0	0	0	--	--	29	0	0	0	114.8	--	440.0
4	4/21-23	0	0	0	0	--	--	41	0	2	0	119.0	--	665.0
5	4/23-25	1	0	0	0	120.0	--	24	0	1	0	115.8	--	411.0
6	4/25[b]	--	--	--	--	--	--	--	--	--	--	--	--	--
7	4/27-29	0	0	0	0	--	--	29	3	1	0	119.8	163.3	567.5
8	4/29[b]	--	--	--	--	--	--	--	--	--	--	--	--	--
9	5/2-4	0	0	0	0	--	--	21	5	0	0	127.1	170.0	665.0
Totals or Averages		1	0	0	0	120.0	--	202	11	5	0	119.0	169.5	564.6
						Test Condition - Seawater Controls, C Slots								
1	4/14-16	0	0	0	0	--	--	34	1	1	0	123.3	170.0	637.0
2	4/16-18	0	0	0	0	--	--	28	0	0	0	118.0	168.7	602.0
3	4/17-19	0	0	0	0	--	--	17	3	0	0	115.0	161.7	355.0
4	4/21-12	1	0	0	0	105.0	--	36	0	1	0	123.0	--	689.0
5	4/23-25	0	0	0	0	--	--	45	0	4	0	122.1	--	821.0
6	4/25-27	1	0	0	0	110.0	--	26	2	0	0	116.7	172.5	532.0
7	4/27[b]	--	--	--	--	--	--	--	--	--	--	--	--	--
8	4/29-5/1	0	0	0	0	--	--	29	13	0	2	129.1	172.7	1,220.0
9	5/2-4	0	0	0	1	--	150.0	16	8	0	0	129.4	170.0	707.0
		2	0	0	1	107.5	150.0	231	27	6	2	122.2	170.3	695.3
						Test Condition - Gatewell A Slots								
1	4/14-16	0	0	0	0	--	--	31	0	0	0	119.4	--	481.0
2	4/16-18	0	0	1	0	115.0	--	34	0	1	0	118.7	--	554.0
3	4/17-19	0	0	0	0	--	--	30	1	1	0	116.1	185.0	482.0
4	4/21-23	3	0	0	0	113.3	--	54	0	1	0	130.8	--	1,021.0
5	4/23-25	0	0	0	0	--	--	40	0	2	0	120.4	--	709.0
6	4/25-27	0	0	0	0	--	--	21	3	1	0	123.6	166.7	567.5
7	4/27-29	0	0	2	0	107.5	--	33	1	2	0	123.0	160.0	636.0
8	4/29-5/1	3	0	0	0	113.3	--	32	13	4	1	123.5	172.1	1,282.7
9	5/2-4	0	0	0	0	--	--	39	4	0	0	125.1	168.7	936.0
Totals or Averages		6	0	3	0	112.2	--	314	22	12	1	122.9	170.9	741.0
						Test Condition - Prior to Separator								
1	4/14-16	0	0	1	0	115.0	--	24	0	0	0	119.8	--	383.0
2	4/16-18	1	0	0	0	115.0	--	22	0	2	0	123.5	--	418.0
3	4/17-19	1	0	2	0	106.7	--	19	0	0	0	115.3	--	303.0
4	4/21-13	0	0	0	0	--	--	17	0	3	0	118.2	--	270.0
5	4/23-25	0	0	2	0	122.5	--	19	0	1	0	119.5	--	363.0
6	4/25-27	1	0	0	0	115.0	--	20	1	0	0	120.4	180.0	382.9
7	4/27-29	1	1	1	0	115.0	135.0	19	0	1	0	119.7	--	326.3
8	4/29-5/1	0	0	0	0	--	--	20	2	1	0	117.9	150.0	403.0
9	5/2-4	1	0	0	0	120.0	--	19	1	0	0	123.4	165.0	415.0
Totals or averages		5	1	6	0	114.5	135.0	179	4	8	0	119.8	165.0	362.7
						Test Condition - Raceway Evening (+ 45 min)								
1	4/14-16[c]	--	--	--	--	--	--	--	--	--	--	--	--	--
2	4/16-18	0	0	2	0	115.0	--	21	3	1	1	118.6	168.7	587.0
3	4/17-19	2	0	3	0	116.0	--	32	3	1	0	119.1	155.0	643.0
4	4/21-23	1	0	0	0	140.0	--	30	2	2	0	118.9	147.5	595.0
5	4/23-25	1	0	0	0	90.0	--	19	4	4	0	119.8	165.0	539.0
6	4/25-27	1	0	0	0	115.0	--	9	5	0	1	118.9	165.0	397.2
7	4/27-29	1	1	2	1	110.0	170.0	18	9	2	2	117.7	170.9	885.0
8	4/29-5/1	1	0	2	0	113.3	--	14	20	2	1	117.5	159.3	570.4
9	5/2-4	0	0	3	0	110.0	--	8	2	4	1	114.2	165.0	360.0
Totals or averages		7	1	12	1	113.4	170.0	151	48	16	6	116.4	163.1	572.1

a/ Biomass includes incidental catches of other species
b/ Termination due to air stone failure
c/ Excluded due to too many fish in sampler

Appendix Table 6.--Continued

Replicate number	Date	Dead Fish: Number nondescaled Chin.	Sthd.	Dead Fish: Number descaled Chin.	Sthd.	Dead Fish: Average fork length (mm) Chin.	Sthd.	Live Fish: Number nondescaled Chin.	Sthd.	Live Fish: Number descaled Chin.	Sthd.	Live Fish: Average fork length (mm) Chin.	Sthd.	Total biomass (gm)[a]
						Test Condition - Raceway Prior to Loading (+10-12 h)								
1	4/15-17	1	0	0	0	140.0	--	45	2	2	0	119.5	177.5	829.0
2	4/17-19	3	0	1	0	113.7	--	52	0	1	0	115.7	--	787.0
3	4/18-19	0	0	0	0	--	--	23	3	0	0	111.1	153.3	386.0
4	4/22-24	3	0	3	0	114.2	--	18	1	1	1	116.8	172.5	454.0
5	4/24-26	2	0	0	0	105.0	--	19	1	0	0	121.3	170.0	397.2
6	4/26-28	1	0	2	0	103.3	--	29	0	5	0	112.1	--	489.0
7	4/28-30	1	0	1	0	107.5	--	24	2	0	0	116.0	165.0	460.0
8	5/1[b]	--	--	--	--	--	--	--	--	--	--	--	--	--
9	5/3-5	0	0	1	0	110.0	--	13	1	1	1	118.2	172.5	334.2
Totals or averages		11	0	8		111.8	--	223	10	10	2	116.2	167.1	517.0
						Test Condition - Truck During Loading								
1	4/15-17	0	0	0	0	--	--	20	0	0	0	119.5	--	297.0
2	4/17-19	2	0	1	0	110.	--	25	2	0	0	117.4	165.0	484.0
3	4/18-20	0	0	1	0	130.0	--	40	2	3	0	115.9	145.0	706.0
Totals or averages		2	0	2	0	115.0	--	85	4	3	0	117.2	155.0	495.7
						Test Condition - Truck 20-30 min Post Loading								
1	4/15-17	0	0	1	0	105.0	--	30	2	5	0	125.1	185.0	793.0
2	4/17-19	0	0	0	0	--	--	19	6	1	0	114.2	175.8	531.0
3	4/18-20	0	0	0	0	--	--	22	0	2	1	118.5	180.0	411.0
Totals or averages		0	0	1	0	105.0	--	71	8	8	1	120.4	178.3	578.3
						Test Condtion - Lower Granite Truck to Bonneville - Immediate Challenge								
1	4/15-17	1	0	2	0	121.0	--	9	3	0	0	--	--	d/
2	4/17-19	4	0	2	0	109.5	--	30	3	0	0	121.2	164.3	d/
3	4/18-20	4	0	0	0	106.2	--	26	4	0	0	119.8	161.0	636.0
Totals or averages		9	0	2	0	109.3	--	65	10	0	0	121.0	169.3	512.9
						Test Condition - Lower Granite Truck to Bonneville - 24 h Delayed Challenge								
1	4/16-18	1	0	1	0	125.5	--	17	1	0	0	120.0	181.0	449.3
2	4/18-20	1	0	0	0	108.0	--	23	2	1	0	119.7	176.0	556.2
3	4/19[b]	--	--	--	--	--	--	--	--	--	--	--	--	--
Totals or averages		2	0	1	0	119.7	--	40	3	1	0	120.2	117.7	502.7
						Test Condition - Lower Granite Truck to Bonneville - 48 h Delayed Challenge								
1	4/17-19	0	0	1	0	110.0	--	17	4	0	0	127.2	190.0	605.5
2	4/19-21	1	0	1	0	111.5	--	24	2	2	0	123.0	191.5	619.1
3	4/20-22	2	0	3	0	108.8	--	27	0	0	0	116.1	--	408.6
Totals or averages		3	0	5	0	109.6	--	68	6	2	0	121.4	190.5	544.4
						Test Condition - Lower Granite Truck to Bonneville - 72 h Challenge								
1	4/18-20	0	0	0	0	--	--	13	6	1	1	125.3	177.3	590.2
2	4/20-22	3	0	1	0	110.7	--	22	2	0	0	124.0	171.0	589.5
3	4/21-12	3	0	2	0	107.2	--	21	0	0	0	116.4	--	381.9
Totals or averages		6	0	3	0	108.8	--	56	8	1	1	121.5	175.9	520.5
						Test Condition - Lower Granite Truck to Bonneville - 96 h Delayed Challenge								
1	4/19-21	0	0	0	0	--	--	10	12	1	0	128.1	181.2	862.6
2	4/21-23	1	0	2	0	111.7	--	14	2	1	0	120.5	168.0	402.1
3	4/22-24	1	0	0	0	115.0	--	25	2	0	0	123.0	179.5	596.1
Totals or averages		2	0	2	0	112.5	--	49	16	2	0	123.0	179.5	620.3
						Test Condition - Lower Granite Truck to Bonneville - 120 h Delayed Challenge								
1	e/	--	--	--	--	--	--	--	--	--	--	--	--	--
2	4/22-24	0	0	2	0	107.0	--	8	8	0	0	114.0	168.6	523.2
3	4/23-25	2	0	1	0	119.0	--	19	0	0	0	122.9	--	310.1
Totals or averages		2	0	3	0	114.2		27	8	0	0	120.3	168.6	416.6
						Test Condition - Lower Granite Truck to Bonneville - 144 h Delayed Challenge								
1	e/	--	--	--	--	--	--	--	--	--	--	--	--	--
2	e/	--	--	--	--	--	--	--	--	--	--	--	--	--
3	4/24-26	0	0	0	0	--	--	27	1	0	0	118.4	165.0	d/
Totals or averages		0	0	0	0	--	--	27	1	0	0	118.4	165.0	

a/ Biomass includes incidental catches of other species
b/ Termination due to air stone failure
d/ No weight taken
e/ Not enough fish sampled

Appendix Table 6.—Continued

Replicate number	Date	Dead Fish: Number nondescaled Chin.	Dead Fish: Number nondescaled Sthd.	Dead Fish: Number descaled Chin.	Dead Fish: Number descaled Sthd.	Dead Fish: Average fork length (mm) Chin.	Dead Fish: Average fork length (mm) Sthd.	Live Fish: Number nondescaled Chin.	Live Fish: Number nondescaled Sthd.	Live Fish: Number descaled Chin.	Live Fish: Number descaled Sthd.	Live Fish: Average fork length (mm) Chin.	Live Fish: Average fork length (mm) Sthd.	Total biomass (gm)a/
Test Condition - Barge Post-loading														
1	4/22-24	7	0	3	0	115.5	—	28	1	2	0	114.7	180.0	642.0
2	4/24-26	2	0	0	0	120.0	—	38	1	3	0	116.5	125.0	640.0
3	4/26-28	0	0	1	0	120.0	—	29	3	1	0	117.7	163.3	548.0
4	4/28-30	3	0	0	0	106.7	—	29	4	1	2	117.3	171.7	748.0
5	4/30-5/2	2	0	1	0	108.3	—	42	1	1	2	109.4	166.7	747.0
6	5/3-5	1	0	0	0	120.0	—	7	11	1	0	138.7	174.1	581.6
Totals or averages		15	0	5	0	114.0	—	173	21	9	4	115.8	169.6	656.1
Test Condition - Barge Post-Transport														
1	f/	—	—	—	—	—	—	—	—	—	—	—	—	—
2	4/26-28	2	0	2	0	121.5	—	27	1	0	0	115.6	133.0	484.8
3	4/18-30	1	0	1	0	121.5	—	24	1	1	0	115.6	133.0	484.8
4	4/30-5/2	1	0	3	0	117.7	—	32	0	0	0	115.0	—	d/
5	5/3-5	0	0	4	0	128.0	—	15	2	2	0	121.8	168.0	492.4
6	5/5e/	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals or averages		4	0	10	0	120.6	—	98	4	3	0	116.6	150.7	486.0
Test Condition - Upwell Box (Dipped with Sanctuary Net)														
1	4/15-17	0	0	1	0	95.0	—	21	0	2	0	119.8	—	d/
2	4/22-24	1	0	2	0	115.0	—	25	0	0	0	115.2	—	447.0
3	4/24-26	1	0	0	0	106.7	—	32	0	0	0	120.5	—	589.0
Totals or averages		2	0	3	0	106.0	—	78	0	2	0	118.6	—	518.0
Test Condition - Isolate Standard Dipnet (Dipped with Sanctuary Net)														
1	4/15-17	3	0	0	0	106.7	—	22	0	0	0	118.2	—	372.0
2	4/22-24	0	0	5	0	109.0	—	19	0	1	0	117.5	—	348.0
3	4/24-26	3	0	1	0	111.2	—	19	0	0	0	115.8	—	317.0
Totals or averages		6	0	6	0	109.2	—	60	0	1	0	117.2	—	345.6
Test Condition - Isolate Unbuffered MS-222 (Dipped with Sanctuary Net)														
1	4/15-17	1	0	0	0	115.0	—	23	0	0	0	124.8	—	432.0
2	4/22-24	0	0	0	0	—	—	22	0	1	0	122.0	—	411.0
3	4/24-26	0	0	1	0	125.0	—	23	0	0	0	119.1	—	399.0
Totals or averages		1	0	1	0	120.0	—	68	0	1	0	122.0	—	414.0
Test Condition - Traditional Handling and Marking (Early Groups)														
1	4/15-17	4	0	1	0	116.0	—	19	0	1	0	124.0	—	405.0
2	4/22-24	3	0	3	0	115.8	—	17	0	1	0	118.6	—	350.0
3	4/24-26	5	0	3	0	114.4	—	15	0	1	0	118.7	—	349.0
Totals or averages		12	0	7	0	115.3	—	51	0	3	0	120.6	—	368.0
Test Condition - Traditional Handling and Marking (Later Groups)														
1	5/13-15	5	0	4	0	122.2	—	13	0	0	0	127.7	—	481.0
2	5/17-19	5	0	3	0	137.5	—	18	0	0	o	142.2	—	737.0
3	5/18-20	10	0	4	0	120.7	—	11	0	0	0	128.2	—	468.0
Totals or averages		20	0	11	0	125.5	—	42	0	0	0	134.0	—	562.0
Test Condition - Benzocaine, MS-222, and Traditional Handling and Marking														
1	4/24-26	3	0	0	0	120.0	—	20	0	1	0	117.4	—	416.0
2	4/28-30	1	0	6	0	112.9	—	17	0	0	0	120.3	—	344.0
3	4/30-5/2	2	0	2	0	115.0	—	21	0	0	0	126.4	—	471.0
Totals or averages		6	0	8	0	115.0	—	58	0	1	0	121.4	—	410.3
Test Condition - Traditional Handling and Marking in 10 ppt Seawater														
1	5/13-15	5	0	6	0	128.2	—	12	0	1	0	130.8	—	525.0
2	5/17-19	5	0	4	0	137.8	—	15	0	2	0	142.2	—	737.0
3	5/18-20	3	0	3	0	112.5	—	8	0	0	0	128.7	—	241.0
Totals or averages		13	0	13	0	127.9	—	35	0	3	0	135.5	—	501.0
Test Condition - Little Goose Raceway + 45 min														
1	4/22-24	2	0	0	0	106.5	—	10	2	1	0	133.2	172.5	d/
2	4/24-26	0	0	4	0	110.7	—	26	1	2	0	118.4	165.0	d/
3	4/26-28	2	0	0	0	117.5	—	25	2	2	0	121.1	167.5	d/
Totals or averages		4	0	4	0	111.4	—	61	5	5	0	122.0	168.0	
Test Condition - Little Goose Raceway (Held 10-12 h), Target Species-Steelhead														
1	5/12-14	0	0	0	0	—	—	3	15	0	3	138.3	201.4	d/
2	5/24-26	0	0	0	1	—	161.0	3	12	0	1	141.7	193.8	d/
3	5/24-26	0	0	0	0	—	—	5	13	0	0	124.0	220.0	d/
Totals or averages		0	0	0	1	—	161.0	11	40	0	4	132.7	204.7	
Test Condition - Raceway Prior to Loading (Held 10-12 h), Target Species-Steelhead														
1	5/11-13	0	0	0	0	—	—	12	11	0	0	134.2	202.3	1,163.0
2	5/12-14	0	6	0	3	—	191.7	1	14	o	1	155.0	192.0	1,543.0
3	5/18-20	0	3	0	0	—	176.7	0	18	0	0	—	181.9	1,375.0
Totals or averages		0	9	0	3	—	187.9	13	43	0	1	135.8	190.5	1,360.3

a/ Biomass includes incidental catches of other species
b/ Termination due to too many fish in sampler
c/ Excluded due to too many fish in sampler
d/ No weight taken
e/ Not enough fish sampled
f/ Too many fish in replicate; aborted

Appendix Table 7.—Seawater challenge test data for spring chinook salmon from McNary Dam collection and transportation system, including test biomass and average length of live and dead fish by sample area and replicate after 48 h exposure to 30 ppt artificial seawater. (Includes data for steelhead which were unintentionally sampled with spring chinook in some tests.)

Replicate no.	Date	Dead Fish: Number nondescaled Chin.	Dead Fish: Number nondescaled Sthd.	Dead Fish: Number descaled Chin.	Dead Fish: Number descaled Sthd.	Dead Fish: Average fork length (mm) Chin.	Dead Fish: Average fork length (mm) Sthd.	Live Fish: Number nondescaled Chin.	Live Fish: Number nondescaled Sthd.	Live Fish: Number descaled Chin.	Live Fish: Number descaled Sthd.	Live Fish: Average fork length (mm) Chin.	Live Fish: Average fork length (mm) Sthd.	Total biomass (gm)[a]
Test Condition - Fresh Water Controls, C Slots														
1	5/3-5	0	0	0	0	—	—	25	0	8	0	136.7	—	872.6
2	5/5-7	0	0	0	0	—	—	20	1	3	0	127.2	195.0	564.5
3	5/6-8	0	0	0	0	—	—	23	0	1	o	139.8	—	692.5
4	5/11[b]	—	—	—	—	—	—	—	—	—	—	—	—	—
5	5/12-14	0	0	0	0	—	—	33	0	3	0	134.4	—	841.9
6	5/14-16	0	0	0	0	—	—	25	0	5	0	132.0	—	683.8
7	5/16-18	0	0	0	0	—	—	19	0	2	0	135.0	—	496.0
8	5/19-20	0	0	0	0	—	—	21	2	1	2	132.0	174.2	766.0
9	5/24-25	0	0	0	0	—	—	21	2	3	0	133.5	166.5	821.0
Totals or averages		0	0	0	0	—	—	187	5	26	2	133.7	175.0	717.3
Test Condition - Seawater Controls, C Slot														
1	5/3-5	0	0	0	0	—	—	37	2	5	0	125.6	172.5	836.8
2	5/5-7	0	0	1	0	110.0	—	23	2	5	0	133.9	179.5	835.7
3	5/6-8	3	0	2	0	142.0	—	26	1	2	0	140.5	200.0	964.0
4	5/11-13	0	0	1	0	149.0	—	31	1	3	0	132.8	162.0	829.1
5	5/12-14	1	0	0	0	139.0	—	30	0	3	0	136.4	—	821.3
6	5/14-16	0	0	0	0	—	—	26	0	1	0	135.6	—	664.8
7	5/16-18	1	0	0	0	142.0	—	26	0	5	0	133.7	—	710.0
8	5/18-20	0	0	0	0	—	—	26	0	2	0	137.6	—	748.5
9	5/24-26	0	0	0	0	—	—	18	2	2	0	137.1	172.5	807.2
10	5/26-28[c]	2	1	0	0	138.5	162.0	18	0	1	0	123.9	—	1,220.2
Totals or averages		7	1	4	0	138.8	162.0	261	8	29	0	133.6	176.4	765.2
Test Condition - Gatewell, A Slots														
1	5/3-5	0	0	0	0	—	—	27	1	5	0	129.2	160.0	764.6
2	5/5-7	0	0	2	0	113.5	—	34	2	3	0	136.1	195.0	1,080.5
3	5/6-8	1	1	2	0	131.7	175.0	17	2	1	0	140.7	186.5	718.5
4	5/11	0	0	0	0	—	—	0	0	0	0	—	—	—
5	5/12-14	3	0	0	0	112.7	—	24	0	4	0	136.4	—	739.5
6	5/14-16	0	0	0	0	—	—	27	1	2	0	135.8	162.0	753.2
7	5/16-18	1	0	2	0	109.7	—	34	1	6	0	126.1	159.0	862.0
8	5/18-20	1	0	1	0	129.0	—	22	3	3	0	133.5	171.7	760.7
9	5/24-26	1	1	2	0	125.7	170.0	21	2	2	1	140.9	162.3	997.5
10	5/26-28	1	0	0	0	145.0	—	7	1	0	0	127.4	157.0	812.1
Totals or averages		7	2	9	0	121.2	172.5	213	13	26	1	133.8	171.6	831.0
Test Condition - Pre-Separator														
1	5/3-5	0	0	1	0	122.0	—	7	8	0	0	141.6	170.5	580.1
2	5/5-7	1	0	1	0	112.5	—	16	1	1	2	138.5	165.7	604.5
3	5/6-8	1	0	1	0	123.5	—	10	0	5	0	141.5	—	442.4
4	5/11-13	5	0	1	0	131.7	—	23	1	2	0	134.7	185.0	778.0
5	5/12-14	5	0	6	0	137.9	—	16	2	5	0	135.0	185.5	828.1
6	5/14-16	1	0	2	0	123.0	—	25	0	8	0	137.2	—	862.3
7	5/16-18	0	0	1	0	111.0	—	17	1	7	0	136.8	160.0	661.5
8	5/18-20	0	1	0	0	—	160.0	18	3	6	0	136.8	168.0	714.5
9	5/24-26	1	0	0	0	92.0	—	15	0	1	0	132.9	—	729.3
Totals or averages		14	1	13	0	128.6	160.0	147	16	35	2	136.8	171.2	689.0

a/ Biomass includes incidental catches of other species
b/ Terminated due to air stone failure
c/ Two replicates combined
d/ Inaccurate weight recorded
e/ No weight taken

Appendix Table 7.—Continued.

Repli-cate no.	Date	Dead Fish: Number nondescaled Chin.	Sthd.	Number descaled Chin.	Sthd.	Average fork length (mm) Chin.	Sthd.	Live Fish: Number nondescaled Chin.	Sthd.	Number descaled Chin.	Sthd.	Average fork length (mm) Chin.	Sthd.	Total biomass (gm)[a]
Test Condition - Concrete Raceway														
1	5/3-5	3	0	4	0	109.0	—	33	0	7	0	142.7	—	990.6
2	5/5-7	2	0	2	0	118.7	—	23	0	3	0	126.0	—	537.4
3	5/6-8	8	0	3	0	122.9	—	27	0	5	0	127.7	—	922.8
4	5/11-13	3	0	2	0	123.4	—	24	0	3	0	136.9	—	754.9
5	5/12-14	2	0	2	0	126.0	—	28	0	8	0	133.3	—	875.0
6	5/14-16	2	0	3	0	116.2	—	31	0	10	0	133.6	—	1,039.3
7	5/16[b]	—	—	—	—	—	—	—	—	—	—	—	—	—
8	5/18[b]	—	—	—	—	—	—	—	—	—	—	—	—	—
9	5/24-26	3	0	1	0	128.2	—	15	2	6	0	148.7	167.0	845.2
10	5/26-28	0	0	0	0	—	—	5	0	1	0	121.5	—	655.8
Totals or averages		23	0	17	0	120.1	—	186	2	43	0	134.9	167.0	827.6
Test Condition - Plastic Raceways														
1	5/4-6	4	0	1	0	124.2	—	33	0	4	0	123.3	—	735.7
2	5/6-8	6	0	5	0	114.3	—	29	0	0	0	134.1	—	866.4
3	5/7-9	7	0	2	0	116.2	—	21	0	6	0	130.0	—	732.2
4	5/12[b]	—	—	—	—	—	—	—	—	—	—	—	—	—
5	5/13-15	2	0	0	0	126.0	—	39	2	7	0	129.8	167.0	1,026.5
6	5/15-17	2	0	1	0	140.3	—	25	0	5	0	133.5	—	800.0
7	5/17-19	2	0	2	0	135.7	—	22	1	10	1	133.8	164.5	924.2
8	5/19-21	0	0	1	0	97.0	—	27	4	2	0	133.2	163.7	815.7
9	5/26-28	0	0	1	0	165.0	—	20	0	2	0	135.5	—	819.5
10	5/28-30	1	0	0	0	124.0	—	13	1	3	0	129.0	165.0	617.6
Totals or averages		24	0	13	0	122.3	—	229	8	39	1	131.1	164.8	815.3
Test Condition - Barge Post Loading														
1	5/4-6	2	0	2	0	113.7	—	26	0	8	0	125.6	—	772.2
2	5/6-8	3	0	1	0	116.7	—	13	0	2	0	130.6	—	663.2
3	5/7-9	2	0	1	0	123.7	—	23	1	3	0	127.3	178.0	679.1
4	No test	—	—	—	—	—	—	—	—	—	—	—		
5	5/13-15	1	0	4	0	122.8	—	27	1	7	0	132.4	157.0	832.9
6	5/15-17	0	0	0	0	—	—	8	0	3	0	133.2	—	283.5
7	5/17-19	1	0	1	0	127.5	—	26	1	5	0	126.6	173.0	754.8
8	5/19-21	1	0	0	0	107.0	—	19	2	2	0	133.0	171.0	831.5
9	5/26-28	1	1	3	0	140.5	145.0	5	1	1	0	139.8	145.0	607.0
10	5/28-30	1	1	0	0	131.0	161.0	12	4	4	0	139.7	157.2	770.1
Totals or averages		12	2	12	0	123.4	153.0	159	10	35	0	130.4	145.1	688.3
Test Condition - Barge Post Transport														
1	5/5-7	0	0	1	0	118.0	—	24	0	1	0	130.8	—	d/
2	5/7[b]	—	—	—	—	—	—	—	—	—	—	—	—	—
3	5/8-10	0	0	5	0	121.4	—	6	1	1	1	131.1	144.0	d/
4	No test	—	—	—	—	—	—	—	—	—	—	—	—	
5	5/14-16	2	0	5	0	122.9	—	14	6	2	0	137.3	196.3	e/
6	5/16-18	5	0	0	0	124.4	—	18	2	6	0	130.4	183.5	d/
7	5/18-20	2	1	4	0	137.8	190.0	14	1	0	0	136.0	152.0	723.7
8	5/20-22	0	0	1	0	126.0	—	20	5	0	0	136.3	181.2	879.1
Totals or averages		9	1	16	0	126.4	190.0	96	15	10	1	133.5	180.7	801.4

a/ Biomass includes incidental catches of other species
b/ Terminated due to air stone failure
c/ Two replicas obtained
d/ Inaccurate weight recorded
e/ No weight taken

Appendix Table 8.—Transport density test data when chinook salmon were transported alone at 0.25, 0.50, 1.00 or 1.50 lb/gal from Lower Granite Dam to Bonneville Dam including species numbers, number/lb, total weight and lbs/gal by test condition and replicate of live fish prior to transport and test numbers sampled, percent descaled, average length and total biomass of live and dead chinook salmon by test condition and replicate after 48-h exposure to 30 ppt artificial seawater.

		Numbers and pounds of fish Transported				Post-transport seawater challenged (controls seawater challenged at Lower Granite)							
						Dead Fish			Live Fish				
Rep-li-cate no.	Date	Number Chin.	Number/lb Chin.	Total fish wght. (lb)	Tot. lb / gal	Number nondescaled Chin.	Number descaled Chin.	Ave. fork length (mm) Chin.	Number nondescaled Chin.	Number descaled Chin.	Ave. fork length (mm) Chin.	Total biomass (gm)	Comments
								Test Condition - Control					
1	4/24-26	—	—	—	—	4	1	115.0	28	1	116.9	498.0	
2	4/26-28	—	—	—	—	1	0	120.0	27	2	122.3	541.9	
3	4/28-30	—	—	—	—	1	1	117.5	27	2	117.6	472.0	
Totals or averages						6	2	116.2	82	4	118.9	504.0	
								Test Condition - 0.25 lb/gal					
1	4/24-26	112	22	5.1	0.25	5	1	115.5	15	1	125.6	—	No weight taken
2	4/27	116	25	4.6	0.23	—	—	—	—	—	—	—	Terminated-air stone failure
3	4/29-5/1	92	22	4.2	0.21	2	5	125.7	16	4	120.5	452.8	
Totals or averages						7	6	121.0	31	5	122.8	452.8	
								Test Condition - 0.50 lb/gal					
1	4/26-28	226	22	10.3	0.51	7	3	121.0	16	2	119.2	—	No weight taken
2	4/26	221	25	8.8	0.44	—	—	—	—	—	—	—	Terminated-air stone failure
3	4/29-5/1	198	22	9.0	0.45	4	5	121.3	25	2	114.3	604.7	
Totals or averages						11	8	121.2	41	4	116.2	604.7	
								Test Condition - 1.00 lb/gal					
1	4/24-26	452	22	20.5	1.02	2	4	128.2	25	1	125.3	—	No weight taken
2	4/26-28	446	25	17.8	0.89	1	7	115.2	20	1	125.5	615.7	
3	4/29-5/1	411	22	18.7	0.93	6	8	117.4	24	1	119.0	666.9	
Totals or averages						9	19	119.1	69	3	123.2	641.3	
								Test Condition - 1.50 lb/gal					
1	4/24-26	683	22	31.0	1.55	13	3	115.2	29	3	123.7	—	No weight taken
2	4/26-28	683	25	27.3	1.36	5	6	116.0	17	5	128.2	696.7	
3	4/29-5/1	629	22	28.6	1.43	8	14	114.2	19	2	117.0	527.0	
Totals or averages						26	23	114.9	65	10	123.1	611.8	

Appendix Table 9.—Transport density test data for spring chinook salmon when transported with steelhead at 0.25, 0.50, 1.00, or 1.50 lb/gal from Lower Granite Dam to Bonneville Dam, including species numbers, number/lb, total weight and lb/gal by test condition and replicate of live fish prior to transport and test numbers sampled, percent descaled, average length and total biomass of live and dead fish by test condition and replicate after 48 h exposure to 30 ppt artificial seawater. (Includes data for steelhead which were unintentionally sampled with spring chinook in some tests).

		Numbers and pounds of fish transported						Post-transport seawater challenged (controls seawater challenged at Lower Granite)														
								Dead Fish						Live Fish								
Rep-li-cate no.	Date	Number Chin.	Number Sthd.	Number/lb Chin.	Number/lb Sthd.	Total fish wgt. (lb)	Total lb/gal	Number nondescaled Chin.	Number nondescaled Sthd.	Number descaled Chin.	Number descaled Sthd.	Ave. fork length (mm) Chin.	Ave. fork length (mm) Sthd.	Number nondescaled Chin.	Number nondescaled Sthd.	Number descaled Chin.	Number descaled Sthd.	Ave. fork length (mm) Chin.	Ave. fork length (mm) Sthd.	Total biomass[a/] (gm)	Comments
												Test Condition - Controls									
1	4/24-26	—	—	—	—	—	—	6	0	1	0	114.3	—	23	0	2	0	122.8	—	530.7	
2	4/26-28	—	—	—	—	—	—	1	2	1	0	137.5	185.0	26	15	1	1	122.8	183.4	1,452.3	
3	4/28-30	—	—	—	—	—	—	5	0	1	0	114.2	—	16	7	0	0	116.1	181.4	690.0	
4	4/30-5/2	—	—	—	—	—	—	1	0	1	0	122.5	—	20	1	1	0	124.3	180.0	491.0	
5	5/2-4	—	—	—	—	—	—	5	0	2	0	119.3	—	21	1	1	0	119.0	180.0	515.0	
6	5/4-6	—	—	—	—	—	—	2	0	0	0	117.5	—	19	15	1	1	131.6	177.5	1,255.0	
Totals or averages								20	2	6	0	118.3	185.0	125	39	6	2	123.2	180.6	822.3	
												Test Condition - 0.25 lb/gal									
1	4/24-26	41	16	22.0	5.5	4.7	0.24	2	0	1	0	103.7	—	16	0	1	0	121.5	—	317.8	
2	4/27-29	23	26	25.0	7.0	4.6	0.23	6	0	0	0	110.3	—	11	0	3	0	123.5	—	363.2	
3	4/29-5/1	13	28	22.0	6.4	4.9	0.25	1	0	2	0	119.7	—	13	0	1	0	115.5	—	364.6	
4	5/1-3	19	29	23.0	6.5	5.2	0.26	3	0	4	0	108.0	—	16	1	4	0	119.8	175.0	578.7	
5	5/3-5	12	31	21.0	6.0	5.7	0.29	0	0	4	0	112.7	—	7	0	1	0	125.7	—	147.2	
6	5/5-7	8	31	21.0	6.0	4.9	0.25	0	0	0	0	—	—	5	0	3	0	121.9	—	204.3	
Totals or averages								12	0	11	0	110.4	—	68	1	13	0	120.9	175.0	329.3	
												Test Condition - 0.50 lb/gal									
1	4/24-26	84	32	22.0	5.5	9.6	0.48	4	0	4	0	109.2	—	18	1	0	0	116.7	147.0	—	No weight taken
2	4//27-29	48	54	25.0	7.0	9.6	0.48	4	0	4	0	112.2	—	18	2	6	0	118.1	167.5	622.5	
3	4/29-5/1	28	58	22.0	6.4	10.4	0.52	6	0	1	0	112.6	—	11	4	0	0	118.1	173.5	417.1	
4	5/1-3	39	59	23.9	6.5	10.7	0.53	2	0	6	0	112.1	—	9	0	0	0	123.6	—	—	No weight taken
5	5/3-5	24	66	21.0	6.0	12.0	0.60	2	0	7	1	110.3	203.0	6	4	1	2	127.9	182.3	648.9	
6	5/4-7	15	57	21.0	6.0	9.1	0.46	2	0	8	0	124.5	—	1	0	2	2	120.7	151.5	253.9	
Totals or averages								20	0	30	1	113.9	203.0	63	11	9	4	119.5	171.5	485.6	
												Test Condition - 1.00 lb/gal									
1	4/24-26	167	65	22.0	5.5	19.2	0.96	6	0	6	0	111.3	—	16	0	2	0	121.8	—	—	No weight taken
2	4/27-29	92	105	25.0	7.0	18.6	0.96	5	0	5	0	113.4	—	13	0	5	0	119.8	—	507.8	
3	4/29-5/1	57	119	22.0	6.4	21.2	1.06	4	0	10	0	108.6	—	11	0	2	0	120.2	—	398.2	
4	5/1-3	79	116	12.0	6.5	21.2	1.06	6	0	8	0	121.9	—	7	0	2	0	125.	—	416.7	
5	5/3-5	46	123	21.0	6.0	22.5	1.12	5	0	6	0	123.3	—	3	9	0	0	114.7	172.4	662.4	
6	5/5-7	32	117	21.0	6.0	18.8	0.94	1	0	7	0	108.0	—	5	2	5	0	122.7	161.0	368.7	
Totals or averages								27	0	42	0	114.8	—	55	11	16	0	121.3	170.4	470.8	
												Test Condition - 1.50 lb/gal									
1	4/24-26	252	98	22.0	5.5	28.9	1.44	14	0	2	0	118.4	—	18	1	0	0	117.8	175.0	—	No weight taken
2	4/27-29	140	158	25.0	7.0	28.1	1.40	18	0	6	0	111.5	—	8	1	4	0	122.7	186.0	771.8	
3	4/29-5/1	86	179	22.0	6.4	31.9	1.59	9	1	13	1	115.5	172.0	1	2	0	0	141.0	176.5	552.6	
4	5/1-3	117	173	23.0	6.5	31.5	1.57	8	0	7	0	115.0	—	6	0	0	0	119.3	—	397.9	
5	5/3-5	69	186	21.0	6.0	34.0	1.70	3	0	6	1	119.9	192.0	1	8	0	0	121.0	167.9	572.8	
6	5/5-7	46	171	21.0	6.0	27.5	1.37	4	0	4	0	118.9	—	2	10	2	1	136.7	185.6	811.0	
Totals or averages								56	1	38	2	115.6	178.7	36	22	6	1	121.9	178.2	621.2	

a/ Biomass includes incidental catches of other species.

Appendix Table 10.—Transport density test data when steelhead were transported alone at 0.25, 0.50, 1.00, or 1.50 lb/gal from Lower Granite Dam to Bonneville Dam, including species numbers, number/lb, total weight and lb/gal by test condition and replicate of live fish prior to transport and test numbers sampled percent descaled, average length and total biomass of live and dead steelhead by test condition and replicate after 48-h exposure to 30 ppt artificial seawater.

	Numbers and pounds of fish transported					Post-transport seawater challenged (controls seawater challenged at Lower Granite)							
						Dead Fish			Live Fish				
Rep-li-cate no.	Date	Number Sthd.	Number/lb Sthd.	Total fish wgt. (lb)	Tot. lb / gal.	Number nondescaled Sthd.	Number descaled Sthd.	Ave. fork length (mm) Sthd.	Number nondescaled Sthd.	Number descaled Sthd.	Ave. fork length (mm) Sthd.	Total biomass (gm)	Comments
						Test Conditions - Controls							
1	4/30	—	—	—	—	—	—	—	—	—	—	—	Lost control, O_2 problems
2	5/2-4	—	—	—	—	1	0	170.0	29	2	209.0	2,718.0	Two aquaria
3	5/4-6	—	—	—	—	0	0	—	23	1	197.7	1,652.8	Two aquaria
Totals or averages						1	0	170.0	52	3	203.8	1,092.7	Per aquaria
						Test condition - 0.25 lb/gal							
1	5/1-3	35	6.5	5.4	0.27	2	3	221.0	14	2	206.3	—	No wgt taken; no matching control
2	5/3-4	35	6.0	10.8	0.29	0	0	—	25	0	—	—	No weight taken
3	5/5-7	30	6.0	5.0	0.25	0	2	227.5	10	2	192.9	923.7	Terminated at 24 h
Totals or averages						2	5	222.9	49	4	200.6	923.7	One aquaria
						Test Condition - 0.50 lb/gal							
1	5/1-3	70	6.5	10.8	0.54	2	5	211.9	18	1	198.5	—	No matching control
2	5/3-4	70	6.0	11.7	0.58	0	1	150.0	26	0	—	—	Terminated at 24 h
3	5/5-7	60	6.0	10.0	0.50	1	3	195.2	22	0	206.0	1,869.5	Two aquaria
Totals or averages						3	9	209.5	66	1	202.5	934.7	Per aquaria
						Test Condition - 1.00 lb/gal							
1	5/1-3	140	6.5	21.5	1.10	1	3	196.0	18	3	194.9	1,545.8	No matching control, 2 aquaria
2	5/3-4	140	6.5	23.3	1.20	2	2	221.7	23	0	—	—	Terminated at 24 h
3	5/5-7	120	6.0	20.0	1.00	0	0	—	13	1	194.1	953.4	One aquarium
Totals or averages						3	5	208.8	54	4	194.8	833.1	Per aquaria
						Test Condition - 1.50 lb/gal							
1	5/1-3	208	6.5	32.0	1.60	0	5	201.1	17	3	193.8	1,746.2	No matching control, 2 aquaria
2	5/3-4	210	6.0	35.0	1.70	2	0	205.0	3	2	207.2	1,204.9	One aquarium
3	5/5	180	6.0	30.0	1.50	—	—	—	—	—	—	—	Terminated due to O_2 problems
Totals or averages						2	5	202.1	28	5	199.1	983.7	Per aquarium