CZES Coastal Zone and Estuarine Studies

EFFECTS OF POWER PEAKING OPERATIONS ON JUVENILE SALMON AND STEELHEAD TROUT MIGRATIONS — PROGRESS 1977

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Final Report of Research

Financed by

U.S. Army Corps of Engineers

(Contract No. DACW68-77-C-0025)

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

July 1978

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INTRODUCTION

Research activities in 1977 continued to define the effects of dams, power peaking, and flow regulation on juvenile salmon and steelhead migrations in the Snake and Columbia Rivers.

Juvenile salmonid migrations were sampled in the Salmon, Snake, and Columbia Rivers (Figure 1). Fish were marked and released at various sites to provide information on survival, migrational timing, and rates of downstream movement. A scanning sonar system was used to define movement and behavioral characteristics of juveniles at dams. Diel movement patterns at dams, residualism, and predator fish population were also investigated.

River flows in the Columbia River Basin during 1977 were the lowest on record. The fishery agencies and water management entities implemented an action plan to protect downstream migrants. This plan, called "Operation Fish-flow 1977", provided water for augmenting river flows and spilling at Columbia River dams during periods of peak juvenile migration. This research program was charged with monitoring fish migrations at McNary, John Day, The Dalles, and Bonneville Dams to insure the optimum use of allotted water along with measuring the benefits of this special spill and flow augmentation.

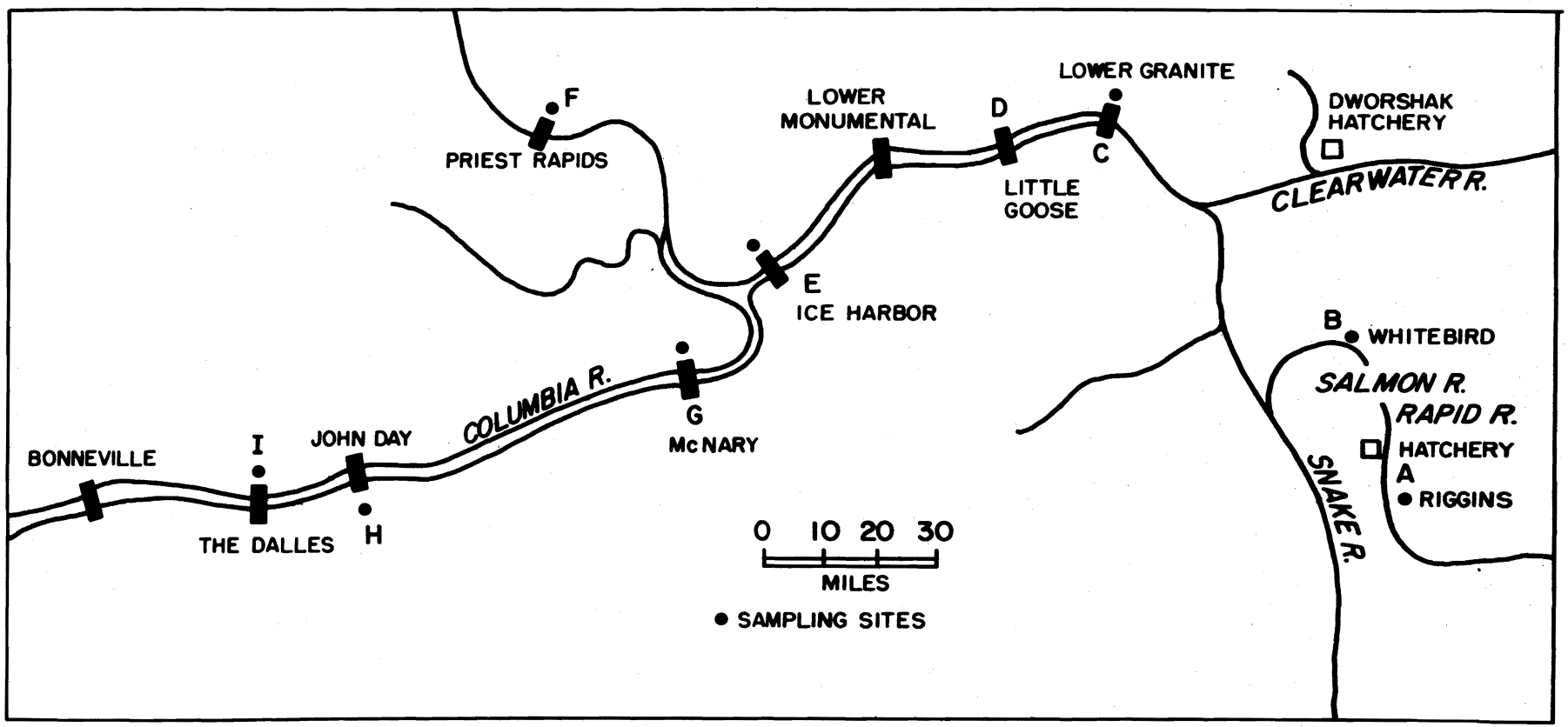

Figure 1.--Juvenile salmonid sampling sites on the Salmon, Snake, and Columbia Rivers, 1977.

METHODS

Juvenile salmon and steelhead migrations were sampled in the Salmon, Snake, and Columbia Rivers in 1977. Self-cleaning scoop traps were used to sample the Salmon River at Riggins and Whitebird, Idaho. On the Snake River catches from the fingerling collection facilities at Little Goose, Lower Granite, and Ice Harbor Dams were sampled. On the Columbia River turbine intake gatewells at Priest Rapids[1/], McNary, John Day, and the Dalles Dams were sampled. Sampling schedules at the various locations in 1977 were as follows:

Sampling Site	Period Sampled
Riggins, Idaho	29 March to 18 June
Whitebird, Idaho	15 March to 30 May
Lower Granite Dam	29 April to 26 June
Lower Granite Forebay	4 May to 3 November
Little Goose Dam	29 April to 20 June
Ice Harbor Dam	4 April to 21 July
Priest Rapids Dam	19 April to 13 August
McNary Dam	12 April to 15 Sept.
John Day Dam	29 April to 3 December
The Dalles Dam	8 May to 1 July

A percentage of smolts sampled at each location were marked by thermal branding (cold brand) and released. Subsequent recoveries of these fish provided information on migrational timing, magnitude, travel time, and survival. Permission was also obtained in 1977 to sacrifice a percentage of wire tagged fish collected at each sampling site in the Columbia River and in the forebay of Lower Granite Dam. These tags were read and this information was used to supplement our marking program.

1/ Sampling at Priest Rapids funded by Grant, Chelan, and Douglas County P.U.D.'s

TRAVEL TIME

Travel times through specified sections of the Columbia River system were calculated from recoveries of marked fish; the median recovery date was subtracted from median release date to provide this information. Travel times calculated in this manner reflect the movement rate of only those fish surviving from point of release to point of recapture.

TIMING

Migrational timing at Lower Granite Dam was determined by calculating the date when 50% of the estimated juvenile salmonid migration passed the dam. Timing at John Day Dam cannot be measured in this manner because fish from both the mid-Columbia and Snake Rivers are entering the gatewells at the same time. Therefore, timing at John Day Dam was calculated from recaptures of marked fish released at the upper dams during the peak of the migration at that point.

POPULATION ESTIMATES

Because of a reluctance to migrate and/or poor survival of marked fish, methods used to estimate population size in the past could not be used in 1977. In 1977 the population sizes at Lower Granite and Ice Harbor Dams were estimated by applying past collection efficiencies to the number of fish collected. Population estimates at John Day and The Dalles Dams were made by applying survival estimates derived from mark releases to the Lower Granite Dam population estimates.

SURVIVAL ESTIMATES

Estimates of survival of yearling chinook salmon and steelhead from the Snake River were calculated through three areas in 1977: (1) Lower Granite Dam to Ice Harbor Dam; (2) Ice Harbor Dam to John Day-The Dalles Dams; and (3) Lower Granite Dam to John Day-The Dalles Dams (Figure 1). Because of reluctance to migrate and/or poor survival of marked fish, survival from the Salmon River traps to Lower Granite Dam could not be measured in 1977, and all survival estimates are based on very small numbers of mark recaptures.

DIEL MOVEMENT AT DAMS

Diel movement patterns of chinook salmon smolts were examined at John Day and The Dalles Dams during 1977. Turbine intake gatewells 3A and 3B at John Day Dam (both units have vertical barrier screens) were dip-netted at 2-hour intervals over a 28-hour test period on 11 and 12 October. A similar test was conducted in turbine unit 1 at The Dalles Dam on 9 and 10 June.

FRONTROLL-BACKROLL SURVIVAL EVALUATION

The effect of predator concentrations in backroll areas of the turbine discharge tailrace on salmonid smolt survival was examined at Little Goose Dam in 1977. Spring chinook salmon and steelhead smolts were taken from the fingerling collection facility, marked by cold-branding, and released into frontroll and backroll areas below the dam on a daily basis. Evaluation of relative survival was based on mark recoveries at Ice Harbor, McNary, and John Day Dams.

HOLDOVER AND RESIDUALISM

The effects of river flow on the number of juvenile salmon and steelhead holding over or residualizing in reservoirs were measured by sampling in the reservoirs with purse seines and by sampling the turbine intake gatewells at the dams. A residual is defined as a salmon or steelhead that never goes to sea, and a holdover as one that remains in a reservoir beyond the usual downstream migration period, but which eventually goes to sea. By continuing to sample with comparable effort each year, an attempt is made to equate the number of holdovers to variations in annual or short-term river regulation. Sampling for residuals and holdovers is scheduled during early spring and late fall. Spring sampling provides information on holdover fish from the previous year; fall sampling is aimed at determining how long various groups of fish are delaying in the reservoirs before moving downstream.

PREDATION

Squawfish populations were sampled at several locations in the Snake River during 1977. Purse seines were used to sample squawfish concentrations in the area below Little Goose and Lower Granite Dams and in Lower Monumental and Lower Granite reservoirs. Ladder counts at various dams were taken to define yearly changes in squawfish abundance.

Estimates of squawfish populations below Lower Granite and Little Goose Dams in 1977 were derived by the method described in our 1976 Progress Report (Sims et al. 1977).

RESULTS

All information collected during 1977 has been compiled and analyzed, and the results are discussed in this section. (Data summaries for 1977 sampling activities are included in the Appendix).

River flows from 1974 through 1976 were high, and the spring outmigration of juveniles in the Snake and Columbia Rivers occurred during flow regimes not typical of peaking-type river regulation. In 1977, flows were so low during the outmigration that peaking-type river regulation again did not occur during the outmigration. The extreme low flows also seriously impacted smolt migrations and survival in 1977. This resulted in extremely low recovery rates of marked fish; consequently, the precision of estimates of magnitude, survival, and timing was affected.

TIMING OF MIGRATIONS AND TRAVEL TIME

Yearling Chinook Salmon, Snake River

The outmigration of yearling chinook salmon peaked at the Whitebird trap on the Salmon River on 18 April in 1977, about one week later than in 1976 (Table 1). The effect of the low river flow on the rate of downstream movement was evident. The migration did not peak at Lower Granite Dam until 9 May (21 days travel time from the Salmon River). In contrast, travel time from the Salmon River to Lower Granite Dam was 12 days in 1976 and 9 days in 1975. Additional migrational delay occurred below Lower Granite Dam. Peak migration of those fish surviving to The Dalles Dam occurred on 13 June 1977. This indicates a total travel time from the Salmon River to The Dalles Dam of 57 days in 1977 as compared to 27 days in 1976, 21 days in 1975 (years of above average flows), and 41 days in 1973 (another low flow year). Increased flows in the Columbia as a result of "Operation Fish-Flow" apparently had little effect on these fish.

Table 1.--Timing and travel time of Snake River yearling chinook salmon and steelhead in 1977.

	Chinook	Steelhead
Timing		
Salmon River-Whitebird Trap	18 April[1/]	[3/]
Lower Granite Dam	9 May[1/]	12 May[2/]
The Dalles Dam	13 June[2/]	18 June[2/]
Travel Time		
Salmon River to Lower Granite Dam	21 days	[3/]
Lower Granite Dam to The Dalles Dam	36 days	37 days
Salmon River to The Dalles Dam	57 days	[3/]

1/ Based on passage of 50% of total migration

2/ Based on marked fish recoveries

3/ Insufficient numbers collected to make estimate.

Steelhead, Snake River

The migration of juvenile steelhead in the Snake River peaked at Lower Granite Dam on 12 May 1977. Based on a very limited number (six) of mark recaptures, travel time from Lower Granite Dam to the Dalles Dam was estimated at 37 days. This represents an increase of about 20 days over 1976, and 27 days over 1975. There was no evidence that increased flows in the Columbia from "Operation Fish-Flow" benefitted Snake River steelhead.

Sockeye Salmon, Mid-Columbia River

The outmigration of juvenile sockeye salmon from the mid-Columbia River was monitored at Priest Rapids, McNary, and John Day Dams in 1977 (See Appendix Tables A5, A6, and A7). The movement of sockeye salmon peaked at Priest Rapids Dam on 14 May, at McNary Dam on 23 May and at John Day Dam on 1 June. Operation "Fish-Flow" apparently benefitted these fish. In 1973 a similar low flow year, peak migration at McNary was 17 May and at The Dalles Dam 20 June.

Yearling Chinook Salmon, Mid-Columbia River

"Operation Fish-Flow" had a positive effect on the timing of the yearling chinook salmon outmigration in the mid-Columbia River. Even with the extreme low flows recorded in 1977, the outmigration of yearling chinook salmon peaked at Priest Rapids Dam on 17 May, only 3 days later than in 1976 (Sims and Miller, 1977). Travel time from Priest Rapids Dam to The Dalles Dam was 14 days, about the same as in 1976.

"0"-Age Chinook Salmon, Mid-Columbia River

The outmigration of "0"-age chinook salmon from the mid-Columbia was monitored at Priest Rapids, McNary, and John Day Dams in 1977. Gatewell catches at the respective dams are given in Appendix Tables A5 through A7.

The outmigration of "0"-age chinook salmon at Priest Rapids Dam did not begin until 3 August in 1977, almost 2 weeks later than in 1976. Sampling operations at Priest Rapids Dam terminated on 13 August 1977; therefore, peak movement at Priest Rapids Dam was not measured. "0"-age chinook salmon did not begin to move past McNary Dam until after 1 July in 1977. The outmigration at McNary Dam began on 21 June in 1976.

Gatewell catches at John Day Dam in 1977 also indicated a significant delay in the "0"-age chinook salmon migration. More than 40 percent of the total number of "0"-age chinook salmon sampled at John Day Dam were taken after 1 September in 1977. In 1976, only 25% of the migration occurred after this date.

RELATIVE MAGNITUDE AND SURVIVAL

Survival of juvenile salmon and steelhead in the Snake River was even less than the record low levels measured in 1973 (Figure 2). This low survival reflects the record low river flows and absence of spilling in 1977. Without collection and transportation of juveniles at Lower Granite and Little Goose Dams, it is doubtful that sufficient numbers of the Snake River runs of yearling chinook salmon and steelhead would have survived to maintain viable stocks of adults in succeeding years. Survival of yearling salmon and steelhead stocks from the mid-Columbia was considerably higher as a result of the spilling and freshet provided by "Operation Fish-Flow."

Yearling Chinook Salmon, Snake River

Of the 4 to 5 million yearling chinook salmon starting migration from tributaries, only 2 million yearling chinook salmon are estimated to have

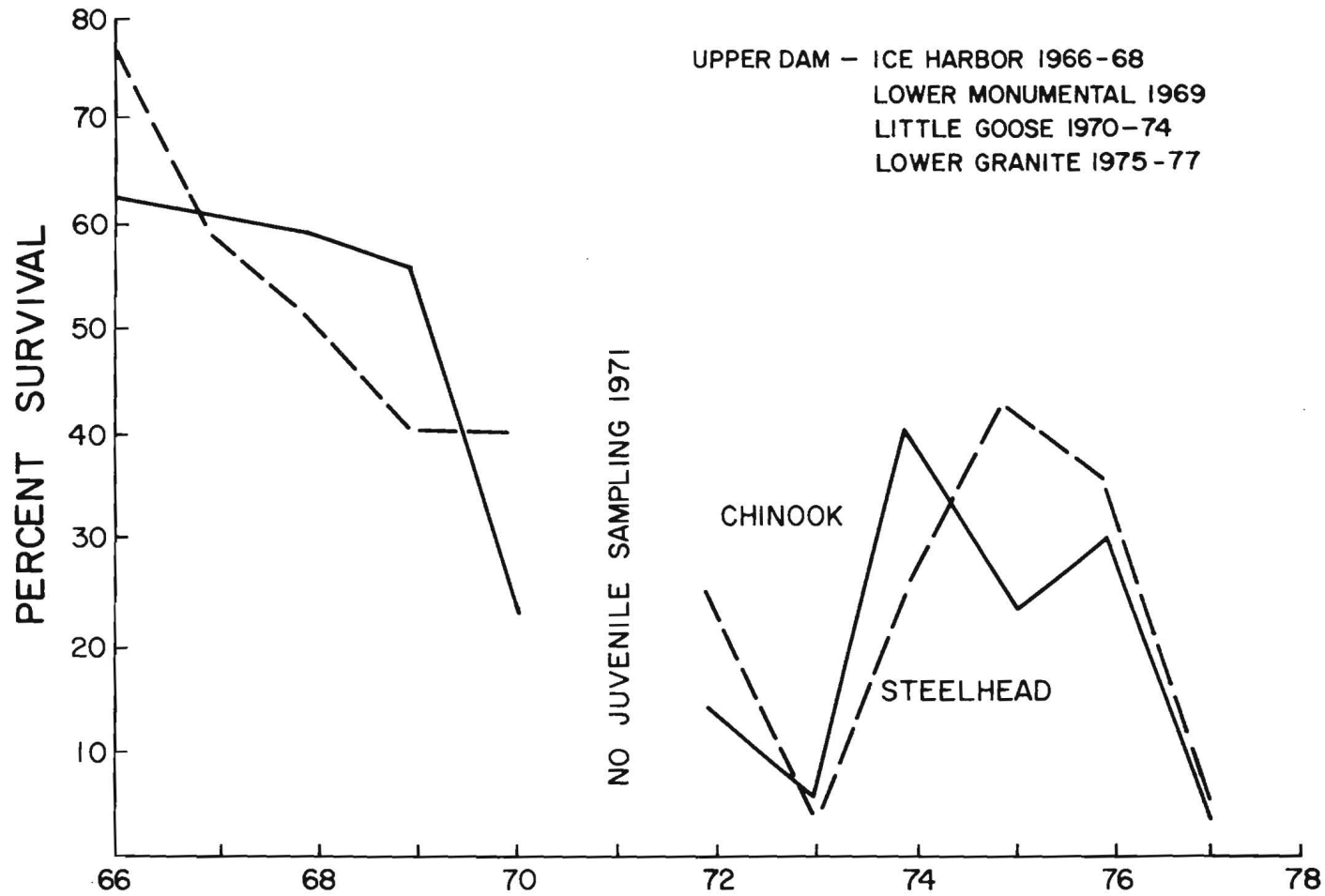

Figure 2.--Survival of juvenile chinook salmon and steelhead from the upper Snake River dams to the Dalles Dam, 1966-1977

reached Lower Granite Dam in 1977 (Table 2). This represents the smallest outmigration ever measured at the middle Snake River Dams (Table 3). Low flows in Salmon River tributaries significantly retarded migrations; (peak movement from Salmon River 1 week later than 1976) survival to Lower Granite Dam was poor and those fish surviving to Lower Granite Dam were in very poor condition (Park et al. 1978). About 1.6 million smolts were collected at the collection facilities at Lower Granite and Little Goose Dams, and 1.4 million were barged or trucked downstream. Of the 0.6 million smolts allowed to pass on downstream, less than 0.1 million survived to Ice Harbor Dam, and only 20,000 (3%) are estimated to have survived to The Dalles Dam. This compares to survival estimates of 5% in 1973 and is significantly lower than the 30 and 25% measured during more favorable passage conditions in 1975 and 1976 (Sims et al. 1976, 1977).

Steelhead, Snake River

Survival of steelhead smolts in the Snake River system was also poor in 1977 (Table 2). Of the 3 to 4 million fish estimated to have started migration from the tributaries, only 1.4 million reached Lower Granite Dam. This represents the lowest outmigration measured since 1966 (Table 3). As with chinook salmon, not all fish succumbed. Many were delayed in their migration by low tributary flows and lost their urge to migrate (see section on holdover and residualism). About 1.1 million steelhead smolts were collected at Lower Granite and Little Goose Dams and 0.9 million were transported downstream. Of the 0.5 million not transported, less than 0.1 million survived to Ice Harbor Dam, and only 10,000 were estimated to have reached the John Day-The Dalles Dams area. This indicates a survival rate of 2% or slightly less than the 4% rate measured in 1973, and well below the 36% survival measured in 1976.

Table 2.--Estimated numbers and survival of Snake River spring chinook salmon and steelhead passing Lower Granite and The Dalles Dams in 1977.

	Numbers of fish (millions)				Overall Survival C/A-B X100 (%)
	A	B		C	
Species	Lower Granite	Transported	A-B[1/]	The Dalles	
Spring Chinook	2.0	1.4	0.6	0.02	3
Steelhead	1.4	0.9	0.5	0.01	2

1/ Number of fish remaining to migrate downstream after deducting number of fish transported from Lower Granite and Little Goose Dams.

Table 3.--Estimated numbers of Snake River chinook salmon and steelhead smolts arriving at Lower Granite, Little Goose, Ice Harbor, and The Dalles Dams from 1966 to 1977.

	Number of chinook (millions of smolts)			
	Lower Granite	Little Goose	Ice Harbor	The Dalles[1/]
1966	-	-	3.0	1.9
1967	-	-	2.3	1.4
1968	-	-	2.7	1.6
1969	-	-	2.1	1.4
1970	-	5.0	1.6	1.2
1971	-	4.0	1.9	-
1972	-	5.0	1.8	0.75
1973	-	5.0	0.6	0.25
1974	-	3.5	1.7	1.4
1975	4.0	-	1.3	0.9
1976	5.1	-	2.7	1.3
1977	2.0	-	< 0.1	0.02

	Number of steelhead (millions of smolts)			
	Lower Granite	Little Goose	Ice Harbor	The Dalles[1/]
1966	-	-	1.8	1.4
1967	-	-	2.7	1.6
1968	-	-	3.7	1.9
1969	-	-	2.2	1.0
1970	-	4.7	4.0	1.9
1971	-	5.5	3.4	-
1972	-	2.5	1.5	0.5
1973	-	5.5	1.4	0.22
1974	-	5.0	4.0	1.35
1975	3.2	-	1.7	1.1
1976	3.0	-	1.8	0.9
1977	1.4	-	< 0.1	0.01

1/ John Day Dam for 1976-1977 only.

Yearling Chinook Salmon, Mid-Columbia River

The spilling at main stem dams on the Columbia River associated with "Operation Fish-Flow" resulted in significantly higher survival of spring chinook stocks in this area. Of the 4 million smolts estimated to have originated above Priest Rapids Dam, about 1 million (25%) are estimated to have reached The Dalles Dam in 1977 (Table 4). Survival of mid-Columbia stocks was not measured in 1976, but, based on Snake River survival, was probably also in range of 25 to 30%. Without the spill afforded by "Operation Fish-Flow", we can assume that survival in the mid-Columbia River would have been similar to that in the Snake River.

Steelhead Trout, Mid-Columbia River

Steelhead smolts in the mid-Columbia River appeared to have benefitted less from the special spill provided than chinook salmon smolts. Steelhead smolt survival from the upper river above Priest Rapids Dam to The Dalles Dam was estimated at 16% in 1977 (Table 4). This was lower than the 36% survival of Snake River steelhead in 1976, but significantly higher than the 3% survival estimated for Snake River stocks in 1977. It would appear that larger volumes of water will have to be spilled to raise survival enhancement of steelhead to the level attained by spring chinook salmon.

Steelhead recruitment above Priest Rapids Dam was estimated at 0.7 million fish in 1977. Of this number, 0.11 million smolts were estimated to have reached The Dalles Dam.

Table 4.--Estimated numbers and survival of mid-Columbia spring chinook salmon and steelhead passing Priest Rapids[1/], McNary, and The Dalles Dams in 1977.

	Number of fish (millions)				
	A	B	C	D	Overall survival (D/A x100)
Species	Above Priest Rapids	Priest Rapids	McNary	The Dalles	(%)
Spring chinook	4.0	2.5	1.7	1.0	25
Steelhead	0.7	0.4	0.3	0.11	0.16

1/ Monitoring at Priest Rapids funded by Grant, Chelan, and Douglas County P.U.D.'s.

"0"-Age Chinook Salmon, Mid-Columbia River

As in 1976, survival of "0"-age chinook salmon smolts from above Priest Rapids Dam appears to have been poor. Survival of two groups of wire tagged summer chinook from Wells Spawning Channel to John Day Dam averaged only 13% in 1977. By contrast, survival of wire tagged fall chinook salmon from the Priest Rapids Spawning Channel to John Day Dam was measured at 45%. Since the outmigration of "0"-age fish from above Priest Rapids Dam did not begin until the first week in August and the special spill for fish ended in mid-May, these fish received little or no benefit from "Operation Fish-Flow".

SMOLT SURVIVAL--FRONTROLL VS BACKROLL

In 1977 an attempt was made to define salmonid smolt survival in terms of frontroll and backroll release areas of the tailrace below Little Goose Dam. This was done to measure the effect of predator concentrations in backroll areas on smolt survival. More than 117,000 salmonid smolts were marked and released below the dam (Table 5). The exceptionally low river flows during the period of evaluation resulted in a substantial migrational delay and associated high mortality of test fish. As a result, recoveries at the downstream dams were too low to measure statistical differences between frontroll and backroll releases (Table 6); therefore, no valid conclusion relative to the merit of either release site was possible.

DIEL MOVEMENT PATTERNS

Diel movement of juvenile salmonids was examined at John Day Dam and The Dalles Dam in 1977. Movement patterns of "0"-age chinook were evaluated at John Day Dam on 11-12 October 1977 (Figure 3). Movement into the turbine

Table 5.--Releases of marked spring chinook salmon and steelhead smolts released into frontroll and backroll areas below Little Goose Dam in 1977.

Time Period	Number Released	
	Spring chinook	Steelhead
Frontroll releases		
2 May to 21 June	38,346	22,204
Backroll releases		
2 May to 16 June	37,405	19,751

Table 6.-- Recoveries of marked spring chinook salmon and steelhead smolts from frontroll and backroll releases at Little Goose Dam in 1977.

Recovery Point	Spring chinook recoveries (No)	(%)	Steelhead recoveries (No)	(%)
Ice Harbor Dam				
Backroll	158	0.42	56	0.28
Frontroll	129	0.34	112	0.50
McNary Dam				
Backroll	124	0.33	18	0.90
Frontroll	87	0.23	25	0.11
John Day Dam				
Backroll	41	0.11	7	0.04
Frontroll	34	0.09	12	0.05
The Dalles Dam				
Backroll	6	0.02	0	0.00
Frontroll	8	0.02	0	0.00

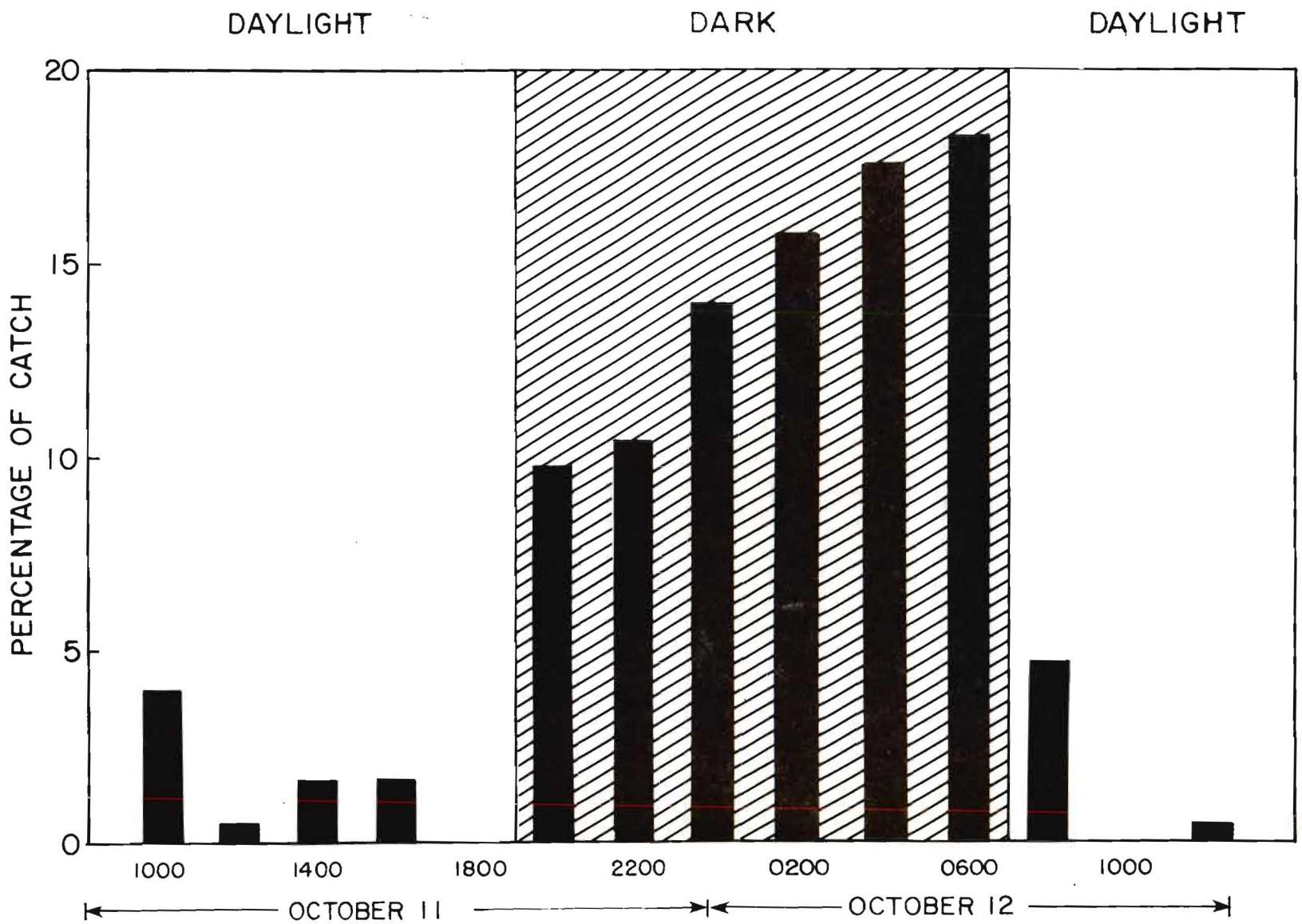

Figure 3.--Diel movement of juvenile salmon and steelhead at John Day Dam 11-12 October 1977.

intake gatewells was the same as in 1975 and 1976. More than 90% of the "0"-age chinook salmon smolts entered the turbine intake gatewells during the hours of darkness (1900 to 0600 hours).

Movement of yearling chinook salmon and steelhead smolts at The Dalles Dam in 1977 (Figure 4) were very different from patterns observed with "0"-age chinook salmon at John Day Dam. Almost 70% of the steelhead smolts and 90% of the yearling chinook salmon smolts entered the gatewells during daylight hours. Diel movement of "0"-age chinook salmon smolts measured at The Dalles Dam in 1976 also showed similar daytime movement.

HOLDOVER AND RESIDUALISM

No evidence of residualism has ever been found in the Snake or Columbia Rivers. However, holdover rates in 1977 for chinook salmon and steelhead were the highest ever seen in both rivers.

Snake River

The record low-flows in the Snake River in 1977 resulted in the holdover of record numbers of juvenile spring chinook salmon and steelhead in the various reservoirs. Purse seine catches at the Lower Monumental Index Site during the fall of 1977 averaged 8.0 chinook salmon and 15.9 steelhead per set. This exceeded the previous high holdover rate recorded in 1973 (Table 7). Turbine gatewell sampling at Ice Harbor Dam during November and December 1977 produced 511 chinook salmon and 708 steelhead (Table 8). This compares to 994 chinook salmon and 48 steelhead trout in 1976. The large number of chinook salmon taken during the fall at Ice Harbor Dam in 1976 were from the fall releases at Decker Flats and did not represent holdover fish (Sims et al, 1977). By contrast, length frequencies and coded wire tag recoveries indicated that only about one-third of the 1977 chinook salmon catch represented fall hatchery releases.

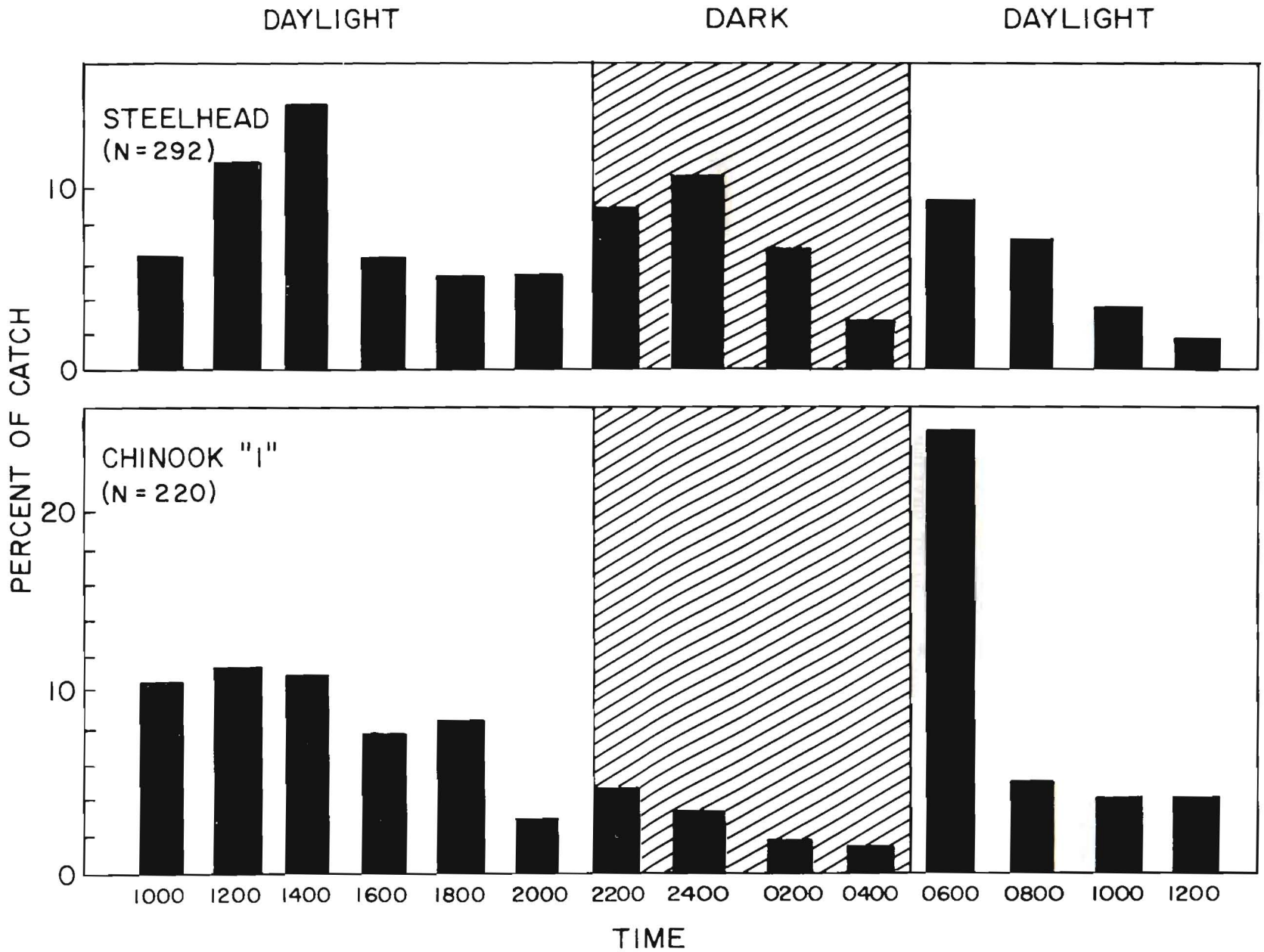

Figure 4.--Diel movement of juvenile salmon and steelhead at The Dalles Dam, 9-10 June 1977.

Table 7.--Fall purse seine catches at Lower Monumental Index Site, 1973 to 1977.

Year	Effort-Sets	Catch		Catch/effort	
		Chinook	Steelhead	Chinook	Steelhead
	(No.)	(No.)	(No.)	(No.)	(No.)
1973	12	30	154	2.5	12.8
1974	16	0	0	0.0	0.0
1975	12	0	0	0.0	0.0
1976	12	26	0	2.2	0.0
1977	26	209	413	8.0	15.9

Table 8.--Gatewell catches at Ice Harbor Dam during the fall of 1977.

Date	Yearling Chinook	Steelhead	Sockeye	Coho	Total
November 9	82	98	0	0	180
11	45	120	0	0	165
14	44	81	0	1	126
18	110	114	1	2	227
21	54	104	0	2	160
25	48	59	1	0	108
28	39	40	1	1	81
December 2	89	92	2	1	184
Totals	511	708	5	7	1,231

The holdover of juvenile salmon and trout in Lower Granite Reservoir was also monitored in 1977. Purse seines were used to sample the forebay above Lower Granite Dam from 4 May to 3 November 1977 (Appendix Table A10). Relatively large numbers of yearling chinook salmon were taken in the forebay through mid-July. During normal flow years, very few yearling chinook salmon are found in this area after mid-June. Juvenile steelhead held over in the Lower Granite Reservoir for an even longer period. Substantial numbers of steelhead remained in the reservoir until early November. Coded wire tag recoveries indicated that a large percentage of holdover steelhead in the Lower Granite Reservoir were Niagara Spring Hatchery fish that had been released into the Pahsimeroi River in early April, 1977 (Appendix Table B2).

Mid-Columbia River

For the first time since 1973, a significant delay of the yearling chinook salmon and steelhead migration occurred in John Day Reservoir in 1977. A comparison of purse seine catches during 1975 (a high flow year) and 1977 shows the extent of this delay (Figure 5). Very few yearling chinook salmon and no steelhead trout were found in John Day Reservoir by the end of July in 1975. Both species were still abundant in the reservoir when sampling was terminated in mid-November in 1977 (See Appendix Table A9).

A delay of the "0"-age chinook salmon migration has been observed in John Day Reservoir each year since 1973. The low flows in 1977 resulted in even longer delays than occurred in previous years (Figure 5). Purse seine catches of "0"-age chinook salmon in John Day Reservoir during October and November amounted to about 36% of the total June to November catch in 1975. More than 52% of the total "0"-age chinook salmon catch was made during October to November in 1977.

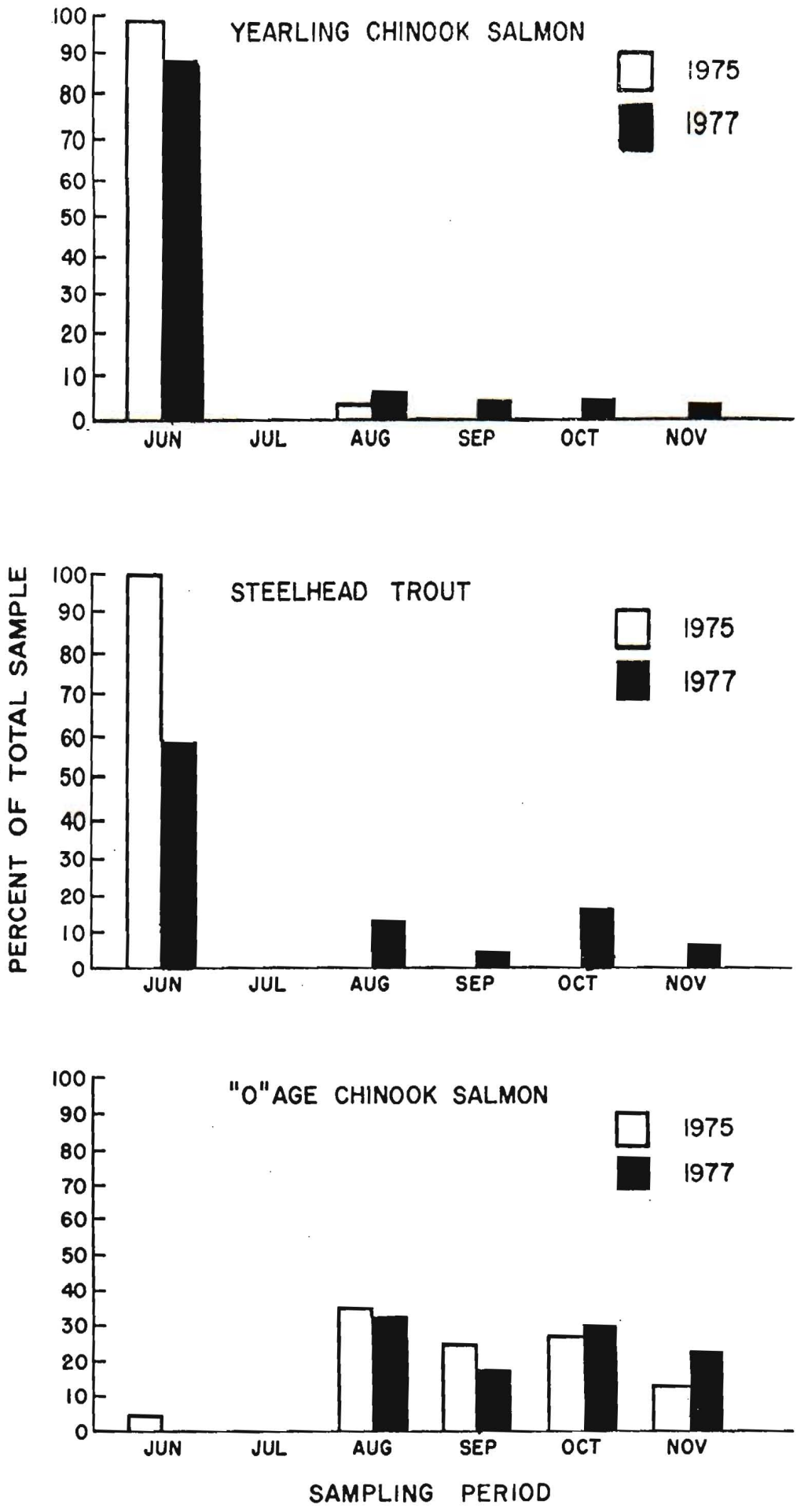

Figure 5.--Catch distribution of juvenile salmon and steelhead at John Day Dam during the summer and fall of 1977.

SQUAWFISH STUDIES

Predation studies continued in the Snake River in 1977. Sampling with purse seines was used to define squawfish populations for the first time in the tailrace areas at Little Goose and Lower Granite Dams. In both these areas, squawfish catches were less than expected during a no-spill year (Table B3). Only 301 squawfish were taken below Lower Granite Dam. Of this number, 299 were marked and released back into the tailrace. Seven of these fish were subsequently recaptured. Sampling in the tailrace at Little Goose Dam produced 1,649 squawfish. Of this total, 1,406 were marked and released, and 25 of these marked fish subsequently recaptured. Squawfish abundance in the tailrace areas at each dam was estimated as follows:

Little Goose Dam	Lower Granite Dam
$\hat{N} = 75,000$	$\hat{N} = 45,000$
$\bar{N} = 106,000$	$\bar{N} = 164,000$
$\underline{N} = 53,000$	$\underline{N} = 13,000$

Squawfish predation on salmonids was high in 1977 (Table 9). Predation index was about 88 percent (9 of every 10 squawfish stomachs examined contained salmonid remains). The predation index in 1976 was only about 20 percent (1 in 5). For the first time during this study, significant numbers of steelhead were found in squawfish stomachs.

Ladder counts at the various dams in 1977 are shown in Appendix Table B4. No counts were made at Little Goose, Lower Granite, John Day, or The Dalles Dams. Counts at McNary and Ice Harbor Dams were higher than in 1976 while counts at Lower Monumental Dam were about the same.

Table 9.--Results of food analyses of adult squawfish (180 mm. or greater) captured with purse seine below Little Goose and Lower Granite Dams in 1977.

Date	Number of fish sampled	Fish with salmonids in stomach (No)	(%)
5/11	210	210	100.00
5/12	124	124	100.00
5/27	89	77	86.52
6/1	44	11	25.00
6/22	6	6	100.00
6/24	18	3	16.67
Totals	491	431	87.80

SUMMARY

In 1977 research was continued to define the effects of dams, power peaking, and flow regulation on juvenile salmon and trout migrations in the Snake and Columbia Rivers. Juvenile salmon and trout migrations were sampled in the Salmon, Snake, and Columbia Rivers and information relative to migrational timing, travel time, magnitude, and survival was obtained. Holdover in reservoirs and predator squawfish populations were also examined.

River flows in 1977 were the lowest on record. A special action plan to protect migrating juveniles was initiated by the fishery agencies and water management entities. The plan, called "Operation Fish-Flow 1977", provided water to augment river flows and spill at Columbia River Dams. Research was conducted to evaluate the effect of this additional water for fish.

Research results for 1977 are summarized as follows:

1. Extreme low flows slowed movement, increased mortality, and caused substantial delays in juvenile salmonid migrations in the Snake River system.

2. Low river flows resulted in low recovery rates of marked fish and consequently adversely effected the precision of estimates of magnitude, survival, and timing.

3. The yearling chinook salmon migration peaked at Lower Granite Dam on 9 May 1977. Travel time from the Salmon River was 21 days. The migrational peak at The Dalles Dam occurred on 13 June. Total travel time from the Salmon River to The Dalles Dam was 57 days.

4. The steelhead trout migration peaked at Lower Granite Dam on 12 May 1977. Travel time from Lower Granite Dam to The Dalles Dam was estimated at 37 days.

5. In 1977 peak movement of sockeye salmon smolts occured at Priest Rapids Dam on 14 May, at McNary Dam on 23 May, and at John Day Dam on 1 June.

6. The timing of yearling chinook salmon in the mid-Columbia River was favorably affected by "Operation Fish-Flow". Peak migration at Priest Rapid Dam occurred on 17 May 1977, only 3 days later than in 1976. Travel time from Priest Rapids Dam to The Dalles Dam was 14 days, about the same as in 1976.

7. The migration of "0"-age chinook salmon at Priest Rapids Dam in 1977 was about 2 weeks later than in 1976.

8. About 2 million yearling chinook salmon are estimated to have reached Lower Granite Dam in 1977. About 1.4 million smolts were collected at Lower Granite and Little Goose Dams and transported downstream. Of the 0.6 million smolts allowed to pass downstream, only 20,000 (3%) were estimated to have reached The Dalles Dam.

9. Survival of steelhead smolts in the Snake River was also poor. Only 1.4 million smolts are estimated to have reached Lower Granite Dam in 1977. About 0.9 million were collected and transported downstream. Survival of the remaining fish to The Dalles Dam was estimated at 2%.

10. As a result of "Operation Fish-Flow", survival of yearling chinook smolts was higher in the mid-Columbia River than in the Snake River. Of the 4.0 million smolts estimated to have entered the river above Priest Rapids Dam, 25% (1.0 million) survived to The Dalles Dam in 1977.

11. Survival of steelhead trout smolts in the mid-Columbia River in 1977 was poorer than that of yearling chinook salmon, but better than that of steelhead smolts in the Snake River. Overall steelhead survival from above Priest Rapids Dam to The Dalles Dam was estimated at 16%.

12. Survival of "0"-age chinook from Priest Rapids Spawning Channel was good (45%), but survival of "0"-age chinook from above Priest Rapids Dam was poor in 1977. Survival of two groups of marked fish to The Dalles Dam was measured at 13 percent. The higher survival of "0"-age chinook salmon from Priest Rapids Spawning Channel was attributed to benefits resulting from "Operation Fish-Flow".

13. An attempt to define smolt survival in terms of frontroll and backroll release areas in the tailrace at Little Goose Dam was unsuccessful. Low river flows resulted in such low recovery rates for mark releases that no realistic conclusion could be made as to the merit of either release area.

14. Diel movement patterns of "0"-age chinook salmon smolts at John Day Dam were similar to those observed in 1976. About 90% of all smolts entered the turbine intake gatewells between 1900 and 0600 hours.

15. Measurement of diel movement of yearling chinook salmon and steelhead trout smolts at The Dalles Dam showed 90% of all smolts entered the gatewells during the daytime.

16. Large numbers of yearling chinook salmon and steelhead trout smolts held over in Lower Granite, Lower Monumental, and John Day Reservoirs in 1977.

17. The delay of "0"-age chinook salmon smolts in John Day Reservoir was even longer in 1977 than in previous years. About 52% of the "0"-age chinook salmon catch at John Day Dam was made in October and November.

18. Squawfish populations below Little Goose and Lower Granite Dams were estimated at 75,000 and 45,000 respectively.

19. Counts of squawfish in the ladders at McNary and Ice Harbor Dams were higher in 1977 than in 1976. Counts in the ladders at Lower Monumental Dam were about the same in 1977 as in 1976.

20. Squawfish predation on salmonids in 1977 was high. Predation index in 1977 was 88% as compared to 20% in 1976.

21. Significant numbers of steelhead smolts were found in squawfish stomachs for the first time during this study.

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APPENDIX A

Catch summaries of juvenile salmon and steelhead taken at various locations during 1977.

Table A1.--Scoop trap catches of juvenile salmon and steelhead from the Salmon River at Riggins, Idaho in 1977.

Table A2.--Scoop trap of juvenile salmon and steelhead from the Salmon River at Whitebird, Idaho in 1977.

Table A3.--Weekly samples of juvenile salmon and steelhead from the collection facility at Lower Granite Dam in 1977.

Table A4.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at Ice Harbor Dam during 1977.

Table A5.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at Priest Rapids Dam during 1977.

Table A6.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at McNary Dam during 1977.

Table A7.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at John Day Dam during 1977.

Table A8.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at The Dalles Dam during 1977.

Table A9--Purse seine catches of juvenile salmon and steelhead from the forebay of John Day Reservoir during 1977.

Table A10.--Purse seine catches of juvenile salmon and steelhead from the forebay of Lower Granite Reservoir during 1977.

Table A1.--Scoop trap catches of juvenile salmon and steelhead from the Salmon River at Riggins, Idaho in 1977.

Date	Chinook	Steelhead	Sockeye	Coho
	(No.)	(No.)	(No.)	(No.)
March 29-Apr. 11	1,367	0	0	0
April 12-19	1,648	2	0	0
20-24	871	6	0	0
25-27	1,853	9	0	0
28-30	1,982	57	0	0
May 1-3	2,030	57	0	0
4-6	1,038	109	1	0
7-11	1,033	44	0	0
12-15	993	274	0	0
16-22	961	508	0	0
23-28	2,243	955	2	0
May 29-June 3	1,072	508	4	0
June 4-10	1,752	374	2	0
11-17	2,296	179	0	0
18-24	140	7	0	0
TOTAL	21,279	3,089	9	0

Table A2.--Scoop trap catches of juvenile salmon and steelhead from the Salmon River at Whitebird, Idaho, in 1977.

Date	Chinook	Steelhead	Sockeye	Coho
	(No.)	(No.)	(No.)	(No.)
March 15-April 7	2,578	1	0	0
April 8-10	7,458	5	0	0
11-13	9,235	3	0	0
14-16	10,022	5	0	0
17-19	7,137	0	0	0
20-22	8,955	0	0	0
23-25	4,965	8	0	0
26-28	2,047	39	0	0
April 29-May 2	1,290	88	0	0
May 3-5	1,135	114	0	0
6-9	1,038	51	1	0
10-12	1,848	52	0	0
13-15	1,563	95	0	0
16-22	1,752	186	3	0
23-29	1,680	901	3	0
May 30-June 3	612	338	0	0
TOTAL	63,315	1,886	7	0

Table A3.--Weekly samples of juvenile salmon and steelhead from the collection facility at Lower Granite Dam in 1977.

Date	Chinook "0"	Chinook "1"	Steelhead	Sockeye	Coho
	(No.)	(No.)	(No.)	(No.)	(No.)
April 29-30	0	4,109	1,579	0	0
May 1-7	0	18,522	12,999	2	0
8-14	3	15,235	20,423	1	0
15-21	10	13,946	11,308	2	0
22-28	9	15,325	11,524	5	0
29-June 4	30	8,156	6,489	11	1
June 5-11	31	14,430	6,549	23	0
12-18	44	5,655	4,724	12	0
19-25	10	4,948	2,159	5	18
26	3	697	440	1	1
TOTALS	140	101,023	79,194	62	20

Table A4.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at Ice Harbor Dam during 1977.

Date	Chinook "0"	Chinook "1"	Steelhead	Sockeye	Coho
	(No.)	(No.)	(No.)	(No.)	(No.)
April 4-9	0	187	3	8	0
10-16	0	32	3	3	0
17-23	0	57	3	7	0
24-30	0	18	2	1	0
May 1-7	0	206	113	18	0
8-14	0	845	226	36	0
15-21	0	904	282	21	0
22-28	0	741	275	23	0
29-June 4	0	1,447	1,833	24	0
June 5-11	0	2,926	3,509	39	1
12-18	0	680	1,543	8	0
19-25	0	646	146	7	0
26-July 2	0	241	119	6	0
July 3-9	0	3	3	1	0
10-16	0	64	6	2	0
17-21	0	333	90	7	0
TOTALS	0	9,330	8,156	211	1

Table A5.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at Priest Rapids Dam during 1977.[1/]

Date	Chinook "0"	Chinook "1"	Steelhead	Sockeye	Coho
	(No.)	(No.)	(No.)	(No.)	(No.)
April 17-23	0	26	11	82	3
24-30	1	229	39	359	15
May 1-7	1	6,676	1,138	7,159	18
8-14	2	14,951	1,766	9,680	303
15-21	2	15,431	1,549	8,408	2,097
22-28	1	10,716	985	4,532	3,743
29-June 4	3	3,664	718	1,534	1,975
June 5-11	5	1,506	331	375	908
12-18	1	625	411	86	319
Aug. 1-6	1,740	219	40	18	39
7-13	2,351	168	37	10	41
TOTALS	4,107	54,211	7,025	32,243	9,461

1/ Sampling operations funded by Grant, Douglas and Chelan County P.U.D.'s.

Table A6.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at McNary Dam during 1977.

Date	Chinook "0"	Chinook "1"	Steelhead	Sockeye	Coho
	(No.)	(No.)	(No.)	(No.)	(No.)
April 10-16	0	0	0	0	0
17-23	-	-	-	-	-
24-30	0	33	11	3	9
May 1-7	0	192	61	18	61
8-14	0	3,468	453	316	951
15-21	1	23,417	1,430	658	1,228
22-28	0	34,527	1,435	1,326	1,606
May 29-June 4	0	8,690	917	397	967
June 5-11	0	5,160	1,487	115	646
12-18	27	2,706	1,088	21	312
19-25	189	1,263	676	12	188
June 26-July 2	438	1,384	398	10	102
July 3-9	795	705	158	3	40
10-16	1,859	913	244	5	41
17-23	1,752	494	185	5	6
24-30	2,579	164	269	6	9
July 31-Aug.6	758	48	120	3	1
Aug. 7-13	978	62	253	3	2
14-20	120	9	141	0	1
21-27	503	139	256	15	1
Aug. 28-Sept. 3	178	11	46	9	0
Sept. 4-10	46	3	41	2	6
11-17	292	19	4	0	0
TOTALS	10,515	83,407	9,673	2,927	6,177

Table A7.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at John Day Dam during 1977.

Date	Chinook "0"	Chinook "1"	Steelhead	Sockeye	Coho
	(No.)	(No.)	(No.)	(No.)	(No.)
April 29	0	278	96	20	0
May 1-7	0	303	170	17	2
8-14	2	1,693	1,012	349	165
15-21	1	9,162	2,710	2,285	536
22-28	5	15,640	4,653	3,434	1,189
May 29-June 4	4	6,910	1,550	2,596	652
June 5-11	5	4,178	1,792	1,324	686
12-18	21	4,537	2,816	1,592	504
19-25	30	3,338	1,474	1,277	590
June 26-July 2	283	1,831	365	149	117
July 3-9	406	1,253	114	134	67
10-16	1,762	1,556	133	331	94
17-23	1,853	894	202	107	96
24-30	3,011	865	167	92	121
July 31-Aug. 6	6,178	422	152	108	102
Aug. 7-13	2,238	304	154	16	87
14-20	2,318	133	277	10	127
21-27	1,456	68	109	23	93
Aug. 28-Sept. 3	3,009	79	142	56	27
Sept. 4-10	2,965	116	111	337	98
11-17	3,611	612	125	216	74
18-24	759	19	25	14	9
25-Oct. 1	1,711	18	51	58	23

Table A7.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at John Day Dam during 1977.

(continued)

Date	Chinook "0"	Chinook "1"	Steelhead	Sockeye	Coho
	(No.)	(No.)	(No.)	(No.)	(No.)
Oct. 2-8	2,123	25	32	45	14
9-15	1,069	17	29	33	9
16-22	393	7	18	17	5
23-29	586	3	7	8	10
Oct. 30-Nov. 5	1,261	8	12	18	2
Nov. 6-12	507	2	2	3	4
13-19	740	11	11	2	23
20-26	0	0	0	0	0
Nov. 27-Dec. 3	240	17	3	0	2
Totals	38,547	54,299	18,514	14,671	5,528

Table A8.--Weekly catches of juvenile salmon and steelhead from the turbine intake gatewells at The Dalles Dam during 1977.

Date	Chinook "0"	Chinook "1"	Steelhead	Sockeye	Coho
	(No.)	(No.)	(No.)	(No.)	(No.)
May 8-14	222	1,105	432	13	41
15-21	860	3,693	1,104	33	329
22-28	2,029	4,745	1,693	126	644
May 29-June 4	1,813	2,875	1,426	98	870
June 5-11	3,253	1,556	1,158	60	487
12-18	4,374	691	694	33	228
19-25	2,312	1,124	579	49	419
June 26-July 1	2,097	586	244	18	102
TOTALS	16,960	16,375	7,330	430	3,120

Table A9 --Purse seine catches of juvenile salmon and steelhead from the forebay of John Day reservoir during 1977.

Date	Chinook "0"	Chinook "1"	Steelhead	Sockeye	Coho	Sets
	(No.)	(No.)	(No.)	(No.)	(No.)	(No.)
June 15	0	192	665	0	1	4
16	0	451	17	371	106	6
17	0	40	20	318	94	6
19	0	20	127	47	15	6
20	0	95	133	8	26	4
21	0	107	196	34	12	4
22	0	270	486	152	29	4
23	0	366	377	142	17	3
24	0	407	446	171	21	5
Aug. 17	264	27	203	0	0	4
18	0	6	25	1	0	2
19	76	6	94	0	0	5
22	453	13	64	10	0	4
29	309	16	58	5	0	4
Sept. 7	131	7	24	2	0	4
8	316	9	7	0	0	4
9	342	30	11	9	0	4
Oct. 4	247	0	96	5	0	3
6	124	4	21	0	0	3
13	97	3	56	2	0	4
18	198	11	98	5	0	3
Nov. 16	112	3	29	0	0	3
Totals	2,669	2,083	3,253	1,282	321	89

Table A10.--Purse seine catches of juvenile salmon and steelhead from the forebay of Lower Granite Reservoir during 1977.

Date	No. sets	Yearling chinook		Steelhead	
		No.	No. per set	No.	No. per set
	(No.)	(No.)	(No.)	(No.)	(No.)
5/4	3	17	5.7	369	123.0
5/5	3	2,450	816.7	855	285.0
5/6	3	1,550	516.7	645	215.0
5/21	8	917	114.6	4,042	505.3
5/24	2	1,882	941.0	1,273	636.5
5/25	4	453	113.3	1,573	393.3
5/26	4	694	173.5	593	148.3
6/7	42	736	368.0	1,414	707.0
6/8	2	830	415.0	1,091	545.5
6/9	3	2,256	752.0	1,310	436.7
6/10	2	382	191.0	210	105.0
6/12	2	3,350	1,675.0	700	350.0
6/14	2	831	415.5	663	331.5
5/15	2	1,450	725.0	3,135	1,567.5
6/16	4	2,875	718.8	2,875	718.8
6/17	2	250	125.0	300	150.0
7/12	3	12	4.0	305	101.7
7/13	6	243	40.5	681	113.5
7/14	9	91	10.1	310	34.4
7/19	7	171	24.4	698	99.7
7/20	7	2	0.3	402	57.4
7/21	8	12	1.5	294	36.8
8/2	8	0	0.0	122	15.3
8/3	7	0	0.0	68	9.7
8/4	7	0	0.0	211	30.1
8/9	7	0	0.0	268	38.3
8/10	9	0	0.0	143	15.9
8/11	7	0	0.0	182	26.0
10/26	4	104 1/	26.0	189	47.3
10/27	3	33 1/	11.0	68	22.7
11/1	5	4 1/	0.8	69	13.8
11/2	5	5 1/	1.0	166	33.2
11/3	5	0	0.0	26	5.2
Totals	155	21,600		25,250	

1/ Hayden Creek smolts released Sep. 20 and Oct. 8, 1977.

APPENDIX B

Supplemental information compiled during 1977.

Table B1.--Summary of hatchery releases of juvenile chinook salmon and steelhead in the Snake River system.

Table B2.--Adipose clip recovery and coded wire tag analysis--Lower Granite Reservoir, 1977.

Table B3.--Squawfish mark and recapture statistics for purse seining in the tailrace of Lower Granite and Little Goose Dams 1977.

Table B4.--Counts of Squawfish in the fish ladders at various dams on the Snake and Columbia Rivers in 1977.

Table B1.--Summary of hatchery releases of juvenile chinook salmon and steelhead in the Snake River system.

Station	Species	Date of release	Release area
	(No.)		
	Chinook		
Rapid River	2,906,000	April	Salmon River
McCall	247,445	April 5-10	So. Fork Salmon River
Pahsimeroi	234,397	May 16-22	Pahsimeroi River
Hayden Creek	207,000	April 1-3	Lemhi River
Kooskia	1,367,865	April 20-30	Clearwater Creek
Total	4,962,707		
	Steelhead		
Hayden Creek	222,404	April 5-10	Lemhi River
Niagara Springs	1,574,700	April 5-10	Pahsimeroi River
Dworshak	1,814,428	Spring	Clearwater River
Total	3,611,532		
Late release:	Chinook		
Hayden Creek Ponds	86,000	September 20	Lemhi River
	75,000	October 8	Lemhi River
Total	161,000		

Table B2.--Adipose clip recovery and coded wire tag analysis--Lower Granite Dam Reservoir, 1977.

Recapture date	Species	Length (mm)	Tag code Agency	Data 1	Data 2	Hatchery
July 20, 1977	Steelhead	240	10	02	34	Niagara Spr.
		253	10	02	34	Niagara Spr.
		255	10	02	34	Niagara Spr.
		222	10	02	34	Niagara Spr.
		250	10	02	35	Niagara Apr.
		258	10	02	35	Niagara Spr.
		224	10	02	35	Niagara Spr.
		245	10	02	35	Niagara Spr.
		229	10	02	36	Niagara Spr.
		260	10	02	36	Niagara Spr.
		223	10	02	36	Niagara Spr.
		231	10	02	36	Niagara Spr.
		255	10	02	36	Niagara Spr.
		245	10	02	33	Hayden Ck.
		242	10	02	33	Hayden Ck.
		240	-	-	-	No tag recovered
		235	-	-	-	No tag recovered
		226	-	-	-	No tag recovered
July 21, 1977	Steelhead	223	10	02	35	Niagara Spr.
		240	10	02	36	Niagara Spr.
		226	10	02	36	Niagara Spr.
		246	10	02	36	Niagara Spr.
		276	-	-	-	No tag recovered

Table B2.--Adipose clip recovery and coded wire tag analysis--Lower Granite Dam Reservoir, 1977

(continued)

Recapture date	Species	Length (mm)	Tag code Agency	Data 1	Data 2	Hatchery
August 9, 1977	Steelhead	220	10	02	34	Niagara Spr.
		230	10	02	34	Niagars Spr.
		235	10	02	34	Niagara Spr.
		240	10	02	35	Niagara Spr.
August 10, 1977	Steelhead	240	10	02	34	Niagara Spr.
		235	10	02	34	Niagara Spr.
		230	10	02	36	Niagara Spr.

Table B3.--Squawfish mark and recapture statistics for purse seining in the tailrace of Lower Granite and Little Goose Dams, 1977.

Little Goose Dam				Lower Granite Dam			
Date	No. Caught	No. Marked	No. Recaps	Date	No. Caught	No. Marked	No. Recaps
5/9	250	163	0	5/27	112	112	0
5/10	342	325	0	6/21	23	23	0
5/11	245	192	2	6/22	10	10	0
5/12	177	115	3	6/23	0	0	0
5/13	66	64	2	6/24	19	19	0
5/17	99	93	7	6/28	69	67	2
5/18	151	148	8	6/29	62	62	0
6/1	60	52	2	6/30	2	2	0
6/2	41	41	1	7/1	4	4	0
6/3	218	218	6				
Totals	1,649	1,411	31		301	299	2

Mean length, males, 296.32 mm.
Mean length, females, 358.77 mm.
100 ♂♂ : 71 ♀♀

Mean length, males, 311.17 mm.
Mean length, females, 336.46 mm.
100 ♂♂ : 98 ♀♀

Table B3.--Adipose clip recovery and coded wire tag analysis--Lower Granite Dam Reservoir, 1977.

(continued)

Recapture date	Species	Length (mm)	Tag code Agency	Data 1	Data 2	Hatchery
July 22 , 1977	Steelhead	212	10	02	36	Niagara Spr.
		233	10	02	36	Niagara Spr.
		222	10	02	34	Niagara Spr.
		224	-	-	-	No tag recovered
August 3, 1977	Steelhead		10	02	34	Niagara Spr.
			10	02	35	Niagara Spr.
			10	02	35	Niagara Spr.
			10	13	12	Dworshak
			-	-	-	No tag recovered
Aug. 5-8, 1977	Steelhead	248	10	02	34	Niagara Spr.
		265	10	02	34	Niagara Spr.
		245	10	02	34	Niagara Spr.
		245	10	02	34	Niagara Spr.
		275	10	02	34	Niagara Spr.
		250	10	02	35	Niagara Spr.
		255	10	02	35	Niagara Spr.
		242	10	02	36	Niagara Spr.
		230	10	13	12	Dworshak
		232	-	-	-	No tag recovered
Aug. 8-10, 1977	Steelhead	239	10	02	34	Niagara Spr.
		222	10	02	34	Niagara Spr.
		278	10	02	34	Niagara Spr.
		235	10	13	12	Dworshak
		247	10	13	12	Dworshak

Table B4 .--Counts of squawfish in the fish ladders at various dams on the Snake and Columbia Rivers in 1977.

Dam	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
	(No.)	(No.)	(No.)	(No.)	(No.)	(No.)	(No.)	(No.)
McNary	477	[1]/	10,977	4,573	717	761	116	17,662
Ice Harbor	0	843	4,046	1,234	536	683	178	7,520
Lower Monumental	0	4,260	4,285	1,548	1,577	1,025	447	13,142
Little Goose	[1]/							
Lower Granite	[1]/							
Totals	477	5,103	19,308	7,355	2,830	2,469	741	38,324

[1]/ No counts taken.