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Columbia Basin Fish and Wildlife Authority

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FISH PASSAGE CENTER

ANNUAL REPORT

1990

This report responds to the Fish Passage Center annual reporting requirements to the Northwest Power Planning Council under its Columbia River Basin Fish and Wildlife Program, and the annual reporting requirements to the Bonneville Power Administration under its funding contracts which supported this work.

BPA PROJECT NO. 87-127

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We thank all the individuals, agencies, and organizations who contributed to the successful completion of the 1990 program.

Fish marked for the 1990 Smolt Monitoring Program (SMP) were provided by Idaho Department of Fish and Game (IDFG), Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), U.S. Fish and Wildlife Service (USFWS), and the Oregon Department of Fish and Wildlife (ODFW). We are indebted to the managers and staffs of Lyons Ferry, Wells, Winthrop, Leavenworth, Entiat, Priest Rapids, Ringold, Rapid River, McCall, Dworshak, Sawtooth, Magic Valley, and Irrigon hatcheries, all of whom assisted in the marking program. We extend thanks to the hatchery release coordinators, managers and staffs of all basin facilities for providing timely information on hatchery release.

We extend a special thanks to those who marked fish (PIT tagged or freeze branded) for the SMP and other programs which provide additional marked groups for travel time determinations. Fish marking was carried out by USFWS, IDFG, WDF, ODFW, and Chelan County Public Utility District (PUD).

We appreciate the efforts of the field crews at each of the monitoring sites. Sampling and reporting was carried out by WDF at McNary Dam, by WDW at Lower Monumental and Lower Granite dams, by National Marine Fisheries Service (NMFS) at John Day, The Dalles, and Bonneville dams, and by Chelan County PUD at Rock Island Dam. Juvenile fish traps located near Lewiston, Idaho were operated and sampled by IDFG. We wish to extend thanks to researchers at USFWS for their work on the physiological monitoring program.

In addition to the foregoing monitoring supported under the SMP, related activities by others, such as the fish transportation program supported by the COE, provided valuable information at various monitoring sites. The COE also provides facilities and accomodations for smolt monitoring activities at their projects.

This report was prepared by the Fish Passage Center staff: Michele DeHart, Malcolm Karr, Tom Berggren, Margaret Filardo, Larry Basham, Dave Marvin, Mike Lim, Lucy Bernard, Ted Vieira, and Coral Hughes.

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EXECUTIVE SUMMARY

Water Budget Flow Augmentation

The 1990 Water Budget Coordinated Plan of Operation (CPO) was essentially the same as the 1989 plan. The only change made to the document was the incorporation of language pertaining to Dworshak Dam releases. Specifically, flows above 10 kcfs could be allowed at Dworshak Dam on a case-by-case basis. Experience has proven that many of the actions believed by the state and federal fishery agencies and Indian tribes to be essential to protect the juvenile fish outmigration cannot be achieved through the annual process of developing the CPO. The inherent weakness in meeting juvenile fish outmigration needs is in the NPPC's Fish and Wildlife Program. The Program does not provide sufficient allocation of water for fish, contains unsuitable implementation constraints, and does not enforce execution of some components essential for fish protection. For example, the Program calls for experimentation with the Water Budget in the interest of fish survival; however, nearly all recommendations made by the Fish Passage Center on behalf of the fishery agencies and tribes, that represent any departure from the language of the Program, have been rejected. The position is exemplified by the Corps of Engineers' statement that issues involved in CPO additions and recommendations by the Fish Passage Center "...would best be resolved at a different policy-level forum." The 1990 season provided further documentation that with the inherent weaknesses of the NPPC's Fish and Wildlife Program, suitable juvenile fish passage conditions cannot be achieved with the present Water Budget concept.

The January through July runoff volume was 98% of the 50-year average (1928-1978) at The Dalles Dam, 109% at Rock Island Dam, and only 72% at Lower Granite Dam. Nine days of Snake River flow augmentation were possible in 1990, with the 449,000 acre-feet of Water Budget (305,000 acre-feet from Dworshak and 144,000 acre-feet from Brownlee). Also, the BPA 30,000 acre-feet equivalent of exchange energy stored in Brownlee was viewed by Idaho Power Company as part of the water it provided, rather than as an additional amount to be provided, as viewed by BPA. Flows in the Snake River did not reach the level requested on any of the nine Water Budget use days, and averaged 8 kcfs less than requested over that period.

Flow level requests for the lower Columbia River were again denied in 1990, on the basis of the 140 kcfs flow request limitation imposed at Priest Rapids Dam. Because of the very low Snake River flow, additional mid-Columbia River flow was needed to provide higher flows in the lower river at the time of greatest smolt passage. The Water Budget requests were denied because of the 140 kcfs limitation. Yet, when runoff and precipitation had increased, flows were averaging 182 kcfs at Priest Rapids as the result of operations for flood control and power. Because of the rejection of the

Water Budget requests, approximately 23% of the Columbia Water Budget (0.79 MAF) went unused. This amount of water would have been adequate to provide the requested flows in the lower river and increased juvenile protection.

Spill Implementation

All Parties to the Fish Spill Memorandum of Agreement supported and implemented the Agreement as written. The amount of flow spilled for fish was similar to the amount of flow spilled during 1989. However, as a result of overgeneration spill that occurred primarily during the beginning of June, 1990 was generally characterized by higher spill levels. Spill implementation could be facilitated by BPA providing projected flows rather than relying on "after-the-fact" flow scenarios to develop instantaneous spill percentages.

Smolt Monitoring Program

Annual passage indices of spring migrants were higher at Lower Granite Dam and lower at Rock Island, McNary, and Bonneville dams compared to the historical average, in spite of the fact that hatchery releases above Lower Granite, Rock Island, and McNary dams was near, or above, the average for the past five or six years. Reduced survival from lower flows during mid-May in the Snake River, and the lower contribution of mid-Columbia River yearling chinook, steelhead and sockeye may have contributed to the reduced cumulative passage indices of these spring migrants in the lower Columbia River this year.

High flows throughout June and early July in the lower Columbia River contributed to the highest cumulative passage indices for summer migrants being recorded at McNary and Bonneville dams since monitoring began at these sites. The data collected through the smolt monitoring program once again documented the close relation that exists between changes in flow and corresponding changes in the passage indices. Increases and decreases in streamflow were reflected by increases and decreases in the passage index.

With the exception of summer migrating upriver bright fall chinook, migration timing was similar to historic timing. The large number of upriver bright fall chinook passing Bonneville Dam during the period of high flow during June and early July resulted in an early 90% passage date for 1990.

Smolt monitoring of marked juvenile fish for travel time in 1990 further documented the close relation between increases in flow and corresponding decrease in travel time. Smolts migrating during the spring of 1990 in the Snake River drainage were subjected to low flows (between 40 and 80 kcfs) during most of the migration season. However, when flows in the Snake increased to over 100 kcfs, the travel time estimates obtained were reduced by one-half. In the lower Columbia River, the higher flows, which began at the end of May and continued through mid July, had a profound effect on smolt migration rates. Subyearling chinook migrated between McNary and Bonneville dams faster during 1990 than in recent years characterized by lower summer flows.

Hatchery Releases

Approximately 81 million juvenile salmonids from state, federal, and tribal fish hatcheries were released into the Columbia River Basin above Bonneville Dam. This was approximately 2.7 million more hatchery fish than were released in 1989. By major river reaches, the hatchery releases totaled 27.2 million in the Snake, 19.6 million in the mid-Columbia , and 34.2 million in the lower Columbia.

Adult Fish Passage

During 1990, most adult fish passage facilities were operated at, or near, criteria throughout the adult fish passage season. Several passage problems were observed in 1990 including: the powerhouse failure at John Day Dam and the high flow levels in the Columbia River from May 30 through the middle of June, which resulted in high spill levels and high dissolved gas levels; short term equipment failures resulting in minor fish passage delays; and, the warmer than normal water temperatures and low flows from late July through September in the Snake River, which delayed migrations and likely caused additional mortalities from stress and disease. Overall, based on counts at individual dams, the loss of fish between projects was higher than normal.

I. INTRODUCTION

The Fish Passage Center (FPC) is a technical office of the Columbia Basin Fish and Wildlife Authority (CBFWA). The FPC is operated by a fish passage manager and supporting staff, representing the seven state and federal fish and wildlife agencies and the thirteen Indian tribes included in the CBFWA membership.

Technical advice and guidance for day-to-day FPC operations are provided to the fish passage manager through the Fish Passage Advisory Committee (FPAC), a subcommittee of CBFWA, with the fish passage manager serving as committee coordinator.

Responsibilities assigned to the FPC by CBFWA encompass matters relating to both adult and juvenile salmon passage, and include consideration of resident fish needs in making water management decisions. These responsibilities incorporate those listed in the Columbia Basin Fish and Wildlife Program (Program) Sections 200, 300, 400, and 1400. Section 303(b)(1) states that, among other things, the fish passage manager is responsible for:

"*A) planning and implementing the annual smolt monitoring program called for in section 303(d)(1);*

B) developing and implementing flow and spill requests; and

C) monitoring and analyzing research results to assist in implementing the water budget and spill planning and in preparing reports."

This report responds to the Program requirement for an annual report from the Fish Passage Center to the NPPC "...that explains the scheduling of the water budget and supporting rationale for that calendar year" (Section 303(c)(3). This report summarizes the annual implementation and analysis activities carried out by the FPC in Water Budget management, spill management, and smolt monitoring. More detail is included than required by the Program, in order to provide the interested reader with a better understanding of the water management procedures involved and the results, both positive and negative.

II. 1990 WATER BUDGET FLOW AUGMENTATION

The Fish and Wildlife Program established a Water Budget volume of 1.19 million acre feet for the Snake River, and 3.45 million acre feet for the Columbia River, to be released during the downstream spring migration of juvenile salmon. The NPPC Program allows the fish passage manager to utilize the Water Budget volumes to maximize juvenile salmonid survival. The objective of the fishery agencies and Indian tribes (A&T) is to maximize protection by attempting to provide migration flows for at least 80% of the spring migration. In order to manage the limited water available for flow augmentation, the fish passage manager utilizes a broad spectrum of information sources related to hydrosystem operations, hydrology, and fish passage, including: (1) historical data bases for flow; (2) historical fish passage data bases; (3) current flow forecasts; (4) current runoff forecasts; (5) projected power and reservoir operations; (6) current hourly spill and flow; (7) current water temperature data; and, (8) current nitrogen saturation monitoring data. The most important information source for Water Budget management is the Smolt Monitoring Program (SMP), which provides fish passage data for Water Budget implementation and a data base for long term evaluation of the Water Budget. The SMP is designed to provide information on several aspects of fish passage, including: (1) passage indices of migration timing and magnitude; (2) fish physiological condition; and, (3) movement and timing of specific mark groups. The SMP addresses interacting variables which affect outmigrant survival, including flow, travel time, predation, water temperature, fish condition, and others. This information provides a basis for the management of Water Budget flows, as provided by the NPPC Program.

A. THE 1990 WATER BUDGET COORDINATED PLAN OF OPERATION (CPO)

Section 303(c) of the Program, titled "Coordination of the Water Budget," calls for a meeting by January 15 of each year of "...a committee composed of the fish passage manager, the Council's fish passage advisor, and operators of the power system." Representation on the committee from the power system includes the U.S. Army Corps of Engineers (COE), Bonneville Power Administration (BPA), Pacific Northwest Utilities Conference Committee (PNUCC), mid-Columbia Public Utility Districts (PUD), U.S. Bureau of Reclamation (USBR), and Idaho Power Company (IPC). The committee is named the Water Budget Implementation Work Group (Work Group) and is chaired by the COE.

The primary purpose of the Work Group is to review official runoff forecasts and develop a Coordinated Plan of Operation (CPO) for accounting and use of both the mid-Columbia River and Snake River Water Budgets for the current year. Subsequent meetings are held as needed during February and March. The Program calls for the COE to submit the CPO to the Council by March 20 of each year.

1. Negotiating the 1990 Water Budget CPO

The Work Group held four meetings in the process of developing the 1990 Water Budget CPO: on January 18, February 22, March 2, and March 29. At the first meeting, the COE stated that the 1990 Water Budget CPO should remain essentially the same as the 1989 CPO, with the exception that they would prefer different constraints for the Snake River, so that 85 kcfs would be the target flow and Dworshak Dam would not be required to spill. The COE further indicated that they would have a review CPO draft available before the next Work Group meeting that might incorporate Snake River changes from the 1989 CPO. The January water supply outlook indicated that 1990 would be a below average runoff year, but there was more water in storage than at this time in 1989.

Water supply forecasts available at the second Work Group meeting, held on February 22, showed improvement in runoff volumes over the January forecasts. Some reservoir drafting would be necessary to meet mid-April flood control rule curves. This action was expected to impact streamflows and the timing and magnitude of Water Budget requests, and were considerations in developing the CPO.

The draft 1990 Water Budget CPO, provided by the COE before the second meeting, was mostly unchanged from 1989 except for operation of Dworshak Dam to provide the Water Budget. Because agreement could not be reached on the COE proposed operational constraints for Dworshak Dam, it was agreed that each entity would provide written comments on the COE draft CPO, followed by another meeting prior to the next Mainstem Executive Committee (MEC) meeting, to see if an understanding could be reached by the Work Group, or if the issue should be elevated to the MEC. The MEC is a committee consisting of representatives from the state and federal fish and wildlife agencies, Indian tribes, USBR, COE, BPA, and PNUCC, which was established in 1987 to address major policy issues relating to mainstem fish passage. The USBR and PNUCC representatives indicated that their agencies probably would not comment in writing on this issue.

The third Work Group meeting was held on March 2, 1990, specifically to address Water Budget releases from Dworshak reservoir. Written comments which had been received from the FPC and NPPC were discussed. In addition, BPA comments, still in preparation, were summarized verbally by the BPA representative. The following box summarizes those three sets of comments.

BPA comments focused on three issues:

- Mid-Columbia Water Budget flow requests should not exceed 140 kcfs, measured as outflow at Priest Rapids Dam.
- Lower river target flow requests should not be allowed.
- An 85 kcfs target flow cap at Lower Granite Dam should be a CPO stated flow constraint.

<u>NPPC</u> comments focused on the Snake River Water Budget, and provided specific language for operation of Dworshak Dam:

- The Fish and Wildlife Program allows for Water Budget requests for flows up to 140 kcfs at Lower Granite Dam.

- The COE and BPA have the responsibility to decide how to provide flows from Dworshak and Brownlee dams to fulfill Water Budget requests.

- Dworshak Dam releases up to 25 kcfs should be allowed to meet Water Budget requests.

- The decision to release more than 10 kcfs from Dworshak Dam should be made by the COE on a case-by-case basis considering non-power impacts.

- In accordance with the NPPC priority recommendations for competing uses of the hydropower system (section 303(a)(8) of the Fish and Wildlife Program), water budget volumes should take priority over reservoir refill from April 15 through June 15.

<u>FPC</u> comments reiterated recommendations made for the 1989 CPO, which were still believed to be essential to adequately protect the juvenile fish outmigration; the FPC proposed specific language for operation of Dworshak Dam:

- A common fishery objective should be adopted to protect at least the middle 80% of the juvenile outmigration.

- The Snake River accounting system should be utilized in the Columbia River by measuring Water Budget use as the outflow increases required at Grand Coulee to meet Water Budget requests.

- A sliding scale should be adopted to define guaranteed power base flows at both Priest Rapids and Lower Granite dams.

- Reservoir refill should be a lower priority than providing flows for fish.

- A larger Water Budget volume commitment from Dworshak Dam should be provided and the sliding scale that drops to zero in above average runoff years eliminated.

- Flow changes outside the Water Budget period that create low flow conditions unfavorable to fish should be minimized.

- For Dworshak Dam operations,
  - Water Budget requests can be made for flows up to 140 kcfs at Lower Granite Dam up to a release of 25 kcfs from Dworshak Dam;

  - Dworshak Dam discharges in excess of 10 kcfs will be provided based on COE case-by-case evaluation of non-power impacts; and

  - Flows beyond the Water Budget commitment may be provided from Dworshak Dam if refill is not jeopardized.

A revised draft for Dworshak Dam operation (CPO Section 6(a)(3)), giving consideration to applicable comments cited above, was presented by the COE. The revised language dropped the reference to 85 kcfs as a target flow at Lower Granite Dam, and allowed for flows above 10 kcfs at Dworshak Dam, which requires spill, on a case-by-case basis. This revised draft was acceptable to the Work Group representatives.

2. The Final 1990 Water Budget CPO

The final 1990 meeting of the Work Group was held on March 22 to review water supply and refill projections, and the final 1990 Water Budget CPO draft. The latest runoff forecast (March mid-month) indicated near normal April-July runoff at The Dalles Dam, comprised of a little above average from the mid and upper Columbia River drainage, but substantially below average from the Snake River drainage. Some reservoirs were drafting for flood control but, with continued dry weather in March, it was expected that flood control requirements probably would be relaxed at most reservoirs.

The revised 1990 Water Budget CPO, which incorporated the language on Dworshak Dam releases agreed to at the March 2 meeting, was distributed for comment. This final draft by the COE was unchanged from the 1989 Water Budget CPO, except for the aforementioned Dworshak Dam operations changes, which means that all other recommendations by other Work Group members were rejected by the COE. No further comments were offered, and this CPO version was later transmitted to the NPPC and other involved parties as the final 1990 Water Budget CPO (see Appendix A for the full text). In its transmittal letter to the FPC, dated April 10, 1990, the COE stated that issues involved in the other CPO additions and modifications recommended by the FPC would be best resolved at a policy-level forum.

B. 1990 RUNOFF

The Northwest Power Planning Council's Fish and Wildlife Program 303(c)(3) requires this report to include:

1. *The actual flows achieved for the calendar year;*
2. *A record of the estimated number of smolts that passed Lower Granite and Priest Rapids dams, and the period of time over which the migration occurred; and*
3. *A description of the flow shaping used for the calendar year to achieve improved smolt survival.*

Each of these activities is dependent upon the magnitude and timing of natural runoff from the previous winter's snowpack, operation of storage reservoirs (including Water Budget flow augmentation), and the amount and distribution of precipitation during the runoff period. The following is a discussion of the 1990 runoff and precipitation and a brief discussion of the resultant streamflows. A more thorough discussion of streamflows appears later in this report.

1. Runoff Volumes

Two different periods of record are used in comparing historical runoff averages with current year averages. Power planning in the Pacific Northwest and some other hydrological analyses are based upon "critical" low periods of runoff. For these purposes, therefore, a 50-year record from 1929-78 is used in order to incorporate the critical runoff years of the 1930's and 1940's.

According to the Northwest River Forecast Center (NWRFC) of the National Weather Bureau, the 25-year period of 1961-85 has been adopted for runoff forecasts and precipitation comparisons. This is based on the premise that the shorter period more accurately reflects the present, worldwide weather cycle. The NWRFC intends to add another five years after 1990 data becomes available. Thereafter, a moving 30-year average will be used, updated in 5-year increments.

Since the 25-year period now in use does not include the very dry years in the 1930's and 40's, averages for this shorter period range from 3 to 7% higher than for the 50-year period. To be consistent with accepted reporting practices, this report uses the 50-year period in comparing observed runoff volumes, and the 25-year period in comparing runoff forecasts and precipitation.

Table 1 provides comparisons of the 1990 January through July (Jan-Jul) runoff volumes in million acre-feet (MAF), adjusted for upstream storage and diversions, in the Snake, mid-Columbia, and lower Columbia rivers with the 50-year (1929-78) averages. System runoff in 1990 as measured at The Dalles Dam was 98% of the 50-year average. This ranks 1990 as comparable to 30th out of 50 years in Jan-Jul runoff volume.

Table 1. January-July runoff comparisons.

Location	50-Year Average (MAF)	1990 Adjusted (MAF)	1990 % of 50-Yr. Average	1990 Rank (1928-78)
The Dalles Dam	101.7	99.7	98	30
Rock Island Dam	68.7	74.7	109	16
Lower Granite Dam	28.1	20.2	72	40

The January-July runoff was 109% of the 50-year average (rank 16) in the mid-Columbia River as measured at Rock Island Dam, but the Snake River produced only 72% of the 50-year average (rank 40) at Lower Granite Dam. This illustrates that, although the total runoff was near average, the percentage of 1990 runoff contribution to lower Columbia flows was much less than the 50-year average for the Snake compared to the mid-Columbia.

2. Runoff Forecasts

Runoff forecasts are made each month beginning in January by selected members of the Columbia River Water Management Group, with the April forecast designated as the "official" runoff forecast for the year. The March forecast, however, is the latest available to work with for

developing the final CPO for the season's Water Budget implementation.

Each monthly runoff forecast assumes that normal precipitation will occur throughout the duration of the forecast period. The following two tables compare the effect of departures from normal precipitation on month-to-month runoff forecasts. Table 2 compares the 1990 month-to-month Jan-Jul runoff forecasts with the 1961-85 average runoff at selected locations in the Snake, mid-Columbia, and lower Columbia rivers. Table 3 compares 1990 observed monthly precipitation with the normal (1961-85 average) for each month for comparable runoff areas.

Table 2. 1990 Forecasted vs. average (1961-85) January-July runoff.

JAN-JUL RUNOFF	ROCK ISLAND		LOWER GRANITE		THE DALLES	
	kaf	% of Ave.	kaf	% of Ave.	kaf	% of Ave.
1961-85 Ave.	70,690		31,060		108,700	
MONTHLY FORECAST:						
January	64,200	91	19,100	62	86,500	80
February	74,800	106	22,600	73	101,000	93
March	76,000	108	23,500	76	104,000	96
April	72,300	102	19,900	64	96,000	88
May	73,200	104	19,600	63	96,000	88
June	76,100	108	20,700	67	99,500	92
Adjusted	74,700	106	20,200	65	99,700	92

Table 2 shows a sizable increase in forecasted runoff volume between the January and February forecasts for each location. This corresponds with the Table 3 listing of precipitation well above normal for each watershed in January, which would lead to an increased runoff forecast for the following month. The decrease in the April forecasted runoff volume at each location (Table 2) reflects that March was a very dry month throughout the basin (Table 3). Above normal precipitation from May through August in the Columbia drainage above Grand Coulee Dam was balanced by below normal precipitation in the Snake drainage, resulting in precipitation for the entire basin above The Dalles Dam totaling about 100% of normal by the end of August. A very dry September in all areas dropped the water year total (Oct 1989-Sept 1990) to 96% of normal for the Columbia above The Dalles Dam.

Table 3. 1990 Observed vs. average (1961-85) monthly precipitation.

	Col. above Coulee		Col. above TDA		Upper Snake		Snake above IHR	
MONTH	inches observed	% of Ave.	inches observed	% of Ave.	inches observed	% of Ave.	inches observed	% of Ave.
January	4.03	124	3.77	122	1.98	82	2.54	103
February	2.27	98	2.17	99	1.49	81	1.58	89
March	0.96	52	1.23	64	0.93	54	1.27	70
April	1.53	94	2.04	124	2.41	143	2.33	142
May	3.71	181	3.07	171	2.11	95	2.64	149
June	2.81	117	1.93	100	1.14	50	1.10	61
July	1.92	127	1.20	113	0.71	56	0.77	90
August	2.02	121	1.58	125	0.78	54	1.07	102
September	0.19	11	0.31	21	1.46	83	0.50	38
Water Year:								
Oct-Sept.	28.04	104	23.27	96	16.65	74	17.04	82

A graphical comparison of how forecasted runoff varied from what actually occurred at Rock Island, Lower Granite, and The Dalles dams is shown in Figure 1. The numbers at the top of each adjusted[1] volume bar represent the percentage of the 25-year average runoff, also shown, that occurred in 1990 during each runoff period. Note that the runoff volumes illustrated in Figure 1 are the remaining runoff volumes from the forecast month through July, whereas the forecasts in Table 2 are for the Jan-Jul period updated each month. Recall that the March forecasts in Table 2 was used in preparing the CPO, because the observed runoffs in Figure 1 can only be determined after-the-fact. Forecasts for residual runoff in Figure 1, together with the month-by-month magnitude and departure of forecasted runoff from runoff that actually occurs, and the storage status of the system reservoirs have the greatest influence on the degree of in-season system operational flexibility available to meet the needs of migrating juvenile fish.

The percentage values illustrate that, for the six runoff periods, adjusted runoff ranged between 100-107% of average in the mid-Columbia River, 60-66% in the Snake River, and 90-92% in the lower Columbia River. These closely parallel the effect of monthly precipitation departures from normal, especially the above average months in the upper Columbia River watershed and below average months in the Snake River watershed.

[1] observed volume adjusted for upstream storage.

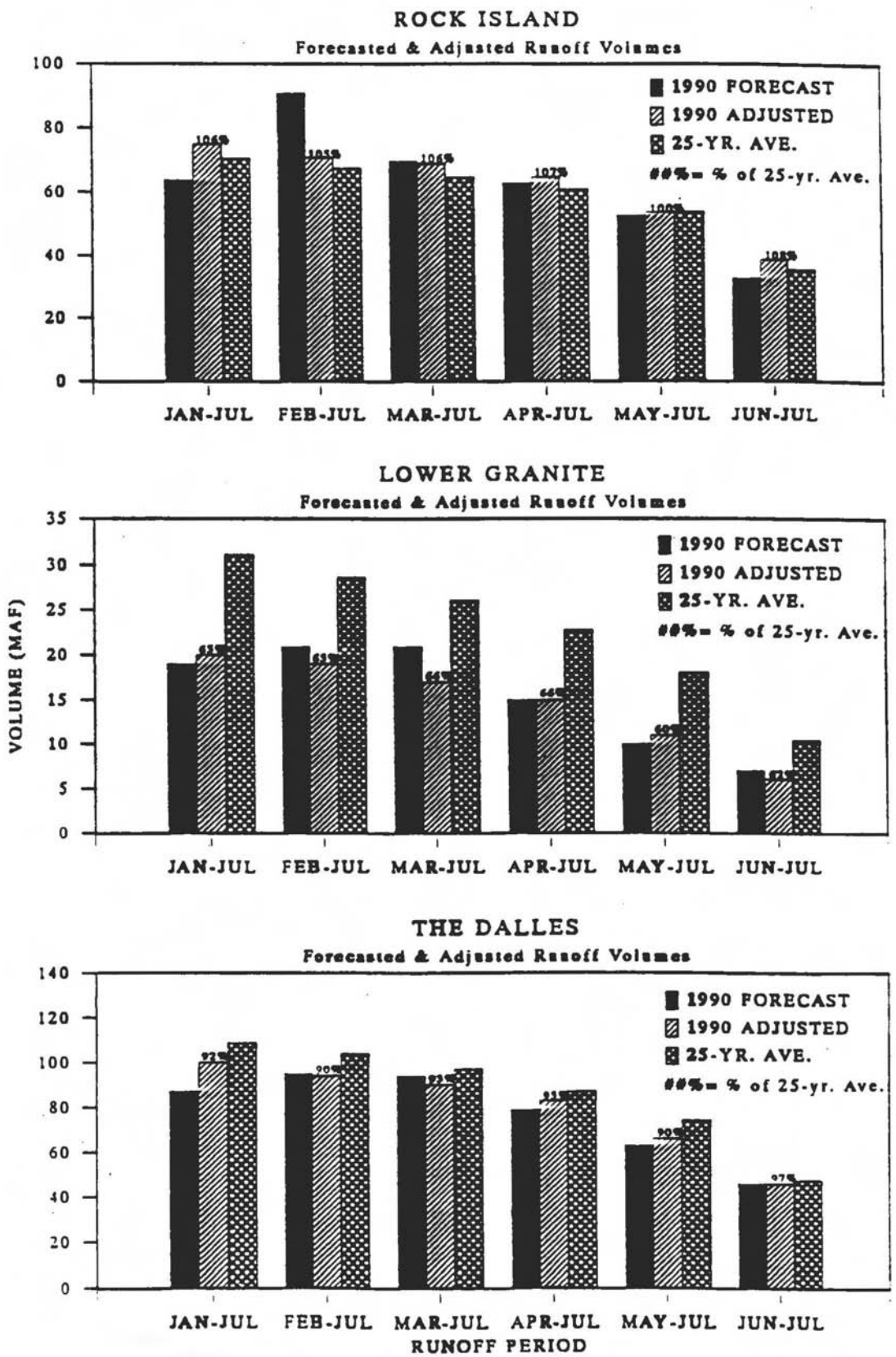

Figure 1. **1990 Forecasted and observed runoff volumes, and the 25-year average in the mid-Columbia, Snake, and lower Columbia River reaches.**

C. 1990 WATER BUDGET IMPLEMENTATION CHRONOLOGY

The following chronology summarizes the Water Budget flow augmentation decisions made going into each weekly Water Budget period, and the rationale and other considerations used in determining whether or not to submit a Water Budget request for a particular week. The discussion for a given week centers on events, circumstances, and information available at the beginning of the week. Any changes in conditions from what was anticipated when decisions were made for the week in question are also discussed.

Mid-Columbia River flow augmentation with the Water Budget is implemented in weekly time increments. Snake River flow augmentation with the Water Budget can be on a day-by-day basis because of the relatively small shapeable[2] Water Budget volume available. In either case, decisions on Water Budget usage are based on the information available at the time the decisions are made. Supporting smolt monitoring data for the discussions that follow appear in Section IV of this report.

A series of figures and tables are presented in the week-to-week chronology; they will be useful references for the discussions to follow. Figure 2 illustrates reservoir elevations from April 1 through June 30 for Dworshak, Brownlee, and Grand Coulee reservoirs, and the Water Budget use days for their respective river reaches, and illustrates the impact of the Water Budget on these reservoirs. Figure 3 shows the relationship between flows and smolt index counts in the Snake, mid-Columbia, and lower Columbia rivers, requested flow levels with Water Budget flow augmentation, and the Water Budget use days during the spring migration period. Figure 4 illustrates daily water temperatures from March through August, compared to the average for 1981 through 1989. Tables 4 and 5 summarize Water Budget requests and responses in the Columbia and Snake rivers, respectively. Detailed supporting data for statements regarding the levels of streamflows and smolt indices appear in corresponding Weekly Reports published by the FPC during the migration season. Plots of smolt migration timing at monitoring sites appear in Appendix E.

WEEK 1: APRIL 16 - 22

1. Water Budget Implementation

No Water Budget flow augmentation was requested for this week. Based on the 1990 Water Budget CPO guidelines, Dworshak reservoir was to provide 308,000 acre-feet of Water Budget shapeable by the FPC and 307,000 acre-feet for firm power base flow. Idaho Power Company (IPC) committed Brownlee reservoir participation to 150,000 acre-feet.

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2 The term "shapeable" was adopted by the COE to identify the volume of Water Budget stored in Dworshak that is controlled by the fish passage manager in terms of the timing and rate of its use to augment flows.

2. Supporting Rationale

a. Streamflow and Water Supply

Streamflows during the previous week averaged about 139 kcfs at Priest Rapids Dam, 47 kcfs at Lower Granite Dam, and 190 kcfs at The Dalles Dam. The COE projected average flows greater than 130 kcfs at Priest Rapids Dam for this week, and the computer simulation of system streamflow and reservoir regulation (SSARR) indicated an average flow of 143 kcfs at Priest Rapids for this week. The SSARR projection also indicated that Snake River flows at Lower Granite would continue at about 49 kcfs for the week.

Reservoirs were at, or near, April 30 flood control rule curve elevations (Figure 2). Therefore, additional drawdowns resulting in significant flow increases were not expected. The sizeable drop in forecasted runoff volume indicated by the April forecast could lead to reduction of flood control requirements. Planned reservoir operation at this time was to maintain Grand Coulee reservoir no lower than its April 30 flood control rule curve elevation of 1257.6 feet, and to operate Dworshak Dam at 4600 cfs outflow, which is full load on the two small units, for the remainder of April. Dworshak reservoir inflow at this time was about 17,000 cfs. This would keep more water in storage for later flow augmentation with less impact on refill probability. At the start of this week, BPA had stored the energy equivalent of about 30,000 acre-feet in Brownlee reservoir under its 1990 agreement with IPC for the Water Budget contribution from Brownlee reservoir.

b. Smolt Monitoring

Hatchery releases of spring migrants above Bonneville Dam totaled 33 million fish as of April 12 (including fall 1989 and early spring 1990 releases). This was 57% of the planned 57.8 million hatchery fish released for outmigration in the spring of 1990. Another 23.2 million hatchery summer migrants would not begin to be released until closer to mid-May, for a total of approximately 81 million hatchery fish being released for outmigration in 1990.

By the end of this week, hatchery releases of spring chinook in the Snake River drainage were nearing completion, totaling more than 15 million fish, while about 10 million hatchery steelhead still remained to be released. Smolt index counts at Lower Granite Dam exhibited a steady, rapid increase last week from about 8,000 on April 9 to nearly 71,000 on April 15 (Figure 3). Spring chinook from Lookingglass Hatchery dominated the branded recoveries, followed by spring chinook from Rapid River Hatchery. Wild steelhead ranged from 80 to 94% of the juvenile steelhead collected at Lower Granite Dam. Collections at Lower Monumental Dam continued at low levels. Transportation of juveniles collected at Lower Granite Dam was under way, with small numbers transported by truck until the run size increased and barging started on April 11. It was estimated that the Snake River migration at Lower Granite Dam reached the 10% point during the previous

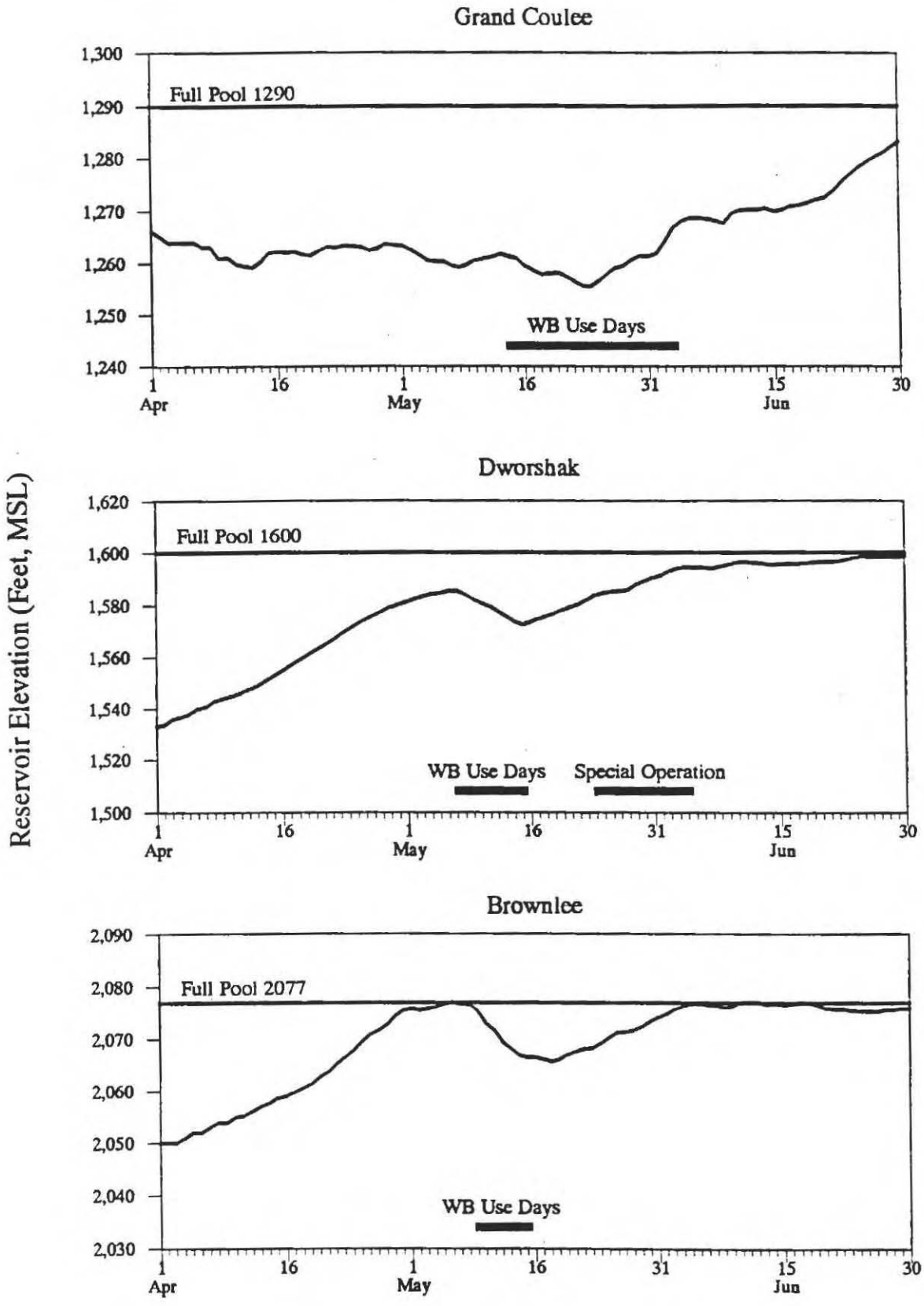


Figure 2. 1990 Reservoir elevations and Water Budget use days.

week.

During the previous week, hatchery releases in the mid-Columbia River drainage totaled only about 2 million fish, and collections at Rock Island Dam were low (Figure 3). Most of the planned spring chinook releases from mid-Columbia hatcheries were scheduled for this week.

Lower Columbia River hatchery releases totaled more than 11 million fish last week, with the second of three planned releases from Spring Creek Hatchery taking place on April 12. This required special operations at Bonneville Dam to increase smolt survival in the lower river. Most of the spring chinook releases from lower Columbia hatcheries were completed by the end of this week. About one-half of the Ringold Hatchery spring chinook releases had been accounted for at McNary Dam by April 13. Smolt transportation from McNary Dam was under way at that time.

c. Water Quality

Water temperatures were holding at about 49°F during the previous week throughout the system. This was about two or three degrees above normal for that time of year (see Figure 4). Dissolved gas data were not yet available for the 1990 season.

d. Other Considerations

Precipitation through April 19 had been only 46% of normal for the month above Grand Coulee Dam, 16% above Ice Harbor Dam, and 30% above The Dalles Dam. The 6 to 10-day weather forecast, however, indicated cooler, wetter weather, which could increase uncontrolled runoff and streamflows without the need for flow augmentation. Countering this possibility of natural increases in streamflow over the next 10 days was the fact that recent dry, warm weather with air temperatures from 10 to 15°F above normal had removed most of the low elevation snowpack, thereby reducing the residual runoff volume.

WEEK 2: APRIL 23 - 29

1. Water Budget Implementation

No Water Budget flow augmentation was requested for either the mid-Columbia or Snake rivers.

2. Supporting Rationale

a. Streamflow and Water Supply

Reservoirs continued to be operated at outflow rates needed to keep reservoir elevations within flood control rule curve requirements. Dworshak and Brownlee reservoirs continued to fill during the previous week and Grand Coulee reservoir held fairly constant at elevation 1263 (Figure 2). During the previous week, streamflows averaged 133 kcfs at Priest Rapids Dam, 65 kcfs at Lower Granite Dam, and 209 kcfs at The Dalles Dam (Table 4). The COE projected average flows greater than 140 kcfs at Priest Rapids Dam for this week, and the SSARR projections indicated that the

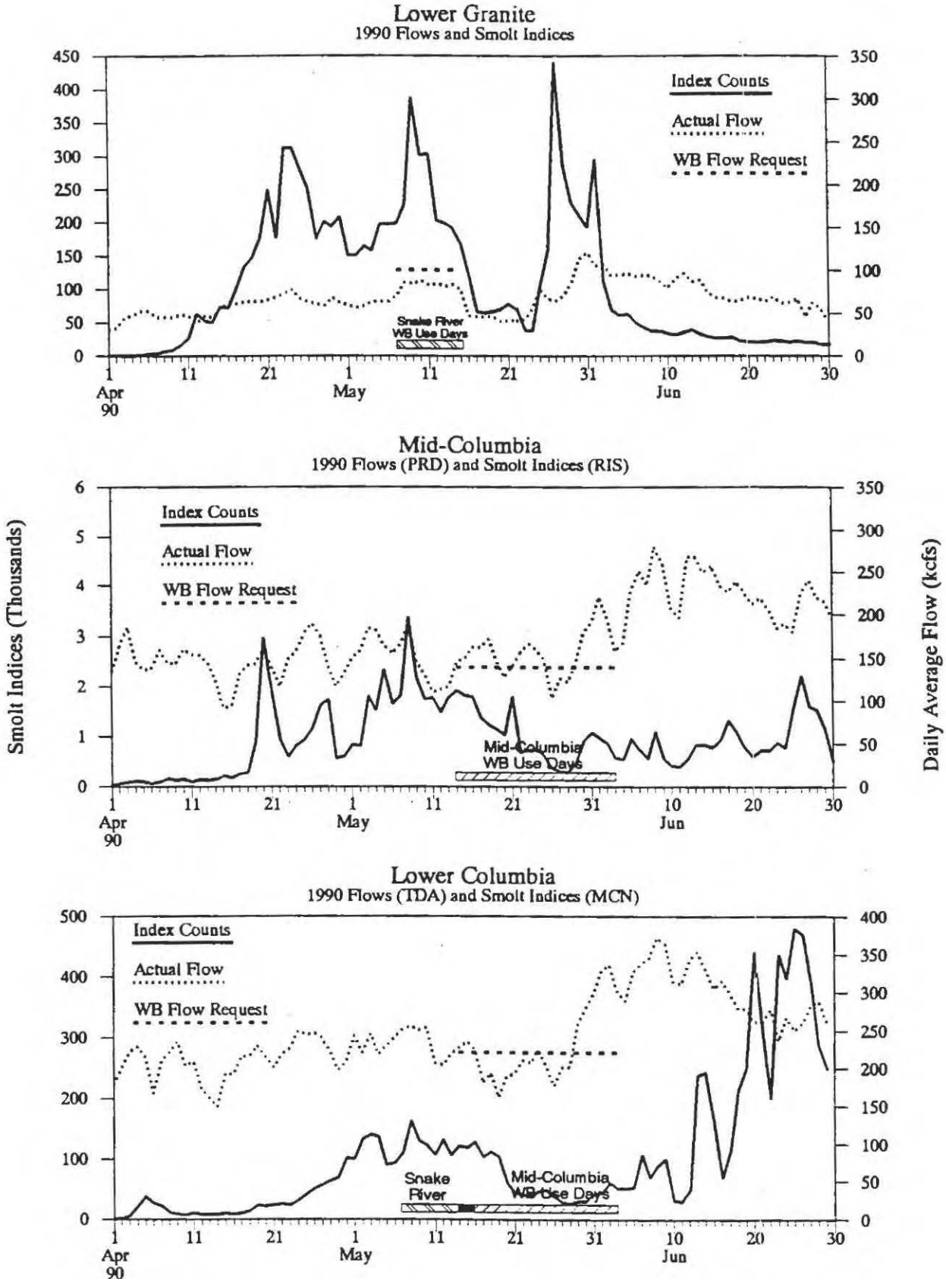


Figure 3. 1990 Smolt indices, flows, and Water Budget use days.

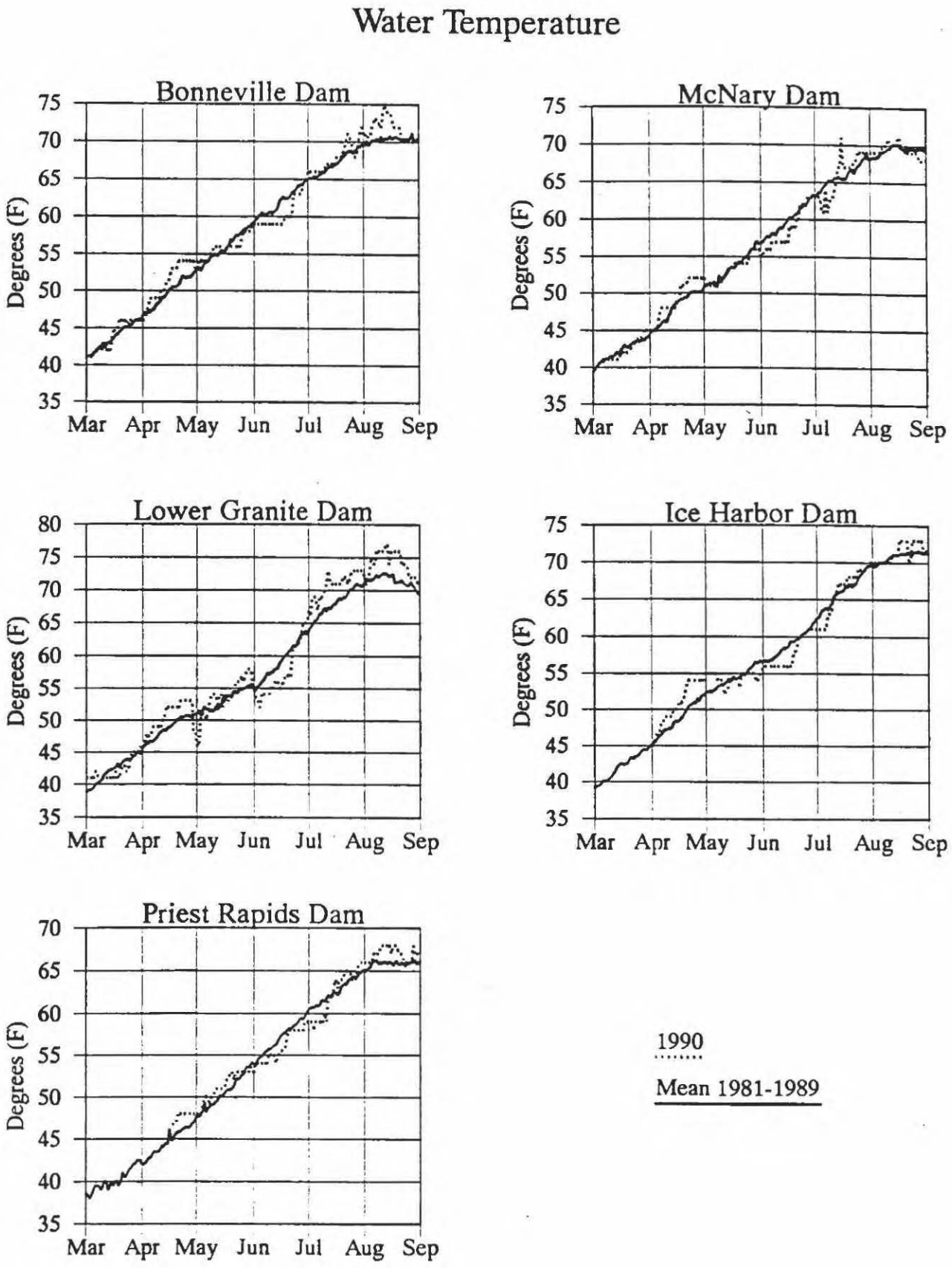


Figure 4. 1990 River temperatures at key hydroelectric projects.

Table 4. 1990 mid-Columbia Water Budget accounting and control point streamflows.

	MID-COLUMBIA				
	PRD flow kcfs	WB use MAF	WB sum MAF	TDA flow kcfs	LGR flow kcfs
APRIL 16 - 22:					
1. FP Mgrs Request	No WB				
2. Projected w/o WB	130				
3. Actual	133	0.00	0.00	209	65
4. Weekday Ave.	135		209		
5. Weekend Ave.	128		207		
6. % Wkend/Wkday	95		99		
APRIL 23 - 29:					
1. FP Mgrs Request	No WB				
2. Projected w/o WB	>140				
3. Actual	158	0.00	0.00	233	67
4. Weekday Ave.	170		236		
5. Weekend Ave.	128		225		
6. % Wkend/Wkday	76		95		
APRIL 30 - MAY 6:					
1. FP Mgrs Request	No WB				
2. Projected w/o WB	>135				
3. Actual	161	0.00	0.00	223	61
4. Weekday Ave.	162		223		
5. Weekend Ave.	161		223		
6. % Wkend/Wkday	99		100		
MAY 7 - 13:					
1. FP Mgrs Request	No WB				
2. Projected w/o WB	>135				
3. Actual	139	0.00	0.00	237	83
4. Weekday Ave.	149		250		
5. Weekend Ave.	116		205		
6. % Wkend/Wkday	78		82		
MAY 14 - 20:					
1. FP Mgrs Request	140*				
2. Projected w/o WB	>110				
3. Actual	153	0.89	0.89	206	55
4. Weekday Ave.	159		217		
5. Weekend Ave.	138		177		
6. % Wkend/Wkday	87		82		
MAY 21 - 28 (Mem. Day Wkend):					
1. FP Mgrs Request	140*			220	
2. Projected w/o WB	110				
3. Actual	141	1.01	1.90	201	58
4. Weekday Ave.	155		206		
5. Weekend Ave.	117		193		
6. % Wkend/Wkday	76		94		
MAY 29 - JUNE 3:					
1. FP Mgrs Request	140*			220	
2. Projected w/o WB	100				
3. Actual	182	0.76	2.66	283	105
4. Weekday Ave.	184		259		
5. Weekend Ave.	177		332		
6. % Wkend/Wkday	96		128		
JUNE 4 - 10:					
1. FP Mgrs Request	No WB				
2. Projected w/o WB	>140				
3. Actual	234	0.00	2.66	333	91
4. Weekday Ave.	235		319		
5. Weekend Ave.	232		367		
6. % Wkend/Wkday	99		115		
JUNE 11 - 15:					
1. FP Mgrs Request	No WB				
2. Projected w/o WB	>140				
3. Actual	248	0.00	2.66	331	88

* Basis for Water Budget accounting

weekly average would be about 161 kcfs at Priest Rapids Dam, 63 kcfs at Lower Granite Dam, and 235 kcfs at The Dalles Dam.

b. Smolt Monitoring

As of April 19, hatchery releases of spring migrants above Bonneville Dam totaled 47.9 million fish, 82.9% of the planned 57.8 million fish to be released for the springtime migration period.

Snake River collections of spring chinook showed large increases during the previous week at Lower Granite, Little Goose, and Lower Monumental dams. The daily index count for all species at Lower Granite Dam had increased from about 71,000 fish on April 15 to nearly 172,000 fish on April 22 (Figure 3). Physiological monitoring of fish collected at Lower Granite Dam on April 19 showed ATPase levels (a smoltification indicator) approach half the maximum level observed last year for spring chinook and a quarter of the maximum for steelhead. At Dworshak Hatchery, the steelhead were in good health and behaviorally appeared ready to migrate. Steelhead in Oregon hatcheries were also in excellent health. Continuous monitoring of streamflows, fish condition and ATPase level was important at this stage in the migration, to protect as many groups of fish as possible. These factors and the decision as to when to release Dworshak Hatchery's 1.2 million steelhead were to be reassessed on Monday, April 30.

Mid-Columbia passage indices at Rock Island Dam increased sharply on April 19 (Figure 3) due to the arrival of Leavenworth Hatchery spring chinook.

Lower Columbia collections at McNary Dam were dominated during the previous week by spring chinook from the mid-Columbia River drainage. McNary Dam shifted from full transport to partial bypass on April 20. Unit 5 at John Day Dam, which contained the airlift sampler, was out of service from April 16 through 18, creating a smolt monitoring gap at an important time during the spring chinook migration in the lower Columbia River.

c. Water Quality

During the previous week, water temperatures continued to be about three degrees above normal for that time of year, and reached 54°F in the lower Snake River on April 22 (Figure 4). Dissolved gas was below 110% saturation in the Snake and lower Columbia rivers, and slightly above 110% in the mid-Columbia River.

d. Other Considerations

Continuation of water temperatures above normal increased the importance of physiological monitoring, because temperature influences the rate of smoltification. Flow augmentation actions were being considered because of the influence of warmer water temperature on smoltification, fish health, and increased predator activity.

WEEK 3: APRIL 30 - MAY 6

1. Water Budget Implementation

No Water Budget flow augmentation was requested for this week for the mid-Columbia and the Snake rivers as of April 26. Rapidly changing passage conditions in the Snake River required continuous attention and prompted in-week reassessment of Water Budget flow augmentation needs by the FPC and its Advisory Committee on Monday, April 30 and Thursday, May 3. The decision reached on both of those dates, for reasons described below under Supporting Rationale, was to continue this week without a Snake River Water Budget flow augmentation request.

In regards to shapeable Water Budget in the Snake River, the BPA/IPC agreement on Brownlee reservoir participation apparently was not clear on the use of the volume equivalent of BPA-stored energy in Brownlee reservoir. BPA believed that the 30,000 acre-feet involved should be added to the IPC commitment of 150,000 acre-feet, whereas IPC took the position that the BPA storage was included in the 150,000 acre-feet commitment. This difference in interpretation represented about a one-day difference in the length of time that Snake River flows then occurring could be augmented to a desirable level with the Water Budget.

2. Supporting Rationale

a. Streamflow and Water Supply

Reservoirs were filling or holding during the previous week, with Dworshak reservoir at elevation 1573 and Grand Coulee reservoir at 1263 on April 27 (Figure 2). Flood control requirements were being adjusted daily because of fluctuating runoff conditions. During the previous week, streamflows averaged 158 kcfs at Priest Rapids Dam, 67 kcfs at Lower Granite Dam, and 233 kcfs at The Dalles Dam (Table 4).

The COE projected average flow greater than 135 kcfs for this week at Priest Rapids Dam, whereas the SSARR projection made on April 25 was for a weekly average of 145 kcfs.

Ten-day SSARR projections for the Snake River at Lower Granite Dam indicated a steady increase in uncontrolled runoff that would result in continuous daily flow increases between April 30 and May 6. That, coupled with the fact that augmenting the current April 26 flows to meaningful levels would exhaust the Water Budget in four or five days, provided some of the reasons for the FPC decision to get new SSARR projections and reassess conditions on Monday, April 30. The ten-day SSARR projections of April 30 indicated that flows at Lower Granite Dam would steadily increase from 60 kcfs to 90 kcfs by May 10, ten days later. The FPC decision was to continue day-by-day monitoring to see if the projected flows materialized, and to reassess flow conditions, along with other factors (discussed below) and options for Water Budget use on Thursday, May 3. On May 3, the ten-day SSARR projections showed Lower Granite flows reaching 100 kcfs on May 9 due to the

need to increase Dworshak Dam outflow to 10 kcfs on that date, and remaining for several more days near 10 kcfs to provide flood control space in anticipation of increased runoff. Flows after May 9 were projected to drop at a rate of about 5 kcfs per day through May 13, the 10th day out. On May 3, the FPC decision for most effective use of the Water Budget was to wait until the flows reached the projected 100 kcfs, and then use it to maintain flow at that level as long as possible. This decision was to be reassessed on Monday, May 7.

b. Smolt Monitoring

Total hatchery releases of spring migrants above Bonneville Dam as of April 26 was about 51.9 million fish, which was 90% of the planned spring outmigration releases. About 2.9 million spring migrants had been transported by April 26, mostly from Lower Granite Dam.

Snake River index counts for all species at Lower Granite Dam increased dramatically to more than 308,000 fish on April 23, and remained high with more than 246,000 fish reported on April 26 when the first Snake River Water Budget decision was made for this week (Figure 3). Yearling chinook and steelhead passage at Little Goose and Lower Monumental dams also increased greatly during the previous week. On April 30, when the assessment of passage conditions was made, it appeared that migrating fish were in good condition, except for descaling levels 2-3% above normal at Lower Granite Dam, likely due to the trash racks requiring cleaning. Spring chinook made up about 27% of the total collection at Lower Granite Dam on that date. PIT tag data indicated that wild spring chinook were arriving at Lower Granite Dam along with the hatchery fish, the largest numbers of marked wild chinook passing from April 19 to 25. Considering all factors, a decision was made on April 30 to release Dworshak Hatchery steelhead on May 3 and 4. Several days later at the May 3 assessment of passage conditions, these items were noted: (1) ATPase levels were following the trend for past years; (2) spring chinook migration was nearing the end at Lower Granite Dam; (3) steelhead median passage at Lower Granite Dam was expected during the week of May 10-16; and (4) wild chinook migration at Lower Granite peaked on April 23 and 24, based on PIT-tag data.

Mid-Columbia passage indices for yearling chinook at Rock Island Dam reached their first peaks last week on April 23 and 24, as large numbers from Leavenworth Hatchery passed the project. Spring chinook from Winthrop and Entiat hatcheries were also passing the project by the end of the previous week.

Lower Columbia passage indices followed an increasing trend last week at McNary and John Day dams (Figure 3). Brand recoveries at McNary Dam indicated that both mid-Columbia and Snake River smolts were entering the lower river. Coho, followed closely by spring chinook, was the dominant species at Bonneville Dam during the previous week.

c. Water Quality

Water temperatures remained nearly the same over the previous two weeks and, by April 29, were near normal at most locations for this time of year. Dissolved gas levels also did not show much change over that period.

d. Other Considerations

Cooler, wetter weather had increased the April precipitation nearer to normal by April 25, reaching 60% of normal above Grand Coulee Dam, 95% above Ice Harbor Dam, and 68% above The Dalles Dam. The forecast was for a few more days of temperatures below normal and precipitation above normal, with the snow level dropping to elevation 3,000 or lower, followed by a warming trend. These forecasted conditions, if held, would increase the anticipated uncontrolled runoff in the Snake drainage during the next week, thereby increasing the effectiveness of contemplated Water Budget flow augmentation.

WEEK 4: MAY 7 - 13

1. Water Budget Implementation

No Water Budget flow augmentation was requested for the mid-Columbia for this week. That decision, made on May 3, also applied to the Snake River Water Budget but was changed on Monday, May 7 because of both the failure of projected Snake River flow levels to occur and the status of the smolt migration, as described below under Supporting Rationale. The COE Reservoir Control Center was notified early on May 7 of the decision for Water Budget flow augmentation in the Snake River. The request was for flow augmentation to 90 kcfs at Lower Granite Dam, starting May 8, and continuing until the shapeable Water Budget was used or until otherwise notified by the FPC. The COE implemented the request about six hours after receiving it, bringing Dworshak Dam outflow to 25 kcfs by 1800 hours on May 7. Because additional time was needed for IPC to make power marketing arrangements, the use of Water Budget from Brownlee reservoir did not occur until May 9. Brownlee Dam outflow reached 29 kcfs by 1300 hours on that date.

2. Supporting Rationale

a. Streamflow and Water Supply

Flood control rule curves, based upon April 30 data, allowed for increased storage in May, except at Grand Coulee reservoir. These rule curves were subject to change when the official May runoff forecast became available later during this week. Until then, Grand Coulee reservoir was to be held at its May 4 level (Figure 2). Dworshak reservoir was to be held 10 feet below full pool; this would require increasing outflow to full powerhouse capacity by the middle of this week. Brownlee reservoir was nearly full on May 4. In response to recent rains and the aforementioned flood control

operations, streamflows increased during the previous week to averages for the week of about 161 kcfs at Priest Rapids Dam, 61 kcfs at Lower Granite Dam, and 223 kcfs at The Dalles Dam.

The COE provided an average flow projection of greater than 135 kcfs for this week at Priest Rapids Dam, and the May 7 SSARR projections, which took planned power operations into account, were for a weekly average of 164 kcfs.

In contrast, the increased uncontrolled runoff and accompanying streamflow projected on May 3 for the Snake River for this week did not materialize. Lower Granite flow was 21 kcfs below that anticipated, reaching only 71 kcfs on May 7. The May 7 SSARR projections showed a continuing decrease to 40 kcfs below the earlier anticipated 100 kcfs by May 11. Those declining flow projections, coupled with other factors discussed below, prompted the request for Water Budget flow augmentation this week.

b. Smolt Monitoring

Hatchery releases above Bonneville Dam of spring migrants reached 54.0 million fish on May 3, which was 93% of the planned spring outmigration release. About 5.4 million juvenile fish had been transported by that date; 3.7 million from Lower Granite Dam, 0.8 million from Little Goose Dam, and 0.9 million from McNary Dam.

Snake River index counts for all species declined at Lower Granite Dam along with decreasing flows through the start of this week, reaching a low during that period of about 146,000 fish on May 1 and 2 (Figure 3). Counts dramatically increased to more than 383,000 fish by May 9, the second day of Water Budget flow augmentation. For the remainder of this week, counts remained near or above 200,000 fish per day; flows were held above 81 kcfs, compared to the requested 90 kcfs flow level. Passage indices also increased with the higher flows at Little Goose and Lower Monumental dams.

Mid-Columbia passage indices increased at Rock Island Dam this week, reflecting the movement of several hatchery releases, and the influence of the relatively high flow of 188 kcfs on May 8.

With the exception of substantial increases in sockeye salmon passage this week at John Day, The Dalles, and Bonneville dams, lower Columbia passage indices remained fairly uniform with occasional spikes. As in the mid-Columbia River, the relatively high flow of 276 kcfs on May 9 produced a passage peak at McNary Dam.

c. Water Quality

Water temperatures dropped as low as 46°F for several days in the Snake River, 49°F in the mid-Columbia, and 51°F in the lower Columbia River. This was cooler than normal for this time of year at all locations. Dissolved gas was below 105% saturation in the lower Snake River, and ranged from 110-115% in the mid- and lower Columbia rivers.

d. Other Considerations

Late April precipitation resulted in small increases in the official May forecasted January-July runoff at most locations, except for a sizeable decrease in the Brownlee watershed which, in turn, decreased runoff measured at Lower Granite Dam. Precipitation through May 8 was only 22% of average for the month above Grand Coulee Dam, 13% above Ice Harbor Dam, and 23% above The Dalles Dam. This further worsened the runoff volume potential, adding to the difficulty of securing adequate flows in the lower Snake River, and increasing the importance of judicious Water Budget use.

WEEK 5: MAY 14 - 20

1. Water Budget Implementation

The FPC requested Water Budget flow augmentation for 140 kcfs average for this week at Priest Rapids Dam. The lower Snake River Water Budget flow augmentation request made on May 7 remained in effect until May 15, when all of the shapeable Water Budget volume was used. During that 9-day period, 305,000 acre-feet of Water Budget was provided from Dworshak reservoir and 144,000 acre-feet from Brownlee reservoir. Daily accounting of the use of the 1990 Snake River Water Budget is detailed in Table 5. To counteract the sudden drop in flows to the low 40's that followed the end of shapeable Water Budget use, the FPC requested continued flow supplementation from Dworshak and Brownlee reservoirs. Continued flow supplementation at this time would be of the greatest benefit to migrating fish, rather than immediately filling the reservoirs and later releasing excess water after the fish migration had tailed off. The COE advised the FPC that additional water could not be provided from Dworshak reservoir because the refill probability at that time had dropped to 86%.

Table 5. 1990 Snake River Water Budget accounting

Date	LGR flow kcfs	Base flow kcfs		Outflow kcfs		WB used ksfd	
		DWR	BRNin	DWR	HCD	DWR	HCD
M 5/7	70.9	9.50	—	13.90	—	4.40	—
T 5/8	86.0	9.50	—	24.90	—	15.40	—
W 5/9	84.2	9.50	11.18	25.00	20.41	15.50	9.23
T 5/10	88.6	9.50	11.49	22.50	27.45	13.00	15.96
F 5/11	83.2	2.20	13.89	21.60	24.95	19.40	11.06
S 5/12	85.0	2.20	7.55	25.00	21.49	22.80	13.94
S 5/13	81.1	2.20	10.73	24.80	21.46	22.60	10.73
M 5/14	83.5	2.20	10.49	24.70	17.85	22.50	7.36
T 5/15	77.9	2.20	10.45	20.70	14.90	18.50	4.45
						Σ 154.10	Σ 72.73
						= 305 kaf	= 144 kaf

LGR = Lower Granite Dam; DWR = Dworshak Dam; HCD = Hells Canyon Dam

2. Supporting Rationale

a. Streamflow and Water Supply

The May runoff forecast did not result in revised flood control rule curve elevations and most reservoirs continued filling. Grand Coulee reservoir was at elevation 1260 on May 11, compared to a May 31 flood control rule curve elevation of 1265. Drawdown of Dworshak and Brownlee reservoirs (13 and 10 feet, respectively) for Water Budget flow augmentation created enough storage space below their flood control rule curves to put them in a refill mode after the Water Budget was exhausted (Figure 2). During the previous week, streamflows averaged about 139 kcfs at Priest Rapids Dam, 83 kcfs at Lower Granite Dam, and 237 kcfs at The Dalles Dam (Table 4). The flow averages for the Snake and lower Columbia rivers incorporate the effect of Water Budget flow augmentation.

On May 10, the COE projected average flow greater than 110 kcfs for this week at Priest Rapids Dam, whereas the SSARR projection of May 11, which incorporated the Water Budget request, indicated that the weekly average would be 144 kcfs. SSARR projections showed a rapid drop in flows to the 40's at Lower Granite Dam following Water Budget implementation.

b. Smolt Monitoring

Only 320,600 hatchery spring migrants were released during the previous week.

Snake River index counts for all species at Lower Granite Dam once again decreased sharply as flows decreased. They dropped from 197,340 fish on May 12, when flows were 85 kcfs with Water Budget augmentation, to only 59,250 on May 17, when flows dropped to 46 kcfs following the May 15 end of Water Budget augmentation. The number of steelhead entering Lower Granite reservoir still remained high, based on collections at the Snake River and Clearwater River traps.

Mid-Columbia smolt movement past Rock Island Dam remained fairly constant during the previous week for all species except steelhead. Steelhead passage indices decreased each day.

Lower Columbia passage indices also were fairly constant for most species. Steelhead passage at McNary Dam was increasing and was expected to continue increasing as the middle of the migration approached. It was estimated that 50% of the spring chinook run was past McNary Dam and in the lower river. Snake River and mid-Columbia spring chinook hatchery stocks were at both McNary and Bonneville dams during this week.

c. Water Quality

Water temperatures increased steadily during the previous week, reaching 54°F in the lower Snake River, 52°F in the mid-Columbia, and 55°F in the lower Columbia River. This was near normal for that time of year (Figure 4). Dissolved gas continued at about 110-115% saturation in the mid-Columbia River, and below 110% in the Snake and lower Columbia rivers.

d. Other Considerations

The mid-month runoff forecasts in May showed an additional drop in both the January-July and April-July runoff volumes at all locations. These forecasts reflected the below normal precipitation so far in May, and assumed 70% of normal precipitation for the remainder of the month. Precipitation through May 15 was 72% of average for the month above Grand Coulee Dam, 60% above Ice Harbor Dam, and 65% above The Dalles Dam. The short-range outlook was for continuation of cooler-than-normal weather, which would keep the freezing level below elevation 6,000 feet and continue to slow the rate of snowmelt.

WEEK 6: MAY 21 - 28 (8 days including Memorial Day)

1. Water Budget Implementation

The status of juvenile fish migration in the lower Columbia River, coupled with a sharp drop in flow contribution from the Snake River, prompted the FPC on May 17 to request Water Budget flow augmentation for an average of 220 kcfs for this week at The Dalles Dam. To meet this average flow level might have required flow greater than 140 kcfs at Priest Rapids Dam on some days, which would have been accounted for as Water Budget usage. The COE response, however, was to provide only a weekly average flow of 140 kcfs at Priest Rapids, even though that might not provide the requested flow level at The Dalles Dam. On May 21, the FPC reiterated the lower river flow request for 220 kcfs weekly average at The Dalles Dam. This did not change the earlier stated COE position. On May 22, the FPC requested cessation of the John Day reservoir storage operations that were taking place, as those operations further reduced lower river flows at a time when increased flows were urgently needed. The COE concurred in this case, and took action accordingly.

In addition to the request made the previous week for supplemental flows from Dworshak and Brownlee reservoirs, the FPC this week requested that nighttime flows at Lower Granite Dam be increased to 80 kcfs during the hours of 2000 to 0200 from May 24 through 28 to help move juvenile fish through the reservoir. The COE/BPA decision on that request was to pass inflow or greater from 2000 to 2400 hours during the five nights requested. About mid-week, the COE also decided to increase Dworshak outflow to full hydraulic capcity of 10 kcfs, because current rain-induced runoff increases would allow the FPC's request for supplemental flow to be met without jeopardizing refill. The increased Dworshak Dam outflow would help maintain flood control space. The combination of nighttime flow shaping starting May 24, and the Dworshak Dam outflow increase to hydraulic capacity starting May 25, were termed "special operations", although the Dworshak reservoir contribution was part of the non-shapeable Water Budget commitment.

2. Supporting Rationale

a. Streamflow and Water Supply

The reservoir system continued to refill, except for Grand Coulee reservoir, which was providing mid-Columbia Water Budget flow augmentation releases. As of May 23, Dworshak reservoir had recovered about 10 feet since the May 15 end of Water Budget releases and was 18 feet from full; Brownlee reservoir had recovered about 2 feet and was 9 feet from full. Grand Coulee was at elevation 1256, which was below its flood control rule curve and 34 feet from full. Streamflows during the previous week averaged about 153 kcfs at Priest Rapids Dam, 55 kcfs at Lower Granite Dam (including the last 2 days with Water Budget flow augmentation), and 206 kcfs at The Dalles Dam.

On May 17, the COE provided an average flow projection of 110 kcfs for this week at Priest Rapids Dam. After power marketing plans incorporated Water Budget flow augmentation, the May 21 SSARR projection was for a weekly average of 140 kcfs at Priest Rapids Dam. Snake River projections were for the weekly average to be only 47 kcfs which, when added to mid-Columbia flows, would result in a lower Columbia average for the week of less than 200 kcfs. Hence the FPC requested 220 kcfs average flow at The Dalles Dam.

b. Smolt Monitoring

Approximately 3.4 million hatchery spring migrants were released above Bonneville Dam during the previous week, completing the planned releases for 1990's spring outmigration. Hatchery releases of 8.2 million summer migrants began during the previous week, which was 35% of the planned 23.2 million fish for the 1990 summer outmigration period. Juvenile fish transportation totaled 9.5 million fish from the three collection projects, about equally divided between yearling chinook and steelhead.

Snake River index counts at Lower Granite Dam continued their steady decrease with the decreasing flows, reaching a low of 29,000 fish on May 24, the day the special flow operations described above were instituted. Smolt index counts responded to these flow improvements with a jump to nearly 430,000 fish three days later on May 27. The total index count for the five days preceding these operations was only about 250,000 fish, compared to about 1,300,000 fish for the five days following their start. These improved passage conditions were occurring later than desired. The physiological monitoring of steelhead from the run-at-large at Lower Granite Dam showed ATPase values leveling off for both wild and hatchery stocks since May 17. If further migration delays were experienced; these steelhead in time would begin to revert back to parr, thus reducing survival upon saltwater entry. This is another reason for FPC requesting higher lower river flow levels.

Mid-Columbia index counts for steelhead were projected on May 25 to be only about 40% of the total annual index anticipated for 1990 at Rock Island Dam, and between 50 and 75% of what was

anticipated at McNary Dam. These projections were based on the number of hatchery steelhead released above each site and the historic ratio of annual passage index to hatchery release.

Lower Columbia collections at Bonneville Dam were dominated early in the previous week by the final release of Spring Creek Hatchery tule fall chinook for the season, and by coho at the end of that week.

c. Water Quality

Water temperatures remained near normal for this time of year (about 55°F) and dissolved gas was about 115% saturation in the mid-Columbia and below 110% saturation elsewhere in the system.

d. Other Considerations

Hatchery releases of subyearling salmon were scheduled throughout late spring and early summer. June releases were scheduled for hatcheries in the lower Snake, lower Columbia, and Hanford section of the mid-Columbia rivers.

The weather trend for this week and into the next week was for temperatures below normal and precipitation above normal, which were predicted to help keep Snake River passage conditions from further deterioration.

WEEK 7: MAY 29 - JUNE 3 (six days following Memorial Day)

1. Water Budget Implementation

The Water Budget flow augmentation decision for this week, made by the FPC on May 24, was to continue the attempt to maintain higher flows in the lower Columbia by requesting a weekly average of 220 kcfs at The Dalles Dam. The COE again planned to treat that as a request for 140 kcfs weekly average flow at Priest Rapids Dam. Dworshak reservoir continued to operate at hydraulic capacity because of increasing runoff, and began to spill water at the end of this week (June 4) in order to retain about 5 feet of flood control space. This provided the needed flow increases in the lower Snake River, and prompted a May 29 request from the FPC to continue special operations at Dworshak and Lower Granite reservoirs through June 4.

2. Supporting Rationale

a. Streamflow and Water Supply

Runoff responses to relatively heavy late May precipitation increased inflow into storage reservoirs and accelerated refill, bringing flood control rule curves into consideration. Mid-week (June 1) plans were to regulate Arrow reservoir outflow in order to maintain flood control space in Grand Coulee reservoir. To prevent Dworshak reservoir from filling too fast, the project outflow would continue at full hydraulic capacity or greater until reservoir inflow decreased below hydraulic capacity, which was estimated to occur about June 10. Then outflow would be reduced to fill the

reservoir. Brownlee Dam would release 7 to 12 kcfs until the reservoir was full, estimated to occur on June 2, and then pass inflow, which would be about 20 kcfs at that time. Streamflows during the preivous week averaged about 141 kcfs at Priest Rapids Dam, 58 kcfs at Lower Granite Dam, including the higher releases from Dworshak Dam, and 201 kcfs at The Dalles Dam. An average flow of 220 kcfs had been requested for The Dalles Dam (Table 4). By the end of the previous week, 1.9 MAF of the 3.45 MAF total Columbia River Water Budget allocation had been used. Using 140 kcfs at Priest Rapids Dam for Water Budget accounting, Water Budget use would total 2.66 MAF at the end of this week.

The COE projection on May 24 was for an average flow of 100 kcfs for this week at Priest Rapids Dam. In actuality, the increased runoff and resulting storage operations for flood control and power described above produced an average of 182 kcfs at Priest Rapids Dam for this week. These conditions produced better flow levels in the Snake and lower Columbia rivers this week, averaging 105 kcfs at Lower Granite Dam and 283 kcfs at The Dalles Dam. These were the highest flows of the spring migration season in the Snake and lower Columbia rivers.

b. Smolt Monitoring

As of May 24, hatchery releases of summer migrants totaled 10.6 million fish, 46% of the planned releases for the 1990 summer outmigration season. No new hatchery releases were made this week, although many of the previous week's releases were still underway. The juvenile fish transportation total as of May 25 was 10.8 million fish: 6.9 million from Lower Granite Dam, 1.5 million from Little Goose Dam, and 2.4 million from McNary Dam.

Snake River index counts at Lower Granite Dam continued to respond to improved flow levels, remaining above 200,000 fish daily through May 30 and peaking again at more than 285,000 fish on June 1 with flows above 100 kcfs. It appeared that higher flows during this week were succeeding in flushing many of the remaining spring migrants from the Snake River.

Mid-Columbia index counts exhibited a similar response to flows as high as 221 kcfs at Priest Rapids Dam on May 31, with consistent increases in the passage indices at Rock Island Dam. Indications were that many of the remaining spring migrants in the mid-Columbia River also had reached the lower Columbia River by the end of the week.

Lower Columbia passage indices for subyearling chinook also increased dramatically at McNary, The Dalles, and Bonneville dams in response to increased flows, which were well above 300 kcfs in the lower river for several days during this week. Index count increases for yearling chinook and steelhead at John Day and The Dalles dams reflected a barge release of about 600,000 fish (85% steelhead, 15% chinook) into John Day reservoir on May 30. This release was necessary because a control room fire caused the total shutdown of John Day Dam on May 29, and made the navigation

locks inoperable due to lack of power.

c. Water Quality

By the end of the previous week, water temperatures leveled off around 54°F in the mid-Columbia, 56°F in the Snake, and 58°F in the lower Columbia rivers, a few degrees below normal. Dissolved gas readings ranged from 105 to 110% saturation in the Snake and lower Columbia rivers above John Day Dam, and from 110 to 117% in the mid-Columbia River. The aforementioned outage at John Day Dam, which required all flow to be passed as spill, caused a jump in dissolved gas from 125 to 135% saturation at The Dalles Dam, and from 120 to 128% at Bonneville Dam. Monitoring of fish passing those two projects, while dissolved gas saturation was above 125%, showed a high percentage of smolts with gas bubble disease, especially steelhead. This undoubtedly had adverse impact on the migrants, but the magnitude of the mortalities was unknown (see Section III of this report).

d. Other Considerations

Increases in natural runoff and accompanying streamflows were anticipated because of the wet weather in late May. Precipitation totals for the month were 227% of average above Grand Coulee Dam, 141% above Ice Harbor Dam, and 182% above The Dalles Dam. Snow was occurring this week above 4,000 feet elevation in some areas. The freezing level was expected to reach 7,000 feet the following week, and precipitation was expected to remain normal. Under these conditions, continued relatively high runoff was anticipated the following week.

The large numbers of fish arriving at Lower Granite Dam in response to improved flow conditions were taxing the raceway holding capacity, making it imperative to keep the fish transport barges moving without interruption. Thus, the decision was made to release the barge load with juvenile fish below McNary Dam when the John Day navigation lock was inoperable and blocked barge traffic in either direction. This allowed the barge to return to Lower Granite Dam for additional loading from the raceways, rather than continuing downstream to release the fish nearer John Day Dam or wait until the lock was repaired.

WEEK 8: JUNE 4 - 10

1. Water Budget Implementation

With flows at The Dalles Dam were expected to average more than 240 kcfs this week. Therefore, the FPC did not request Water Budget flow augmentation on May 31 for this week, but did retain the option to do so later in the week if flows at The Dalles Dam were scheduled to go below 220 kcfs. At the start of this week, there was 0.79 MAF of unused mid-Columbia Water Budget remaining. Snake River flows were 114 kcfs at Lower Granite Dam on May 31. This flow

level provided good passage conditions so that additional flow augmentation requests were unnecessary.

2. Supporting Rationale

a. Streamflow and Water Supply

Grand Coulee reservoir was expected to be at its flood control rule curve elevation of 1270 (20 feet from full) by June 10; after that date it would pass inflow in order to retain flood control space. Dworshak Dam continued to release flows in excess of its hydraulic capacity in order to retain about five feet of flood control space in the reservoir. This operation was expected to continue as long as inflow (now about 15 kcfs) remained relatively high. Brownlee reservoir was now full and passing about 20 kcfs inflow. As stated earlier, streamflows during the previous week averaged 182 kcfs at Priest Rapids Dam, 105 kcfs at Lower Granite Dam, and 283 kcfs at The Dalles Dam. Even higher flows were expected for this week at Priest Rapids and The Dalles dams, although the COE provided a projection on May 31 for a weekly average of greater than 140 kcfs at Priest Rapids Dam without an indication of how much greater. In contrast, the May 30 SSARR streamflow projections indicated an average for this week of 175 kcfs at Priest Rapids Dam and 244 kcfs at The Dalles Dam.

b. Smolt Monitoring

Subyearling fall chinook releases of 9.2 million fish began this week at Priest Rapids and Lyons Ferry hatcheries. These releases were scheduled to be made over 12 to 36 days at each respective hatchery. These releases brought the total hatchery release for summer migrants to 19.8 million fish, 85% of the planned total for the season.

Snake River passage indices for spring migrants were decreasing during the previous week at all of the projects, indicating that high flows since May 30 probably had moved most of the spring migrants to transportation facilities or into the lower Columbia River.

Mid-Columbia passage indices for spring migrants were also decreasing during the previous week at Rock Island Dam, indicating that most of the mid-Columbia spring migrants had reached the lower river. This was reflected in a corresponding decrease in passage indices at McNary Dam. The higher flows since May 30 also increased the passage indices of subyearling fall chinook at both Rock Island and McNary dams.

Increases in the lower Columbia passage indices for subyearling chinook at The Dalles and Bonneville dams also reflected the increased flows. It was estimated that with the lower river flows ranging between 280 and 340 kcfs from May 30 to June 3, the fish released from barges below McNary Dam traveled at an average speed of 40 miles per day to Bonneville Dam.

c. Water Quality

Water temperatures remained in the range of 52-59°F, which kept them a little below normal for

this time of year. Resumed operation and reduced spill at John Day Dam reduced dissolved gas levels at Bonneville Dam to below 115% saturation by the end of this week, virtually eliminating gas bubble disease observations at the monitoring sites.

d. Other Considerations

June precipitation to day 5 was 307% of average above Grand Coulee Dam, 74% above Ice Harbor Dam, and 222% above The Dalles Dam. That, together with the outlook for continued wet weather for the next week, indicated that there might not be need for any additional Water Budget flow augmentation this year.

WEEK 9: JUNE 11 - 15 (last 5 days)

1. Water Budget Implementation

Continuing high flows in the lower river precluded any request for Water Budget flow augmentation on the June 7 decision date. The mid-Columbia Water Budget usage ended on June 3 with a total of 2.66 MAF used (Table 4). The 0.79 MAF unused would have been more than adequate to maintain the flow level requested at The Dalles Dam for the week of May 21 to 28, and would have reduced the high flow levels required from May 29 to June 15 to meet flood control requirements.

2. Supporting Rationale

a. Streamflow and Water Supply

Considerable runoff potential remained at the end of this week, as evidenced by a snow survey of the Dworshak watershed showing the snowline at elevation 5300 feet with 19% of the area still with snow cover. Portions of the Flathead watershed snow in the upper Columbia still held 200-300% of the normal water content for this time of year. As a result, Grand Coulee Dam was passing 215 kcfs inflow, Dworshak Dam was passing 12 kcfs, and Brownlee Dam, with a full reservoir, was passing 14 kcfs. Streamflows during the previous week averaged 234 kcfs at Priest Rapids Dam, 91 kcfs at Lower Granite Dam, and 333 kcfs at The Dalles Dam. The averages for this week at the same three locations were 248, 88, and 331 kcfs, respectively. The COE projection provided on June 7 was for an average of greater than 140 kcfs at Priest Rapids Dam for this week, while the June 6 SSARR projections indicated that the average would be 232 kcfs.

b. Smolt Monitoring

As of June 14, a total of 20.1 million summer migrants had been released into the system. An additional 3.2 million summer migrants released from late June through August 1990 were expected to complete the hatchery releases for the 1990 outmigration season. Monitoring data indicated that the spring migration was winding down throughout the basin, while the summer migration was well

underway by the end of this week.

Snake River steelhead were still being collected in sizeable numbers at Lower Granite Dam (15,000-22,000 per day) this week. Fall chinook released at Lyons Ferry Hatchery on May 6 began showing in large numbers at Lower Monumental Dam the evening of June 8.

The mid-Columbia passage index for subyearling chinook, dominated by Priest Rapids Hatchery fall chinook, exhibited a large increase on June 14 at McNary Dam. Large numbers of branded subyearling spring chinook from Leavenworth Hatchery were also recovered at McNary Dam from June 12 to 14.

Lower Columbia branded fall chinook from the Irrigon Hatchery May 23 release in the Umatilla River began arriving June 11 at John Day Dam and June 12 at Bonneville Dam.

Figure 3 illustrates passage index counts, actual daily average flows, and Water Budget flow request levels and days for the period April 1 through June 30 in the Snake, mid-Columbia, and lower Columbia rivers. These plots once again illustrate the close parallel between increases and decreases in index counts and flows. The instantaneous flow of 335 kcfs reached at Priest Rapids Dam on June 8 was the highest flow at that location since 1982. The highest flow for this year in the lower river was 371 kcfs at McNary Dam; it also occurred on June 8.

c. Water Quality

Water temperatures again remained fairly constant instead of the normal gradual increase, resulting in temperature ranges of 55 to 59°F, which were about 2 to 5°F below normal for this time of year. Dissolved gas levels this week ranged between 110 and 118% saturation, without any incidence of gas bubble disease in juvenile migrants detected after June 12.

III. 1990 SPILL IMPLEMENTATION

The objective of the 1990 Spill Program was to implement the fish spill provisions of the Northwest Power Planning Council's Fish and Wildlife Program. This includes the Fish Spill Memorandum of Agreement, which is intended to "provide fish passage conditions through the commitment of spill for juvenile anadromous fish and avoidance of turbine impacts" at Lower Monumental, Ice Harbor, John Day and The Dalles dams. The NPPC Fish and Wildlife Program also provides for spill at Bonneville Dam.

A. SPILL PLANNING

The Mainstem Executive Committee negotiated a program for spill to improve fish passage survival at federal hydroelectric projects on the Snake and Columbia rivers that are not presently equipped with, or have inadequate, fish bypass facilities. The negotiations culminated in a ten-year Fish Spill Memorandum of Agreement (Agreement) that commenced on December 31, 1988. Participants in the Agreement were BPA, PNUCC (who participated in the negotiations but did not sign the Agreement), and the region's state and federal fishery agencies and Indian tribes. In February of 1989, the NPPC incorporated the spill terms of the Agreement into the Fish and Wildlife Program. The COE was not party to the Agreement, and did not endorse the ten year agreement. However, the COE did provide spill as described in the NPPC Amendments during 1989, and agreed to implement the Agreement again in 1990.

The Agreement specifies that an annual monitoring plan be developed by November 1 each year, for implementation during the following spring and summer season. The Agreement also states that this plan be integrated with the annual Smolt Monitoring Program of the fishery agencies and tribes. This was accomplished for 1990. The spring and summer migrations were monitored at Lower Monumental Dam through gatewell sampling using a dipnet. At John Day Dam, a gatewell airlift system was used during the summer months. Monitoring at The Dalles Dam occurred during the spring and summer months using a dipnet, which was replaced by an airlift system on July 5. No monitoring was conducted at Ice Harbor Dam in 1990.

On February 21, 1990, the FPC hosted the pre-season spill plan meeting that is required by the Agreement. At this meeting it was agreed that there would be no pre-season adjustments to spill percentages at either Lower Monumental or Ice Harbor dams. The pre-season forecast for Jan-Jul runoff volume was discussed, as were plans for in-season implementation.

Load factoring describes a power marketing strategy whereby, with a given amount of water, flows are decreased during nighttime hours when power demand is low, and are increased during daytime hours when electricity demands are high. Spill is most often requested at night when there is peak

fish passage at a project, and is coincident with the lower flow regime. The Agreement recognizes that load factoring would result in a lesser percentage of daily average flow being used as spill than intended. To compensate for load factoring, the Agreement allowed instantaneous spill percentages to be increased at some projects. At Lower Monumental and Ice Harbor dams, the April 1 forecast for Jan-Jul runoff volume is used to determine if instantaneous spill levels can be adjusted based on daily average flow. At The Dalles Dam, since spill is allowed on a 24 hour basis, in-season adjustments to instantaneous spill levels may be made based on daily average flow during both the spring and summer spill periods. No load factoring adjustment is allowed for John Day Dam. Spill adjustments for load factoring are not transferrable among projects, even if load factoring results in an instantaneous spill percentage greater than 100% of instantaneous flow, while comprising only a small percentage of the daily average flow.

On any given day, the FPC relied on COE hourly flow data from the previous day to determine instantaneous spill percentages for the following day's spill period. BPA would notify the FPC through the COE Reservoir Control Center when the load factoring was going to be different from what was expected based on the previous day's account. The COE would relay to the FPC what percentage BPA had advised would yield the appropriate daily average. As was pointed out last year, this "guessing" as to what the flow shaping would be two days out based on prior flow data presents a serious flaw in implementation. BPA measures success of the spill program's implementation as whether or not they met the instantaneous spill percentage requested by the A&T. The A&T measure success on the basis of whether or not the daily spill achieved the intent of the Agreement. It appears that implementation should share a common goal--to achieve the intent of the Agreement. With this common goal, the implementation would rely less on "second guessing" what the flow and flow shape will be, and place more responsibility on BPA to achieve the objective of the Agreement.

B. SPILL IMPLEMENTATION

1. Spill at Lower Monumental Dam

The spring spill season at Lower Monumental Dam extended from April 19 through May 31. The January-July runoff forecast as of April 1 was less than 23 MAF. According to the Agreement, with this April 1 runoff forecast, spill levels requested during April, May, June, and July were to be estimated using the Daily Average Method. This method allowed the instantaneous spill percentage to be increased by compressing the hours of spill, and allowed increases in the instantaneous spill percentage to compensate for load factoring. The instantaneous spill percentage specified in the Agreement is 70%. With flat loading of the project, and a 12-hour spill period, this translates to 35% of daily average flow. The daily average spill percentage averaged approximately 32.4% of the daily average flow during the spring spill period (Figure 5). An instantaneous spill percentage of at least

70% had been implemented, but did not always result in the 35% daily average. This occurred because when flow levels decreased during May, project flow was decreased to a minimum during spill hours, and 100% of flow was spilled.

In late May and early June, the flows began to increase, creating excess spill in the river. The Snake River projects were given high priority as places to spill the excess water. A Systems Operational Request (SOR) was submitted to the COE requesting that the summer spill program be initiated subsequent to the surplus spill situation, at which time it was expected that the 10% migration date would have been passed. The daily average spill percent averaged 37.3% of daily average flow for the summer spill period (Figure 5). This average included any spill when flow exceeded project hydraulic capacity, or spill to avoid generation in excess of that needed to meet all available power markets (overgeneration spill). After accounting for overgeneration spill, and spill in excess of hydraulic capacity, the adjusted spill percentage for fish averaged only 15.2% of daily average flow for the summer spill period.

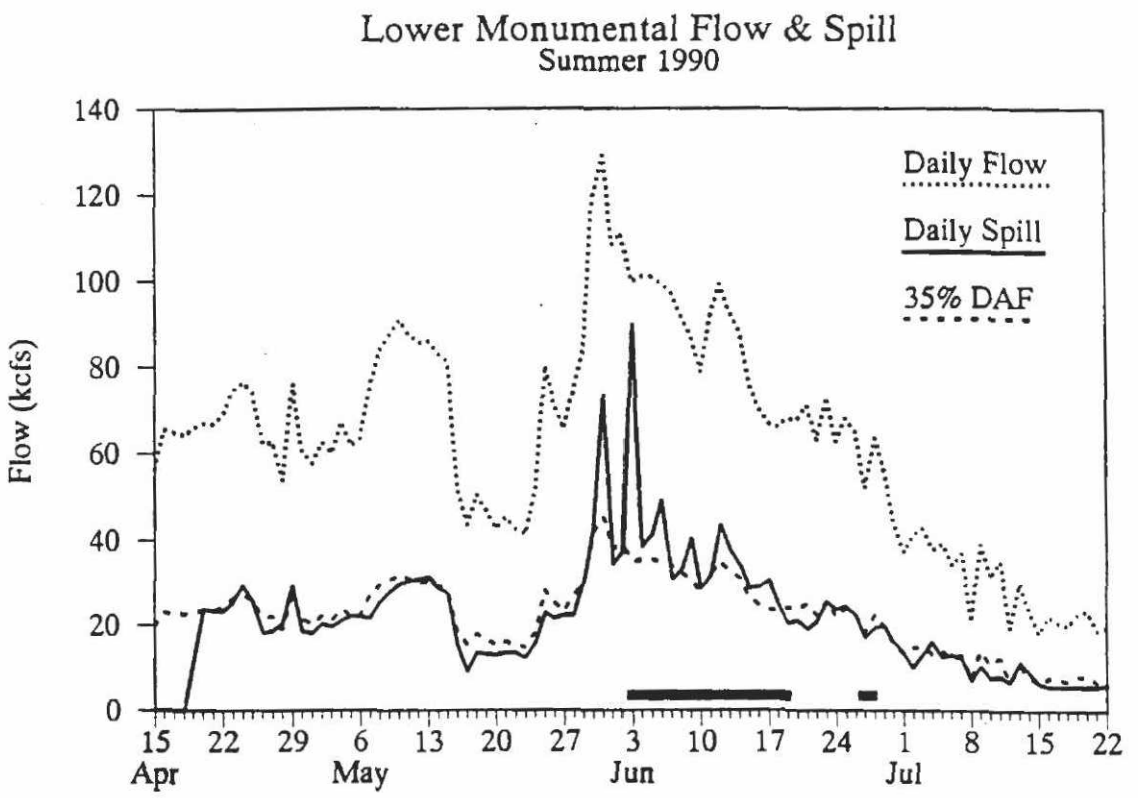


Figure 5. Daily Average Flow (DAF) and spill at Lower Monumental Dam compared to 35% of DAF. Less than 100% of spill is accountable as fish spill on days when spill in excess of hydraulic capacity or was to avoid overgeneration (solid lines).

The summer spill period extended to the last day specified in the agreement. It was extremely difficult to use the Lower Monumental passage index information to predict the 90% passage date in-season, or to calculate the 90% passage date post-season. This was because in the summer spill period when flows were generally low, it was more economical to decrease flow to the project minimum, and spill 100% of the flow. This meant that no units were operated, so a reliable passage index estimate for that day could not be developed. A similar situation occurred for the 1990 spring migration when flows decreased mid-May, and 100% of project flow was spilled during nighttime hours.

The high Snake River flows during June helped to move fish quickly out of the Snake River. The freeze branded Lyons Ferry fall chinook, which were released from the hatchery on June 6, had a 10% passage date of June 20 and a 90% passage date of July 14 at McNary Dam. However, the entire Lyons Ferry Hatchery production was not released on June 6 because of a hatchery program that coded wire tagged all fish released this year. Approximately 2.8 million Lyons Ferry fish were released between June 6 and July 12 and, therefore, spill was continued at the project until 0600 on July 23. Subsequent monitoring indicated many fish were passing the project through the remainder of the month.

2. Spill at Ice Harbor Dam

The instantaneous spill percentage at Ice Harbor Dam specified in the Agreement is 25% of instantaneous flow during 12 spill hours. When the project is flat loaded, this translates to 12.5% of daily average flow. According to the Agreement, adjustments to the instantaneous spill percentage at Ice Harbor Dam are estimated in the same fashion as for Lower Monumental Dam.

The spring spill season extended from April 22 through May 31, and the summer migration extended from June 1 through 0600 on July 23. During the spring season, spill averaged 14% of daily average flow, while in the summer it averaged 20.6%. Overgeneration spill occurred during June and, when the spill amount was adjusted for excess hydraulic capacity and overgeneration spill, it averaged 12.5% and 5.3% of the season daily average flow for spring and summer, respectively. Figure 6 shows the actual daily average spill and flow compared to the 12.5% that would have occurred in a flat-loaded system.

If monitoring was conducted at Ice Harbor Dam, it would be to determine the 10 and 90% passage dates for the spring and summer migrations. During low flow conditions when load factoring can be extensive, the instantaneous spill percent increases to a maximum (some flow is allocated to the operation of the sluiceway and the remainder is spilled). Because of the way spill is provided, it was not believed that accurate migration timing information would be derived from such a program and, therefore, no monitoring was conducted at Ice Harbor Dam during 1990.

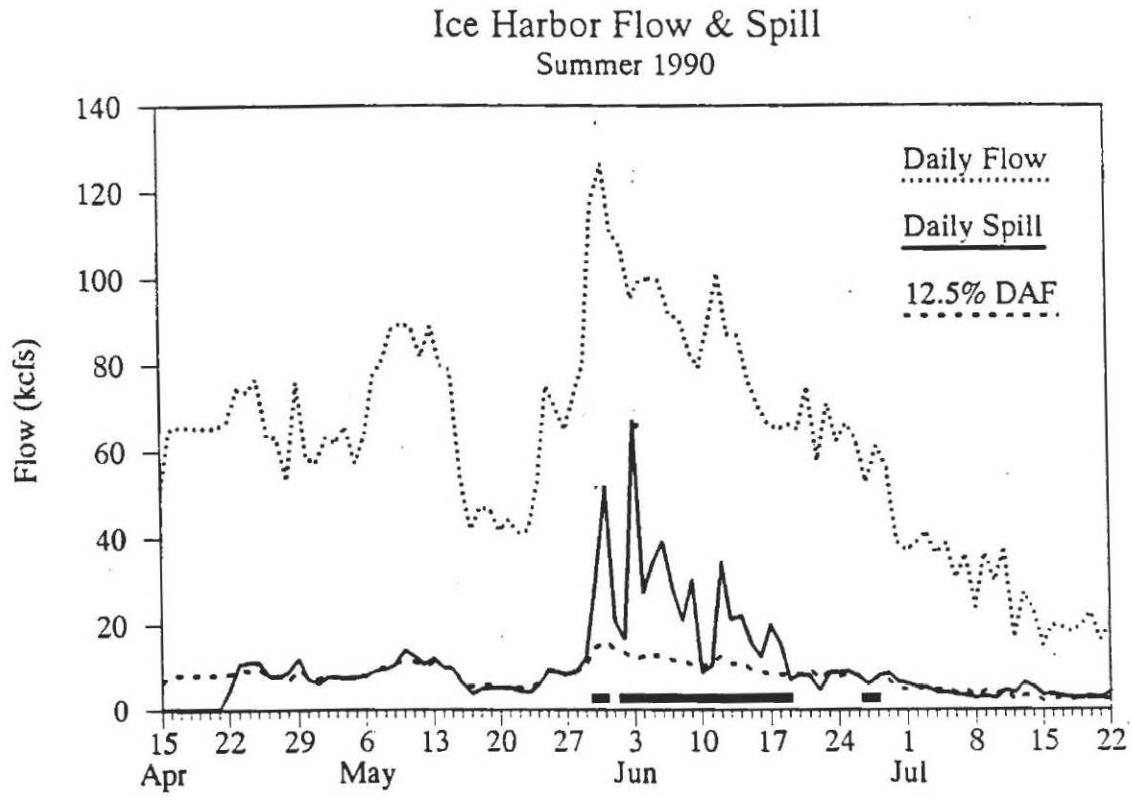


Figure 6. Daily Average Flow (DAF) and spill at Ice Harbor Dam compared to 12.5% of DAF. Less than 100% of spill is accountable as fish spill on days when spill was in excess of hydraulic capacity or was to avoid overgeneration (solid lines).

3. Spill at John Day Dam

The Agreement establishes a summer spill program at John Day Dam to begin on June 7. At that time, overgeneration spill was occurring, as well as spill that was occurring at John Day Dam as a result of the accident that occurred on May 29. Technically, the summer spill program was initiated on June 7th and extended through 0600 on August 23. The instantaneous spill percentage that is specified in the Agreement is 20% for 10 hours. This translates to a spill level equal to 8.33% of daily average flow in a flat loaded system. The instantaneous spill percentage may not be adjusted to compensate for load factoring at this project. The seasonal average was 10.7% of flow (Figure 7), which amounted to just 0.5% after overgeneration spill and spill due to the accident were removed. The daily spill hours were from 2000 to 0600.

At John Day Dam, spill was terminated based on the end date specified in the Agreement. Outages in Unit 5 during the periods May 30 to June 10, June 21 to June 23, and August 13 to 16 made it virtually impossible to estimate the migration timing from the monitoring sample. Since the 90% passage of subyearling chinook at McNary Dam was similar to the median 90% passage date of past years, the assumption was made that the 90% passage date at John Day Dam would also be similar to the historical data.

On May 29 at about 5:15 p.m., a fire in the powerhouse at John Day Dam caused the shutdown of the turbine units, affecting spill levels at the project. High levels of spill resulting from increased flows and an inoperable powerhouse caused dissolved gas levels of about 135% below the project for several days. Because John Day Dam's spillbays are not equipped with fliplips like some of the other projects, these high levels of spill increased dissolved gas saturation above levels safe for fish. The level at Bonneville Dam and the monitoring station about 6 miles below Bonneville recorded over 120% saturation by May 31. As turbine units were being repaired at John Day, the amount of water spilled was reduced. As a result, the saturation levels dropped to about 120% at The Dalles Dam by June 5.

When fish are exposed to high dissolved gas levels (commonly called nitrogen supersaturation) for an extended period of time, gas bubble disease will likely occur unless the fish are able to compensate by swimming at deeper water depths. A review of the literature (Ebel *et al.*, 1979; Dawley *et al.* 1975; Dawley 1986) indicates that at above 115% dissolved nitrogen, fish are subject to severe nitrogen gas bubble disease. The long term chronic effects of this may lead to indirect effects other than those manifested by death.

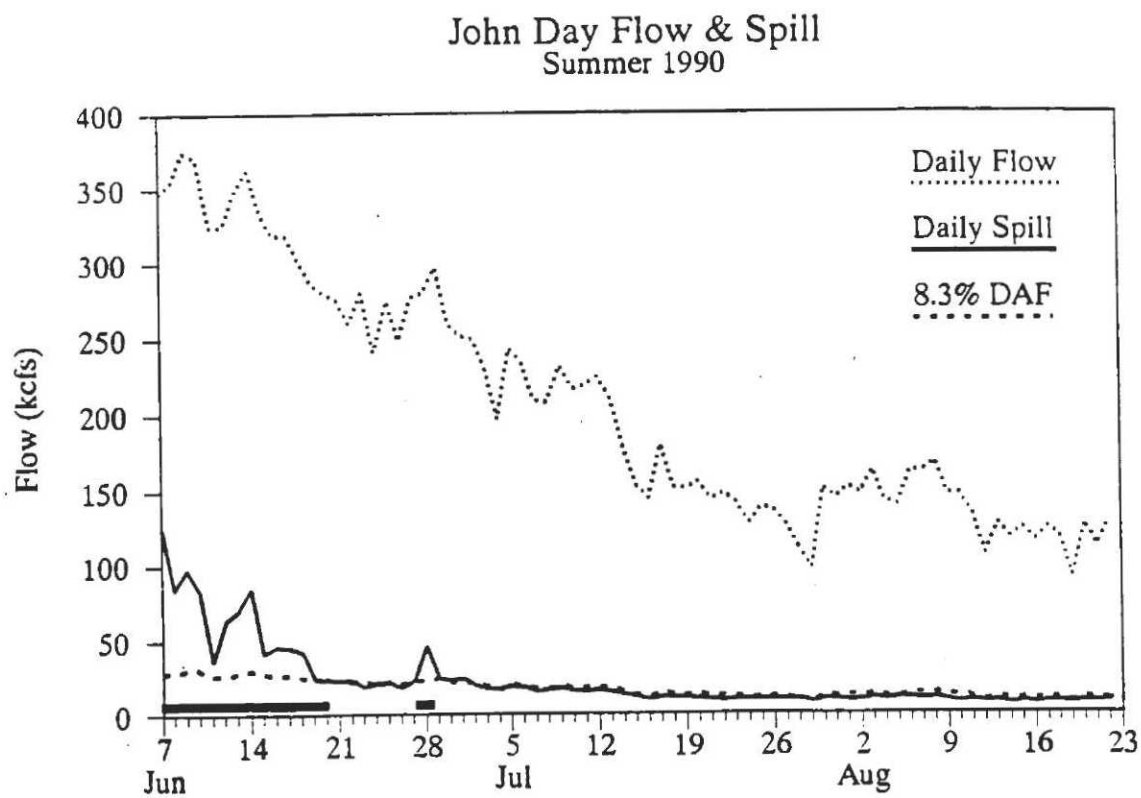


Figure 7. Daily Average Flow (DAF) and spill at John Day Dam compared to 8.33% of DAF. Less than 100% of spill is accountable as fish spill on days when spill was in excess of hydraulic capacity or was to avoid overgeneration (solid lines).

In response to increased flow levels in the Snake River, fish numbers in the Snake River reached peak levels for the season. A tug with two fish barges was on its way to release fish below Bonneville Dam when the incident occurred at John Day Dam. Navigation lock passage was impossible due to the loss of power, and there was uncertainty as to when the power/station service would be restored at the dam. Because of the large number of fish that were still being collected at the Snake River projects, the decision was made to release the barge loads about 2 miles below McNary Dam so that the tug could return quickly to the Snake River juvenile collection facilities to load fish before they exceeded the raceway capacity. The barges were dumped on May 30 at 1:30 p.m. The barges were transporting about 595,000 smolts. About 85% of these fish were steelhead originating in the Snake River. These barged fish and those present in the lower river were subjected to these high dissolved gas levels from the John Day Dam tailwater to below Bonneville Dam, a distance of 69.5 miles. The barge release group began arriving in large numbers in The Dalles Dam sample (6 a.m. - 6 a.m.) the evening of June 1 and sample numbers remained high through the evening of June 2. The Bonneville 1st powerhouse sample (4 p.m.-midnight) began seeing some increase in fish numbers on June 1, probably due to flow increase. On June 2 and 3, the crew at Bonneville Dam observed large numbers of steelhead in the sample, from the barge release on May 30.

Table 6 lists the percentage of fish observed with gas bubbles at The Dalles and Bonneville dams to illustrate the problems that fish encounter when passing through impoundments with high dissolved gas levels. The percentage of gas bubbles increased as the fish were exposed for longer durations. The incidence of gas bubble disease in steelhead was much higher than in the other salmon species. The percent of steelhead affected by the high level of dissolved gas at Bonneville Dam ranged from 22 to 74% of those sampled. The zero-age chinook appeared the least affected by the high saturation of dissolved gases. When the dissolved gas level lowered to near 120%, the gas bubble disease incidence subsided somewhat, but was still evident on a daily basis. To conclude, the high spill levels caused high dissolved gas readings throughout the lower Columbia River that had some degree of adverse impact to fish migrating through the lower reach. The additional mortalities resulting from the high dissolved gas levels present below Bonneville Dam and the lower Columbia River are unknown, but likely were higher, especially on juvenile steelhead.

4. Spill at The Dalles Dam

According to the Agreement, spill can occur at The Dalles Dam for 24 hours a day at a level equal to 10% and 5% of daily average flow during the spring and summer, respectively. In pre-season discussions among the power interests and the fishery agencies and Indian tribes, it was recommended that the available spill be compressed into an 8-hour period in order to increase the instantaneous spill percentage. It was hoped that compressing hours would make the amount of spill

Table 6. Gas bubble incidence observed on salmon and steelhead from May 31 to June 6, 1990 at The Dalles and Bonneville Powerhouse 1 sampling sites.

THE DALLES										
DATE	CHIN 1		CHIN 0		SOCKEYE		COHO		STEELHEAD	
	# samp	% gas disease	# samp	% gas disease	# samp	% gas disease	# samp	% gas disease	# samp	% gas disease
5/31-6/1	26	7.7			2	0	3	33	40	12.5
6/1-6/2	63	7.9			10	20.	4	0	807	1.
6/2-6/3	153	4.6			29	6.9	16	18.8	865	8.2
6/3-6/4	4	0			5	20.			15	20.
BONNEVILLE POWERHOUSE I										
DATE	CHIN 1		CHIN 0		SOCKEYE		COHO		STEELHEAD	
	# samp	% gas disease	# samp	% gas disease	# samp	% gas disease	# samp	%gas disease	# samp	% gas disease
6/1	115	3	638	1<	199	2.5	358	8	189	29
6/2	104	0	466	0	102	0	212	1	663	23
6/3	108	4	461	1<	76	14.	223	38	1314	74
6/4	100	5	791	0	102	5.	214	11	227	37
6/5	73	0	487	0	131	3.	301	1	147	22
6/6	55	2	611	0	218	1.	259	2	121	25

available more effective in passing fish by the project via a non-turbine route.

The spring spill season extended from 2000 hours May 1 through 0400 hours on June 7. Smolt monitoring was conducted using a dip-net basket in one gatewell during the spring season. Since this was the first year of spring monitoring at this project, it was impossible to predict the 90% passage date in-season. The post-season estimated 10 and 90% passage dates for yearling chinook were April 17 and May 28, respectively. The dates for steelhead were April 26 and June 2, respectively. Both 90% passage dates were estimated following subtraction of 4,000 yearling chinook and 38,000 steelhead from the passage indices of June 2 and 3, to account for the fish recovered at The Dalles Dam from the barge release on May 30 below McNary Dam, which was due to the lock outage at John Day Dam resulting from the powerhouse fire.

By June 3, there was substantial overgeneration spill in the hydrosystem. Some of this spill was allocated to The Dalles Dam and, therefore, spill was not terminated on June 6. Instantaneous spill percentages were changed many times throughout the season to compensate for load factoring. The spill hours remained constant (2000-0400) while the amount of spill fluctuated both above and below

10% of daily average flow. The seasonal spill (the average of daily spill during the spring period) was 14.1%. When the amount of spill identified by BPA as overgeneration spill is subtracted, the seasonal spill averaged 8.6%.

A request was submitted to start the summer spill season subsequent to the cessation of overgeneration spill. The summer spill season extended from 2000 hours on June 7 and continued through 0400 hours on August 23. Smolt monitoring occurred throughout the season. It started by gatewell dipnetting, and was replaced on July 5 by a gatewell airlift system. It was not possible to develop reliable 10 and 90% passage dates for the subyearling chinook migration because of the extremely low numbers of fish captured. In addition, the impact to the passage index of switching to the airlift sample mid-season was unknown. The numbers of fish collected prior to the change were much higher than the numbers subsequent to the change. However, it is impossible to determine if the decrease was due to a decrease in the number of fish passing, or to change of equipment.

Since the 90% passage date of subyearling chinook at McNary Dam was similar to the median 90% passage date of past years, the assumption was made that the 90% passage date at The Dalles Dam would also be similar to the historical data. Therefore, it was decided to continue The Dalles spill program through the end date specified in the Agreement, so the summer spill program was

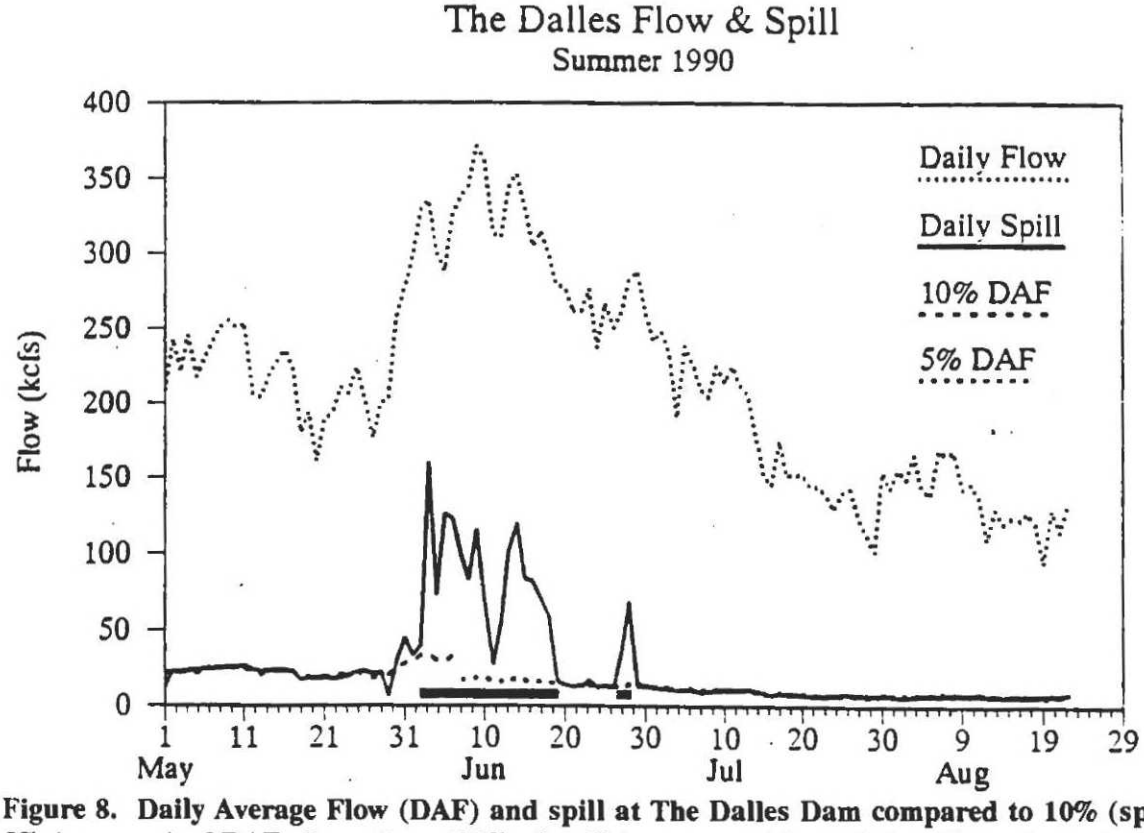


Figure 8. Daily Average Flow (DAF) and spill at The Dalles Dam compared to 10% (spring) and 5% (summer) of DAF. Less than 100% of spill is accountable as fish spill on days when spill was in excess of hydraulic capacity or was to avoid overgeneration.

terminated on August 23 at 0400 hours. Figure 8 compares the actual percent of daily average flow that was spill to the amount specified in the Agreement. The seasonal average spill was 10.2% with overgeneration spill, and 3.5% without overgeneration.

5. Spill at Bonneville Dam

On February 5, 1990 the CBFWA submitted to the COE a recommended operational plan for Bonneville Dam. The proposal for 1990 operations incorporated the criteria listed in the NPPC's 1987 Fish and Wildlife Program, which specifies an 85% fish passage efficiency (FPE) for juvenile fish passage at Bonneville. The CBFWA proposal established a reasonable interim objective of attaining a 70% FPE during the spring, and a 50% FPE during the summer. Based on values of weighted mean fish guidance efficiencies, the CBFWA proposal requested that, in addition to not operating the second powerhouse, 49% of daily average flow be spilled in the spring and 44% of instantaneous flow be spilled during the summer migration (Figure 9).

The COE responded to the February 5 letter on April 11 after receiving input from the power interest groups BPA, PNUCC and the NPPC. This letter stated that 1990 operations at Bonneville Dam would be consistent with constraints used in past years. The COE cited necessary violations of reservoir operating limits, and inability to serve notice to all entities having an interest in Bonneville Project operations, as reasons for denying the CBFWA requested operational plan for 1990.

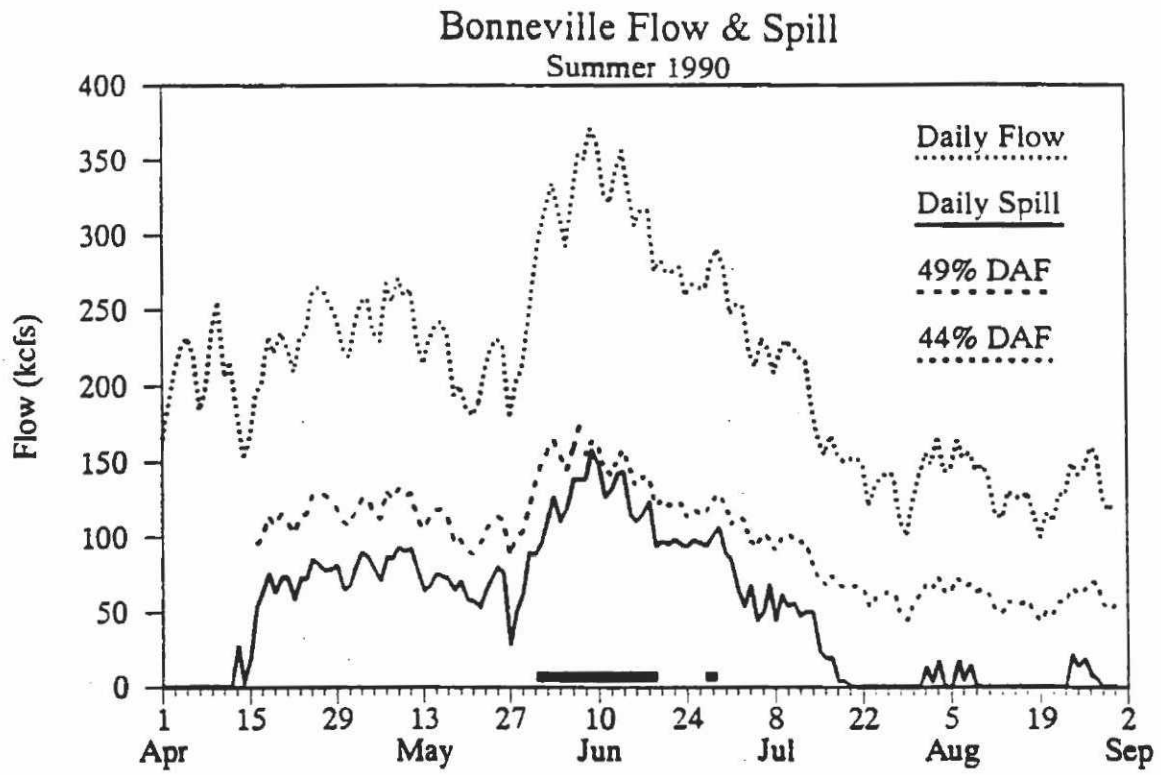


Figure 9. Daily Average Flow (DAF) and spill at Bonneville Dam compared to 49% (spring) and 44% (summer) of DAF. Less than 100% of spill is accountable as fish spill on days when spill was in excess of hydraulic capacity or was to avoid overgeneration.

Spill at Bonneville Dam averaged 24% of daily average flow through the spill season (April 13 through August 31) with overgeneration spill included, and 16.7% with overgeneration spill removed. During July and August when the CBFWA had requested that 44% of instantaneous flow be spilled, there were 28 days on which no spill occurred, and 7 days on which spill was less than 5 kcfs.

C. SUMMARY

The 1990 implementation of the Fish Spill Memorandum of Agreement was successful. All parties carried out the Agreement as written, and no deviations were made. The 1990 season saw more spill than was seen in 1989. Most of this spill came in the form of overgeneration spill and, therefore, the actual cost of the spill program was similar to the cost of 1989 spill.

Monitoring for spill management during 1990 did not generate the data needed for the in-season determination of 90% passage dates. This was partly due to project operation, such as the 100% spill at Lower Monumental Dam and the numerous outages of unit 5 (unit being sampled) at John Day Dam. There was also a change in the way the gatewell slot at The Dalles Dam was monitored.

Because of the high levels of spill that occurred in 1990, monitoring crews were alerted to note any evidence of "gas bubble" disease in the fish sampled. There were no reports of major injury to fish as a result of gas supersaturation. However, large numbers of sockeye, coho and steelhead exhibited symptoms of the disease, with the highest incidence recorded from the group of steelhead released from the barge above John Day Dam subsequent to the fire in the John Day powerhouse. These fish passed John Day Dam when 100% of the flow at the project was being spilled and dissolved gas levels reached 135% supersaturation.

Seasonal totals of flows and spill, including spill due to overgeneration, are listed in Table 7. The 1990 spill program at the four MOA projects resulted in a total of 663,691 MWH being spilled for fish. This total is very close to the total amount spilled for fish in 1989 (646,339 MWH). As stated in the beginning of this section, the primary problem with spill implementation in 1990 was developing a request for an instantaneous flow percentage based upon "after-the-fact" flow data. This information could be more easily provided or implemented by BPA.

Table 7. Seasonal totals of flow, spill, and spill due to overgeneration. (Data provided by PNUCC)

	MOA PROJECT	FLOW (ksfd)	SPILL (ksfd)	FISH SPILL (ksfd)
SPRING	IHR	2,703	382	339
	LMO	2,984	966	966
	TDA	8,690	1,228	746
SUMMER	IHR	2,920	602	175
	LMO	3,041	1,136	461
	TDA	15,793	1,617	546
	JDA	15,673	1,697	796
COMBINED	BVL	32,578	7,797	5,433

IV. 1990 SMOLT MONITORING PROGRAM

The objective of the Smolt Monitoring Program (SMP) is to provide information to the Fish Passage Center on the status of the smolt migration for in-season management of the Water Budget and Spill Agreement. Information is also provided for post-season analyses of the migration in order to meet the requirements of the NPPC Fish and Wildlife Program. This information includes data from key monitoring sites on daily indices of smolt passage, annual indices of relative passage magnitude, smolt condition, and smolt migration timing. Additional information is provided on smolt travel time to many of these sites. This section of the report presents this information for monitoring sites on the Snake and Clearwater rivers and at Lower Granite, Rock Island, McNary, John Day and Bonneville dams. More detailed coverage of the smolt condition data derived from the physiological monitoring will be reported by USFWS researchers in a separate document.

A. PASSAGE INDICES

1. Methods.

Information on the status of the smolt outmigration is provided to the Fish Passage Center for in-season Water Budget and spill management needs through the use of daily indices of smolt abundance (passage indices) at monitoring sites in the Columbia River basin. These passage indices are computed using data from the sampling of the smolt migration passing the monitoring sites listed in Table 8. The daily passage indices at the traps on the Snake and Clearwater rivers equal the daily fish collection for each species. The daily passage indices for each species at hydroelectric sites are computed by dividing the daily fish collection estimate by the proportion of flow passing through the sampled unit or powerhouse. This adjustment compensates for different daily project operations (*e.g.*, spill and unit loading) assuming fish pass through spill and powerhouse units in numbers proportional to the flow through these passage routes. The passage index is not further divided by any estimate of fish guidance efficiency (FGE), since past FGE estimates have been so variable, both across days within years, and across years of study. For this and other reasons, the passage index is not an estimate of absolute daily passage, but does provide a relative measure of how each species' run is progressing over the migration season. Changes in the magnitude of the passage index for a species cannot be considered in isolation from other influential factors such as hatchery releases, smolt condition, flow patterns, and project operations.

Summing the daily passage indices for a particular species over the migration season produces an annual passage index for that site. Since FGE differs by site and species, the annual passage indices should not be directly compared among sites or among species at a site within a given year. However, annual passage indices can be compared to previous years for a particular species and site, provided

Table 8. Smolt monitoring sites for 1990.

SITE	METHOD	DATA GATHERED	DATES OF OPERATION
SNAKE RIVER			
Snake River Trap*	Dipper Trap	PIT tags,brands,species	3/9 - 6/19
Clearwater R. Trap	Scoop Trap	PIT tags,brands,species	3/13 - 6/1
Lower Granite*	Bypass Collection	PIT tags,brands,species	3/26 - 7/26
Little Goose	Bypass Collection	PIT tags,species	4/12 - 7/21
Lower Monumental	Gatewell Dip	Brands,species	3/25 - 8/1
MID-COLUMBIA			
Rock Island*	Bypass Trap(PH2)	Brands,species	3/31 - 8/31
LOWER COLUMBIA			
McNary*	Bypass Collection	PIT tags,brands,species	4/1 - 9/14
John Day*	Airlift Pump	Brands,species	3/26 - 10/31
The Dalles	Gatewell Dip/ Airlift Pump	Brands,species	4/9 - 8/31
Bonneville (PH1)*	Bypass Trap	Brands,species	3/12 - 11/30
Bonneville (PH2)	Bypass Collection	Brands,species	3/12 - 11/30

• Key monitoring sites covered in remainder of this section of report.

they are not considered in isolation of other information. In making comparisons to historical data, the following factors are considered: (1) stability of historic FGE estimates (either fairly constant or following a similar pattern of temporal change within each year); (2) potential FGE improvement due to structural modifications (*e.g.*, raised bulkhead gates at Lower Granite Dam); (3) the magnitude of the annual hatchery releases above a particular monitoring site, by considering a passage index to hatchery release ratio; (4) potential contribution of wild stocks; (5) the magnitude of the transportation program, such as full transportation or a partial bypass mode of operation; and (6) flow conditions. Comparisons of the 1990 annual passage indices are made to the average of the historical values for available years since 1984. An annual passage index/hatchery release ratio is also computed for Lower Granite, Rock Island and McNary dams.

2. Results and Discussion.

The 1990 cumulative passage indices for Lower Granite, Rock Island, McNary, John Day, and Bonneville (powerhouse 1) dams are presented in Table 9. Associated estimated confidence intervals are presented in Appendix D. Several observations should be made before considering each site in detail. First, the size of the total hatchery releases above Lower Granite, Rock Island, and McNary dams were near, or above, the average for the previous five or six years. Therefore, annual passage indices at these three sites should be similar to the historic mean, unless: (1) survival or collection efficiency dropped; (2) the contribution of hatchery to wild fish changed; or (3) in the case of McNary Dam, fewer Snake River fish arrived due to a higher recovery at Snake River transportation facilities. Second, even though annual passage indices are not directly comparable among sites due

Table 9. 1990 and historical annual passage indices for juvenile salmonids at key monitoring sites.

SITE	SPECIES	1990 PASSAGE INDEX (X1000)	1990 HATCHERY RELEASE (X1000)	1990 RATIO	HISTORICAL MEAN PASSAGE INDEX (X1000)	HISTORICAL MEAN HATCHERY RELEASE (X1000)	HISTORICAL MEAN RATIO
LOWER GRANITE	YRLG CHINOOK	3,199.6	12,488	0.26	2,106.5	9,394	0.22
	STEELHEAD	6,139.9	10,154	0.60	3,518.1	7,646	0.46
	SOCKEYE	16.6	0	—	7.8	0	—
ROCK ISLAND DAM	YRLG CHINOOK	20.9	4,632	0.005	29.5	4,897	0.006
	SUBYR CHINOOK	54.7	2,589	0.021	40.9	1,959	0.021
	STEELHEAD	18.1	1,216	0.015	39.3	1,033	0.038
	COHO	15.6	473	0.033	37.7	392	0.096
	SOCKEYE	4.3	0	—	31.6	0	—
MCNARY DAM	YRLG CHINOOK	2,432.7	18,572	0.13	2,946.6	14,998	0.20
	SUBYR CHINOOK	8,507.9	14,267	0.60	6,267.2	13,750	0.46
	STEELHEAD	660.4	12,175	0.05	972.3	9,581	0.10
	COHO	231.0	1,118	0.21	172.0	792	0.22
	SOCKEYE	294.3	0	—	692.5	0	—
JOHN DAY DAM	YRLG CHINOOK	362.0	—	—	820.3	—	—
	SUBYR CHINOOK	513.7	—	—	1,213.7	—	—
	STEELHEAD	133.8	—	—	361.2	—	—
	COHO	84.3	—	—	83.8	—	—
	SOCKEYE	23.6	—	—	157.8	—	—
BONNEVILLE PH#1	YRLG CHINOOK	332.8	—	—	400.7	—	—
	SUBYR CHINOOK	1,219.8	—	—	1,240.5	—	—
	"BRIGHTS"	929.1			347.6		
	STEELHEAD	127.9	—	—	155.0	—	—
	COHO	677.1	—	—	545.4	—	—
	SOCKEYE	81.4	—	—	108.1	—	—

- Historical mean passage indices and hatchery releases are based on data for 6 years (1984-89) at Lower Granite and McNary dams, 5 years (1985-89) at Rock Island and John Day dams, and 2 years (1988-89) at Bonneville Dam.
- Outages of Unit 5 at John Day Dam during the periods April 16-19, May 30-June 10, June 21-23, and August 13-16 make the computed 1990 annual passage indices an underestimate. Historical mean annual passage indices are based on sampling in Unit 3, which typically collects a higher proportion of fish passing John Day Dam than Unit 5.
- An unplanned barge release of approximately 600,000 yearling chinook and steelhead above John Day Dam on May 30 resulted in an excess of about 75,000 steelhead and 5,000 yearling chinook in the Bonneville Dam passage index for June 2 and 3. The estimated extra barged fish were subtracted from the June 2-3 passage indices at Bonneville Dam before computation of the 1990 annual passage index.
- "Brights" at Bonneville Dam refers to subyearling chinook arriving after June 1; this excludes most "tule" fall chinook originating from Spring Creek Hatchery.

to differences in FGE, trends in magnitude between 1990 and historic levels for individual species should be similar in direction at successive downstream sites (provided that recruitment between sites is low or accounted for). Third, monitoring at John Day Dam was in Unit 5 in 1990 as opposed to Unit 3 in previous years. The 1990 annual passage index at John Day Dam for each species was expected to be lower than in prior years, since passage levels tend to decrease at units farther from the Oregon shore at this project. Fourth, annual passage indices at Rock Island Dam are always substantially lower than at other monitoring sites because the bypass collection system there relies on volitional entry into gatewells of an unscreened powerhouse.

The 1990 cumulative passage indices at Lower Granite Dam were 3,199,600 chinook, 6,139,900

steelhead, and 16,600 sockeye/kokanee. Since there was no spill this year, these passage indices equalled the collection numbers. The annual passage index to hatchery release ratio was slightly higher than the prior 6-year average for chinook and substantially higher for steelhead (Table 9). However, the 1990 steelhead passage index/hatchery ratio was not greater than last year's ratio. Without the higher natural flows after May 25, this year's steelhead collection at Lower Granite Dam would have been dismal. About 35% of the total steelhead collection for the season occurred subsequent to May 25 as a result of the higher flows. The annual passage index for wild steelhead in 1990 was 28% higher than in 1989 (Table 10). Overall, there was 88.6% hatchery steelhead and 11.4% wild steelhead in the collection at Lower Granite Dam in 1990, which was close to last year's composition (Table 10). The passage index for sockeye was higher than the 6-year average, surpassing the 15,800 estimate for 1984. It is not clear how many of these fish are anadromous sockeye as opposed to kokanee (resident sockeye) from places like Dworshak reservoir. Apparently, kokanee are passing Dworshak Dam through the turbines and over the spillway, based on research being conducted by IDFG.

The 1990 cumulative passage indices at Rock Island Dam were 20,900 yearling chinook, 54,700 subyearling chinook (including accelerated growth spring chinook from Leavenworth Hatchery), 18,100 steelhead, 15,600 coho, and 4,300 sockeye (Table 9). Given the 1990 hatchery releases, the cumulative passage indices for yearling and subyearling chinook this year were within the range of expectation (similar annual passage index/hatchery release ratio to the prior 5-year average ratio). However, the steelhead and coho cumulative passage indices were about 60% lower than expected given the size of the 1990 hatchery releases. In a FPC letter dated June 12 to NPPC Member Ted Bottiger, it was noted that freeze-branded steelhead from the Wells Hatchery releases into the Methow and Similkameen rivers were recovered at Rock Island and McNary dams in proportions lower than in prior years. It is likely that fewer Wells Hatchery steelhead outplants were surviving to Rock Island and McNary dams this year. Reduced survival may have occurred with wild steelhead also, as the composition of wild to hatchery steelhead at Rock Island Dam did not change much from last year (Table 10). However, the severity of the drop in the 1990 steelhead cumulative passage index compared to the historic levels, the fact that both hatchery and wild steelhead appeared affected, and the similar and simultaneous drop in the coho cumulative passage index, implies that collection efficiency of steelhead and coho may have also been substantially lower in 1990. However, nothing unusual was noted about the flow and spill conditions this year that might impact collection efficiency. Possibly, both reduced survival and collection efficiency were responsible for the low 1990 annual indices for steelhead and coho. These factors, plus a decreasing run of Osoyoos stock sockeye each year since 1986, may have contributed to the 86% drop in the cumulative sockeye passage index

Table 10. Hatchery and wild steelhead passage indices for 1990 compared to 1989 at key monitoring sites.

	1990				1989			
	WILD STEELHEAD		HATCHERY STEELHEAD		WILD STEELHEAD		HATCHERY STEELHEAD	
SITE	P.I.	PERCENT	P.I.	PERCENT	P.I.	PERCENT	P.I.	PERCENT
LOWER GRANITE	698.2	11.4	5,441.6	88.6	545.0	10.4	4,695.9	89.6
ROCK ISLAND DAM	3.7	20.6	14.3	79.4	6.8	17.7	31.6	82.3
MCNARY DAM	166.0	25.1	494.5	74.9	210.5	20.9	796.4	79.1
JOHN DAY DAM	68.4	51.2	65.3	48.8	122.5	43.5	159.2	56.5
BONNEVILLE PH#1	61.7	48.3	66.1	51.7	99.6	48.3	106.4	51.7

- P.I. is annual passage index in thousands.
- Outages of Unit 5 at John Day Dam during the periods April 16-19 and May 30 - June 10 make computed percentiles gross approximations only. It is likely that the hatchery percentage for 1990 would be higher if uninterrupted sampling had occurred.
- An unplanned barge release of juvenile salmonids above John Day Dam on May 30 resulted in excess of approximately 75,000 steelhead in the Bonneville Dam passage index. Therefore, an estimated 8,000 wild and 67,000 hatchery steelhead (barge fish) were excluded from the June 2 and 3 passage indices before computation of cumulative annual passage index and hatchery/wild percentages.

from the average of the previous five years.

The 1990 cumulative passage indices for yearling chinook and steelhead at McNary Dam were 2,432,700 yearling chinook and 660,400 steelhead (Table 9). The annual passage index/hatchery release ratio for yearling chinook and steelhead was lower than the 6-year average. Several factors may have contributed to the reduction in this ratio for yearling chinook and steelhead this year. The reduced Snake River flows during mid-May may have decreased the survival of smolts migrating to McNary Dam. Also, increased collections at transportation sites in the Snake River could have decreased the proportion of Snake River smolts arriving at McNary Dam. Fewer mid-Columbia yearling chinook and steelhead may have arrived at McNary Dam. For example, the recovery proportions of marked spring chinook from Leavenworth, Entiat and Winthrop hatcheries were 20 to 33% lower than last year, and the brand recovery proportions of Wells Hatchery steelhead released in the Similkameen and Methow rivers were 13% and 30% lower than in 1989, respectively. Also, about 10% of the yearling chinook and 20% of the steelhead cumulative passage indices for 1990 occurred on days when over 20% of the flow at McNary Dam was spilled, which may have passed mid-Columbia origin fish at a higher rate than accounted for in the passage index. The reduction in recovery proportion was more severe for hatchery steelhead than wild steelhead at McNary Dam. The 1990 hatchery steelhead passage index was 38% lower than in 1989, while the wild steelhead passage index was 21% lower (Table 10).

The 1990 cumulative passage indices for the remaining species at McNary Dam were 231,000

coho, 294,300 sockeye, and 8,507,900 subyearling chinook (Table 9). The 1990 cumulative passage index for coho did not differ from expectations at McNary Dam, based on the magnitude of the hatchery releases above that site. Almost 60% of these hatchery coho were planted in the Yakima River system, and the remaining 40% were released above Rock Island Dam. The speculation that a lower collection efficiency occurred at Rock Island Dam in 1990 was supported by the fact that the 1990 annual coho passage index/hatchery release ratio at McNary Dam did not decrease. The sockeye annual passage index at McNary Dam continued to decrease in 1990 relative to historical levels. The low recovery of sockeye at McNary Dam and at the other monitoring sites confirmed that the sockeye outmigration for 1990 was depressed. The run of Osoyoos stock sockeye was nearly non-existent this year. On the brighter side, the 1990 annual passage index for subyearling chinook was the highest recorded at McNary Dam since the SMP began in 1984. River flow increased to over 300 kcfs by the start of June and remained above 260 kcfs for all but two days in June, and above 200 kcfs for all but one day in the first half of July. These higher flows moved large numbers of subyearling chinook past McNary Dam this year.

The 1990 cumulative passage indices at John Day Dam were 362,000 yearling chinook, 513,700 subyearling chinook, 133,800 steelhead, 84,300 coho and 23,600 sockeye (Table 9). These passage indices were less than half of the average of the previous five years for all species but coho. However, the use of a 5-year average for coho is inappropriate, since large hatchery releases of coho in the Umatilla River began only three years before 1990. When the 1990 annual passage index for coho was compared to the average of the previous three years, a 33% decrease was detected. The primary reason for the lower collections of all species in 1990 was that Unit 5 was monitored instead of Unit 3. Typically, greater numbers of smolts pass through the units closer to the shoreline, such as Unit 3. In addition, Unit 5 was out of service four times during the season for a total of 19 days. The longest outage of 11 days was due to the fire in the powerhouse late in May. Flows increased dramatically during this outage, which undoubtedly pushed large numbers of late spring migrant and early summer migrants past John Day Dam, as occurred at other monitoring sites. The steelhead annual passage index consisted of 51.2% wild and 48.8% hatchery stocks (Table 10), but had sampling continued during late May into early June, higher percentages of hatchery steelhead would have been collected. Because of these sampling problems, the 1990 cumulative passage indices at John Day Dam have limited utility.

The 1990 cumulative passage indices at Bonneville Dam powerhouse 1 were 332,500 yearling chinook, 1,217,500 subyearling chinook, 127,800 steelhead, 677,100 coho and 81,400 sockeye (Table 9). Approximately 595,000 smolts were released above John Day Dam on May 30 from a transportation barge. An estimate of 5,000 yearling chinook and 75,000 steelhead from this barge

release were subtracted from the passage indices of June 2 and 3 before the annual passage indices listed above for yearling chinook and steelhead were computed. The 75,000 steelhead estimate was further divided into 67,000 hatchery and 8,000 wild fish, based on the 11% wild to 89% hatchery steelhead composition determined at Lower Granite Dam, where most of the fish originated. Although the resulting steelhead cumulative passage index at Bonneville Dam consisted of 48.3% wild and 51.7% hatchery stocks, identical to last year's composition, the index was 38% lower in 1990 than in 1989 for these stocks (Table 10). The relation between the 1990 cumulative passage indices and historical means for each species were similar at Bonneville Dam to that observed at McNary Dam, indicating a consistency in the data for the lower Columbia River reach. Most noteworthy this year was the 167% increase over the previous 2-year average for the cumulative passage index of subyearling chinook passing Bonneville Dam after June 1. These fish were almost exclusively upriver bright stocks (hatchery and wild). The high flows in June and the first half of July moved large numbers of subyearling chinook of both upriver origin and Bonneville pool origin past Bonneville Dam this year.

3. Conclusions.

Cumulative passage indices of spring migrants were higher at Lower Granite Dam and lower at Rock Island, McNary, and Bonneville dams compared to the historical average. Reduced survival from lower flows during mid-May in the Snake River, increased transportation of steelhead from in the Snake River, and lower contribution of mid-Columbia River yearling chinook, steelhead and sockeye may have contributed to the reduced cumulative passage indices of these spring migrants in the lower Columbia River in 1990. High flows throughout June and early July in the lower Columbia River contributed to the highest cumulative passage indices for summer migrants being recorded at McNary and Bonneville dams since monitoring began at these sites. The 1990 summer migration documented the benefits to smolt survival of increased flow levels.

B. MIGRATION TIMING

1. Methods.

The distribution of daily passage indices for a particular species at a monitoring site provides a measure of migration timing. Plots of the passage distributions for each species at the Snake River (Lewiston) trap and Lower Granite, Rock Island, McNary, John Day, and Bonneville (powerhouses 1 and 2) dams are presented in Appendix E in a format that is unchanged from previous years.

Estimates of the 10%, 50% and 90% passage dates for each species were computed from the cumulative passage distributions at each monitoring site. The duration of the migration for each species at a project was computed as the number of days between the 10% and 90% passage dates. The dates of 10%, 50%, and 90% passage for each species and monitoring site from previous years

were ordered in an ascending sequence for each percentile. The median date from sequences provided historical 10%, 50%, and 90% passage dates for comparison with the 1990 data. A theoretical 80% passage duration from the historical record was computed by subtracting the historical 10% date from the historical 90% date. Wild and hatchery steelhead migration timing for 1990 was compared with 1989 timing data (the first year hatchery and wild steelhead passage data were separated). Changes from the historical data cannot be considered in isolation of other influential factors, such as different hatchery release schedules, changing flow patterns, and project operational differences. In addition, the unplanned barge release above John Day Dam on May 30, required that an estimate of barged fish be removed from the June 2-3 passage indices at Bonneville Dam before computation of the 10, 50, and 90% passage dates at that site.

A series of graphs (Appendix F) were generated for the migration timing of the middle 80% of smolt runs of known hatchery origin. The dates of 10% and 90% passage for marked groups of yearling and subyearling chinook and steelhead were estimated from the cumulative passage index distributions, following pooling of replicate releases for each hatchery group of interest. For the lower Columbia River monitoring sites, several marked groups from the same drainage were pooled to increase sample size and allow timing information for fish from that particular drainage. The migration timing of the middle 80% of each mark group was plotted between the 10 and 90% dates.

2. Results and Discussion.

The timing of smolt entry into Lower Granite reservoir was provided by monitoring at the Clearwater and Snake River traps, located near Lewiston, Idaho. Clearwater River trap collections began to increase on March 22 for yearling chinook and April 4 for steelhead, with peak passage on April 6 for chinook and on May 5 for steelhead. These peaks were within 24-48 hours after large production releases from Dworshak Hatchery. Sampling was terminated during periods of high flow at the Clearwater River trap. Snake River trap collections began to increase on March 25 for yearling chinook and on April 16 for steelhead, with the first peak of passage on April 24 for chinook and on May 7 for steelhead, at a time of increasing flow. The second peak day of passage occurred on May 30 for both species, the date of the highest Snake River flow for the 1990 season. Snake River trap collections dropped to negligible levels after June 5 for yearling chinook and after June 13 for steelhead.

The 10%, 50%, and 90% dates of passage and duration of the middle 80% of the run for each species at Lower Granite, Rock Island, McNary, and Bonneville dams are presented in Table 11. Only approximate 10% and 50% dates for spring migrants are presented for John Day Dam, because of the 11-day outage of Unit 5 late in the spring season. Likewise, no passage percentile dates are given for subyearling chinook at John Day Dam due to several outages of Unit 5 during the summer

Table 11. 1990 and historical passage dates for juvenile salmonids at key monitoring sites.

Site	Species	1990 Passage Dates 10%	50%	90%	80% Passage Duration(days)	Historical Passage Dates 10%	50%	90%	80% Passage Duration(days)
LOWER GRANITE	YRLG CHINOOK	04/16	04/24	05/21	35	04/18	04/28	05/25	37
	STEELHEAD	04/26	05/12	06/01	36	04/28	05/13	06/01	34
	SOCKEYE	04/11	05/24	06/23	73	NA	NA	NA	-
ROCK ISLAND DAM	YRLG CHINOOK	04/19	04/29	05/15	26	04/24	05/07	05/22	28
	SUBYR CHINOOK	06/03	06/30	07/31	58	06/09	07/04	08/03	55
	STEELHEAD	04/26	05/11	06/02	37	05/08	05/16	05/29	21
	COHO	05/07	05/18	05/29	22	05/14	05/21	05/28	14
	SOCKEYE	04/18	05/02	06/03	46	04/19	05/01	05/23	34
MCNARY DAM	YRLG CHINOOK	04/23	05/09	05/23	30	04/21	05/10	05/24	33
	SUBYR CHINOOK	06/14	06/26	07/20	36	06/16	07/06	07/21	35
	STEELHEAD	04/29	05/15	06/02	34	04/30	05/18	06/01	32
	COHO	04/23	05/14	05/26	33	05/18	05/23	06/02	15
	SOCKEYE	04/28	05/12	06/03	36	05/02	05/18	06/03	32
JOHN DAY DAM	YRLG CHINOOK	04/25	05/10	NA	-	04/28	05/15	05/30	32
	SUBYR CHINOOK	NA	NA	NA	-	06/08	07/21	09/01	85
	STEELHEAD	04/29	05/07	NA	-	04/26	05/15	05/31	35
	COHO	04/27	05/05	NA	-	05/06	05/13	05/31	25
	SOCKEYE	05/04	05/15	NA	-	05/10	05/22	06/04	25
BONNEVILLE PH#1	YRLG CHINOOK	04/16	05/02	05/22	36	04/19	05/01	05/21	32
	SUBYR CHINOOK	04/21	06/23	07/08	78	NA	NA	NA	-
	"BRIGHTS"	06/07	06/27	07/12	35	06/08	06/29	07/31	53
	STEELHEAD	05/01	05/14	06/04	34	04/26	05/13	05/29	33
	COHO	04/23	05/09	06/09	47	05/01	05/10	05/29	28
	SOCKEYE	05/08	05/22	06/05	28	05/11	05/24	06/04	24

- Historical percentiles are based on passage data for 6 years (1984-89) at Lower Granite and McNary dams, 5 years (1985-89) at Rock Island Dam, 4 years at John Day Dam, and 3 years (1987-89) at Bonneville Dam for spring migrants and 2 years (1988-89) for summer migrants.
- Outages of Unit 5 at John Day Dam during the periods April 16-19, May 30-June 10, June 21-23, and August 13-16 make computed percentiles gross approximations only. It is likely that dates would be up to several days later if uninterrupted sampling had occurred. Dates where not even a gross estimation is feasible are denoted by "NA".
- "Brights" at Bonneville Dam refers to subyearling chinook arriving after June 1; this excludes most "tule" fall chinook originating from Spring Creek Hatchery.
- An unplanned barge release of approximately 600,000 yearling chinook and steelhead above John Day Dam on May 30 resulted in an excess of about 75,000 steelhead and 5,000 yearling chinook in the Bonneville Dam passage index for June 2 and 3. The estimated extra barged fish were subtracted from the June 2-3 passage indices at Bonneville Dam before computation of 10, 50, and 90 percent passage dates.

migration season, and the overall low collections of subyearling chinook. At all five monitoring sites, there was a tendency for the first half of the passage distributions of most species to be shifted earlier in 1990 from the previous years of the SMP. The average difference between the 1990 dates of 50% passage and the historical dates, averaged across all species and sites, was 4 days earlier in 1990. Exceptionally early 10% passage dates were observed in 1990 compared to the historical dates for steelhead at Rock Island Dam (12 days early) and coho at McNary Dam (25 days early), the latter simply reflecting an earlier migration of coho out of the Yakima River drainage. Even though the 10% and 50% dates of the migrations appeared to shift earlier, the 90% passage dates were often

within one day of the historical 90% day, and seldom further than a week away. The largest deviations between 1990 and historical 90% dates occurred for sockeye at Rock Island Dam and coho at Bonneville Dam (11 days later in 1990), and for subyearling chinook, predominantly "upriver brights", at Bonneville Dam (19 days earlier in 1990). There has been a tendency toward earlier 90% dates at Rock Island Dam, with the weakening Osoyoos run of sockeye in recent years. However, the rapid increase in flow beginning May 30 resulted in a corresponding rise in passage indices later in the season for the sockeye at Rock Island Dam as well as coho at Bonneville Dam (Appendix Figures E-3 and E-7), contributing to the later date of 90% passage this year. The high flow in June and the early half of July substantially increased the number of upriver brights chinook passing Bonneville Dam this year. The higher than usual passage indices in June and early July, and the return to lower summer flows after mid-July, together appear to contribute to the 20-day earlier 90% date at Bonneville Dam this year. As a result of uncommon 10% and/or 90% dates, the middle 80% durations for steelhead and sockeye at Rock Island Dam and coho at all Columbia River sites were 8 to 18 days longer than the historical duration, and the middle 80% duration for upriver brights chinook at Bonneville Dam was 19 days shorter. The remaining cases had middle 80% durations differing by less than five days from that of the historical period.

Differences in migration timing between wild and hatchery steelhead past the monitoring sites are evident from Table 12. There was a trend for the first half of the passage distribution of wild steelhead to be skewed earlier than hatchery steelhead. However, the 90% passage dates of wild and hatchery steelhead were very similar. This resulted in wild steelhead having a longer duration of the middle 80% of the run at each monitoring site.

Appendix F graphically presents the middle 80% migration timing of marked hatchery groups of yearling chinook, subyearling chinook and steelhead at key monitoring sites between Lower Granite Dam and Bonneville Dam for Snake River stocks and between Rock Island Dam and Bonneville Dam for mid-Columbia River stocks. The first yearling chinook hatchery group to pass Lower Granite Dam was spring chinook from Lookingglass Hatchery, followed by spring chinook from Imnaha River acclimation pond, and Rapid River, Sawtooth, and Dworshak hatcheries. Summer chinook from McCall Hatchery begin arriving during the later half of the spring chinook migration and extend over a five week period, coincident with the steelhead migration. At McNary Dam, the middle 80% passage of most marked yearling chinook from the Snake River and mid-Columbia River hatcheries occurred between April 27 and May 27 this year. Dworshak and McCall hatchery chinook passage extended later, while Ringold Hatchery spring chinook had a distinct passage period during the first three weeks of April. The migration timing of Ringold Hatchery fish remained distinctively earlier at John Day and Bonneville dams as well. Marked steelhead from Oregon tributaries were

Table 12. Hatchery and wild steelhead passage dates for 1990 compared to 1989 at key monitoring sites.

		1990				1989			
		Passage Dates			80% Passage	Passage Dates			80% Passage
Site	Category	10%	50%	90%	Duration(days)	10%	50%	90%	Duration(days)
LOWER GRANITE	WILD	04/21	05/09	05/30	39	04/22	05/09	05/29	37
	HATCHERY	04/28	05/12	06/01	34	04/30	05/11	06/02	33
ROCK ISLAND DAM	WILD	04/21	05/14	06/06	46	04/28	05/16	06/07	40
	HATCHERY	04/27	05/10	05/31	34	05/10	05/17	06/05	26
MCNARY DAM	WILD	04/22	05/08	06/02	41	04/24	05/14	05/24	30
	HATCHERY	05/02	05/16	06/02	31	05/04	05/19	05/29	25
JOHN DAY DAM	WILD	04/26	05/03	NA	NA	04/18	05/09	05/23	35
	HATCHERY	05/02	05/13	NA	NA	05/08	05/18	05/28	20
BONNEVILLE PH#1	WILD	04/30	05/09	06/02	33	04/20	05/10	05/29	39
	HATCHERY	05/01	05/18	06/05	35	04/27	05/15	05/29	32

- Outages of Unit 5 at John Day Dam during the periods April 16-19 and May 30 - June 10 make computed percentiles gross approximations only. It is likely that dates would be up to several days later if uninterrupted sampling had occurred.

- An unplanned barge release of juvenile salmonids above John Day Dam on May 30 resulted in excess of about 75,000 steelhead in the Bonneville Dam passage index. An estimate of 8,000 wild and 67,000 hatchery steelhead (barge fish) were excluded from the June 2 and 3 passage indices before computation of the 10, 50, and 90 percent passage dates.

the first to arrive at Lower Granite Dam, followed by marked steelhead from Idaho hatcheries. The middle 80% durations of most marked steelhead groups ranged from 3 to 5½ weeks (the Lyons Ferry Hatchery release in Asotin Creek was only 2 weeks). At McNary Dam, marked steelhead from the mid-Columbia River drainage had a compact middle 80% passage duration of 2 weeks, compared to the 2½-4½ week duration of marked steelhead from the drainages of the Snake and Walla Walla rivers. The more compact passage duration of marked mid-Columbia River steelhead continued downstream at John Day and Bonneville dams. The middle 80% passage period for subyearling chinook of hatchery origin occurred at the peak period of subyearling chinook passage at each monitoring site from Rock Island Dam to Bonneville Dam between early June and mid-July. The summer migration after mid-July was composed of mostly subyearling chinook of wild origin. Pre-summer peaks of subyearling passage at Bonneville Dam were dominated by non-branded fish from hatcheries in Bonneville pool, particularly Spring Creek Hatchery.

3. Conclusions.

Peaks in chinook and steelhead passage at the Idaho traps followed large hatchery releases upstream of the Clearwater trap and large increases in flow at the Snake River trap. The migration timing of most species at the monitoring sites averaged about four days earlier this year compared to the historical median dates of 10, 50, and 90% passage. Generally, the duration of the middle 80% of the species run at a monitoring site differed by less than five days from the historical duration. The most notable exception was the earlier 90% date of upriver bright chinook at Bonneville Dam,

and subsequent 19-day shorter middle 80% duration. The large number of upriver bright chinook passing Bonneville Dam during the period of high flow in June and early July resulted in an early 90% date this year.

C. TRAVEL TIME

1. Methods.

Travel time estimates were computed for hatchery and in-river marked freeze brand (FB) and PIT tag (PIT) groups of yearling and subyearling chinook and steelhead in several index reaches. These index reaches are shown in the following shaded box:

Snake River (above Lower Granite Dam)
- Hatchery release site or Idaho trap to Lower Granite Dam (FB, PIT)
- Lower Granite Dam to McNary Dam (FB, PIT)

Snake River (below Lower Granite Dam)
- Hatchery release site to McNary Dam (FB)

Mid-Columbia River
- Hatchery release site to McNary Dam (FB)
- Rock Island Dam to McNary Dam (PIT)

Lower Columbia River
- McNary Dam to John Day Dam (FB)
- McNary Dam to Bonneville Dam (FB)

For PIT groups, travel time was estimated for each individual fish recovered, and a travel time distribution was formed for each daily release or multi-day block of releases. Before computing estimates of median travel time, the recovery number for each daily PIT group release was checked at downstream monitoring sites. Multi-day blocking of adjacent release days was used to increase recovery samples size to close to 30 fish when possible, in order to increase precision around the median travel time estimate. The median travel time for this distribution was estimated as the value of the median observation in the distribution when recovery sample sizes were odd, and the average of the two middle observations when recovery sample sizes were even. No adjustment for passage through spill was made to the resulting 1990 PIT tag recovery distributions at McNary Dam in order to facilitate computation of 95% confidence interval for the median travel time estimate using the normal approximation to the binomial confidence interval around rank ordered observations (Dudewics 1976). For the Lower Granite Dam to McNary Dam index reach, additional blocking of releases was necessary to achieve an adequate recovery size at McNary Dam. New travel time distributions and medians were computed for these two recovery sites. A total of 28 PIT tagged fish

were excluded from the McNary Dam recovery distributions because they had obviously escaped from one transportation barge on four occasions in May (a problem confirmed by the on-site COE biologist). The index reach median travel time was computed as the difference between the median travel time estimates at McNary and Lower Granite dams. Although a 95% confidence interval cannot be directly computed for this index reach median estimate, an indirect error bound was computed. The lower limit error bound was computed as the difference between the upper 95% confidence limit at Lower Granite Dam and the lower limit at McNary Dam. The upper limit error bound was computed as the difference between the lower 95% confidence limit at Lower Granite and the upper limit at McNary Dam.

For FB hatchery groups, travel time was estimated from release to first recovery site by taking the difference between the release date (or median date of release from multi-day releases) and the date nearest the median recovery. In the Lower Granite Dam to McNary Dam index reach, the difference between the dates nearest median passage at each site provided an estimate of median travel time. This is the same method used in previous annual reports. Using the replicate groups released from each hatchery, 95% confidence intervals were computed.

In-river migrating smolts were collected, freeze branded with an unique code on a daily basis, and released 5 to 6 days per week at McNary Dam for estimating travel time in the McNary Dam to John Day Dam index reach. Brand recovery data was expanded by the proportion of flow through the sampled unit at John Day Dam, to adjust for daily changes in operation of Unit 5 and spill. With this expanded recovery data, a frequency distribution of travel times was obtained for the weekly release blocks, and median travel time was interpolated to the nearest tenth of a day. A 95% confidence interval for this median was estimated from the travel time distribution of non-expanded recovery data, as was done for PIT tag groups. This was possible because there was little change in the proportion of flow through the sampled unit, and there was not any spill until sampling on these marked groups was terminated.

Regression analyses were conducted on the PIT groups released from the Idaho traps and from Rock Island Dam. The median travel time and average flow data were both transformed to natural log scale prior to the linear regression analysis. The methods of computing average flow (unchanged from previous years) is specified in the Appendix G travel time tables for each index reach. Differences in median travel time between the Clearwater and Snake River traps, and between hatchery and wild steelhead, were conducted using an analysis of covariance. Because the Snake River trap operated later into the season than the Clearwater River trap, homogeneity of slopes and analysis of covariance were tested for releases covering the same time interval at both sites. Significance was determined at the $\alpha=0.05$ level. Non-significantly different groups were pooled.

Data from the entire release period were used in final regression analyses.

2. Results and Discussion.

The emphasis of this section is to present travel time results for marked groups released in 1990. It covers in-season trends observed in the data, and only limited comparisons with prior years. Although an extensive multi-year data analysis is outside the scope and schedule of this report, the Fish Passage Center staff will continue to analyze the 1990 travel time data along with data from prior years in the context of evaluating factors influencing smolt travel time. This basic information is useful when in-season Water Budget decisions are needed. Detailed travel time tables in a format similar to that of prior years are presented in Appendix G.

a. Idaho Traps to Lower Granite Dam.

A total of 15,165 chinook and steelhead were PIT tagged and released by IDFG from the Snake and Clearwater River traps between March 30 and June 14 (see Buettner and Nelson [in press] for a complete report of this work). Day-to-day recovery proportions of these PIT tagged fish showed random fluctuations, but no trends over the spring migration season (Appendix Tables G-1 to G-6).

Travel time from the Idaho traps to Lower Granite Dam generally decreased as flow increased, as shown by travel time data averaged into 20 kcfs flow intervals (Table 13). The travel time data was averaged from daily and multi-day estimates of median travel time for chinook, wild steelhead, and hatchery steelhead in Lower Granite reservoir for 1990 given in Appendix Tables G-1 to G-6. Eighty-five percent of the median travel time estimates occurred for flow conditions between 40 and 80 kcfs. At these low flow levels, smolt travel time was more than double what was observed with flows over 100 kcfs.

Table 13. Average travel time from Snake River and Clearwater River traps to Lower Granite Dam, 1990, stratified by 20-kcfs flow intervals.

	YEARLING CHINOOK				WILD STEELHEAD				HATCHERY STEELHEAD			
FLOW RANGE	SNK TRAP		CLW TRAP		SNK TRAP		CLW TRAP		SNK TRAP		CLW TRAP	
(kcfs)	Days	N	Days	N	Days	N	Days	N	Days	N	Days	N
40-59.9	8.6	(2)	14.1	(19)	5.1	(5)	6.2	(9)	7.8	(10)	6.7	(6)
60-79.9	7.5	(12)	11.6	(13)	3.8	(23)	4.6	(8)	5.0	(25)	5.6	(14)
80-99.9	4.8	(3)	7.7	(2)	3.3	(1)	3.6	(1)	3.6	(10)	6.2	(1)
>100	3.4	(2)	NA	(0)	2.1	(2)	NA	(0)	2.0	(5)	NA	(0)

The average recovery rate over the entire season at Lower Granite Dam was 32% for Clearwater River chinook, 43% for Snake River chinook, 57% for wild Snake River steelhead, 66% for wild Snake River steelhead, 71% for hatchery Clearwater River steelhead, and 73% for hatchery Snake River steelhead. In all cases, Clearwater River smolts were recovered at a lower rate than Snake River smolts (although some differences were very slight), and wild steelhead were recovered at a lower rate than hatchery steelhead. Whether these different recovery rates at Lower Granite Dam were due to differences in survival through Lower Granite reservoir or differences in guidance

efficiency of the turbine deflector screens for these PIT tagged fish, is not known from this data. It was known that smoltification development, as measured by ATPase level, averaged higher for yearling chinook from the Snake River trap than those from the Clearwater River trap, and higher for wild steelhead than hatchery steelhead at both the Snake River trap and Lower Granite Dam over most of the season (Figure 10 and Appendix Figure H-6). Although the Snake River chinook and wild steelhead groups had the highest ATPase levels, they both did not have the highest recovery rates. Past fish guidance studies of the turbine deflector screens at Lower Granite Dam indicated an exponential relation between guidance efficiency and smoltification for chinook (Muir *et al.* 1990). The chinook from the trap which had the highest ATPase levels were recovered at Lower Granite Dam at the higher rate; however, the increase in ATPase level over the season at either trap did not result in any increasing trend in recovery rate at Lower Granite Dam. In an earlier paper, Muir *et al.* (1988) cited several researchers working with Atlantic salmon and brown trout, who found that hatchery fish were more buoyant than wild fish, due to dietary differences. If this occurred for the steelhead races marked at the Snake River trap, then wild steelhead with higher ATPase levels, but lower buoyancy levels than hatchery steelhead, could tend to migrate lower in the water column and get diverted by the screens at Lower Granite Dam at a lower rate. These arguments must be viewed cautiously, as they are very speculative.

Differences were apparent in smoltification development and migration rate of chinook released from the Snake and Clearwater River traps. Using chinook travel time data from the one month period (April 9 - May 8) of comparable PIT tagging effort at both traps, an analysis of covariance with trap as a factor and flow as the covariate (following confirmation of homogeneous slopes) showed (Figure 10) that Snake River chinook migrated about 40% faster than Clearwater chinook through Lower Granite reservoir over the same range of flows observed (50-85 kcfs). Before April 9, only the Clearwater River trap was collecting enough chinook for marking, which was typical of previous years. These fish, predominantly of Dworshak Hatchery origin, had very low ATPase levels, experienced very low flows in the reservoir, and had median travel time estimates ranging from 16 to 25 days (Figure 10). From May 9 - 16, the Clearwater River trap was out of service due to high flows. When sampling resumed, the shortest travel times were observed under some of the lowest flows for the season. Although significant regressions between travel time and flow could be obtained for portions of the season, the regression using data from the entire season of marking at the Clearwater River trap was not significant (R^2=0.057; n=34). Changes in median travel time for Clearwater River trap chinook correlated better with simple serial date (R^2=0.842; n=34), apparently due to the influences in smoltification and lack of data during the period of high flow. Unlike the Clearwater River trap, the Snake River trap has better collection efficiency during periods of

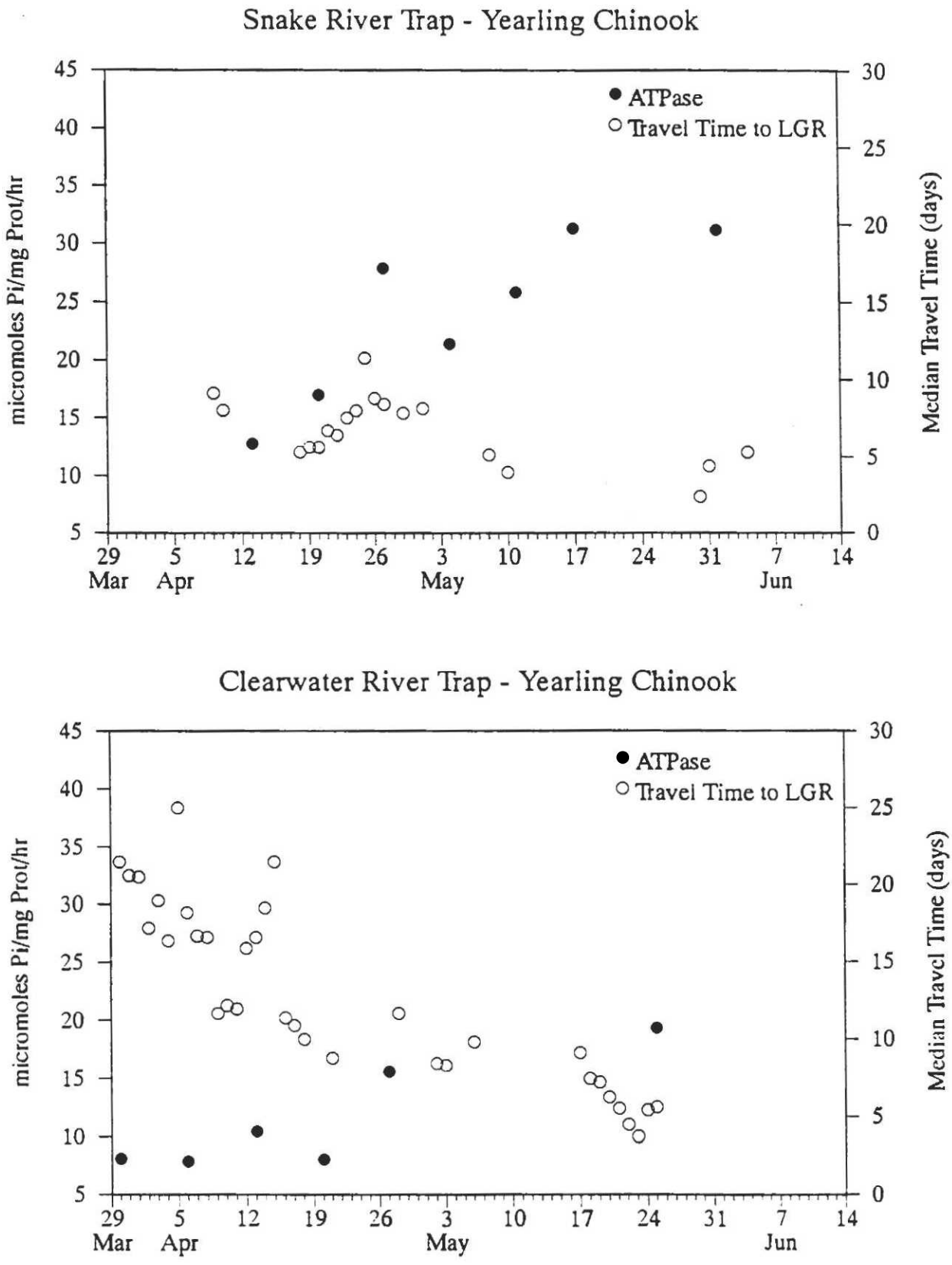


Figure 10. Comparison of average ATPase level of yearling chinook arriving at Snake River and Clearwater River traps, and estimated median travel time from there to Lower Granite Dam, 1990.

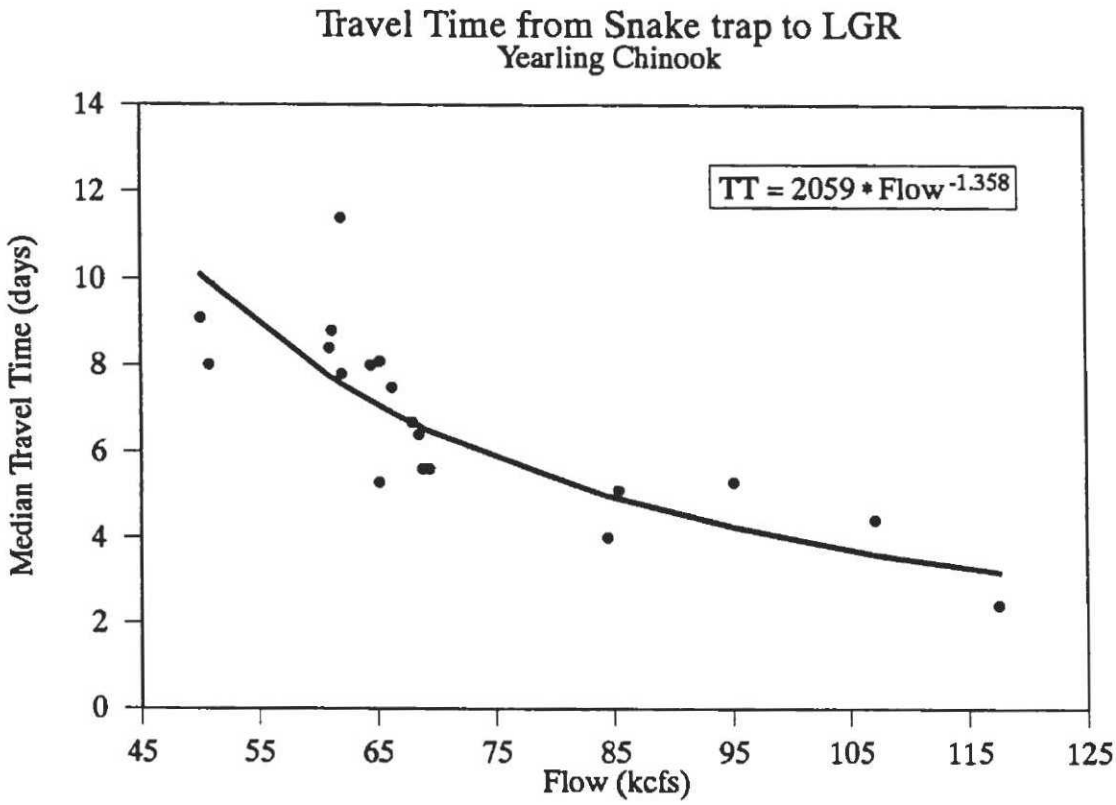
moderate to high flow than during periods of low flow. A significant travel time and flow relation (R^2=0.727; n=19) was observed for the Snake River trap chinook for the season (April 9 - June 8). The travel time and flow relation for chinook released from the Snake River trap (transformed back to the original scale from the natural log scale) is presented in Figure 11.

There was a difference between the migration rates of wild and hatchery steelhead released from the Snake and Clearwater River traps. An analysis of covariance with trap and race as factors, and flow as the covariate (following confirmation of homogeneous slopes), was conducted on steelhead travel time in Lower Granite reservoir for releases through May 25, a period when comparable marking effort occurred at both sites (Figure 12). No significant difference between traps, and no significant interaction between the trap and race variables, were obtained, but a significant difference between races was shown. Wild steelhead migrated about 25% faster than hatchery steelhead over the same flows observed (44-86 kcfs). The Snake River trap continued to operate through June 14 into a period of higher flows. Encompassing flows up to 117.6 kcfs, a final steelhead travel time/flow regression model (R^2=0.659; n=127) was run with race (0=wild, 1=hatchery) and flow as variables. The model produced the two curves shown in Figure 11.

b. Hatchery Release Sites to Lower Granite Dam.

Estimates of median travel time for individual freeze-branded hatchery groups to Lower Granite Dam is presented in Appendix Table G-1 for ease of comparison with past years. To summarize these data, the average of the median travel time estimates from replicate groups are presented here. The estimated average travel times to Lower Granite Dam for hatchery yearling chinook were: 17 days from Lookingglass Hatchery; 24 days from the Imnaha River; 25 days from Dworshak Hatchery; 29 days from Rapid River Hatchery; 36 days from Sawtooth Hatchery; and 61 days from the McCall Hatchery release in the South Fork Salmon River. For hatchery steelhead groups, estimates were: 7 days from Asotin Creek; 8 days from Dworshak Hatchery; 11 days from Wildcat Creek; 16 days from Wallowa Acclimation Pond; 18 days from Little Sheep Creek; 43 days from the Magic Valley Hatchery release in the East Fork Salmon River; and 44 days from the Magic Valley Hatchery release at Sawtooth Hatchery. Details of the migration timing past Lower Granite Dam for these marked groups was presented earlier in Section IV.B.2 of this report, and is graphically shown in Appendix F.

The PIT tagged steelhead released from Dworshak Hatchery provided travel time and recovery data for fish reared in raceways from each of the different water systems available there. Approximately 1000 steelhead were PIT tagged in each of three raceways that also contained a freeze-branded production fish (LA-Z-1). The main differences between the three systems was source of water (flow through versus recirculated), temperature (ambient versus heated), and rearing



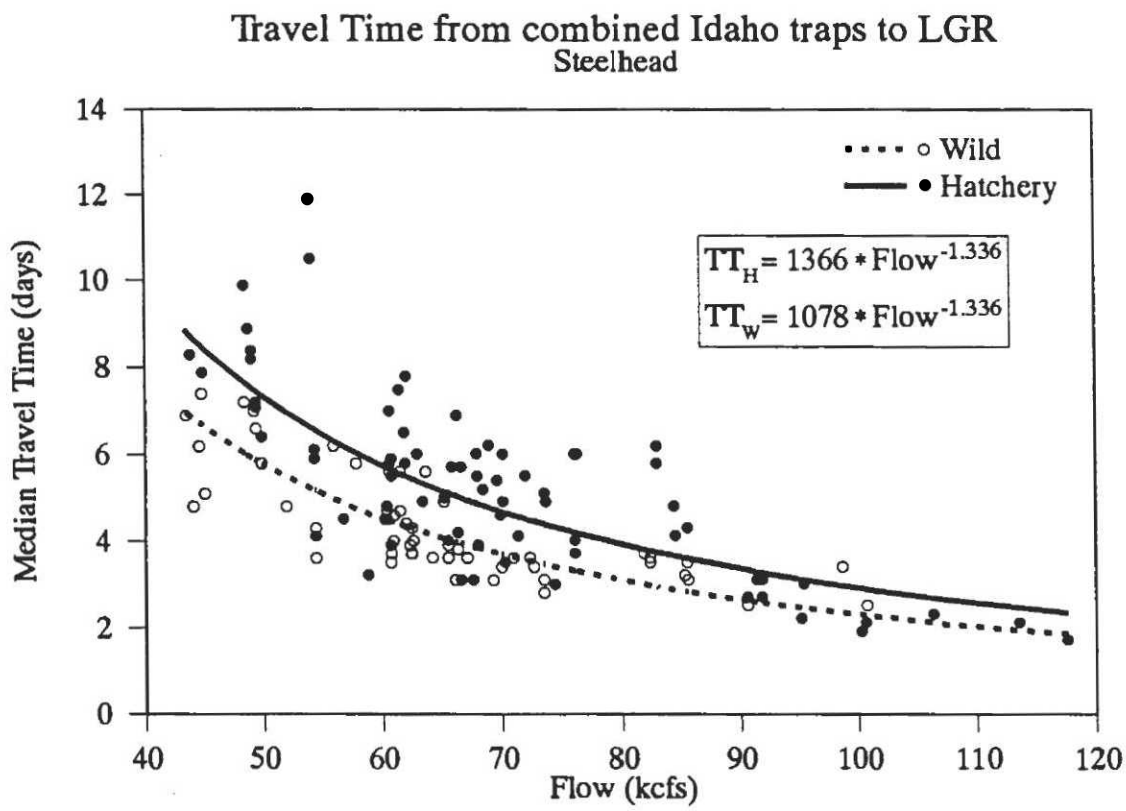
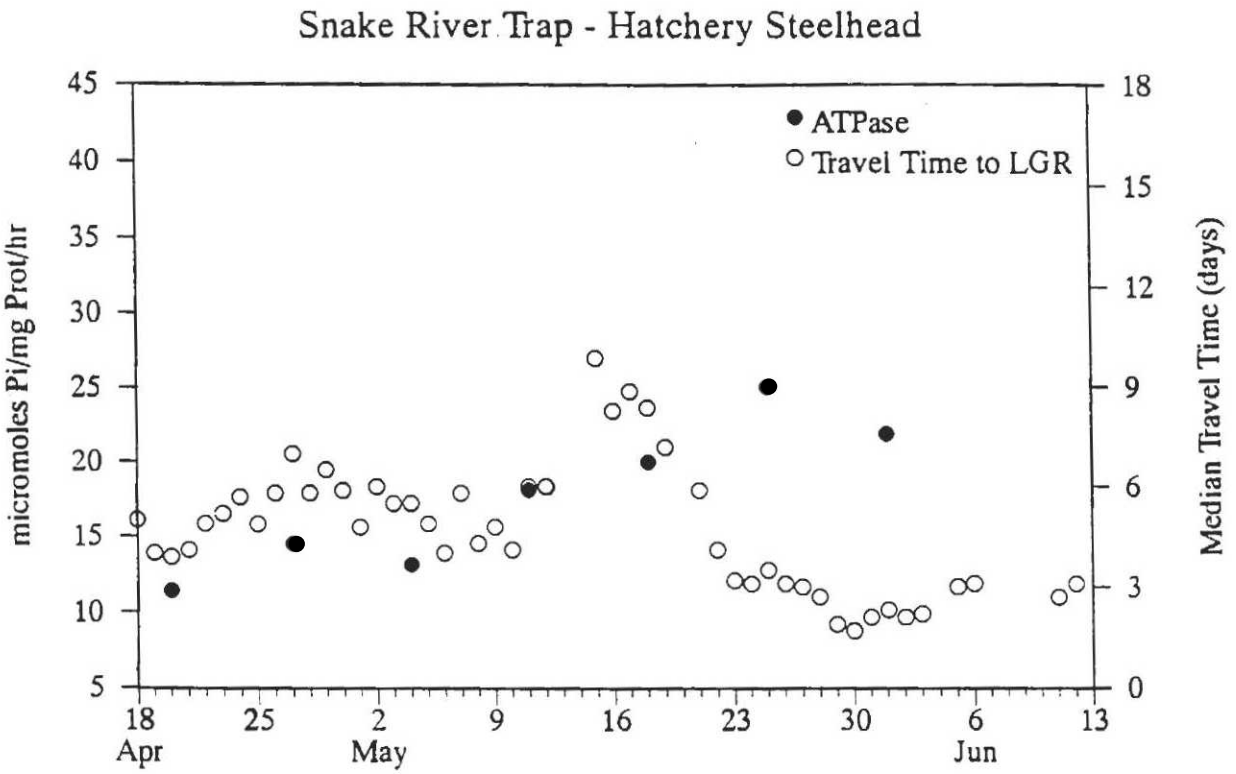


Figure 11. Median travel time to flow relations for yearling chinook and steelhead (marked at Idaho traps) in the Lower Granite Reservoir index reach, 1990.



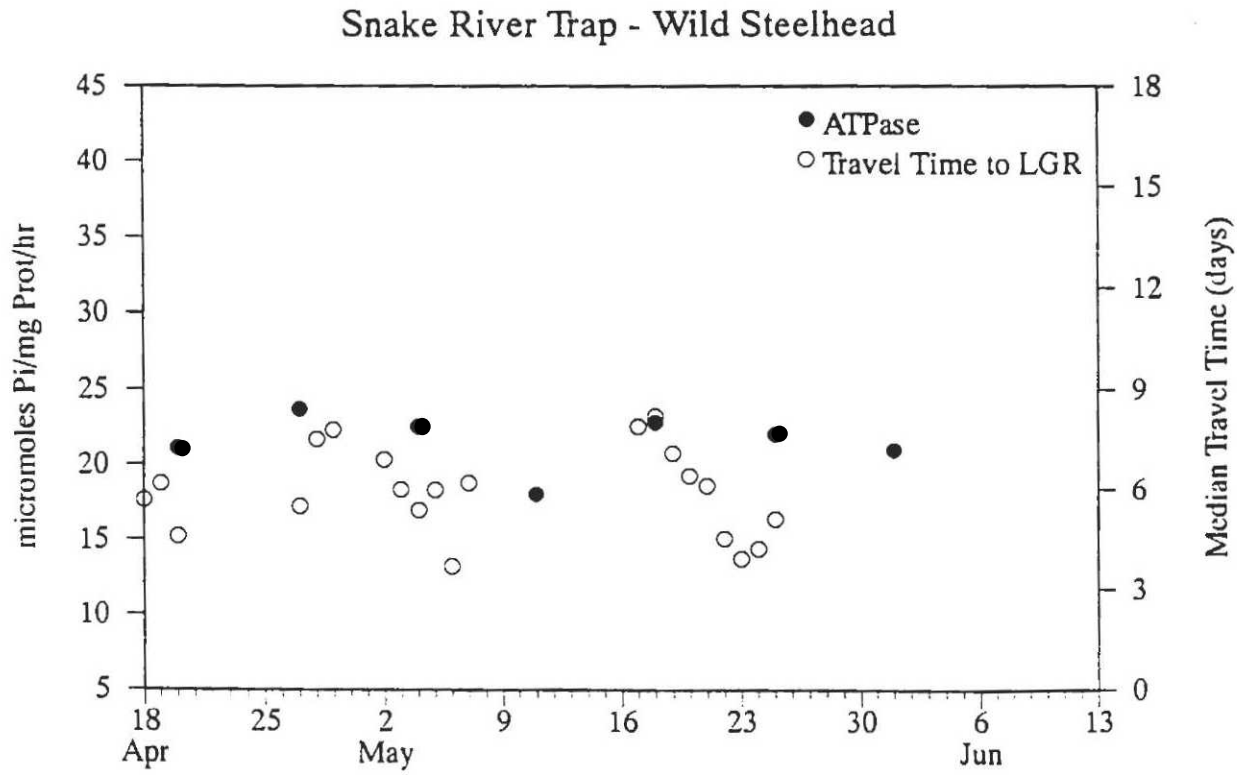


Figure 12. Comparison of average ATPase level of steelhead arriving at the Snake River trap, and estimated median travel time from there to Lower Granite Dam, 1990.

time in a particular system. System 1 had flow-through, ambient-temperature water, while Systems 2 and 3 had separate systems of recirculated, heated water. System 1 raceways were stocked with steelhead earlier than the other systems because longer rearing time is required at ambient water temperature for these fish to reach a size comparable to the fish reared in the other, heated, systems. At time of PIT tagging and release, the largest steelhead were in System 1, and the smallest steelhead were in System 2 (Figure 13). The System 1 PIT tagged steelhead had the lowest median travel time (6.3 days) and highest recovery rate (78.7%) of the three groups at Lower Granite Dam. Median travel times (and recovery percentages) were 7.5 days (67.0%) for System 3 fish and 8.8 days (50.8%) for System 2 fish. Of the size range of fish marked, there was a tendency for a greater proportion of the larger fish (>170mm) to be recovered at Lower Granite Dam (Figure 13). These findings show that rearing environment can greatly influence the size of smolts being released from the hatchery and their subsequent migration and recovery rates to at least the first dam.

c. Lower Granite Dam to McNary Dam Index Reach.

Estimated median travel time (averaged over the replicates) ranged from 11.3 to 16.5 days in the index reach for FB groups of hatchery spring chinook and 10.3 days for the McCall Hatchery summer chinook (Table 14). The spring chinook mark groups migrated through the index reach between mid-April and mid-May, which is typical of past years; the associated average flows for these groups was around 65 kcfs. The summer chinook marked group migrated through the index reach later than in prior years of the SMP (late May instead of the first half of May); the associated average flow for this group was 90 kcfs. Flows dropped nearly in half after May 16 for an 8-day period, which appears to have delayed the bulk of the McCall Hatchery summer chinook passage through the index reach.

Estimated median travel time in the Lower Granite Dam to McNary Dam index reach for multi-day blocks of PIT releases (spanning March 30 - April 26, and May 17-25) from the Idaho traps ranged from 6.7 to 19.3 days. Median travel times over similar dates of release were not significantly different between the two traps, so data from both traps were pooled. A significant relation between travel time and flow (R^2=0.85; n=15) was obtained (Figure 14). The slope of this relation (b=-1.476) was similar to that obtained for the Lower Granite reservoir index reach (b=-1.358), indicating a consistancy in the influence of flow on travel time between the two index reaches. The prediction with these regression models was that increasing flows from 60 to 100 kcfs would approximately cut in half the travel time through each of these respective index reaches. Across this range of flows, the median travel time between Lower Granite and McNary dams (140 miles) was predicted to be about 2¼ times longer than that in Lower Granite pool (31 miles). In terms of migration speed, the yearling chinook were migrating at twice the speed between Lower Granite and McNary dams than through Lower Granite reservoir under similar flows, apparently due to increases in smoltification

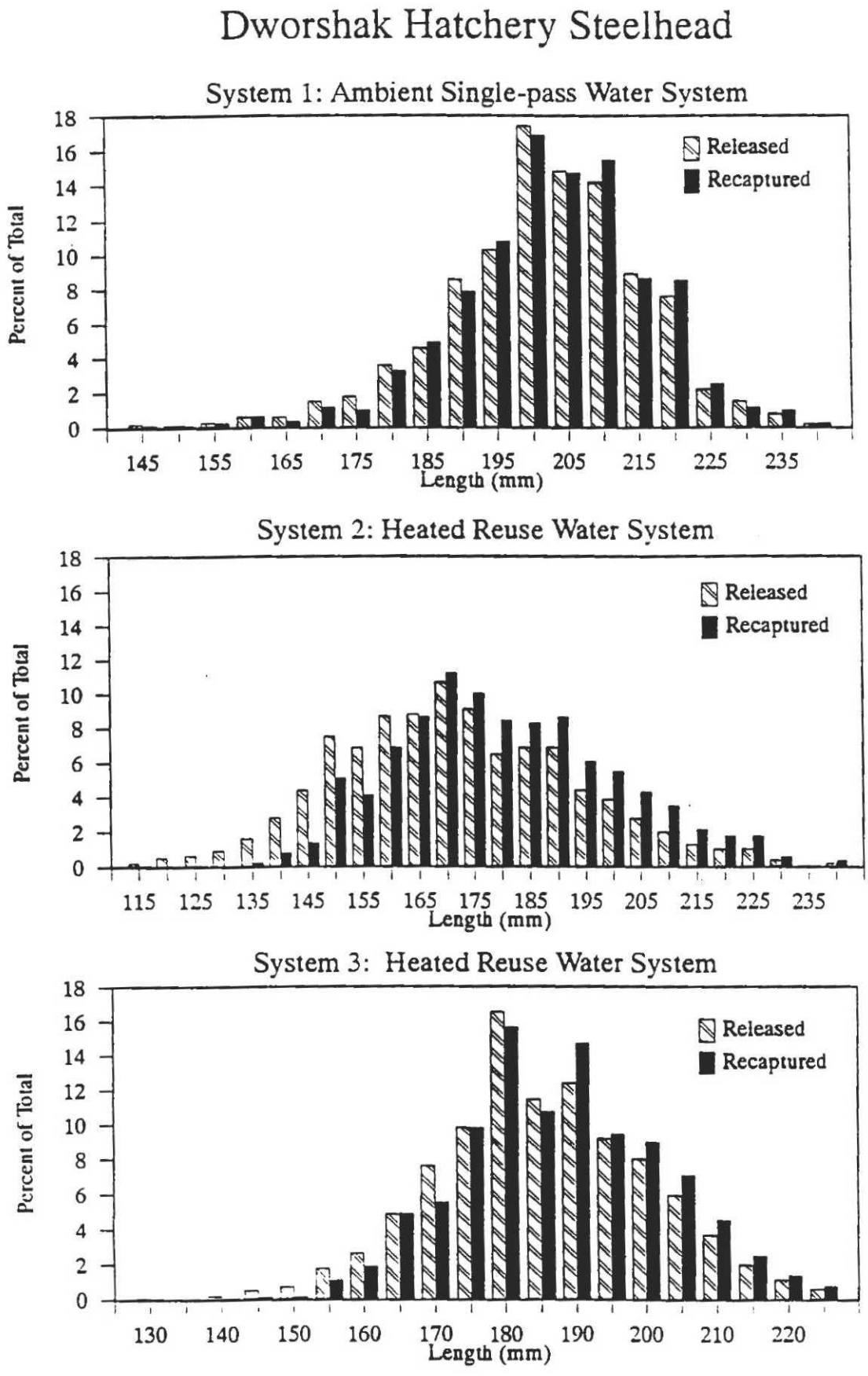


Figure 13. Comparison of the "at time of marking" fork lengths between released Dworshak Hatchery steelhead and those individuals recovered at Lower Granite Dam for the hatchery's three water systems, 1990.

Table 14. Travel time of marked fish in key index reaches, 1990.

SPECIES	RELEASE SITE (ORIGIN)	RLSE #	TRAVEL TIME ESTIMATES: AVERAGE MEDIAN	STD ERROR	95% CONF. INT. L.LIMIT	U.LIMIT	AVG INDEX FLOW	SPEED (MI/DAY)
	SNAKE RIVER INDEX REACH: LOWER GRANITE TO MCNARY DAM							
Yrlg Chinook	Sawtooth Hatchery	3	11.3	0.33	9.9	12.7	62.8	12.4
	SF Salmon (McCall H)	3	10.3	1.76	2.7	17.9	90.1	13.6
	Rapid River Hatchery	3	13.7	1.20	8.5	18.9	61.7	10.2
	Dworshak Hatchery	3	15.3	1.20	10.1	20.5	74.5	9.2
	Lookingglass Hatchery	4	15.8	0.85	13.1	18.5	62.0	8.9
	Imnaha R. Accl. Pond	2	16.5	0.50	n/a	n/a	65.4	8.5
Steelhead	Grande Ronde R.	1	14.0	n/a	n/a	n/a	67.4	10.0
	MID-COLUMBIA RIVER INDEX REACH: RELEASE TO MCNARY DAM							
Yrlg Chinook	Winthrop Hatchery	3	30.7	0.33	29.3	32.1	169.9	9.2
	Entiat Hatchery	2	20.0	0.00	n/a	n/a	151.9	10.1
	Leavenworth H on 4/18	3	26.3	0.33	24.9	27.7	152.1	7.8
	Leavenworth H on 5/4	4	17.5	0.29	16.6	18.4	132.0	11.7
	Ringold Hatchery	2	7.5	0.50	n/a	n/a	151.3	7.5
Steelhead	Similkameen R (Wells H)	2	22.0	0.00	n/a	n/a	144.7	14.3
	Methow R (Wells H)	2	16.0	0.00	n/a	n/a	168.9	15.1
	LOWER COLUMBIA RIVER INDEX REACH: MCNARY TO JOHN DAY DAM							
Yrlg Chinook	Below McNary 4/30-5/18	3	5.3	0.03	5.2	5.4	220.6	14.3
Steelhead	Below McNary 4/30-5/18	3	4.4	0.19	3.6	5.2	219.2	17.3

- This table summarizes data in Appendix G Tables G-12, G-14, and G-15.
- Average flow reported is the mean of the average flows for replicate release groups (Appendix G). Flow is indexed at Ice Harbor Dam for the Snake River index reach, Priest Rapids Dam for the mid-Columbia River index reach, and John Day Dam for the lower Columbia River index reach.
- Distance traveled in the Snake River index reach is 140 miles, the mid-Columbia index is release site specific, and the lower Columbia River index reach is 76 miles. Distances for the mid-Columbia groups are: Winthrop H, 282 miles; Entiat H, 202.3 miles; Leavenworth H, 204.6 miles; Ringold H, 56 miles; Similkameen R, 315.6 miles; and Methow R, 241.9 miles.
- Grande Ronde River release incorporates eight separate brand groups pooled together.

development by the time chinook smolts are migrating through the lower index reach (Appendix Figures H-1 and H-2).

Limited travel time data is available for 1990 on steelhead in the Lower Granite Dam to McNary Dam index reach. Given the high efficiency of the collection system for steelhead at Lower Granite and Little Goose dams, and subsequent transportation via barge of all collected steelhead, few steelhead arriving at these projects continue their migration in-river. For this reason, too few of the PIT tagged Dworshak Hatchery steelhead and freeze branded Wildcat Creek (Irrigon Hatchery plant) steelhead were collected at McNary Dam to allow estimation of median travel time. Because all marked groups of hatchery steelhead released in the Grande Ronde River drainage migrated by Lower Granite Dam over the same time period with very close median dates of passage, the eight ODFW brand groups released at Wallowa Hatchery (Spring Creek Channel), Wallowa River, and

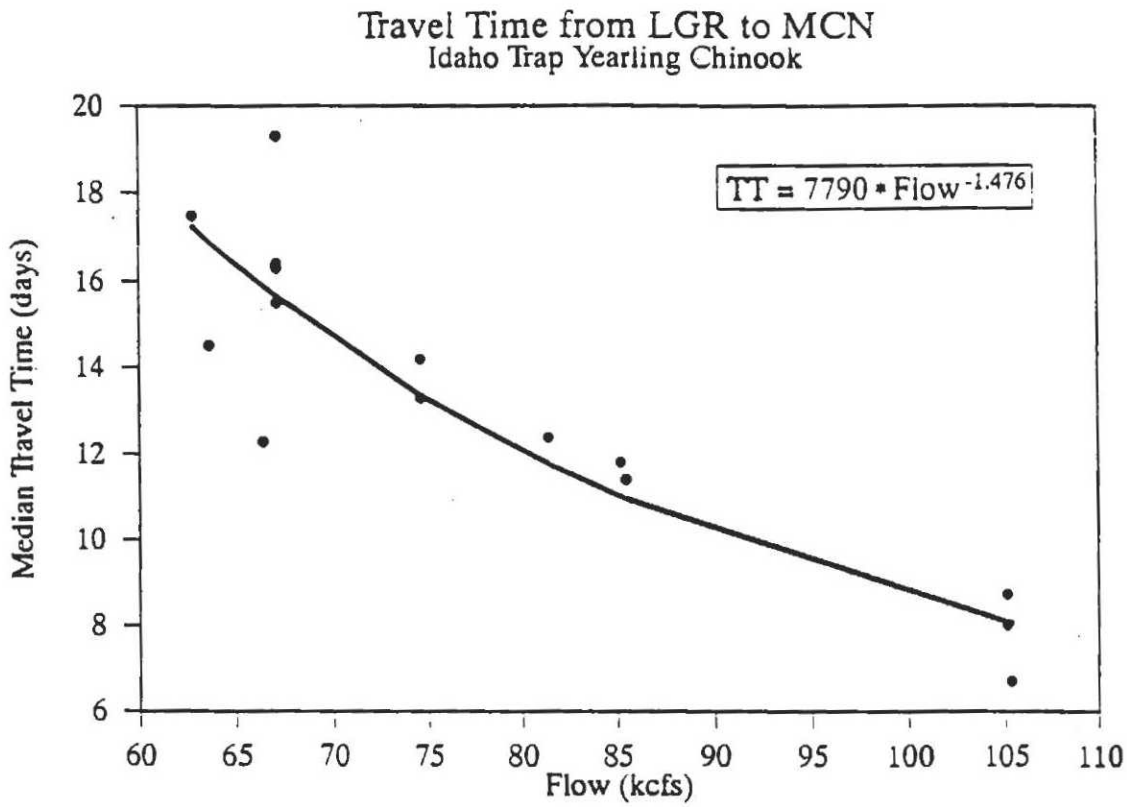


Figure 14. Median travel time to flow relation for yearling chinook (marked at Idaho traps) in the Lower Granite Dam to McNary Dam index reach, 1990.

Wildcat Creek were pooled together to provide an estimate of 14 days median travel time between Lower Granite and McNary dams (Table 14). Large numbers of wild steelhead were PIT tagged at the Snake River trap during the latter part of April. These wild steelhead releases were blocked into two multi-day release groups, and provided median travel time estimates of 10.4 and 10.5 days between Lower Granite and McNary dams.

d. Hatchery Release Sites Below Little Goose Dam to McNary Dam.

Marked Lyons Ferry Hatchery steelhead, released at the hatchery and at Marengo on the Tucannon River, migrated their respective distances of 91 and 111.5 miles to McNary Dam with very consistent migration speeds ranging from 6 to 7 miles/day (Appendix Table G-13). Subyearling chinook released from Lyons Ferry Hatchery on June 6 had travel time estimates ranging from 23 to 24 days, resulting in a migration speed of nearly 4 miles/day (Appendix Table G-13).

e. Mid-Columbia Hatchery Release Sites to McNary Dam.

For hatchery marked groups, the mid-Columbia River index reach spans from a given hatchery's release site to McNary Dam. Because of the variable distances involved, the preferred measure for characterizing index reach travel time is smolt migration speeds. Estimated median travel time (averaged over the replicates) for spring chinook ranged from 7.5 to 30.7 days (Table 14), with Ringold Hatchery and the April 18 release from Leavenworth Hatchery being the slowest migrating

fish (around 8 miles/day), followed by Winthrop and Entiat hatcheries (9-10 miles/day), and the release on May 4 from Leavenworth Hatchery being the fastest migrating chinook group (nearly 12 miles/day). Marked steelhead from the Wells Hatchery releases in the Methow and Similkameen rivers migrated faster (14-15 miles/day) than the yearling chinook groups under similar levels of flow.

The estimated median travel time for subyearling summer chinook from Wells Hatchery (released May 22-25) to McNary Dam was 39 to 40 days, and those of Priest Rapids Hatchery fall chinook for five releases made at 3-day intervals beginning June 7 were 13, 11, 11, 10, and 9 days, respectively (Appendix Table G-14). Average flows of 200 kcfs or better occurred during most of the time these subyearling chinook were migrating through the mid-Columbia River.

f. Rock Island to McNary Dam Index Reach.

A total of 5,808 yearling chinook and steelhead were PIT tagged by Chelan County PUD at Rock Island Dam between April 21 and May 25. The average recovery rate over the entire season at McNary Dam was 25% for chinook, 23% for hatchery steelhead, and 30% for wild steelhead (Appendix Tables G-8 to G-10). Recovery rates did not remain as stable at McNary Dam as had been observed at Lower Granite Dam for the PIT groups from the Idaho traps. Beginning with the May 9 release of yearling chinook, recoveries dropped in half from the levels observed earlier (from averages of 30% to 14%); hatchery steelhead recoveries dropped over half beginning with the May 13 release from the earlier levels (from averages of 27% to 12%); and wild steelhead had a single 4-day block (May 20-23 releases) drop to 14% recovered. These reductions in recovery proportions at McNary Dam may be influenced by lower survival during periods of low flow in mid-to-late May through McNary reservoir, and by lower collection efficiency during periods of high flow and spill after May 30 at McNary Dam. Due to the proximity of the spillway to the Washington shore, large numbers of mid-Columbia fish may be passing in spill.

Estimates of median travel time in the Rock Island Dam to McNary Dam index reach showed a general decreasing trend over time for yearling chinook, but were relatively stable over time for wild and hatchery steelhead. Yearling chinook median travel time estimates dropped from 21.7 days to 8.1 days over the migration season, with the April releases averaging 15.0 days and May releases averaging 9.8 days. No significant relation between travel time and flow was observed for yearling chinook, wild steelhead, or hatchery steelhead within the low range of flows observed in 1990. Mid-Columbia River flows, indexed as 7-day averages at Priest Rapids Dam during the time these PIT tagged groups were estimated to be passing this project, varied only 40 kcfs in 1990, between approximately 130 and 170 kcfs. A significant regression between median travel time and Julian date (R^2=0.705; n=23) was observed for yearling chinook. Julian date was used as a surrogate for smoltification development. Weekly ATPase levels increased over the period that PIT tagged

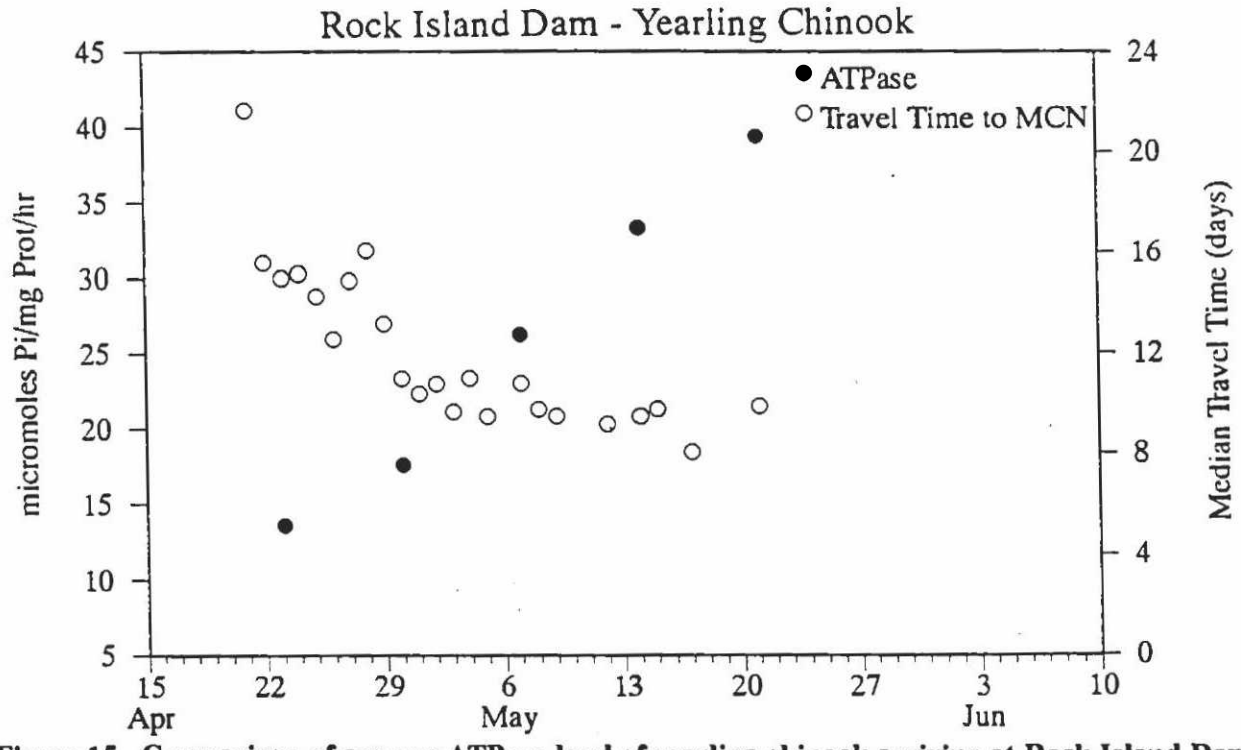


Figure 15. Comparison of average ATPase level of yearling chinook arriving at Rock Island Dam, and estimated median travel time from there to McNary Dam, 1990.

chinook were released from Rock Island Dam (Figure 15).

Although ATPase levels also increased for steelhead over the migration season, no significant relation between median travel time and Julian date (Figure 16) was observed for steelhead, as had been demonstrated for chinook. Median travel time estimates for the multi-day releases of steelhead were relatively stable over the season, varying by less than three days for hatchery steelhead and less than four days for wild steelhead. The average median travel time for the season was 8.3 days for hatchery steelhead and 8.0 days for wild steelhead. These averages are not significantly different.

g. McNary to John Day Dam.

A total of 25,744 yearling chinook and 20,195 steelhead were marked and released at McNary Dam during 5 weeks in 1990. Yearling chinook were released during the week of April 9 to 13 and the four weeks between April 30 and May 25; steelhead were released during the five weeks between April 30 and June 1. Only data from three of these weekly releases were usable for determining median travel time of chinook and steelhead, because of curtailment of monitoring due to outages of Unit 5 at John Day Dam. A 3-day outage between April 16 and 19, and an 11-day outage from May 30 to June 9, resulted in too few recoveries during the first and last weeks for chinook and the fourth and fifth weeks for steelhead. During the three weeks between April 30 and May 18, relatively stable estimates of median travel time (Appendix Table G-15) were observed for yearling chinook and steelhead, averaging 5.3 and 4.4 days, respectively (Table 14). Index reach flow averaged around 220 kcfs during this period. The average recovery proportion over these three weeks for yearling chinook (6.8%) was about half of that observed for steelhead (12.4%).

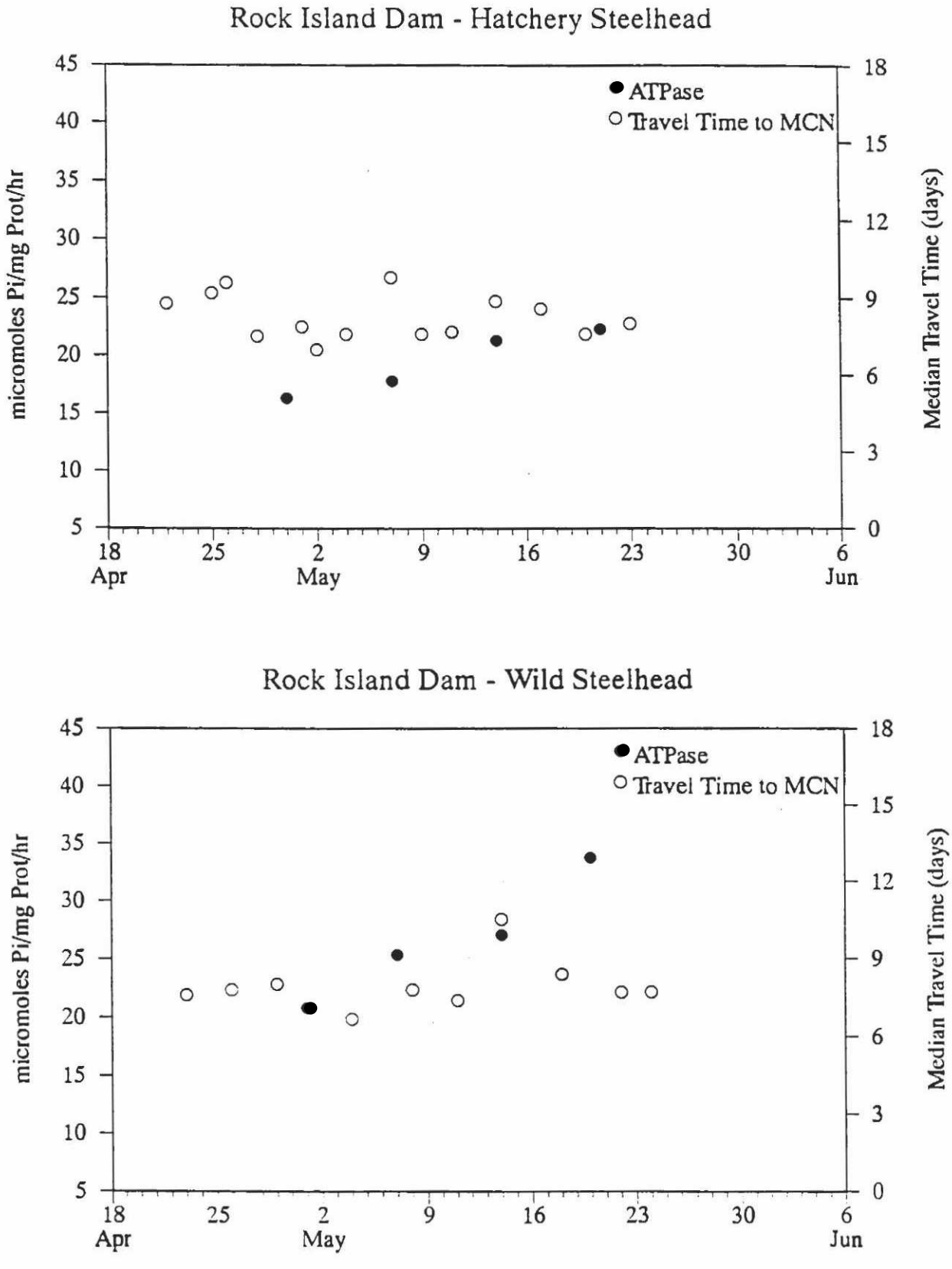


Figure 16. Comparison of average ATPase level of steelhead arriving at Rock Island Dam, and estimated median travel time from there to McNary Dam, 1990.

Unfortunately, no recoveries of steelhead from the last week of marking were possible at John Day Dam when flows in excess of 300 kcfs occurred in the lower Columbia River.

No reliable estimates of median travel time are available for subyearling chinook for John Day reservoir in 1990, because of either too few recoveries of marked fish in Unit 5 or outages in Unit 5 near the middle of marked groups' passage distributions. Either of the incidents would have impacted the determination of a reasonable median. In addition, the high flow and spill levels at McNary Dam may have passed more marked subyearling chinook, particularly those of mid-Columbia River origin approaching the project along the Washington shore, through spill than was accounted for in the passage index. Even with these problems in attempting to estimate median travel time through John Day reservoir, it was apparent from the passage timing of those marked fish recovered at John Day Dam that the higher flows of 1990 in the lower Columbia River during June and early July moved subyearling chinook more quickly through John Day reservoir than the typical estimates above ten days observed in previous years. General information on migration timing, based on approximate 10 and 90% passage dates at John Day Dam, is presented in Appendix F for the marked subyearling chinook from Lyons Ferry, Priest Rapids, and Irrigon hatcheries.

h. McNary Dam to Bonneville Dam.

Limited data on travel time to Bonneville Dam is available for spring migrants in 1990, because of the low numbers of branded yearling chinook and steelhead recovered. The largest recovery at the powerhouse 1 trap was 34 branded steelhead from the first release period (April 30 - May 5) at McNary Dam. This group of steelhead had an estimated median travel time of six days under flows averaging approximately 250 kcfs. (Incidently, from the last weekly release made at McNary Dam, three steelhead were recovered at Bonneville Dam in only 4, 4, and 5 days, respectively, at flows above 300 kcfs.)

Subyearling chinook appeared to migrate faster through the lower Columbia River under the higher flow levels observed in 1990. The five marked fall chinook groups from Priest Rapids Hatchery provided median travel time estimates that ranged from 4 to 6 days between McNary and Bonneville dams, under flows averaging near 265 kcfs. While the recovered numbers were low at Bonneville Dam (*i.e.*, 5-25 fish), the travel time estimates were much shorter than seen in previous years. At the same time, flow was much higher than in the past years. The subyearling chinook released in the Umatilla River from Irrigon Hatchery had a median travel time of 32 days to Bonneville Dam in 1990. The 7-day flow average at the time of median passage at Bonneville Dam was 269 kcfs for this marked group. Subyearling chinook releases in the Umatilla River in 1988 and 1989 took a median of 46 and 32 days, respectively, just to migrate as far as John Day Dam under lower flow levels.

3. Conclusions.

Flow and smoltification development together influenced smolt migration rates in 1990. Smolts migrating in the Snake River drainage experienced flows between 40 and 80 kcfs during most of the spring of 1990. However, when flows increased to over 100 kcfs, travel times were reduced by one-half. In addition to increased flow, smoltification development influenced how quickly smolts were moved through Lower Granite reservoir and the Lower Granite Dam to McNary Dam index reach. With a similarily sloped travel time/flow relation and same range of flows (60 to 100 kcfs), PIT tagged groups of yearling chinook consistently migrated twice as fast between Lower Granite and McNary dams than they did through Lower Granite reservoir, apparently as a result of greater smoltification development by the time the fish were migrating through the lower index reach. The relative range of flows observed in the mid-Columbia River was smaller and at a level above the fishery minimum (140 kcfs) during most of the season. At these high flows, the yearling chinook travel time between Rock Island and McNary dams appeared highly influenced by smoltification development, whereas both wild and hatchery steelhead appeared to migrate at a fairly constant rate regardless of increasing smoltification development over time. In the lower Columbia River, higher flows (over 300 kcfs) beginning at the end of May, and continuing (above 200 kcfs) through mid-July, appeared to have a profound effect on the smolt migration rates. Subyearling chinook migrated between McNary and Bonneville dams much faster in 1990 than in recent years.

V. 1990 HATCHERY RELEASES

The FPC coordinates with the federal, state, and tribal hatchery programs to ensure that juvenile salmonids released above Bonneville Dam during the spring and early summer receive the most favorable migratory conditions possible after their release. The Fish Passage Manager makes flow and operations management recommendations based in part on the arrival time of fish in Lower Granite Pool and at mainstem dams. The FPC maintains hatchery release information, updates it on a weekly basis, and makes it available in Weekly Reports mailed to about 300 parties in the Pacific Northwest throughout the spring and summer juvenile fish emigration.

During the 1990 migration year, about 81 million juvenile salmonids from state, federal, and tribal fish hatcheries were released in the Columbia River Basin above Bonneville Dam (Table 15). This was approximately 2.7 million more hatchery fish than were released above Bonneville Dam in 1989. The Snake and mid-Columbia rivers had increases of approximately 4.4 and 1.9 million hatchery fish, respectively, this year, while the lower Columbia River hatchery releases were about 3.5 million less than in 1989. The lower river reduction was mainly due to 5 million fewer Tule fall chinook being released from Spring Creek Hatchery. Although the overall mid-Columbia hatchery release total increased in 1990, the summer chinook release from Wells hatchery was nearly 600,000 fish less than in 1989. Wenatchee stock sockeye, reared at the NMFS Montlake Laboratory, were released into Cle Elum Lake in the Yakima River Basin in the fall of 1989 and spring of 1990 for outmigration this year. Additional releases of sockeye will be made in the late fall of 1990 in Lake Wenatchee and Cle Elum Lake for outmigration in 1991.

Table 15 shows those fish planted at hatcheries or transported to streams between September 1, 1989 and August 31, 1990. Most fish in the Columbia Basin were released from mid-March to late June. The reader should be aware that the release totals in this table do not include excess fry or egg outplants made in various streams in Idaho, Washington, and Oregon. More detailed data on specific hatchery releases for 1990 are shown in Appendix I.

Table 15. Summary of hatchery releases by species and release area for 1989 and 1990.

Species	Snake River (in Thousands)	Mid-Columbia (in Thousands)	Lower Columbia (in Thousands)	Total (in Thousands)
1989				
Spring Chinook[a]	9,632	4,509	6,032	20,173
Summer Chinook	1,991	2,597	0	4,591
Fall Chk Brights	2,154	7,571	9,409	19,134
Fall Chk Tule	0	0	15,308	15,308
Coho	0	1,085	6,402	7,487
Sockeye	0	107	0	107
Steelhead	9,009	1,751	523	11,283
TOTAL	22,786	17,620	37,674	78,080
1990[b]				
Spring Chinook[a]	10,543	5,280	6,499	22,322
Summer Chinook	2,090	1,913	0	4,003
Fall Chk Brights	3,480	9,339	9,038	21,857
Fall Chk Tule	0	0	10,233	10,233
Coho	0	1,118	7,950	9,068
Sockeye	0	89	0	89
Steelhead	11,116	1,822	458	13,396
TOTAL	27,229	19,561	34,178	80,968

[a] Includes releases of subyearling spring chinook, but no excess fry or egg outplants.
[b] 1990 data is preliminary; includes revisions through 10/30/90.

VI. 1990 ADULT FISH PASSAGE

The FPC objective is to coordinate fishway inspections at 13 mainstem Columbia River dams and maintain upstream passage information on adult salmonids at these sites.

Fish facility inspections by fishery agency personnel are done at monthly intervals to ensure that facilities are operating according to established criteria so that fish will pass safely with minimal delay at each project. During 1990, most facilities were operated at or near criteria throughout the adult fish passage season. A detailed report of the 1990 project inspections will be published in February 1991.

Adult salmonid counts at mainstem projects in the Columbia River provide measures of escapement into various parts of the drainage. These counts are used by harvest managers in setting harvest goals for the various fishing seasons in the Columbia Basin, and in assessing adult passage conditions at the projects. A problem noted in 1990 was the continuing decline in the total number of adult salmonids passing Bonneville Dam and upstream projects (Table 16).

Adult salmonids encounter many obstacles on their upstream journey. They must pass from one to nine mainstem dams, which may have potential high spill levels, varying flow levels, and warm water temperatures during the summer. Several passage problems were observed in 1990. The powerhouse failure at John Day Dam resulted in high spill levels at the project, causing associated passage delays. High spill levels in the Columbia River from May 30 through mid-June resulted in high dissolved gas levels at monitoring sites in the Columbia Basin, and some evidence of gas bubble symptoms in adult and juvenile salmon. Fallback of adults probably occurred at some projects during periods of high spill, resulting in overcounting of adults and some injury to the fish. Some minor delays occurred during short-term equipment failures at the projects. The warmer-than-normal water temperatures from late July through September delayed fish migrations, and likely caused additional mortalities from stress and disease this season. Water temperatures were at near lethal levels at some locations and passage was very low in the Snake River during the summer migration compared to 1989. Systems Operational Requests for flows to facilitate adult fish passage were submitted to the COE in late August. Flow in the Snake was requested to be at an instantaneous minimum of 30 kcfs. The daily average flows were at or above 30 kcfs on only five days during September. The monthly average was 26 kcfs, with a minimum daily average flow of 18.6 kcfs and a maximum of 35.4 kcfs. Overall, the loss of fish between the projects this season was higher than normal, based on counts at individual dams.

A summary of adult fish counts at Bonneville, McNary, Ice Harbor, and Priest Rapids dams is shown in Table 16. Trends in adult passage are illustrated in Figure 17 for Bonneville Dam. Upriver bright and tule fall chinook trends are shown in Figure 18 for McNary Dam and Spring Creek

Table 16. A comparison of Columbia River adult fish counts at Bonneville, McNary, Ice Harbor, and Priest Rapids dams for calendar years 1989 and 1990, and the 10-year average (1980-1989)[1].

	1990	1989	10-Year Average
Summer Steelhead[2]			
Bonneville	183,100	287,800	247,000
McNary	91,500	166,600	125,700
Ice Harbor	51,900	146,400	88,900
Priest Rapids	7,700	10,600	18,000
Spring Chinook			
Bonneville	96,300	87,300	80,800
McNary	44,500	36,000	42,900
Ice Harbor	20,700	17,000	21,800
Priest Rapids	12,300	12,000	14,900
Summer Chinook			
Bonneville	28,000	33,000	30,400
McNary	22,300	24,700	20,900
Ice Harbor	5,800	4,200	5,500
Priest Rapids	16,000	20,200	15,100
Fall Chinook (Adult Count)[3]			
Bonneville	177,300	263,100	199,500
McNary	57,600	96,500	75,800
Ice Harbor	3,500	4,600	2,700
Priest Rapids	6,100	14,800	13,600
Coho			
Bonneville	24,100	39,200	46,200
McNary	2,000	3,400	2,600
Ice Harbor	1	0	98
Priest Rapids	30	33	362
Sockeye			
Bonneville	49,600	41,900	88,100
McNary	45,100	41,300	49,000
Ice Harbor	1	4	85
Priest Rapids	46,300	45,300	68,200

1/ Numbers from 1990 and previous years are from Columbia River Intertribal Fish Commission and U.S. Army Corps of Engineers.
2/ Steelhead counts are from June 1 - October 31 or November 15, except at Bonneville Dam, where counts are from April 1 to November 15.
3/ Counts of Fall Chinook do not include jacks.

Note: All totals greater than 500 fish are rounded to the nearest 100 fish.

Hatchery, respectively. The bulk of the upriver run during the past 4 to 6 years has been composed of fall chinook "brights" and steelhead. This year's total adult salmon count at Bonneville Dam was 558,400 fish, which is the lowest since 1983. Tule fall chinook (Spring Creek Hatchery stock), spring chinook, and sockeye showed increased numbers at Bonneville Dam from 1989 to 1990; however, the overall passage of salmon during the same period was reduced by nearly 150,000 fish. Escapement of some stocks and races remain at extremely low adult return levels. Chinook jack returns at many sites were also depressed, and may result in fewer adult returns for 1991. Most hatcheries were able to obtain sufficient broodstock this season to meet the coming year's planned juvenile salmon releases for the Basin.

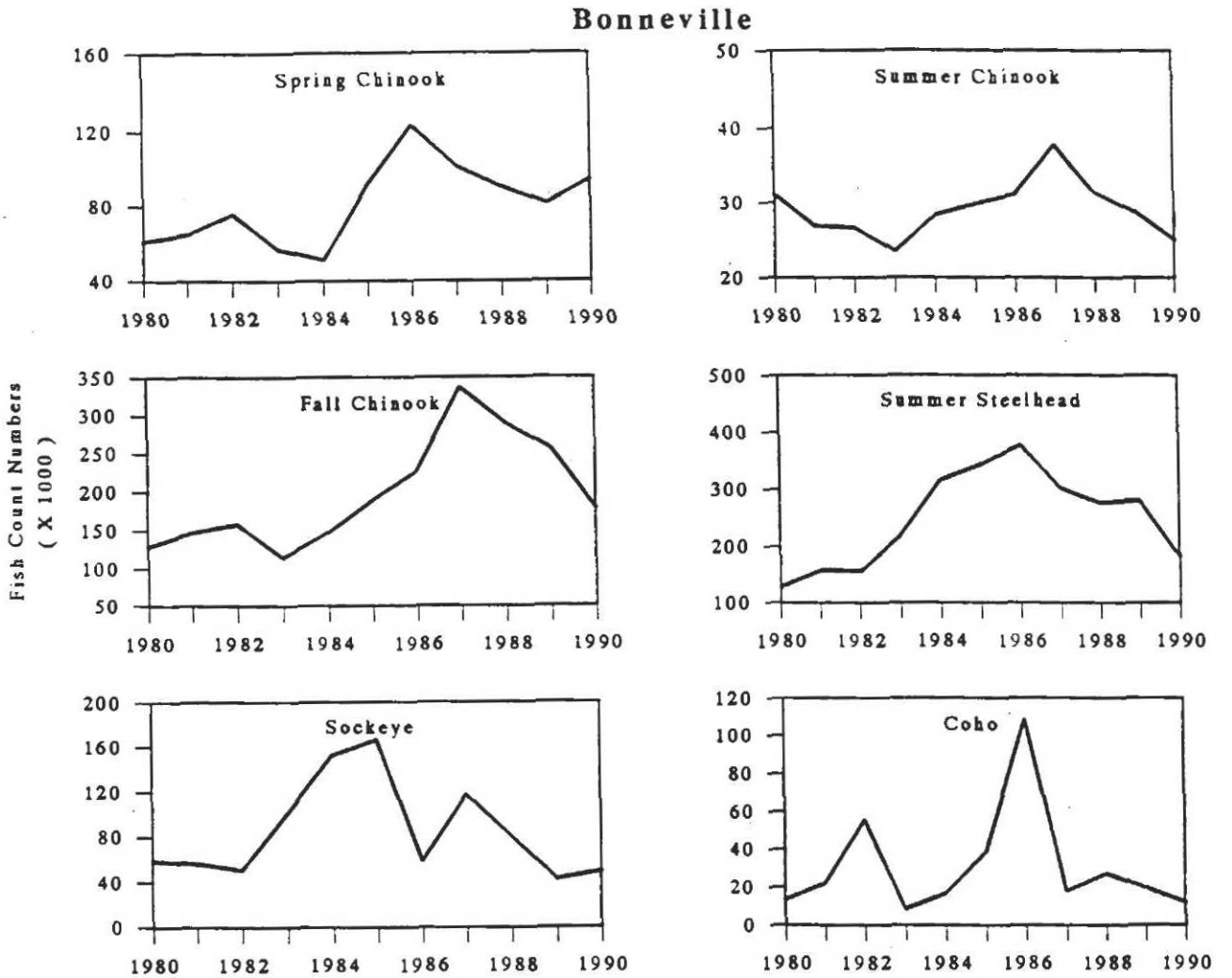


Figure 17. Passage of adult salmonids at Bonneville Dam 1980-1990.

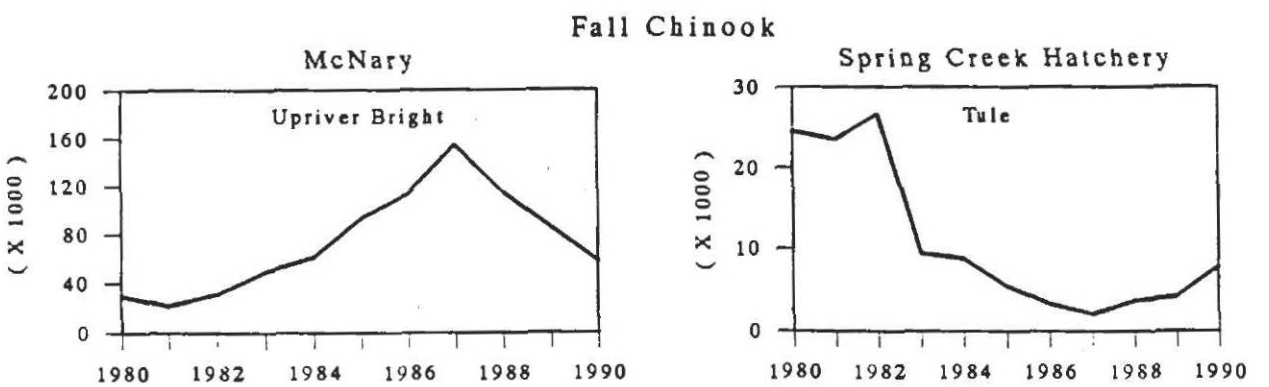


Figure 18. Passage of adult upriver bright fall chinook at McNary Dam, and escapement of adult tule fall chinook to Spring Creek Hatchery, 1980-1990.

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APPENDIX A: 1990 Water Budget Coordinated Plan of Operation

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION, CORPS OF ENGINEERS
P.O. BOX 2870
PORTLAND, OREGON 97208-2870

April 6, 1990

REPLY TO
ATTENTION OF:

Water Management Branch

APR 1990
FISH PASSAGE
CENTER

SEE DISTRIBUTION

SUBJECT: Water Budget Coordinated Plan of Operation

Enclosed for your information is the Corps' 1990 Water Budget Coordination Plan of Operation (CPO), which provides a method for using the Water Budget during the spring of 1990.

The CPO has been developed in cooperation with the Fish Passage Managers, fishery agencies, Bonneville Power Administration, Bureau of Reclamation, utility companies and others. It is consistent with provisions of Section 300 of the Northwest Power Planning Council's Fish and Wildlife Program.

Contact Russell George (503/326-3745) or Bolyvong Tanovan (503/326-3764) of the Corps' Reservoir Control Center if you have questions or desire more information.

Sincerely,

Nicholas A. Dodge

Nicholas A. Dodge, P.E.
Chief, Water Management Branch

Enclosure

DISTRIBUTION:
Douglas County PUD #1
Grant County PUD #2
Chelan County PUD #1
Idaho Power Company
Fish Passage Center
Bureau of Reclamation
Northwest Power Pool
Mid-Columbia PUDs-Portland

CORPS OF ENGINEERS NORTH PACIFIC DIVISION

PORTLAND, OREGON

1990 WATER BUDGET

COORDINATED PLAN OF OPERATION

CENPD-EN-WM
March 20, 1990

CENPD-EN-WM (RCC)
March 20, 1990

1990 WATER BUDGET COORDINATED PLAN OF OPERATION

1. Introduction

This Coordinated Plan of Operation (CPO) provides a method for using the Water Budget to aid the spring outmigration of juvenile salmonids. It has been developed by the U.S. Army Corps of Engineers in cooperation with the Fish Passage Managers, fishery agencies, Indian tribes, Bonneville Power Administration (BPA), U.S. Bureau of Reclamation (USBR), utility companies, and others for use during the April 15 - June 15, 1990 period.

2. Water Supply Forecasts

A copy of the interagency coordinated March 1 Water Supply Forecasts issued by the National Weather Service's Northwest River Forecast Center is attached as Enclosure 1. These forecasts are based on March 1 hydrologic conditions and median precipitation during the March through July period. They are summarized in Table 1 for key locations, in thousands of acre-feet (KAF) and percent of normal (%):

Table 1. Forecast Summary

	Period			
	Jan-Jul		Apr-Jul	
Location	(KAF)	(%)	(KAF)	(%)
Grand Coulee	69,100	107	59,900	107
Priest Rapids (*)	77,500	108	66,800	108
Brownlee	5,300	52	3,170	52
Dworshak	3,340	91	2,580	91
Lower Granite	23,500	76	18,100	80
The Dalles	104,000	96	85,600	98

(*) Estimated from Rock Island forecasts

3. Reservoir Status

The reservoir system, in terms of Mw-months, is 40 percent full compared to only 14 percent full at this time in 1989. This improvement is the result of the reservoir system nearly reaching full content following the 1989 freshet and average to well-above average natural streamflows since autumn 1989. Most reservoirs are still being drafted to meet flood control space requirements. Table 2 summarizes the status of major reservoirs as of March 1 and the projected April 1 elevations resulting from the latest (March 20, 1990) forecasts. The March 1, 1989 elevations are also shown between brackets for comparison purposes.

Table 2. Reservoir Elevations

Reservoirs	Max/Min Limits (MSL)	Max Capacity (MAF)	Elevation Mar 1,1990 (MSL)	Frcst. Elevation Apr 1,1990 (MSL)
Mica	2470/2394	7.0	2402 (2367)	2387 (2352)
			2414 (2394) *	2406 (2383)
Arrow	1444/1378	7.1	1405 (1388)	1391 (1390)
Duncan	1892/1794	1.4	1827 (1804)	1827 (1793)
Libby	2459/2287	5.0	2342 (2323)	2325 (2322)
Hungry Horse	3560/3336	3.2	3514 (3437)	3498 (3415)
Albeni Falls	2062/2050	1.2	2052 (2052)	2052 (2052)
Grand Coulee	1290/1208	5.2	1282 (1230)	1270 (1219)
Dworshak	1600/1445	2.0	1533 (1479)	1530 (1503)
Brownlee	2077/1976	1.0	2052 (2030) **	2050 (2044)

* Adjusted Elevation
** This column shows March 1, 1989 elevations

4. Data Exchange

a. The Fish Passage Managers shall be represented at the daily RCC briefings. The managers will prepare and deliver a fisheries report for each Thursday briefing from April 15 through June 15.

b. The Corps and BPA shall make available to the Fish Passage Managers and the Northwest Power Planning Council Advisor the forecasts prepared for system planning purposes.

5. Priest Rapids Flow Augmentation for Fish

a. The Water Budget at Priest Rapids will be implemented using weekly average flows. It will be based upon advance projections of weekly average flows provided by the Corps after consultation with USBR and BPA. This flow projection may be composed of both power and nonpower components. The flow component for power needs will be provided to the Corps by BPA. The flow component for nonpower needs will be determined by the Corps. Water Budget requests are to be within the time period and flow and volume limits identified in the Council's Program.

b. During the period of April 15 through June 15, the Corps will identify the projected Monday through Sunday weekly average flow by 3:00 p.m. on Wednesday of the preceding week.

c. The Fish Passage Managers will relay their decision, as to whether or not to augment weekly average flow for the next week, to the Corps' RCC by noon on Thursday of the preceding week. If the Fish Passage Managers decide to augment the projected weekly average flow, the Water Budget usage will be measured as the difference between the actual average weekly flows (or the Fish Passage Managers' average weekly flow request, whichever is less) and the power base flow of 76 kcfs and will not exceed 3.45 MAF for the season.

d. When a Water Budget request is in effect, the weekend and holiday average flows will not be lower than 80 percent of the average of the five preceding weekdays.

e. Should the Fish Passage Managers decide not to augment flows with the Water Budget during a given week, reasonable efforts will be made to provide the projected weekly average flow identified by the Corps on the preceding Wednesday. Forecasting errors may cause deviation from the actual flows delivered. If the deviations are considered by the Fish Passage Managers to cause an adverse impact to the migration, a change may be made in the Water Budget request for the remainder of the specified week (Monday - Sunday); implementation of the request will be dependent on the Corps coordinating the request with affected parties.

If the projected weekly average flow is greater than 110 kcfs, the Fish Passage Managers may request that the projected weekly average flow be guaranteed. During this flow condition, the weekend and holiday flows be no less than 85 kcfs.

f. The RCC and Fish Passage Managers will jointly monitor the run-off and juvenile migration and may, by mutual agreement and after consultation with other affected parties, modify the operation at Priest Rapids.

6. <u>1990 Lower Granite Water Budget</u>

a. Requests from the Fish Passage Managers for flow augmentation at Lower Granite (LWG) will be met first from uncontrolled run-off, then from Dworshak (DWR) and Brownlee (BRN) storage under the following conditions:

(1) When BPA has an active storage account with IPC, BPA may in consultation with all parties, choose to release only from BRN. Should the release from BRN not meet the Fish Passage Managers request, then additional flow may be released from DWR.

(2) When BPA does not have an active account with IPC, requests to augment daily average flows at LWG will be met with releases from either or both DWR and BRN. Water Budget release from DWR will be done in accordance with provisions of Section 6.a.(3) below. Water Budget release from BRN will be done in accordance with applicable IPC/BPA Contract.

(3) Water shapable for Water Budget in DWR that can be used to meet an average daily flow at LWG will be based on Enclosure 2. DWR discharges in excess of the 10 kcfs powerhouse capacity may be requested by the Fish Passage Managers subject to Water Budget availability. These higher flows up to a maximum release of 25 kcfs will be provided on a case-by-case basis. Additional flows beyond the Water Budget commitment may be provided from DWR if needed for fish migration and if DWR refill is not jeopardized.

b. Every weekday, if available, the RCC will provide the Fish Passage Managers with (1) a 5-day forecast for the Snake River flow at LWG prepared by the NOAA River Forecast Center, (2) a 5-day operational forecast prepared by IPC for releases at BRN, and (3) a 5-day operational forecast prepared by the Corps for releases at DWR.

c. The Fish Passage Managers, utilizing the information provided in paragraph 6a and other relevant data, shall make flow augmentation requests to the RCC no less than 48 hours in advance of the expected implementation to allow BPA and IPC to schedule flows. Requests will be made Monday through Friday (except holidays) verbally to the RCC and followed by written confirmation. No requests for flows or modifications will be acted upon between Friday 10:00 a.m. and Monday 8:00 a.m.

d. Water Budget usage at DWR and BRN will be measured as the difference between the daily outflow resulting from the Fish Passage Managers' request and the daily operations projection from the Corps. The total Water Budget quantity from DWR will be identified by the Corps from the April 1 forecast and using Enclosure 2. The Water Budget quantity for BRN will be identified by IPC on April 15, with subsequent updates. If BPA has stored water in BRN, the quantity will be identified by BPA on April 15, with subsequent updates.

e. The RCC and Fish Passage Managers will jointly monitor the run-off and juvenile migration and may, by mutual agreement and in consultation with other affected parties, modify the operation at LWG.

7. Lower Columbia River Weekend and Holiday Flows

While there is no Water Budget requirement at the lower Columbia River projects, a 1990 objective for weekend flows will be to not average less than 80 percent of the average flow for the previous five weekdays during the period April 15 through June 15. Memorial Day weekend will be treated as in paragraph 5d above.

8. Nonimplementable Request

A Water Budget request may not be implemented if it conflicts with other non-power requirements. The severity of the conflict will be analyzed by the Corps and appropriate action taken with documentation of the basis for the decision forwarded to the Fish Passage Managers and the Power Planning Council Advisor.

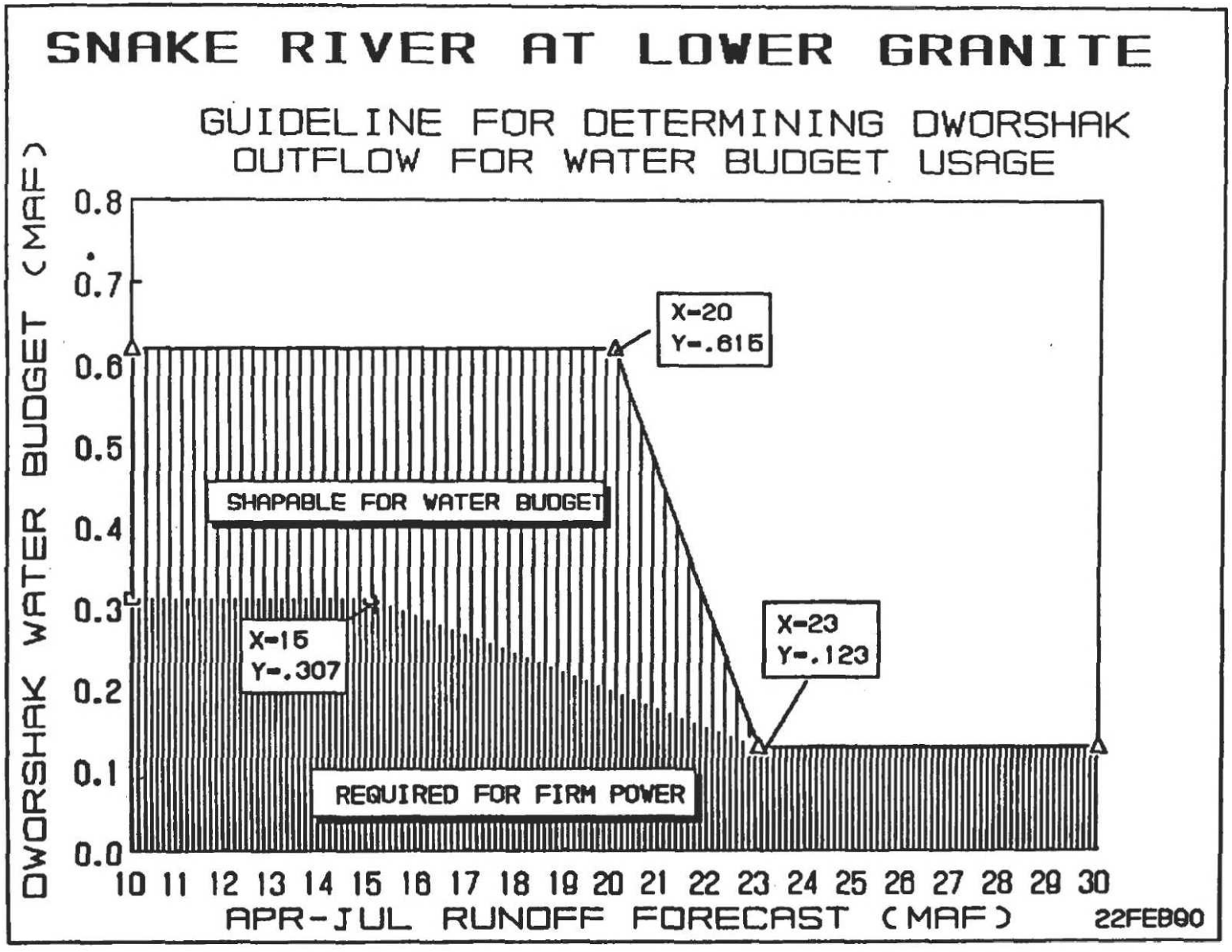
ENCLOSURE 1. SEASONAL WATER SUPPLY FORECASTS ISSUED BY NATIONAL WEATHER SERVICE NORTHWEST RIVER FORECAST CENTER, PORTLAND, OREGON

MARCH 1, 1990 FINAL WATER SUPPLY FORECASTS

STREAM AND STATION	PERIOD	FORECAST	%	AVERAGE
COLUMBIA RIVER				
MICA RESERVOIR INFLOW, BC	FEB-SEP	15200.0	114	13280.
	APR-SEP	14700.0	114	12840.
ARROW LAKES INFLOW	FEB-SEP	30800.0	114	27080.
	APR-SEP	29300.0	114	25800.
BIRCHBANK, BC (1)	APR-SEP	50400.0	114	44390.
GRAND COULEE, WA (1)	JAN-JUL	69100.0	107	64690.
	APR-SEP	71400.0	107	66460.
ROCK ISLAND DAM BLO, WA (1)	APR-SEP	77800.0	108	72250.
THE DALLES NR, OR (1)	APR-SEP	99800.0	98	101800.
	JAN-JUL	104000.0	96	108700.
KOOTENAI RIVER				
LIBBY RES INFLOW, MT (1)	APR-SEP	7990.0	116	6903.
KOOTENAY RIVER				
KOOTENAY LAKE INFLOW, BC	APR-SEP	18800.0	111	16930.
DUNCAN RIVER				
DUNCAN RESERVOIR INFLOW, BC	FEB-SEP	2530.0	108	2332.
	APR-SEP	2440.0	108	2251.
CLARK FORK				
ST. REGIS, MT (1)	APR-SEP	3810.0	88	4325.
PEND OREILLE RIVER				
PEND OREILLE LAKE IN, ID (1)	APR-SEP	14200.0	95	14930.
S.F. FLATHEAD RIVER				
HUNGRY HORSE RES IN, MT (1)	APR-SEP	2380.0	106	2248.
FLATHEAD RIVER				
FLATHEAD LAKE INFLOW, MT (1)	APR-SEP	7700.0	108	7150.
COEUR D'ALENE RIVER				
COEUR D'ALENE LAKE IN, ID	APR-SEP	2890.0	102	2821.
SIMILKAMEEN RIVER				
NIGHTHAWK NR, WA (1)	APR-JUL	1200.0	90	1333.
OKANAGAN RIVER				
TONASKET NR, WA (1)	APR-SEP	1440.0	87	1661.
CHELAN RIVER				
LAKE CHELAN INFLOW, WA (1)	APR-SEP	1280.0	108	1184.

YAKIMA RIVER				
PARKER NR, WA	APR-SEP	1980.0	95	2075.
SKAGIT RIVER				
CONCRETE NR, WA	APR-SEP	6200.0	94	6623.
COWLITZ RIVER				
MAYFIELD RES INFLOW, WA	APR-SEP	2050.0	101	2036.
	APR-JUL	1790.0	100	1782.
CASTLE ROCK, WA	APR-SEP	2850.0	106	2687.
SNAKE RIVER				
JACKSON LAKE INFLOW, WY (1)	APR-JUL	680.0	86	795.
PALISADES RES INFLOW, ID (1)	APR-JUL	2600.0	79	3298.
HEISE NR, ID	APR-JUL	2770.0	79	3524.
WEISER, ID (1)	APR-JUL	2950.0	51	5786.
BROWNLEE RES INFLOW	APR-JUL	3170.0	52	6147.
LOWER GRANITE RES IN, WA (1)	JAN-JUL	23500.0	76	31060.
	APR-JUL	18100.0	80	22760.
TETON RIVER				
ST. ANTHONY NR, ID	APR-JUL	300.0	78	387.
HENRYS FORK				
REXBURG NR, ID	APR-JUL	855.0	68	1260.
PORTNEUF RIVER				
TOPAZ, ID	APR-SEP	63.0	66	96.
BIG LOST RIVER				
MACKAY RESERVOIR INFLOW, ID	APR-JUL	81.0	50	162.
BIG WOOD RIVER				
HAILEY, ID (1)	APR-JUL	140.0	52	268.
MAGIC RESERVOIR INFLOW, ID	APR-JUL	140.0	43	322.
LITTLE WOOD RIVER				
CAREY NR, ID	APR-JUL	51.0	52	99.
DESCHUTES RIVER				
BENHAM FALLS, OR	APR-SEP	480.0	68	709.
OWYHEE RIVER				
OWYHEE RES INFLOW, OR	MAR-JUL	440.0	74	591.
BOISE RIVER				
BOISE NR, ID (1)	APR-JUL	920.0	61	1508.
MALHEUR RIVER				
DREWSEY NR, OR	MAR-JUL	33.0	31	108.
N.F. MALHEUR RIVER				
BEULAH RES INFLOW, OR (1)	MAR-JUL	21.0	26	81.

PAYETTE RIVER				
HORSESHOE BEND NR, ID (1)	APR-JUL	1180.0	69	1717.
WEISER RIVER				
WEISER NR, ID (1)	APR-JUL	270.0	65	414.
POWDER RIVER				
SUMPTER NR, OR	MAR-JUL	37.0	52	71.
SALMON RIVER				
WHITEBIRD, ID (1)	APR-JUL	4940.0	78	6322.
GRANDE RONDE RIVER				
LA GRANDE, OR	MAR-JUL	157.0	72	218.
TROY, OR (1)	MAR-JUL	1220.0	81	1512.
CLEARWATER RIVER				
OROFINO, ID (1)	APR-JUL	4360.0	89	4889.
N.F. CLEARWATER RIVER				
DWORSHAK RES INFLOW, ID (1)	APR-JUL	2580.0	91	2822.
	APR-SEP	2750.0	91	3010.
CLEARWATER RIVER				
SPALDING, ID (1)	APR-JUL	7400.0	93	7916.
	APR-SEP	7820.0	93	8378.
UMATILLA RIVER				
GIBBON NR, OR	APR-JUL	49.0	68	72.
PENDLETON, OR	APR-JUL	100.0	67	149.
S.F. WALLA WALLA RIVER				
MILTON NR, OR	APR-JUL	40.0	73	55.
M.F. JOHN DAY RIVER				
RITTER, OR (1)	APR-JUL	77.0	64	120.
N.F. JOHN DAY RIVER				
MONUMENT NR, OR	APR-JUL	380.0	64	590.
JOHN DAY RIVER				
SERVICE CREEK, OR (1)	APR-SEP	565.0	66	858.
CROOKED RIVER				
PRINEVILLE RES INFLOW, OR	MAR-JUL	83.0	47	176.
OCHOCO CREEK				
OCHOCO RES INFLOW, OR	MAR-JUL	16.0	48	33.
S. SANTIAM RIVER				
WATERLOO, OR	APR-SEP	575.0	100	576.
N. SANTIAM RIVER				
MEHAMA, OR	APR-SEP	870.0	102	854.


SNAKE RIVER AT LOWER GRANITE
GUIDELINE FOR DETERMINING DWORSHAK OUTFLOW FOR WATER BUDGET USAGE
DWORSHAK WATER BUDGET (MAF)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
X=20
Y=.615
SHAPABLE FOR WATER BUDGET
X=15
Y=.307
X=23
Y=.123
REQUIRED FOR FIRM POWER
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
APR-JUL RUNOFF FORECAST (MAF)
22FEB90

Enclosure 2

APPENDIX B & C: These have been omitted

APPENDIX D: Confidence Intervals for 1990 Passage Indices

Introduction

This appendix includes confidence intervals for the 1990 cumulative passage indices of each species at Lower Granite, Rock Island, McNary, John Day, and Bonneville dams. These confidence intervals were computed using a methodology recommended by the FPC contracted Biometrician Group (members are Drs. Lyle Calvin, Cliff Pereira, and Doug Neeley) in their January 1990 report to the FPC, which is presented in this appendix. The recommended methodology was to stratify the migration season into a series of 2-day blocks, and compute variances for each block's passage index total. The passage index totals and associated variances were each summed across the series of 2-day blocks to obtain the cumulative passage index and its respective variance. From this data, 95% confidence interval were then computed for each species and site. In the October 1990 amendment to the January report, the Biometricians noted that this method of using paired-day stratification would lead to conservative confidence intervals. Since the method is also valid for block sizes >2, a comparison to confidence intervals made with blocks of 3-day and 4-day widths is presented in the following tables. The purpose was determine if using 2-day blocks will generally result in narrower confidence intervals than blocks of wider size. Since the methodology already produces conservative confidence intervals, it is preferable to use a blocking size that gives narrowest confidence intervals.

Results and Discussion

Cumulative passage index confidence intervals, based on 2-day blocks, ranged from ±5.1% to ±21.5% of the annual index for all sites and species. The narrowest confidence interval was for yearling chinook at Bonneville Dam and the widest for yearling chinook at Rock Island Dam. About half of the site/species confidence intervals were less than ±10% of the annual passage index. The size of the confidence intervals obtained from the 2-day, 3-day, and 4-day block widths were close. The use of 2-day blocks produced the narrowest confidence intervals for subyearling chinook at each site and for all species at McNary Dam. For spring migrants at the other sites, the 3-day blocks produced slightly narrower confidence intervals compared to the 2-day blocks in two-thirds of the cases, while the 4-day blocks were lower in only one-third of the cases. Overall, the differences between confidence intervals using the three blocking sizes were small, being less than four percentage points different in all cases except yearling chinook at Rock Island Dam. The average size of the confidence intervals across all sites and species was ±11.0% using 2-day blocks, ±11.5% using 3-day blocks, and ±12.1% using 4-day blocks. These results demonstrate that these three levels of blocking will produce similar results, but that the 2-day blocking will, on average, produce slightly narrower confidence intervals.

As stated in the Biometricians report and FPC cover letter on the report, these confidence intervals for cumulative passage indices incorporate day-to-day sampling variability, and provide a measure of precision around the annual fish passage indices. It does not incorporate variability in FGE, nor does it indicate how well the annual indices actually reflect population magnitudes.

Computed Confidence Intervals of 1990 Salmonid Passage Indices at Rock Island Dam

	Passage Index	Confidence Interval Block Size					
		2-Day		3-Day		4-Day	
		CI(±)	%	CI(±)	%	CI(±)	%
Chinook 1s	20,853	4,492	21.5	4,124	19.8	5,592	26.8
Chinook 0s	54,683	3,690	6.8	4,414	8.1	4,747	8.7
Steelhead	18,085	1,236	6.8	1,395	7.7	1,370	7.6
Coho	15,617	2,721	17.4	2,472	15.8	2,572	16.5
Sockeye	4,297	607	14.1	531	12.4	610	14.2

Computed Confidence Intervals of 1990 Salmonid Passage Indices at Lower Granite Dam

	Passage Index	Confidence Interval Block Size					
		2-Day		3-Day		4-Day	
		CI(±)	%	CI(±)	%	CI(±)	%
Chinook 1s	3,199,593	305,079	9.5	300,473	9.4	323,626	10.1
Chinook 0s	N/A						
Steelhead	6,139,888	701,887	11.4	672,907	11.0	694,413	11.3
Coho	N/A						
Sockeye	16,596	2,441	14.7	2,222	13.4	2,532	15.3

Computed Confidence Intervals of 1990 Salmonid Passage Indices at McNary Dam

	Passage Index	Confidence Interval Block Size					
		2-Day		3-Day		4-Day	
		CI(±)	%	CI(±)	%	CI(±)	%
Chinook 1s	2,432,655	143,949	5.9	175,690	7.2	188,557	7.8
Chinook 0s	8,507,935	822,549	9.7	857,362	10.1	868,621	10.2
Steelhead	660,448	48,257	7.3	57,720	8.7	56,205	8.5
Coho	231,034	24,243	10.5	27,264	11.8	28,033	12.1
Sockeye	294,263	18,347	6.2	21,050	7.2	23,739	8.1

Computed Confidence Intervals of 1990 Salmonid Passage Indices at John Day Dam

	Passage Index	Confidence Interval Block Size					
		2-Day		3-Day		4-Day	
		CI(±)	%	CI(±)	%	CI(±)	%
Chinook 1s	361,968	36,182	10.0	34,588	9.6	36,225	10.0
Chinook 0s	513,687	51,873	10.1	66,870	13.0	70,779	13.8
Steelhead	133,777	19,585	14.6	21,072	15.8	22,278	16.7
Coho	84,342	13,697	16.2	15,105	17.9	13,773	16.3
Sockeye	23,610	2,994	12.7	2,797	11.9	2,774	11.8

Computed Confidence Intervals of 1990 Salmonid Passage Indices at Bonneville Dam

	Passage Index	Confidence Interval Block Size					
		2-Day		3-Day		4-Day	
		CI(±)	%	CI(±)	%	CI(±)	%
Chinook 1s	332,792	16,908	5.1	17,536	5.3	21,093	6.3
Chinook 0s	1,219,778	109,726	9.0	150,762	12.4	139,660	11.5
Steelhead	127,882	9,833	7.7	9,336	7.3	11,009	8.6
Coho	677,413	52,945	7.8	51,477	7.6	63,966	9.4
Sockeye	81,403	14,496	17.8	16,991	20.9	13,808	17.0

FPMAR-90.D

FISH PASSAGE CENTER
825 N.E. 20TH AVENUE • SUITE 336 • PORTLAND, OR 97232-2295
PHONE (503) 230-4099

MEMORANDUM

Date: March 27, 1990

To: FPAC

From: Michele DeHart

RE: Report from Biometrician Group regarding confidence intervals for Passage Indices

Last fall NMFS and CRITFC commented on the 1990 Smolt Monitoring Program identifying their need for confidence intervals on the passage indices. This was discussed at FPAC, and subsequently the FPC was requested to have the Biometrician Group, which consists of Drs. Lyle Calvin, Cliff Pereira, and Doug Neeley, address this question. The attached report is the result of their effort to develop a meaningful confidence interval for the cumulative fish passage index. Following discussions with the FPC on applications of the passage index data, they recommended that confidence intervals be developed for the cumulative fish passage index rather than for daily fish passage indices.

The Biometrician Group's report to the FPC provides a methodology for computing a confidence interval. However, it also provides words of caution in how to interpret and use these confidence intervals. It must be emphasized that just as FGE is not factored into the passage index, neither is its variability factored into the confidence intervals defined in this report. A confidence interval around an annual passage index incorporates only a fraction of the variability that would occur around estimates of population magnitude. At most these confidence intervals incorporate day-to-day sampling variability, and provide a measure of precision about the annual fish passage index. They do not necessarily reflect how close the annual index represents the population magnitude.

As stated in our response to NMFS and CRITFC, and concurred by the Biometrician Group report, confidence intervals are desirable, but can be misleading without an explicit definition of what they are intended to measure or represent. The audience who is interested in using the confidence intervals must be cognizant of their limited utility. Their expectation of what the confidence intervals represent will influence what applications they try to make of these confidence interval around cumulative fish passage indices.

199-90.TB

Report of Biometrician Group on a confidence interval for the cumulative fish passage index

January 1990

Biometrician Group members:

Cliff Pereira

Lyle Calvin

Doug Neeley

Introduction

In November, 1989 the Fish Passage Center asked the Biometrician Group (Lyle Calvin, Doug Neeley, and Cliff Pereira) to look at the methods used in calculating the daily and annual fish passage indices (FPI's) to determine the feasibility of obtaining confidence interval (CI) estimates. This was the result of discussion between the FPC staff and the Fish Passage Advisory Committee on behalf of the fishery agencies and tribes.

The Biometrician Group agreed to this assignment and received background material and assistance from the FPC in obtaining a full understanding of the problem and the methods presently used. In particular, Michele DeHart and Tom Berggren met with the group on November 21 and Tom Berggren again on December 22. Several documents were developed and exchanged in November and December; these are not included in the report but are being held in the Fish Passage Center. Some of them deal with methods that appeared promising but which were eventually discarded after gaining further understanding of the situation at each of the dams.

A number of issues related to the determination of the daily and annual passage indices as well as to the estimation of confidence intervals arose in our discussions. Some of those seemed important enough to include in our report and do constitute several sections of the report.

Initially most of our efforts were spent on developing a method of calculating confidence intervals for the daily fish passage index. With the realization that primary interest was really in the cumulative fish passage index (over some number of days within a year) and, speicifically, in the annual fish passage index, our emphasis changed to a procedure for estimating a confidence interval for an annual or other cumulative fish passage index. The method recommended provides a method that can be used at any site where a daily fish passage index can be calculated for each day. It is simple to use and should serve to provide a confidence interval estimate when needed.

The FPI: An index of what?

If the FPI is to be useful, it must be considered to be highly correlated with some parameters of interest. There seem to be two parameters with which the FPI could be correlated and for which other estimates are not readily available. These are (1) the population count (number of fish in the river at the point of collection), and (2) the inherent survival rate. Both are parameters which provide information of interest to fish managers and policy makers.

In this memo we will treat the FPI as being correlated with the population count within a year at a given location. Except for the problem of accounting for the FGE, the FPI is estimated as if it were intended to serve as a population count (i.e. as the population count would be estimated). It reflects the effects of varying inputs of hatchery and wild fish, smolt condition, flow patterns, and project operations in addition to any factors affecting survival of juvenile fish in the river at this location and time. Changes in FGE would affect any actual population estimates as calculated from sample counts but do not affect the FPI since no adjustment for FGE is made. The FPI can, therefore be considered as an estimate of the population count but uncorrected for FGE. As such, it must be considered a finite population index within a year at a given location.

If the FPI were intended to reflect the inherent survival rate, it would have to be adjusted for varying input of fish (particularly hatchery releases) each year and at different locations. Such an input adjustment would be difficult but perhaps no more difficult than interpreting population estimates while recognizing varying inputs.[1]

---

[1]Some attempt is made to account for hatchery releases in the Fish Passage Center annual report by presenting the ratio of FPI to hatchery releases. The Biometrician Group has not studied the use of such a ratio in any detail.

Need or value of confidence intervals (CI) on FPI.

Although the Biometricians Group has been asked to look at the feasibility of calculating confidence intervals for the FPI, there is not a clear recognition of how the CI will be used or how important they are. The FPC uses the FPI in a fairly general way that would probably not change much whether the CI were small or large.

Because only a sample of the fish that enter bypass facilities are counted each day, sampling variation is present. The within-day sampling variation will form the basis for confidence intervals presented in this report. Also present may be non-sampling errors due to such things as varying FGE or the failure of fish passage to be proportional to flow volume. In general, non-sampling errors reduce the value of the FPI as an index and such errors are difficult to assess.

There is validity to the argument that additional information is provided by CI estimates compared to point estimates. Presuming the CI estimates are reliable, an answer is provided to the question of precision of the point estimates. This, in itself, may be sufficient reason for calculating CI when possible. In the case of the FPI, however, there seems to be less use of CI than there would be for the usual statistical estimates because (1) the FPI is an index, not a direct estimate of a parameter, (2) non-sampling errors which cannot be measured may contribute a large part of the total error, and (3) the uses to which the FPI is put are general and do not require high precision.

Comparison of the FPI among projects and among years.

The FPI has been used as a relative measure of the magnitude of the runs of a species at a given location and a given time. The CI estimates that are being recommended apply only to that location and time and are not intended to adequately reflect the variation due to FGE or the changes in the proportion of fish to flow volume.

While these factors vary considerably within any one project and year, the variation among projects and years is even greater and certainly large enough to question the validity of comparing the indices across projects or years.

Looking at the major non-sampling errors, those due to variation in FGE and fish per flow volume, it appears likely that both probably vary more across projects than across years. One might, therefore, expect to have better comparisons among years at the same project, than among projects in the same year. Any such comparisons, however, should recognize the presence of non-sampling errors not included in the CI estimates.

The sampling and non-sampling errors make up the uncontrollable errors constituting the total variation inherent in any comparison of or inference about the FPI. Evaluation of any differences or changes in FPI should also include available information or factors influencing the FPI, e.g. timing and size of hatchery releases, smolt condition, wild stocks, flow patterns and conditions, transportation programs, and project operations.

One may also wish to compare migration timing for different projects. This might be done looking at the consistency of the differences in timing from one project to the next. In addition to the factors listed above, variation in migrational timing may be caused by hatchery releases affecting one dam but not the other.

FGE adjustment for the FPI

The calculation of the FPI includes no adjustment for the FGE of screens, as one would want to do for a population estimate. This is not necessarily a great concern, however, for an index that only needs to be highly correlated with the population count. At least it is of little concern unless the FGE varies considerably among days. If it does, and there is evidence that it does, this will decrease the correlation between the

FPI and the population count and make the FPI less useful.

If the FGE could be measured well each day, an adjustment could be made which would increase the correlation between FPI and the population count. Unfortunately the FGE cannot be measured with any reasonable degree of precision, at reasonable cost, each day and has therefore been excluded from consideration in the FPI calculation. An average FGE value could be used for adjustment but this would not increase the correlation and hence the value of the FPI.

Two additional factors that can reduce the usefulness of the FPI

If hand counts are available only every 24 hours and the sampling rate varies within a day, then variation in the within-day species composition can have the effect of decreasing the correlation between the FPI and the population count. This happens because the data is not available to calculate species-specific 24-hour average sampling rates. The single overall average sampling rate that is used in calculating the daily FPI may be too high for some species and too low for others. Some insight into the effect of within-day variation in species composition may be obtained at projects where hourly hand counts are made. Note that there will not be a problem of this type as long as there is a constant within-day sampling rate or there are separate holding areas for fish sampled at different rates (as at McNary Dam).

Another factor which can vary within a day is the percent of the flow sent through the sampled unit or powerhouse. The flow adjustment used in calculating the daily FPI is based on a single average percent of flow for the day. Depending on the relationships within each day between 1) flow percent, 2) number of fish passing the facility and 3) species composition, the currently used daily flow adjustment can result in decreased correlation between FPI and population count. This problem may potentially be studied at facilities with hourly hand counts, however, a long lag time between entry

into the bypass and entry into the sampling device could make it difficult or impossible to adequately relate the hand counts to within-day flows for this purpose.

Possible confidence intervals for the FPI

We discussed three approaches for generating confidence intervals for the FPI. After briefly describing each, the rationale for rejecting the first two will be summarized.

Approach 1. The first is to consider the day to be stratified into L periods, within which the hourly counts could be assumed to be random counts from a common population (but possibly different for each period). Confidence intervals are then calculated for the total daily count as for a stratified random sample. Consideration needs to be given to the finite population correction needed when subsampling is used. Confidence intervals for cumulative FPI can be obtained in the usual way by summing variances over days. Approaches 1 and 2 both require hourly counts of fish, either by Smith Root counters or hand counts.

Approach 2. The second approach would be to fit a common pattern of hourly counts within the day to be use for all days within some time period and use the deviations from the expected count at each hour to estimate the error for the daily FPI. This should work well if the pattern is fairly consistent across days within the period. The average pattern might be obtained from 7 or 14 days and deviations taken from it. Using the same data to establish the pattern and to calculate the error causes the estimated error to be a little too small, but this is counterbalanced by the failure of the pattern to be common over 7 or 14 days.

Approach 3. This approach does not require hourly counts, although, like the first, it is a stratified approach. The difference is to define strata as periods of several days and use the variation among daily FPI within periods as an estimate of error. For

example, if strata of two days are established, the estimated error variance for each stratum would have one degree of freedom. The error variance for the annual (or other cumulative) FPI is obtained by summing the variances over all strata and the confidence interval is calculated from this.

The third approach was taken because the first two assume that the variance for the daily FPI could be estimated using variation in hourly counts. This would be possible if appropriate within-day stratification of hourly counts were possible. However, there are many daily patterns and activities that could not easily lend themselves to stratification. These include:

1. within-day changes in flow patterns at a project,
2. within day surges of fish caused by hatchery releases, and
3. the long lag-time at some facilities between entry of fish into the bypass and their subsequent entry into the sampling device.

There were other problems associated with the use of variation in hourly counts as a basis of estimating the variance. At some facilities there are no hourly counts of any kind, so that neither approaches 1 nor 2 would be possible. A number of assumptions would be required to use approaches 1 and 2 including that:

1. species composition can be treated as constant over a day,
2. percent flow through the sampled unit or powerhouse can be treated as constant over a day, and
3. (if SR counts are used) the relationship between hand-counts to SR counts can be treated as constant (and known) over a day.

It should be mentioned that approach 3 is not without problems. True day to day variations in such things as hatchery fish inputs, flows, and FGE will tend to bias the confidence interval estimates toward being too large. However, since the variance estimate is based on variation in FPI's between adjacent days only, the bias should be

minimized.

In summary, because the primary interest in confidence intervals is for cumulative FPI's (and not daily FPI's), approach 3 above is the one recommended for use by the Biometrician Group. It is also simpler to compute and incorporates the appropriate components of variances better than the other methods and with fewer assumptions. The method is illustrated below.

Recommended confidence interval for FPI

Let y_i = sample count of a species on day i

f_i = sampling fraction = fraction of time used in collecting sample fish[2]

p_i = proportion of flow from which sample fish taken = index flow

If the sampling fraction changes during the day, an average sampling fraction is calculated by weighting the known sampling fraction in each period (partial day) by the estimate of total fish collected in that period. The average sampling fraction is then used as the sampling fraction for that day.

The FPI for day i is given by

$$(FPI)_i = \frac{y_i}{f_i p_i} = I_i$$

[2]The sampling fraction is a weighted average on days when the sampling fraction varies.

Establishing L strata, with n_h days in each stratum, the estimated variance of the cumulative FPI over the n_h days in the hth stratum, is

$$\hat{V}(I_h) = n_h s_h^2$$

where s_h^2 is the sample variance of the daily FPI in the hth stratum calculated in the usual way.

The annual FPI (API) is obtained by summing the I_h over all strata, i.e.

$$API = \sum I_h$$

and the estimated variance of the API from

$$\hat{V}(API) = \sum \hat{V}(I_h)$$

The (1-α) CI for the API is given by

$$API \pm Z_\alpha \sqrt{\hat{V}(API)}$$

where Z_α is the normal deviate at $P = \alpha$.

The above confidence interval should work well when the sampling fraction within each day is fairly small. If the sampling fraction is large on a number of days each year, the Fish Passage Center may want to again consult with the Biometrician's Group to have them consider ways to reduce the positive bias of the recommended method. If the

sampling fraction on any particular day reaches 100%, some adjustment should be made to account for the fact that the sampling variation is zero for the FPI on that day. One approach that could be considered by the Biometrician Group is to break up the stratum in question, placing the day with less than 100% sampling into an adjacent stratum and placing the 100% sampling day into its own stratum with a known total and, hence, zero variance.

Amendment to

January 1990
Report of Biometrician Group
on a confidence interval for the
cumulative fish passage index

October 1990

Biometrician Group members

Cliff Pereira

Lyle Calvin

Doug Neeley

The Biometrician Group on pages 10 and 11 of the report suggested that, in-addition to the recommended paired-day stratification system, a stratification procedure might be considered that structured strata so that, on days when 100% sampling were realized, a stratum be created to contain those days. This stratum would then have a zero variance associated with the number of fish passing through the bypass.

The Group, based on discussions in a meeting held on 10 October 1990, recommends that the paired-day stratification still be used but that the suggestion for considering a stratum of 100% sampling days be ignored for the time being. The rationale for this recommendation stem from legitiment observations made by Tom Berggren: 100% sampling would only account for the fish in the bypass system; it does not account for FGE. Bypass sampling represents a conditional sampling in that it depends on the number of fish that entered the bypass system. There is another sampling source associated with probabilities of fish entering the bypass. Since this source of sampling is outside the control of the sampling effort, we do not know the variance associated with this source.

According to Tom Berggren, there is a 100% bypass sampling at Rock Island Dam, but the FGE at that project is assumed to be about 5%, meaning that only the 5% of the population entering the gatewell is actually 100% sampled. Apparently, a true 100% sampling rate is rarely approached.

The Group now suggests that no adjustment for finite population be made at the present time. The recommended cumulative-count variance estimate based on paired-day strata estimates of daily count variances is expected to be positively biased. This bias will lead to conservative confidence intervals. The reasons for the positive bias are as follows:

1. There would probably be negative covariances among daily counts because, for a given contribution of fish, an increase in number passing through on one day would tend to reduce the number passing through on subsequent days. These negative covariances are not taken into account. The failure to estimate and add these negative covariances in obtaining the estimated variance of the cumulative count would result in a positive bias in the cumulative count variance estimate. (Failure to account for finite population sampling is included in this source of bias.)

2. The between paired-day variance estimates for the daily count variances is biased. Their expectations include the variances between expected paired-day counts as well as the variances associated with the daily counts. The variance between expected paired-day counts is a source of positive bias.

3. There is an additional source of bias in the estimates of the daily-count variances. The estimates include the subtraction of negative paired-day covariances (mentioned under 1). Subtraction of negatives is an additional source of positive bias.

If less biased estimates of variance of the cumulative count are desired, the Fish Passage Center may want to contact the Biometrics Group to explore and, if necessary and possible, to adjust for these biases.

APPENDIX E: 1990 Smolt Migration Timing Plots

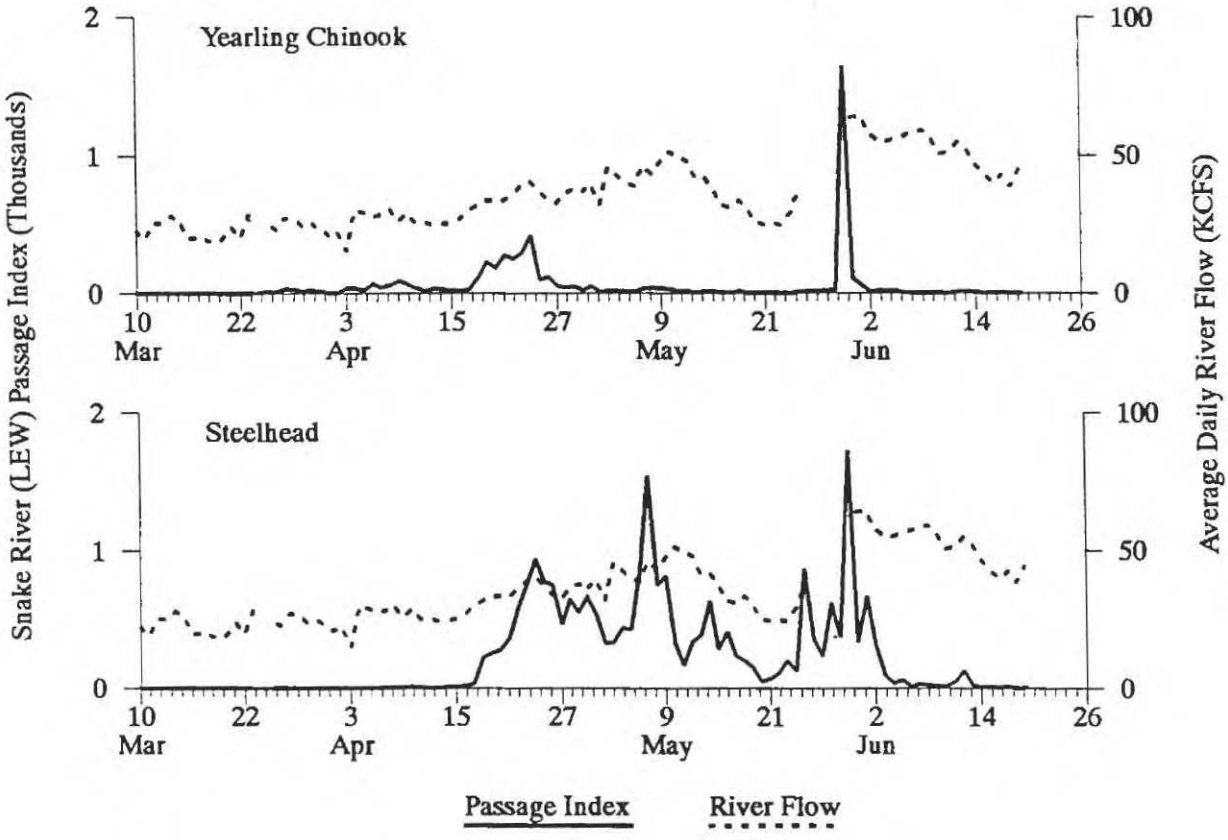


Figure E-1. Smolt migration timing at the Snake River (Lewiston) Trap with the associated flow.

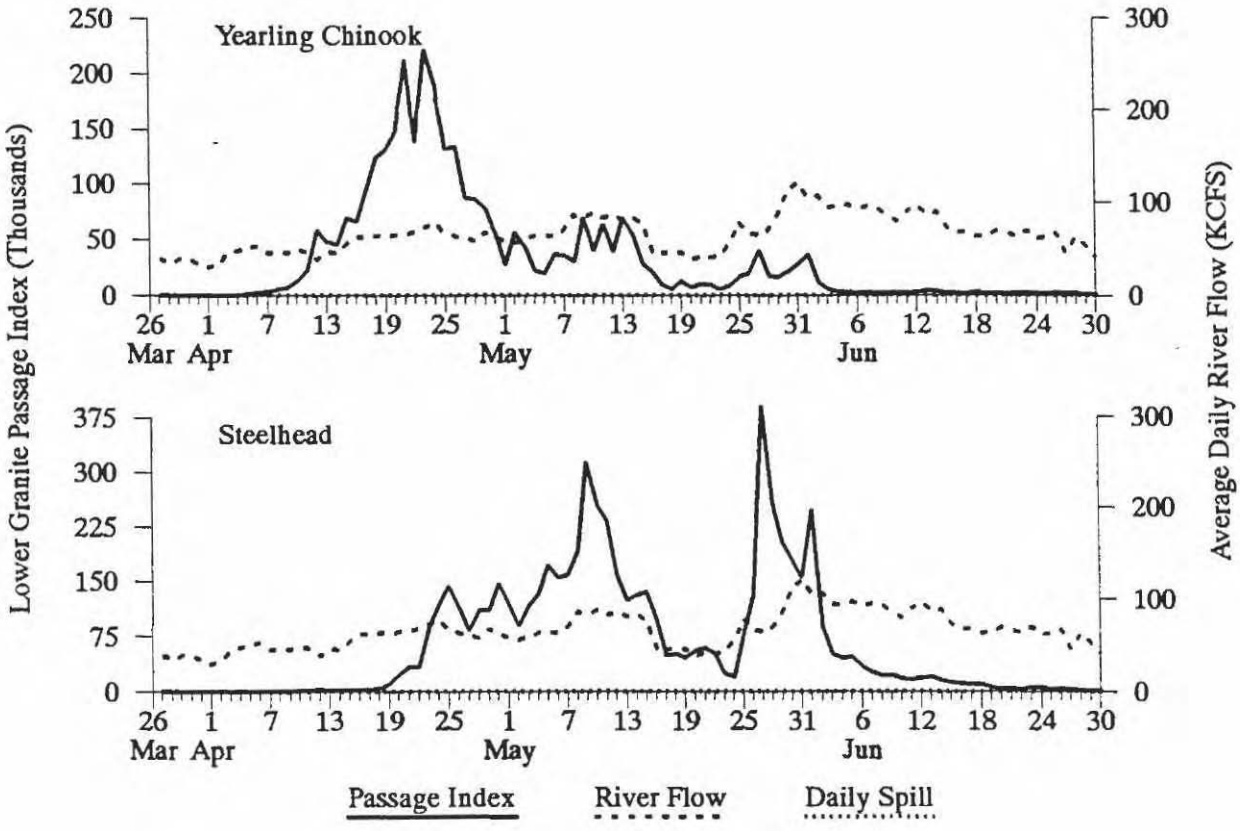


Figure E-2. Smolt migration timing at Lower Granite Dam with associated flow and spill.

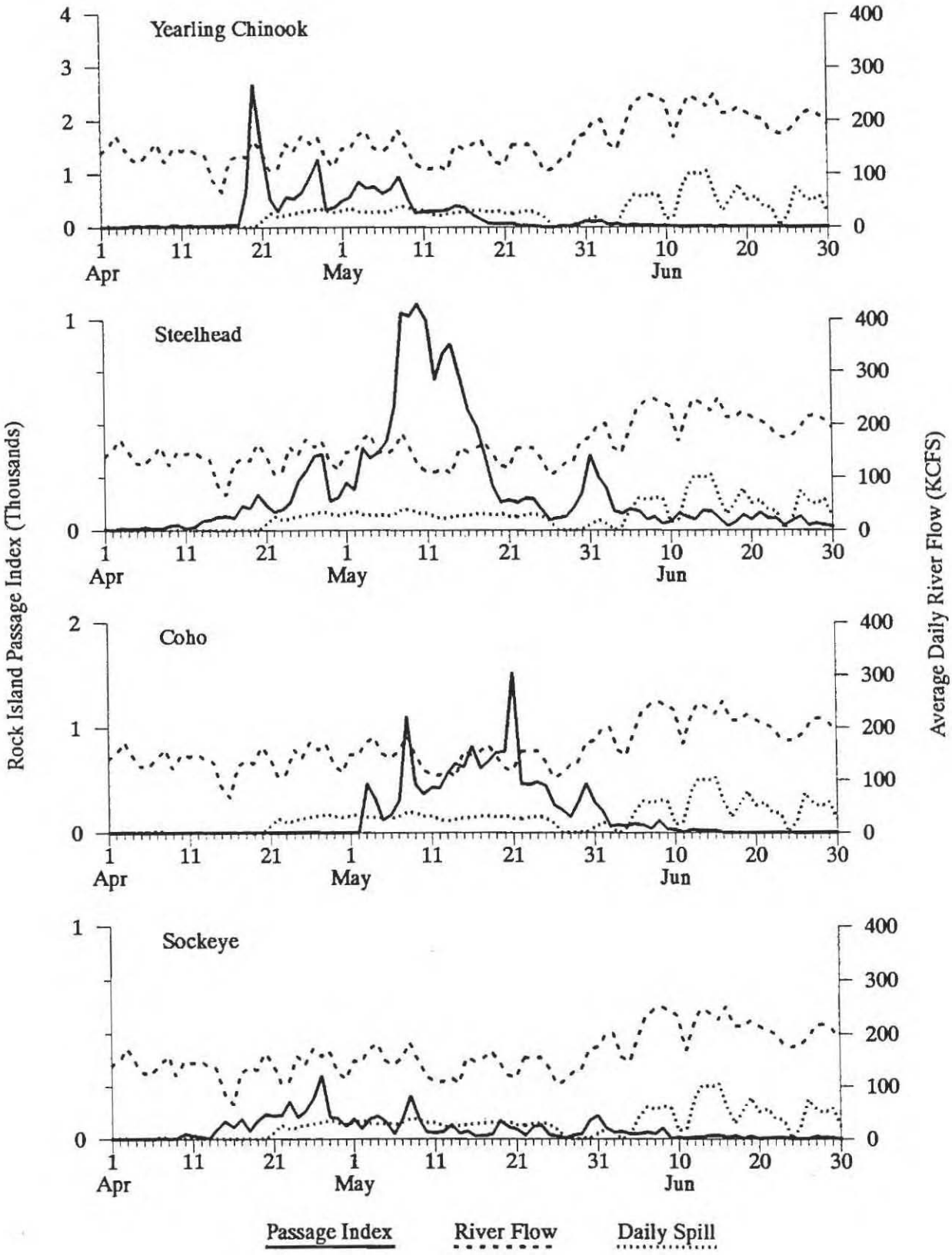


Figure E-3. Smolt migration timing at Rock Island Dam with associated flow and spill.

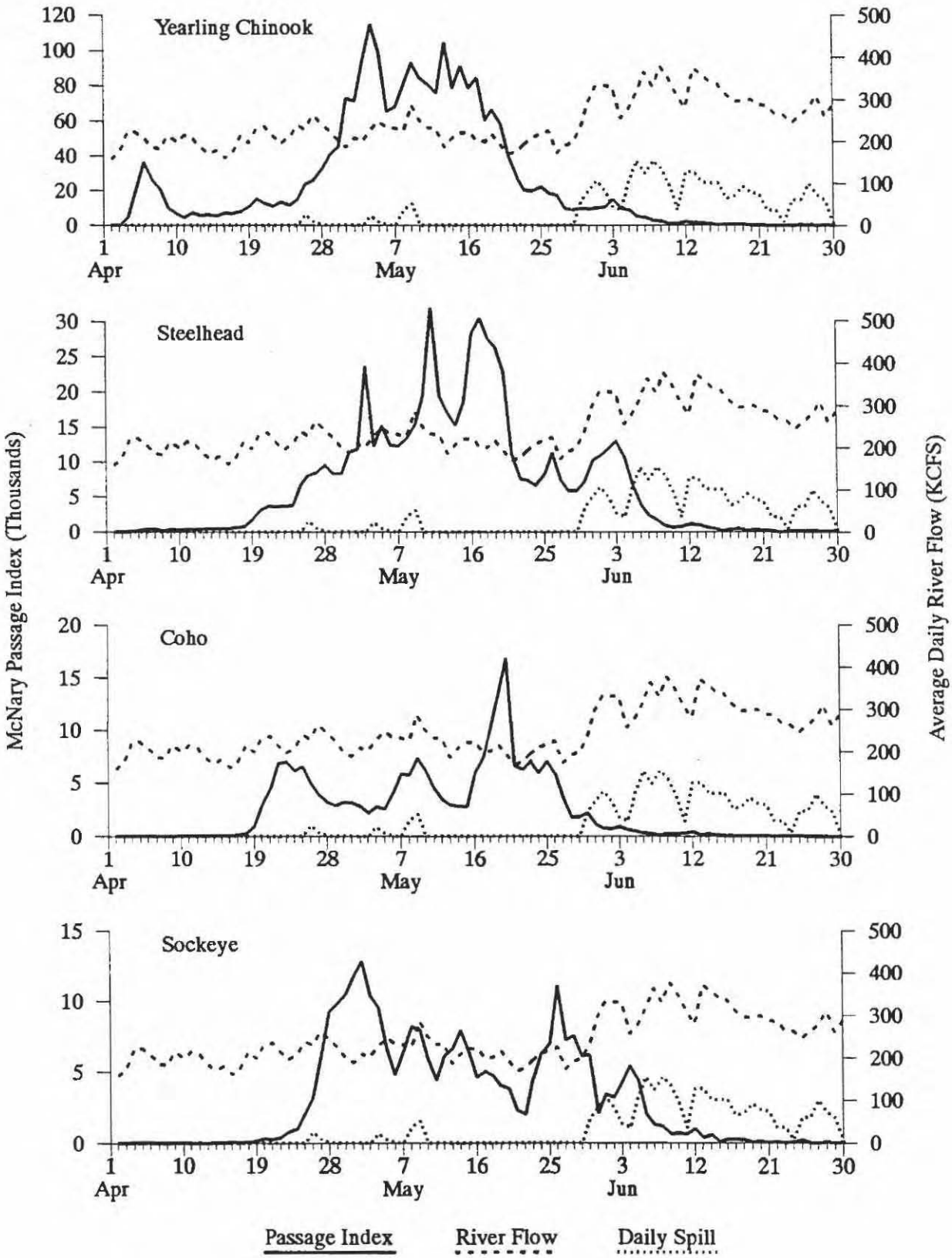


Figure E-4. Smolt migration timing at McNary Dam with assiciated flow and spill.

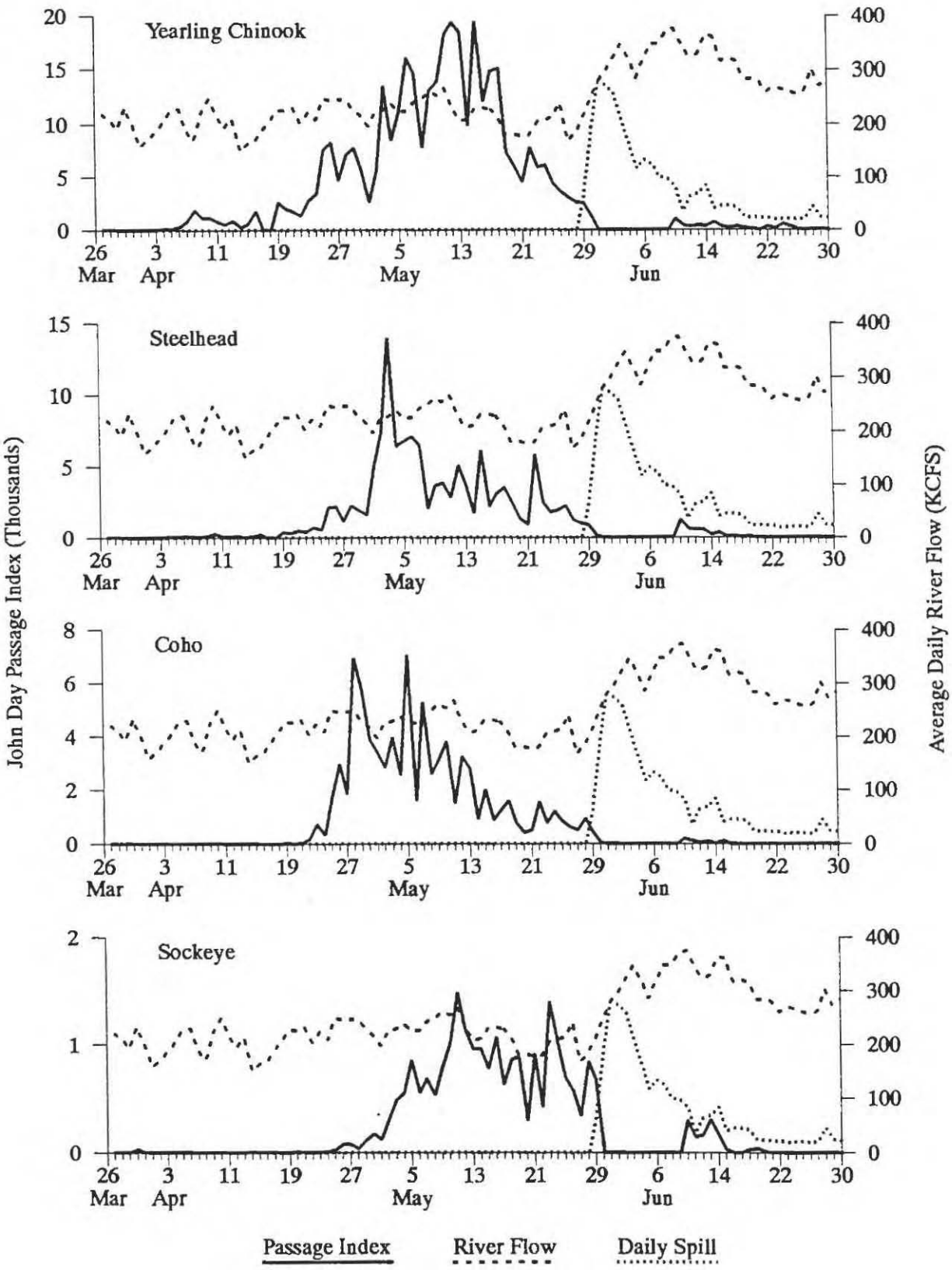


Figure E-5. Smolt migration timing at John Day Dam with associated flow and spill (limited monitoring during Unit 5 outages April 16-19 and May 30 - June 10).

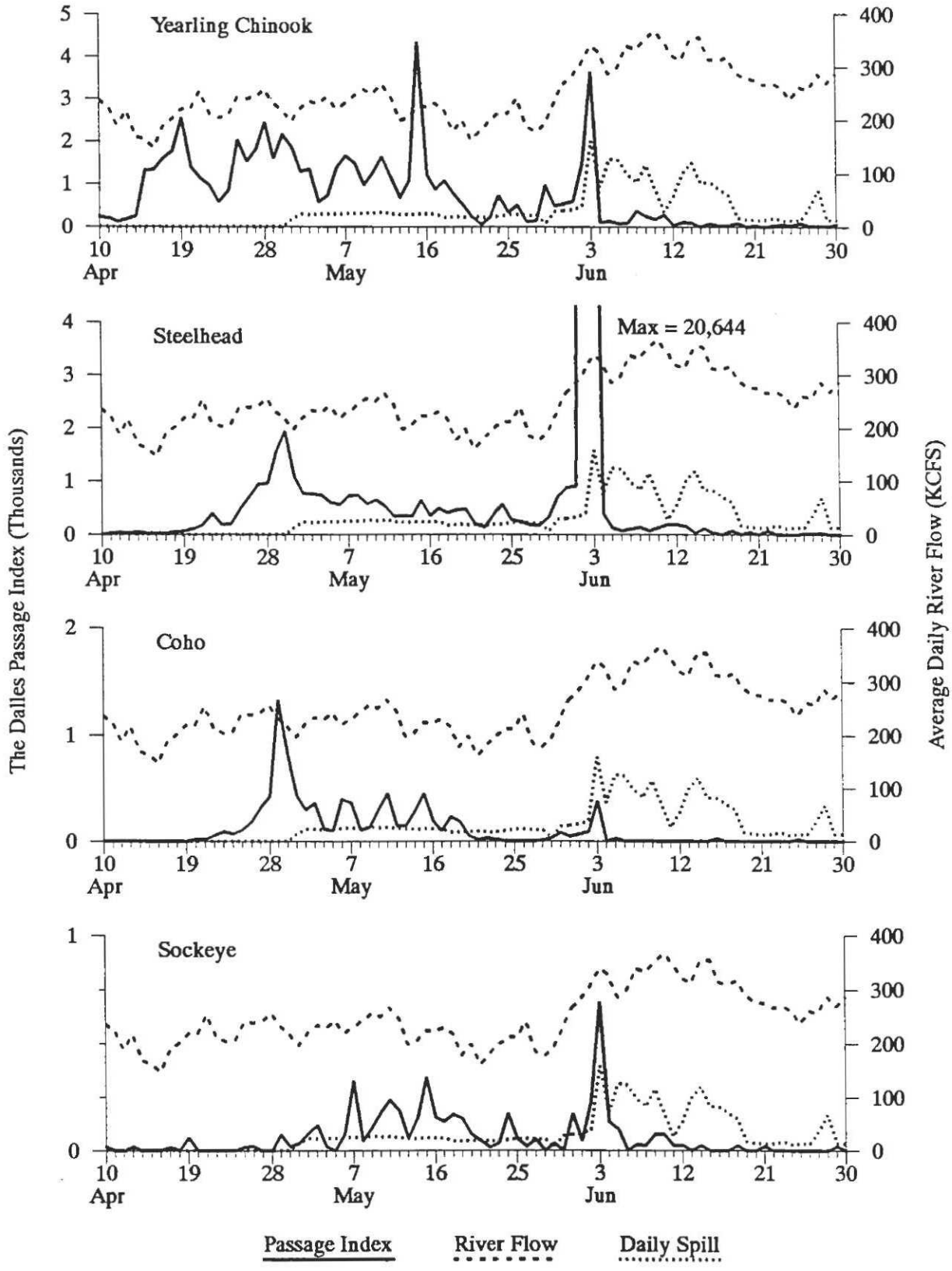


Figure E-6. Smolt migration timing at The Dalles Dam with associated flow and spill (most yearling chinook and steelhead collected on June 2 and 3 are from incidental release of 600,00 barge fish above John Day Dam on May 31).

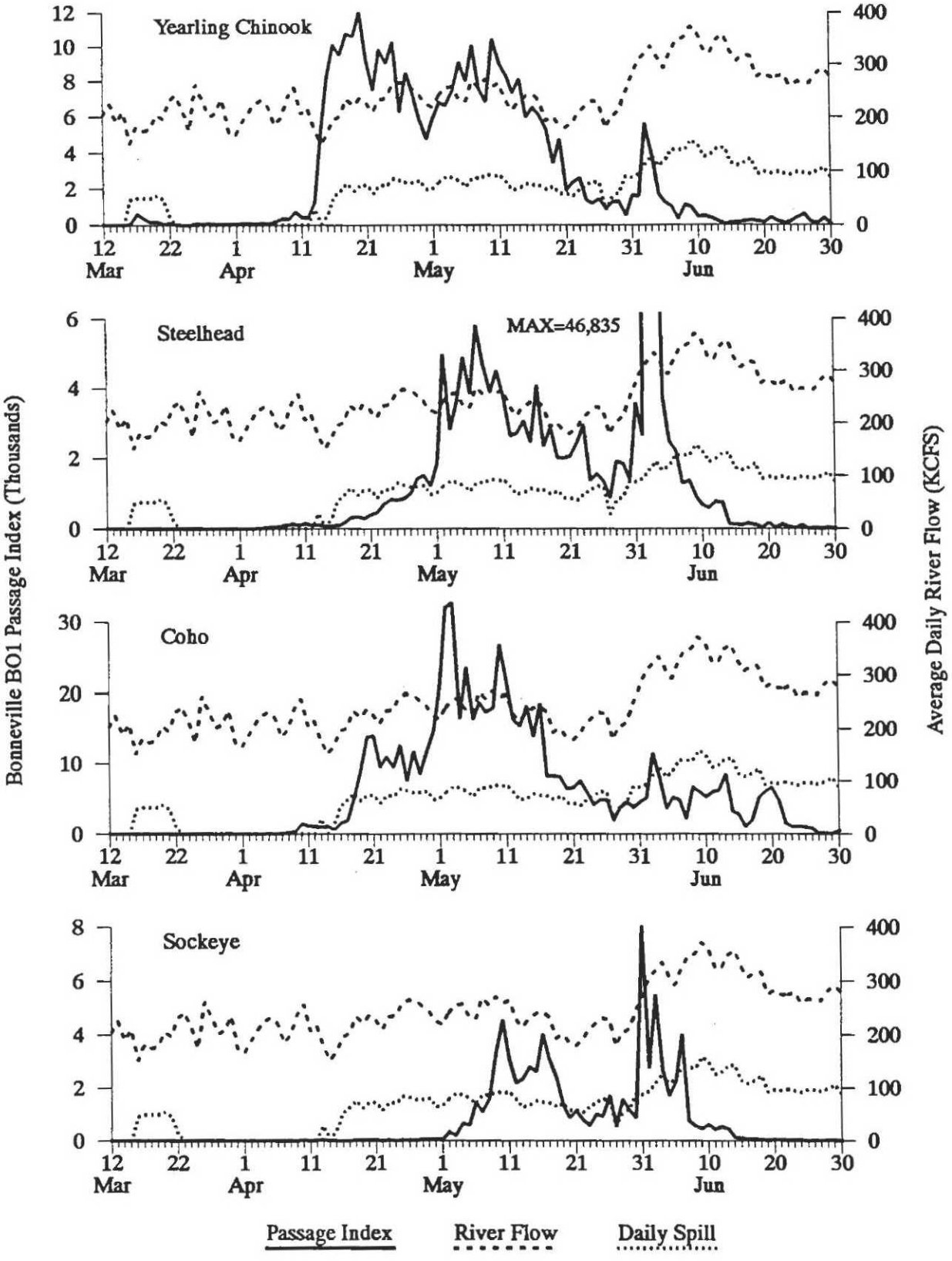


Figure E-7. Smolt migration timing at Bonneville Dam Powerhouse I with associated flow and spill (most yearling chinook and steelhead collected on June 2 & 3 are from release of 600,00 barge fish above John Day Dam on May 31).

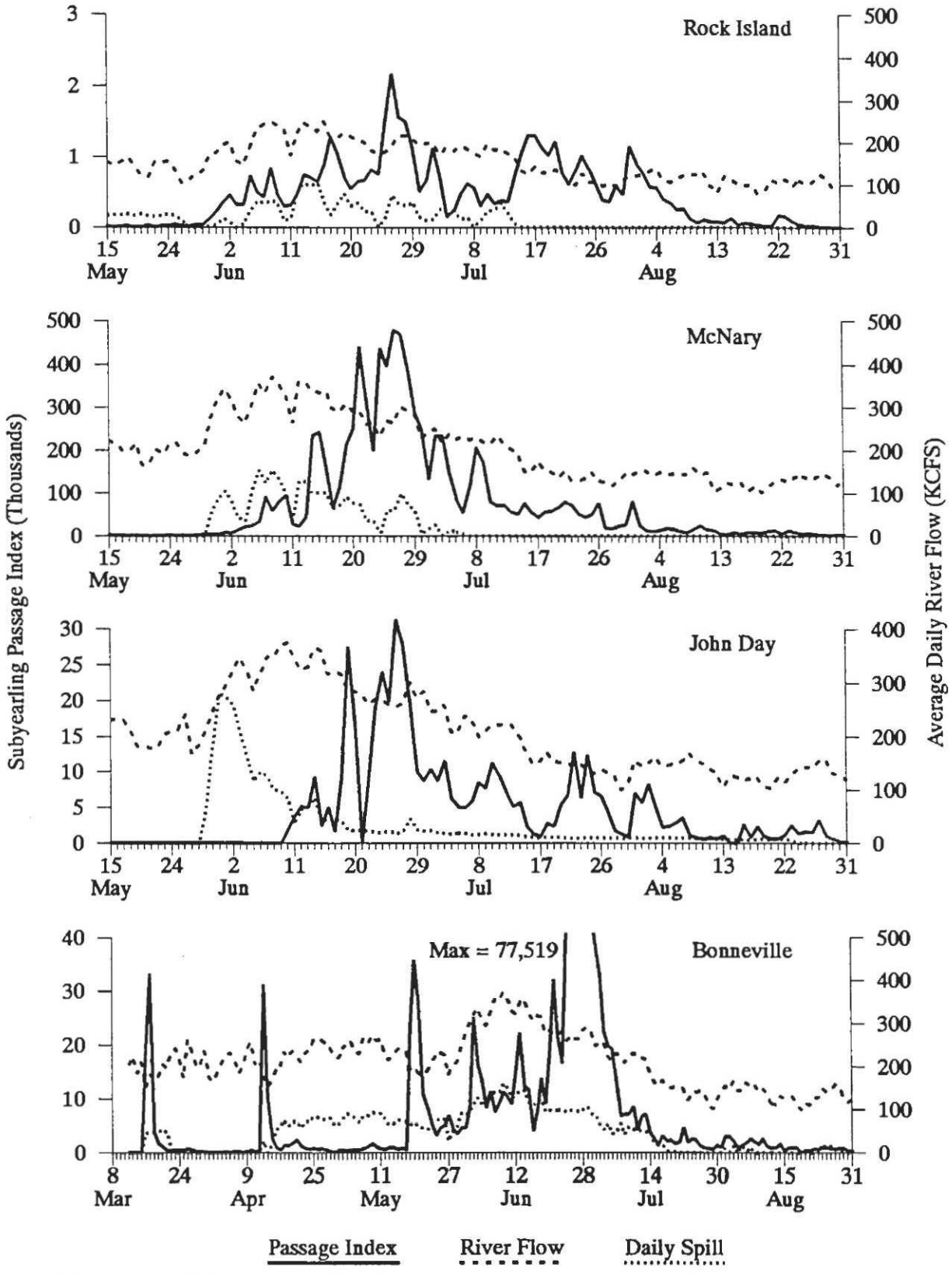


Figure E-8. Subyearling chinook migration timing at key monitoring sites with associated flow and spill.

APPENDIX F: 1990 Migration Timing Plots for Marked Smolts of Hatchery Origin

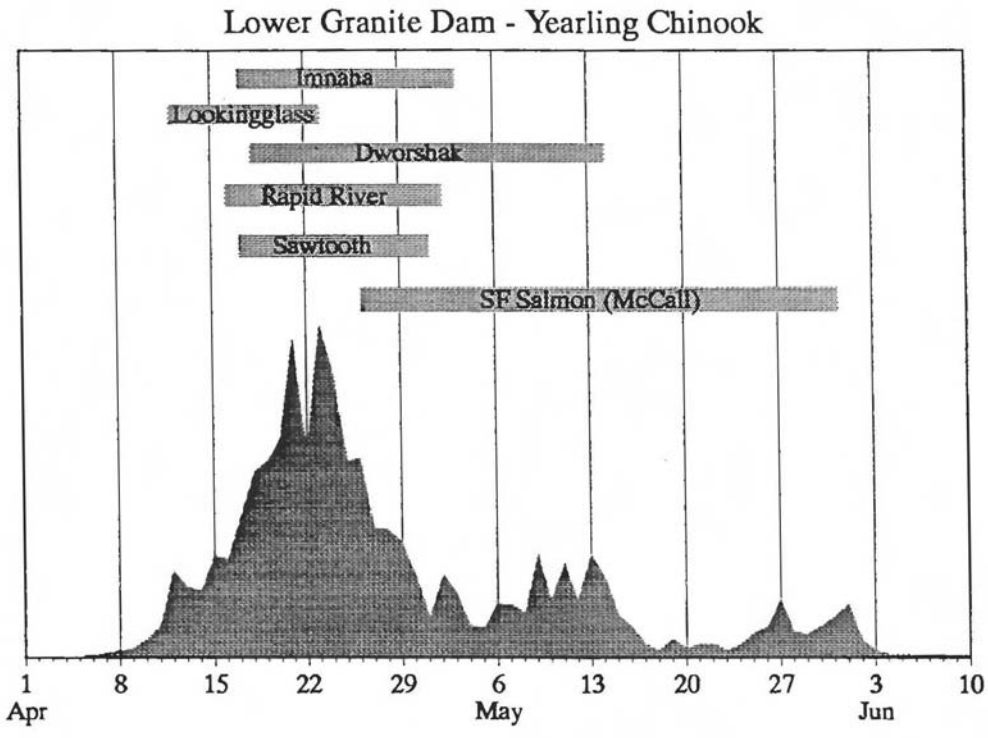


Figure F-1. Yearling chinook migration timing at Lower Granite Dam specifying the middle 80% passage dates of marked hatchery fish.

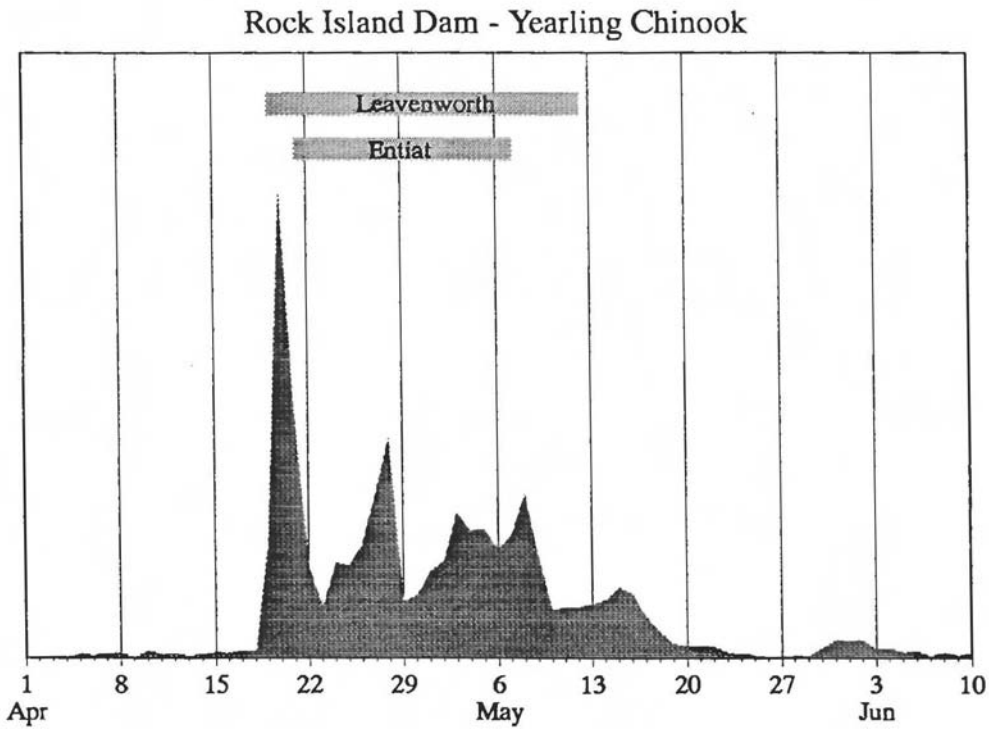


Figure F-2. Yearling chinook migration timing at Rock Island Dam specifying the middle 80% passage dates of marked hatchery fish.

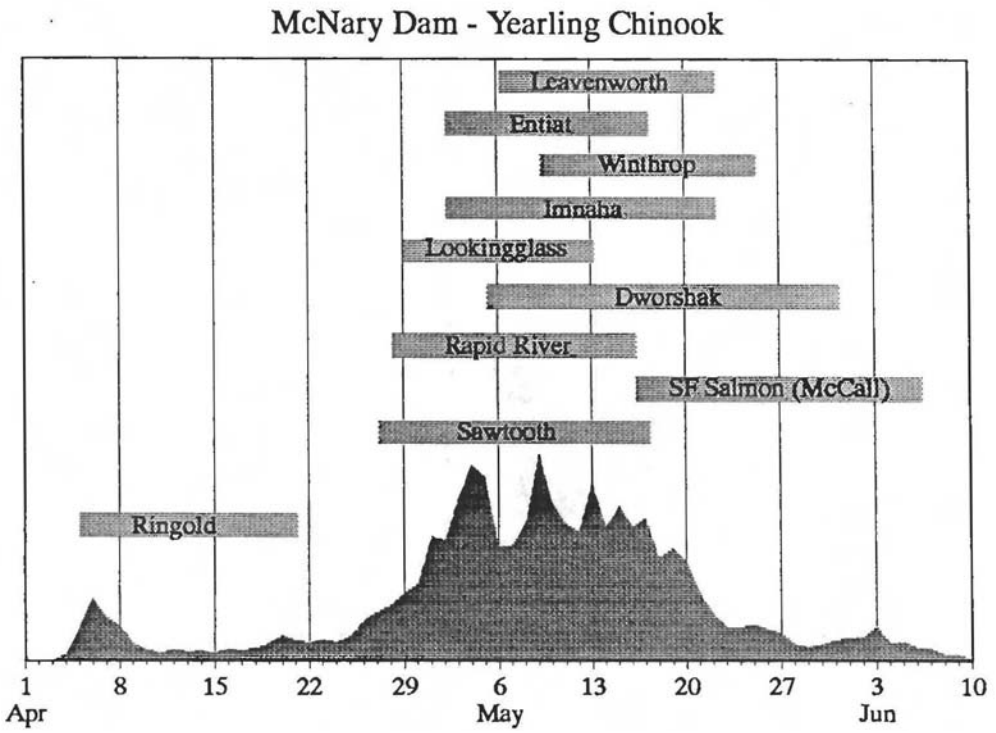


Figure F-3. Yearling chinook migration timing at McNary Dam specifying the middle 80% passage dates of marked hatchery fish.

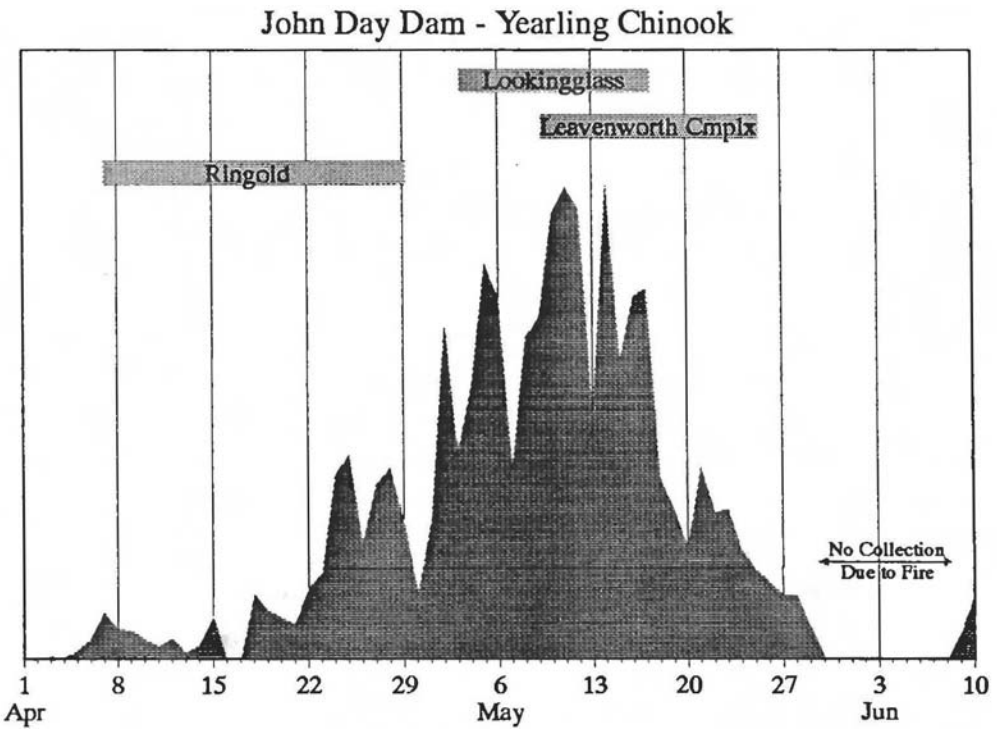


Figure F-4. Yearling chinook migration timing at John Day Dam specifying the middle 80% passage dates of marked hatchery fish.

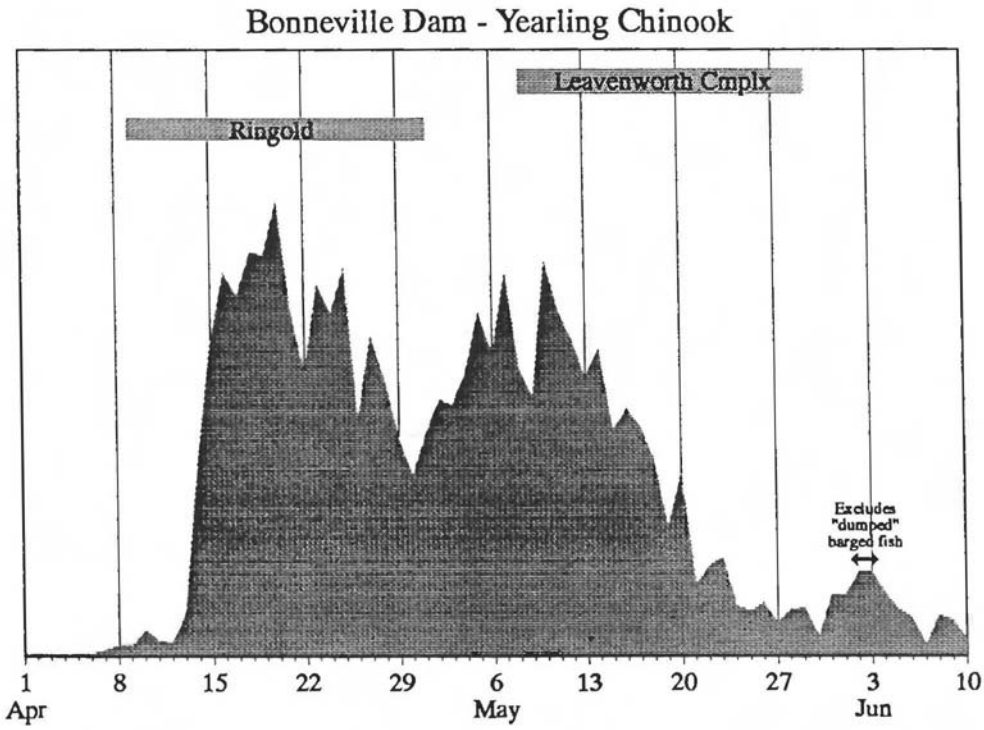


Figure F-5. Yearling chinook migration timing at Bonneville Dam Powerhouse One specifying the middle 80% passage dates of marked hatchery fish.

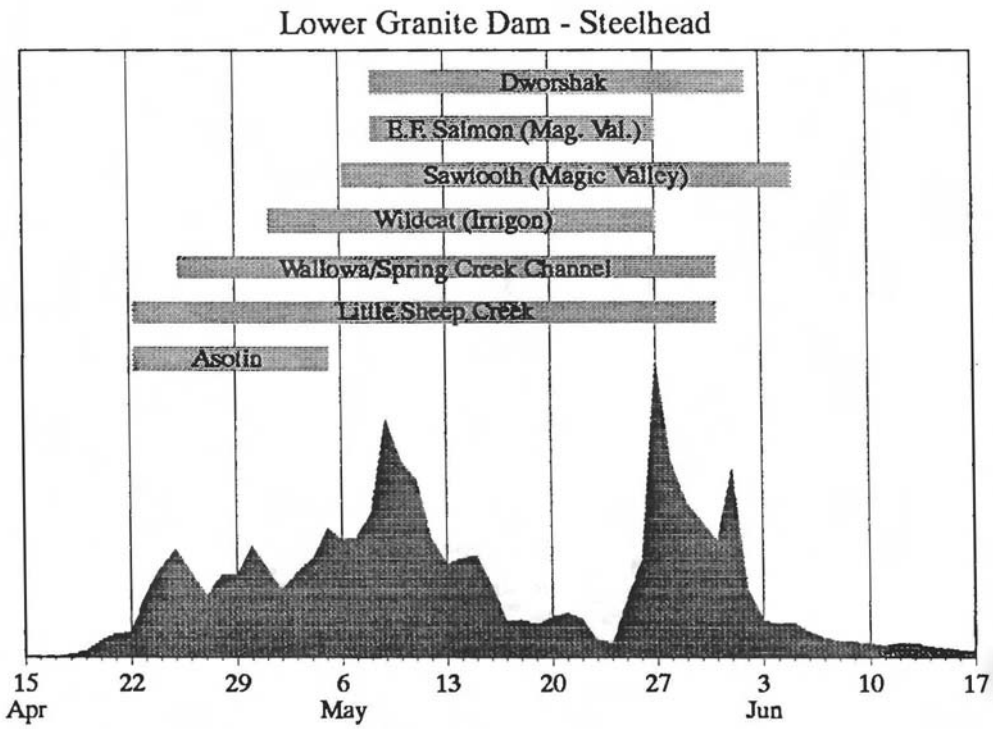


Figure F-6. Steelhead migration timing at Lower Granite Dam specifying the middle 80% passage dates of marked hatchery fish.

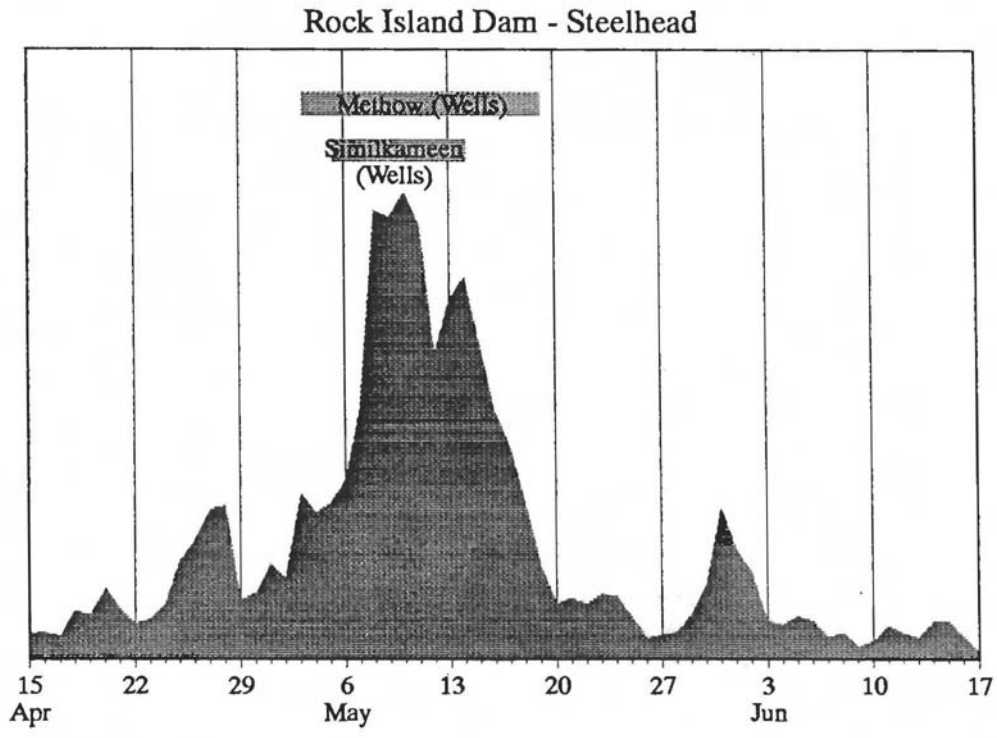


Figure F-7. Steelhead migration timing at Rock Island Dam specifying the middle 80% passage dates of marked hatchery fish.

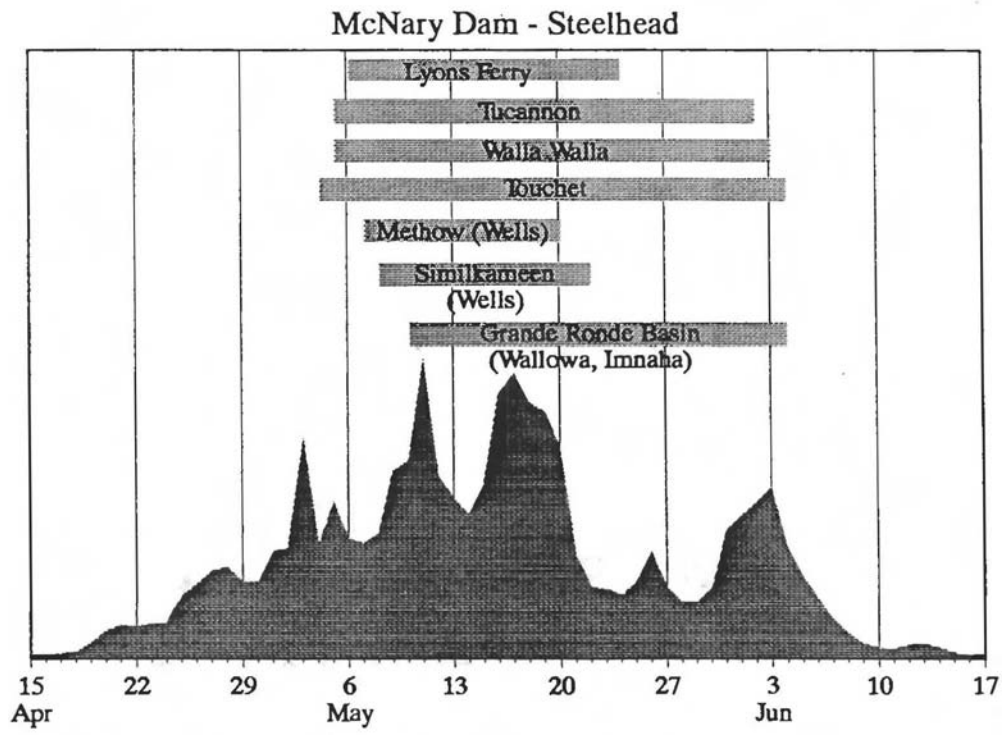


Figure F-8. Steelhead migration timing at McNary Dam specifying the middle 80% passage dates of marked hatchery fish.

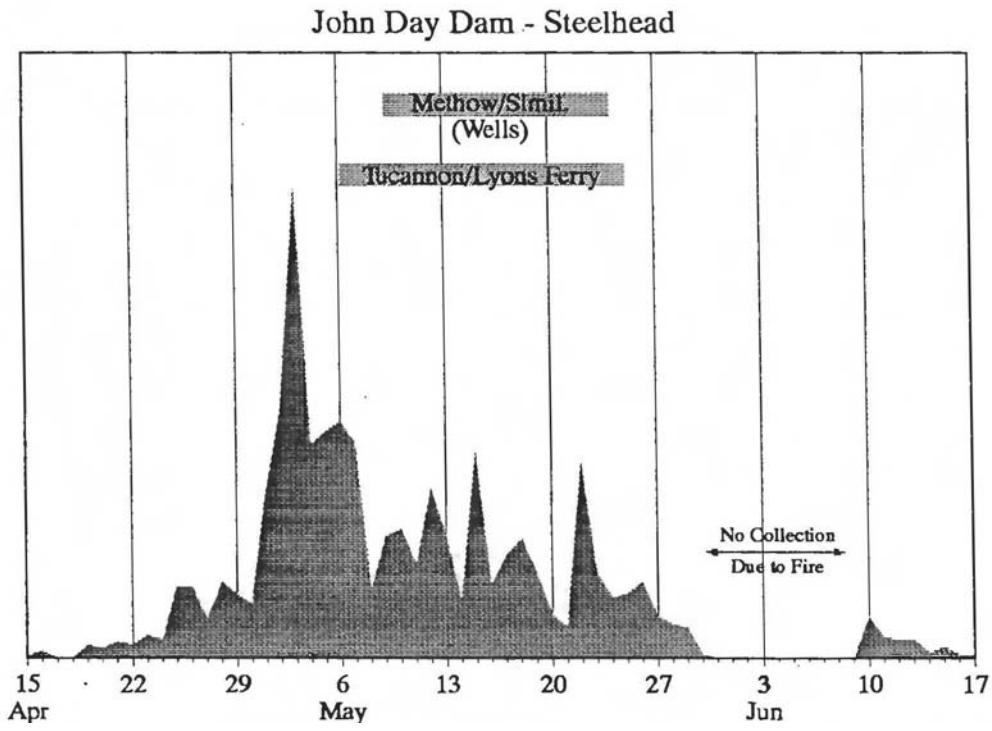


Figure F-9. Steelhead migration timing at John Day Dam specifying the middle 80% passage dates of marked hatchery fish.

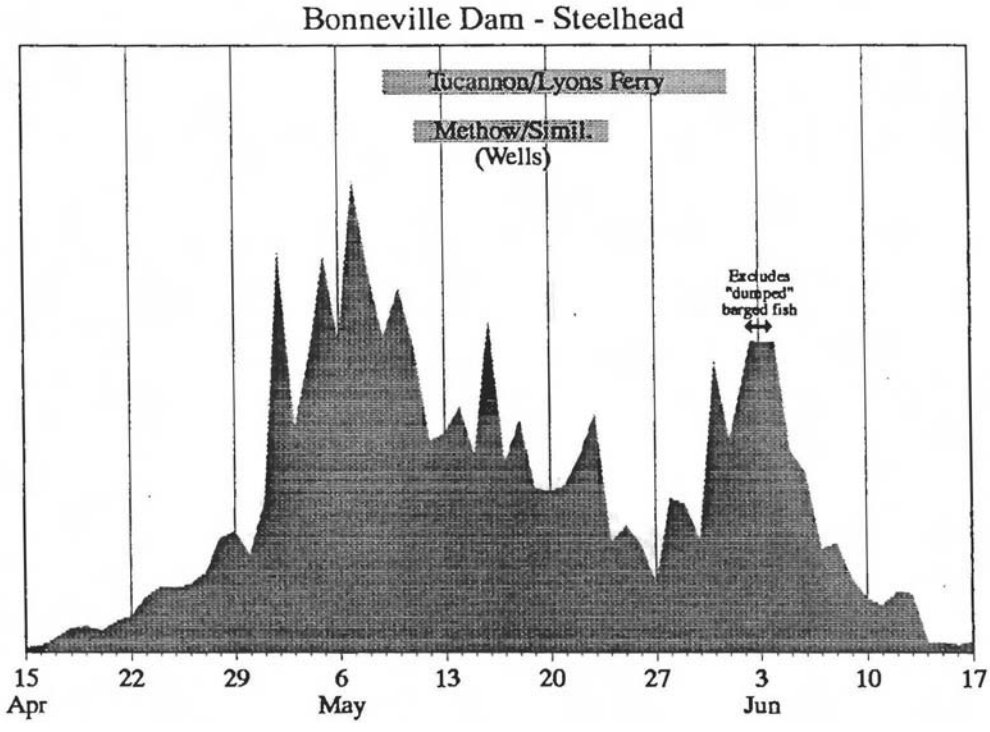


Figure F-10. Steelhead migration timing at Bonneville Dam Powerhouse One specifying the middle 80% passage dates of marked hatchery fish.

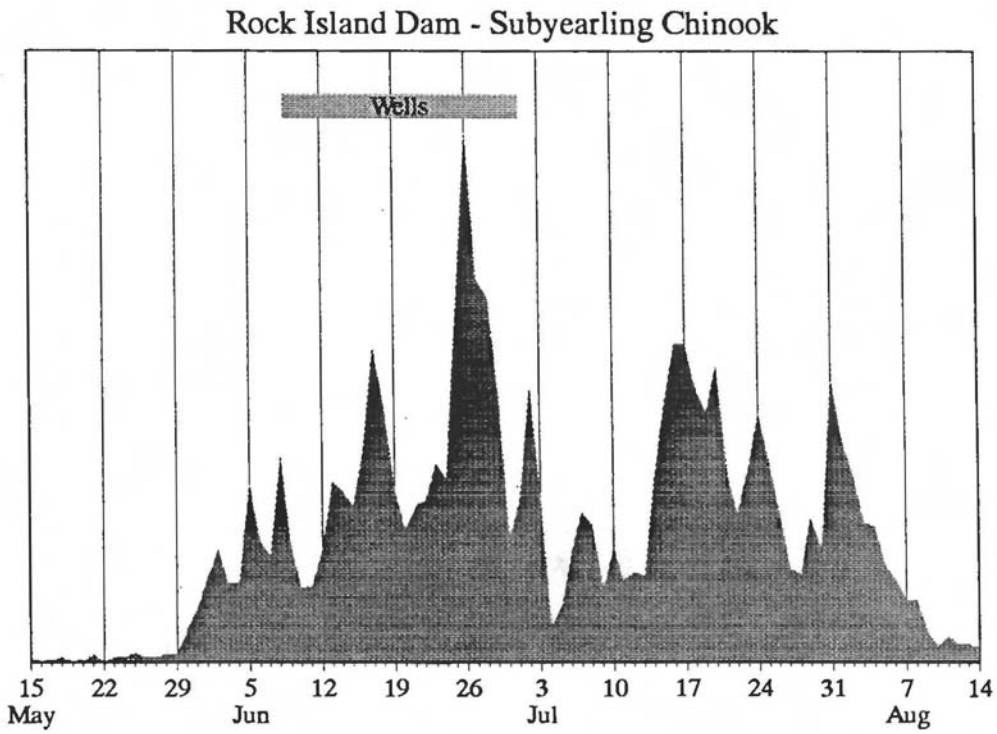


Figure F-11. Subyearling chinook migration timing at Rock Island Dam specifying the middle 80% passage dates of marked hatchery fish.

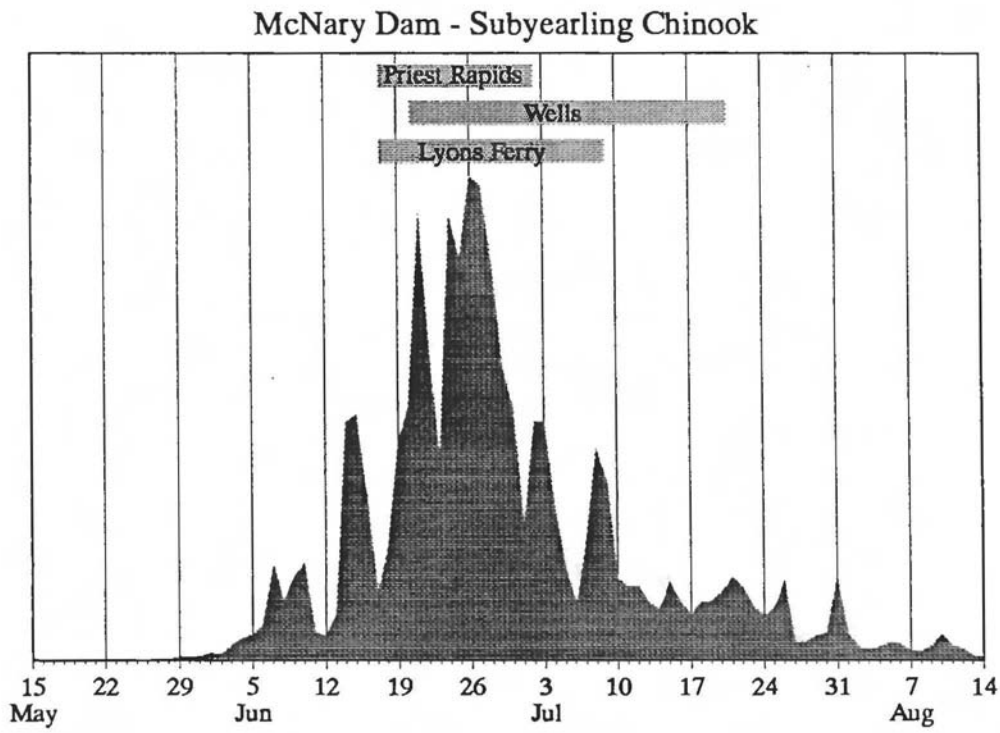


Figure F-12. Subyearling chinook migration timing at McNary Dam specifying the middle 80% passage dates of marked hatchery fish.

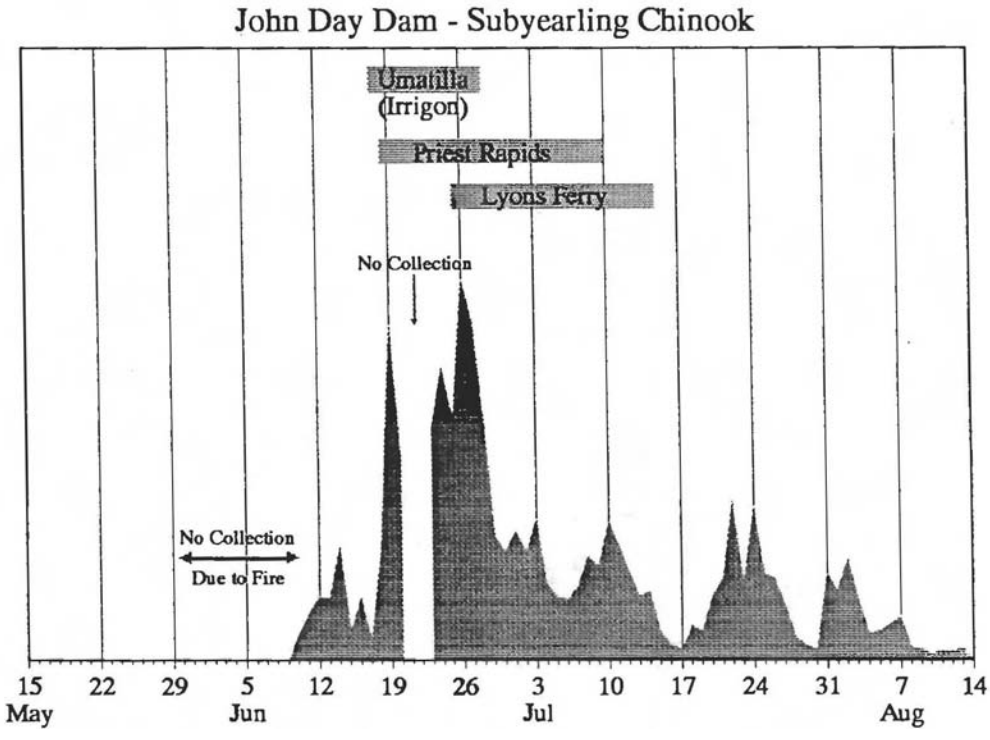


Figure F-13. Subyearling chinook migration timing at John Day Dam specifying the middle 80% passage dates of marked hatchery fish.

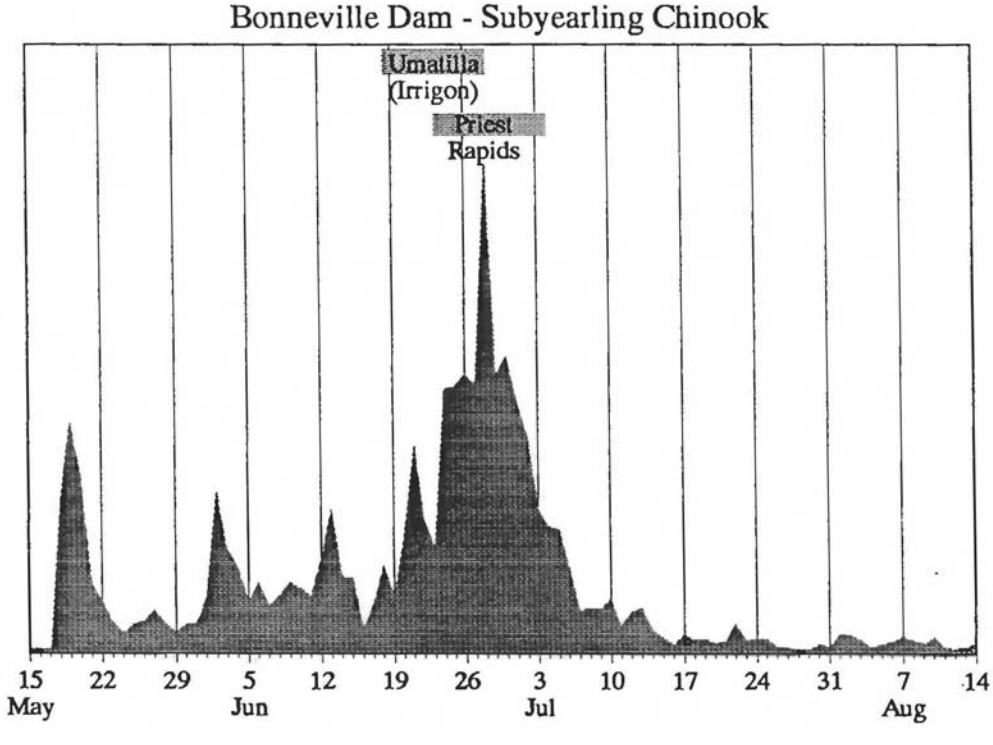


Figure F-14. Subyearling chinook migration timing at Bonnville Dam Powerhouse One specifying the middle 80% passage dates of marked hatchery fish.

APPENDIX G: Detailed Smolt Travel Time Tables

Table G-1. Travel time of PIT tagged yearling chinook smolts from Snake River trap to Lower Granite Dam, 1990.

MULTI-DAY RELEASE	MEDIAN DATES RELEASE	MEDIAN DATES RECAP	TRAVEL TIME (DAYS) MEDIAN	95% CI LIMITS LOWER	95% CI LIMITS UPPER	FISH NUMBER RELEASE	FISH NUMBER DETECTED	PERCENT DETECTED	LGR FLOW (KCFS)
	04/09	04/18	9.1	7	11.1	77	37	48%	50.2
4/10-4/11	04/10	04/18	8	7.2	9.2	100	34	34%	50.8
4/16-4/18	04/18	04/23	5.3	5	5.8	147	59	40%	65.2
	04/19	04/25	5.6	4.6	6.5	151	54	36%	68.9
	04/20	04/26	5.6	5.2	6.4	149	59	40%	69.4
	04/21	04/28	6.7	6.1	7.4	150	59	39%	68.0
	04/22	04/28	6.4	5.8	7.7	148	66	45%	68.5
	04/23	05/01	7.5	5.8	9.7	149	62	42%	66.3
	04/24	05/02	8	7	9.6	150	70	47%	64.5
	04/25	05/06	11.4	8.6	14.3	89	36	40%	62.0
	04/26	05/05	8.8	6.5	11.7	95	44	46%	61.2
4/27-4/28	04/27	05/05	8.4	5.7	10.3	76	28	37%	61.0
4/29-4/30	04/29	05/07	7.8	6.8	8.9	68	38	56%	62.0
5/1-5/5	05/01	05/09	8.1	7.1	9.4	83	34	41%	65.3
5/7-5/8	05/08	05/13	5.1	4.2	5.5	72	31	43%	85.4
5/9-5/13	05/10	05/14	4	3.3	4.5	92	48	52%	84.5
	05/30	06/01	2.4	2.1	2.9	151	66	44%	117.6
5/31-6/1	05/31	06/04	4.4	3.9	6.8	89	41	46%	107.2
6/2-6/8	06/04	06/09	5.3	4.1	7.8	62	30	48%	95.1

- Flow at Lower Granite Dam is the average flow (kcfs) over the period from the median date of release through the date preceding the median date of recovery.
- Distance from Snake River trap to Lower Granite Dam is 32 miles.
- Purse seine caught fish are excluded.

Table G-2. Travel time of PIT tagged hatchery steelhead smolts from Snake River trap to Lower Granite Dam, 1990.

MULTI-DAY RELEASE	MEDIAN RELEASE	DATES RECAP	TRAVEL TIME (DAYS) MEDIAN	95% CI LIMITS LOWER	95% CI LIMITS UPPER	FISH NUMBER RELEASE	FISH NUMBER DETECTED	PERCENT DETECTED	LGR FLOW (KCFS)
4/16-4/18	04/18	04/23	5.0	4.4	5.5	90	75	83%	65.2
	04/19	04/23	4.0	3.8	4.8	61	44	72%	65.5
	04/20	04/24	3.9	3.7	4.9	64	50	78%	68.0
	04/21	04/25	4.1	3.5	6.3	60	43	72%	71.4
	04/22	04/27	4.9	3.1	7.4	53	39	74%	70.1
	04/23	04/28	5.2	3.2	7.7	62	48	77%	68.4
	04/24	04/30	5.7	4.8	6.8	60	43	72%	65.8
	04/25	04/30	4.9	4.4	7.4	60	45	75%	63.4
	04/26	05/02	5.8	4.7	7.1	60	47	78%	61.9
	04/27	05/04	7.0	5.7	8.5	60	43	72%	60.6
	04/28	05/04	5.8	4.7	6.5	64	50	78%	60.6
	04/29	05/06	6.5	4.9	7.4	65	44	68%	61.8
	04/30	05/06	5.9	4.7	6.7	60	40	67%	60.8
	05/01	05/06	4.8	4.3	5.8	60	47	78%	60.4
	05/02	05/08	6.0	4.7	7.8	60	42	70%	62.9
	05/03	05/09	5.5	4.1	7.0	61	40	66%	67.9
	05/04	05/10	5.5	4.7	9.2	60	44	73%	72.0
	05/05	05/10	4.9	3.8	6.3	67	50	75%	73.7
	05/06	05/10	4.0	3.4	6.1	60	48	80%	76.1
	05/07	05/13	5.8	4.3	7.0	59	43	73%	83.0
	05/08	05/12	4.3	3.0	6.5	60	46	77%	85.5
	05/09	05/14	4.8	3.8	5.6	60	41	68%	84.4
	05/10	05/14	4.1	3.8	6.4	60	42	70%	84.5
	05/11	05/17	6.0	3.0	13.8	59	39	66%	76.3
	05/12	05/18	6.0	3.0	8.9	60	42	70%	70.1
	05/13	05/24	10.5	7.9	13.5	60	41	68%	54.0
	05/14	05/26	11.9	6.8	12.4	60	43	72%	53.9
	05/15	05/25	9.9	7.0	11.2	60	44	73%	48.4
	05/16	05/24	8.3	4.9	10.4	60	46	77%	43.9
	05/17	05/26	8.9	7.8	9.4	60	42	70%	48.7
	05/18	05/26	8.4	8.2	8.5	60	46	77%	49.0
	05/19	05/26	7.2	7.0	7.4	60	49	82%	49.4
5/20-5/21	05/21	05/27	5.9	5.2	6.3	74	53	72%	54.3
	05/22	05/26	4.1	4.0	4.7	65	47	72%	54.4
	05/23	05/26	3.2	3.1	3.4	59	40	68%	58.8
	05/24	05/27	3.1	2.7	3.6	60	38	63%	66.6
	05/25	05/29	3.5	3.2	4.1	60	41	68%	70.3
	05/26	05/29	3.1	2.9	3.9	60	35	58%	67.6
	05/27	05/30	3.0	2.6	3.4	58	45	78%	74.4
	05/28	05/31	2.7	2.5	2.9	60	47	78%	90.6
	05/29	05/31	1.9	1.8	2.1	59	49	83%	100.3
	05/30	06/01	1.7	1.5	2.0	62	47	76%	117.6
	05/31	06/02	2.1	1.8	2.7	60	51	85%	113.6
	06/01	06/03	2.3	2.0	2.8	60	49	82%	106.4
	06/02	06/04	2.1	2.0	2.7	60	45	75%	100.7
	06/03	06/05	2.2	2.1	2.8	62	43	69%	95.2
6/4-6/5	06/05	06/08	3.0	2.6	3.5	84	57	68%	95.4
6/6-6/9	06/07	06/10	3.0	2.8	3.6	45	34	76%	91.9
6/10-6/11	06/11	06/14	2.7	2.1	3.0	68	42	62%	91.8
6/12-6/13	06/12	06/15	3.1	2.6	3.8	75	48	64%	91.4

- Flow at Lower Granite Dam is the average flow (kcfs) over the period from the median date of release through the date preceding the median date of recovery.
- Distance from Snake River trap to Lower Granite Dam is 32 miles.
- Purse seine caught fish are excluded.

Table G-3. Travel time of PIT tagged wild steelhead smolts from Snake River trap to Lower Granite Dam, 1990.

MULTI-DAY RELEASE	MEDIAN DATES RELEASE	MEDIAN DATES RECAP	TRAVEL TIME (DAYS) MEDIAN	95% CI LIMITS LOWER	95% CI LIMITS UPPER	FISH NUMBER RELEASE	FISH NUMBER DETECTED	PERCENT DETECTED	LGR FLOW (KCFS)
4/9-4/17	04/15	04/19	4.0	3.6	4.4	52	30	58%	60.9
	04/18	04/22	3.6	3.3	4.2	52	36	69%	64.2
	04/19	04/23	3.6	3.4	4.2	80	50	63%	65.5
	04/20	04/23	3.1	2.9	3.3	62	37	60%	66.1
	04/21	04/24	3.1	2.7	3.5	110	69	63%	69.3
	04/22	04/25	2.8	2.5	3.1	97	72	74%	73.5
	04/23	04/26	3.4	2.8	4.3	88	52	59%	72.7
	04/24	04/28	3.6	3.4	3.8	172	111	65%	67.1
	04/25	04/29	3.9	3.7	4.4	140	86	61%	62.3
	04/26	04/30	4.0	3.8	4.2	143	95	66%	62.6
	04/27	05/01	3.7	3.0	4.9	40	22	55%	62.4
	04/28	05/02	4.4	4.1	4.5	109	66	61%	62.0
	04/29	05/04	4.6	3.9	5.3	81	55	68%	61.0
	04/30	05/05	4.5	4.2	5.2	75	50	67%	60.2
	05/01	05/06	4.5	3.7	5.3	76	49	64%	60.4
	05/02	05/06	3.7	3.4	4.3	42	27	64%	60.8
	05/03	05/07	3.7	3.5	4.6	62	45	73%	62.5
	05/04	05/08	3.9	3.3	4.5	40	27	68%	65.5
	05/05	05/09	3.6	3.4	4.0	72	53	74%	71.0
	05/06	05/09	3.1	2.8	3.7	114	80	70%	73.5
	05/07	05/11	3.5	3.4	3.6	225	147	65%	82.4
	05/08	05/12	3.5	3.1	4.0	129	87	67%	85.5
	05/09	05/12	3.2	2.8	3.6	96	55	57%	85.3
	05/10	05/13	3.1	2.7	3.7	53	36	68%	85.6
5/11-5/12	05/12	05/16	3.7	2.8	5.0	63	39	62%	81.9
	05/13	05/19	5.6	4.2	7.1	66	45	68%	63.6
	05/14	05/20	5.8	4.8	6.6	82	50	61%	57.8
5/15-5/16	05/16	05/21	5.1	4.7	6.0	70	44	63%	45.1
5/17-5/18	05/17	05/22	4.8	4.4	6.1	56	41	73%	44.1
5/19-5/20	05/19	05/25	6.2	5.6	7.1	34	24	71%	44.6
5/21-5/23	05/22	05/26	3.6	3.2	4.0	55	32	58%	54.4
5/24-5/25	05/25	05/28	3.4	3.1	4.1	63	40	63%	70.0
5/26-5/27	05/26	05/30	3.6	3.0	3.9	80	39	49%	72.4
5/28-5/29	05/28	05/31	2.5	2.2	2.6	80	57	71%	90.6
	05/30	06/01	1.7	1.6	2.0	80	62	78%	117.6
5/31-6/1	06/01	06/04	2.5	1.9	3.2	57	44	77%	100.8
6/2-6/5	06/02	06/05	3.4	1.9	4.0	37	27	73%	98.7
6/8-6/14	06/12	06/15	3.1	2.8	4.4	22	15	68%	91.4

- Flow at Lower Granite Dam is the average flow (kcfs) over the period from the median date of release through the date preceding the median date of recovery.
- Distance from Snake River trap to Lower Granite Dam is 32 miles.
- Purse seine caught fish are excluded.

Table G-4. Travel time of PIT tagged yearling chinook smolts from Clearwater River trap to Lower Granite Dam, 1990.

MU RELEASE	LTI-DAY RELEASE	MEDIAN DATES RECAP	TRAVEL TIME (DAYS) MEDIAN	95% CI LIMITS LOWER	95% CI LIMITS UPPER	FISH NUMBER RELEASE	FISH NUMBER DETECTED	PERCENT DETECTED	LGR FLOW (KCFS)
	03/30	04/21	21.5	18.8	24.6	150	46	31%	48.6
	03/31	04/21	20.6	18.3	23.9	150	51	34%	49.1
	04/01	04/22	20.5	18.8	21.4	150	40	27%	50.6
	04/02	04/19	17.2	14.6	20.6	150	42	28%	49.3
	04/03	04/22	19.0	15.6	21.6	150	46	31%	52.6
	04/04	04/20	16.4	11.7	18.9	151	45	30%	51.5
	04/05	04/30	25.0	19.1	31.3	150	44	29%	57.7
	04/06	04/24	18.2	16.2	28.5	149	37	25%	55.3
	04/07	04/24	16.7	15.5	20.6	148	42	28%	55.5
	04/08	04/25	16.6	13.1	23.0	150	48	32%	57.3
	04/09	04/21	11.7	10.1	15.1	148	47	32%	53.6
	04/10	04/22	12.2	10.4	13.3	152	43	28%	55.2
	04/11	04/23	12.0	9.7	16.1	151	42	28%	56.9
	04/12	04/28	15.9	11.2	21.9	150	45	30%	61.1
	04/13	04/30	16.6	13.0	25.4	150	48	32%	62.7
	04/14	05/03	18.5	14.2	22.8	150	43	29%	63.0
	04/15	05/07	21.5	14.8	23.6	150	58	39%	63.7
	04/16	04/27	11.4	9.0	18.3	151	55	36%	66.5
	04/17	04/28	10.9	6.8	18.5	90	29	32%	66.3
4/18-4/19	04/18	04/28	10.0	7.4	17.5	111	36	32%	66.8
4/20-4/21	04/21	04/30	8.8	7.5	13.2	93	33	35%	67.0
	04/28	05/10	11.7	8.8	17.9	24	10	42%	66.3
	05/02	05/10	8.4	7.7	11.8	52	23	44%	68.5
	05/03	05/11	8.3	6.9	9.8	85	28	33%	72.5
	05/06	05/16	9.8	7.4	15.3	31	13	42%	80.4
	05/17	05/26	9.1	7.8	9.4	78	30	38%	48.7
	05/18	05/25	7.4	7.0	8.0	134	41	31%	44.8
	05/19	05/26	7.2	6.3	7.6	151	36	24%	49.4
	05/20	05/26	6.2	5.9	6.4	150	35	23%	49.9
	05/21	05/27	5.5	5.4	5.6	152	58	38%	54.3
	05/22	05/27	4.5	4.4	4.6	150	37	25%	56.7
	05/23	05/27	3.7	3.6	4.2	150	46	31%	60.7
	05/24	05/29	5.4	4.3	6.0	170	61	36%	67.3
	05/25	05/31	5.6	4.5	6.9	82	27	33%	80.3

- Flow at Lower Granite Dam is the average flow (kcfs) over the period from the median date of release through the date preceding the median date of recovery.
- Distance from Clearwater River trap to Lower Granite Dam is 38 miles.

Table G-5. Travel time of PIT tagged hatchery steelhead smolts from Clearwater River trap to Lower Granite Dam, 1990.

MULTI-DAY RELEASE	MEDIAN DATES RELEASE	MEDIAN DATES RECAP	TRAVEL TIME (DAYS) MEDIAN	95% CI LIMITS LOWER	95% CI LIMITS UPPER	FISH NUMBER RELEASE	FISH NUMBER DETECTED	PERCENT DETECTED	LGR FLOW (KCFS)
	04/18	04/24	5.7	4.5	7.9	29	19	66%	66.6
	04/19	04/25	6.2	4.2	8.5	58	42	72%	68.9
4/20-4/21	04/20	04/25	4.6	3.9	5.6	67	47	70%	69.9
	04/27	05/03	5.5	4.5	7.1	42	30	71%	60.8
	04/28	05/06	7.5	6.8	8.9	83	62	75%	61.4
	04/29	05/07	7.8	6.6	8.8	75	62	83%	62.0
	05/02	05/09	6.9	4.9	8.3	40	28	70%	66.2
	05/03	05/09	6.0	5.2	7.6	63	50	79%	67.9
	05/04	05/09	5.4	4.8	8.1	59	47	80%	69.6
	05/05	05/11	6.0	4.5	8.0	60	44	73%	76.1
	05/06	05/10	3.7	3.2	4.3	60	47	78%	76.1
	05/07	05/13	6.2	5.5	6.9	60	46	77%	83.0
	05/17	05/25	7.9	7.6	9.1	61	44	72%	44.9
	05/18	05/26	8.2	7.6	8.8	60	46	77%	49.0
	05/19	05/26	7.1	6.9	7.6	60	27	45%	49.4
	05/20	05/26	6.4	5.9	6.9	62	28	45%	49.9
	05/21	05/27	6.1	5.3	6.6	63	41	65%	54.3
	05/22	05/27	4.5	4.1	4.9	61	31	51%	56.7
	05/23	05/27	3.9	3.6	4.2	61	54	89%	60.7
	05/24	05/28	4.2	3.7	5.2	61	51	84%	66.3
	05/25	05/30	5.1	4.9	5.9	35	25	71%	73.6

- Flow at Lower Granite Dam is the average flow (kcfs) over the period from the median date of release through the date preceding the median date of recovery.
- Distance from Clearwater River trap to Lower Granite Dam is 38 miles.

Table G-6. Travel time of PIT tagged wild steelhead smolts from Clearwater River trap to Lower Granite Dam, 1990.

MULTI-DAY RELEASE	MEDIAN DATES RELEASE	MEDIAN DATES RECAP	TRAVEL TIME (DAYS) MEDIAN	95% CI LIMITS LOWER	95% CI LIMITS UPPER	FISH NUMBER RELEASE	FISH NUMBER DETECTED	PERCENT DETECTED	LGR FLOW (KCFS)
4/4-4/8	04/05	04/12	7.2	5.8	8.1	38	22	58%	48.4
4/9-4/11	04/10	04/17	7.0	5.7	7.5	63	30	48%	49.2
4/12-4/14	04/13	04/19	6.2	5.2	8.7	49	20	41%	55.9
	04/15	04/20	4.7	3.8	6.3	64	36	56%	61.5
4/16-4/21	04/18	04/23	5.1	3.5	8.0	32	18	56%	65.2
4/27-4/28	04/28	05/04	5.6	4.7	6.2	41	26	63%	60.6
	04/29	05/05	5.6	4.8	6.9	74	48	65%	61.5
4/30-5/2	05/01	05/06	4.7	4.3	6.0	30	22	73%	60.4
5/3-5/4	05/03	05/07	4.3	4.0	4.7	43	23	53%	62.5
5/5-5/7	05/07	05/11	3.6	3.3	5.0	52	30	58%	82.4
	05/17	05/24	6.9	5.4	7.6	87	53	61%	43.5
	05/18	05/25	7.4	6.5	8.3	80	37	46%	44.8
	05/19	05/26	6.6	6.2	6.9	75	47	63%	49.4
	05/20	05/26	5.8	5.5	6.4	95	42	44%	49.9
	05/21	05/26	4.8	4.5	5.1	96	55	57%	51.9
	05/22	05/26	4.3	4.1	4.5	87	42	48%	54.4
	05/23	05/27	3.5	3.4	3.7	150	118	79%	60.7
5/24-5/25	05/24	05/28	3.8	3.3	4.3	154	98	64%	66.3

- Flow at Lower Granite Dam is the average flow (kcfs) over the period from the median date of release through the date preceding the median date of recovery.
- Distance from Clearwater River trap to Lower Granite Dam is 38 miles.

Table G-7. Travel time of PIT tagged yearling chinook and steelhead smolts from Lower Granite Dam to McNary Dam, 1990.

MULTI-DAY RELEASE	MEDIAN RELEASE	MEDIAN DATES LGR	MEDIAN DATES MCN	TRAVEL TIME (DAYS) MEDIAN	MAX CI BOUNDS LOWER	MAX CI BOUNDS UPPER	RELEASE NUMBER	NUMBER DETECTED LGR	NUMBER DETECTED MCN	IHR FLOW (KCFS)
*** SNAKE RIVER TRAP YEARLING CHINOOK ***										
4/9-4/11	04/10	04/18	04/30	12.3	9.1	17.2	177	71	18	66.4
4/16-4/19	04/19	04/24	05/09	14.5	12.8	15.8	298	113	35	63.7
4/20-4/21	04/21	04/27	05/11	14.2	11.1	17.0	299	118	38	74.7
4/22-4/23	04/23	04/30	05/12	12.4	10.2	16.2	297	128	29	81.4
4/24-4/26	04/25	05/04	05/16	11.8	8.8	14.7	333	149	32	85.1
*** CLEARWATER RIVER TRAP YEARLING CHINOOK ***										
3/30-4/1	03/31	04/21	05/10	19.3	12.3	24.6	450	137	24	67.1
4/2-4/3	04/02	04/20	05/08	17.5	12.6	22.8	300	88	30	62.9
4/4-4/6	04/05	04/24	05/10	16.3	8.1	23.4	450	126	24	67.1
4/7-4/9	04/08	04/24	05/10	15.5	10.0	19.8	446	137	35	67.1
4/10-4/12	04/11	04/24	05/10	16.4	12.7	22.9	453	130	33	67.1
4/13-4/15	04/14	05/03	05/14	11.4	3.2	16.5	450	149	38	85.5
4/16-4/20	04/17	04/28	05/11	13.3	7.4	17.7	397	133	24	74.7
5/17-5/20	05/19	05/26	06/04	8.7	6.8	10.1	513	142	24	105.1
5/21-5/22	05/21	05/26	06/03	8.0	6.5	9.2	302	95	19	105.1
5/23-5/25	05/24	05/29	06/05	6.7	4.8	8.6	402	134	29	105.3
*** SNAKE RIVER TRAP WILD STEELHEAD ***										
4/19-4/23	04/21	04/24	05/04	10.4	8.1	12.3	436	280	23	62.3
4/24-4/29	04/26	04/30	05/11	10.5	9.7	12.7	685	435	26	74.7

- Lower bound is the minimum difference between the 95% confidence intervals of individual travel time distributions at Lower Granite and McNary dams, i.e., MCN lower limit - LGR upper limit.
- Upper bound is the maximum difference between the 95% confidence intervals of individual travel time distributions at Lower Granite and McNary dams, i.e., MCN upper limit - LGR lower limit.
- Flow at Ice Harbor Dam is the average flow (kcfs) over the seven day period around the estimated date of median passage at Ice Harbor Dam.
- Distance from Lower Granite Dam to McNary Dam is 140 miles.

Table G-8. Travel time of PIT tagged yearling chinook smolts from Rock Island Dam to McNary Dam, 1990.

MULTI-DAY RELEASE	MEDIAN RELEASE	DATES RECAP	TRAVEL TIME (DAYS) MEDIAN	95% CI LIMITS LOWER	95% CI LIMITS UPPER	FISH NUMBER RELEASE	FISH NUMBER DETECTED	PERCENT DETECTED	PRD FLOW (KCFS)
	04/21	05/13	21.7	18.5	24.7	99	21	21%	151.9
	04/22	05/08	15.6	12.5	20.9	93	27	29%	155.6
	04/23	05/08	15.0	10.3	18.2	101	29	29%	154.6
	04/24	05/09	15.2	12.1	20.1	100	27	27%	151.9
	04/25	05/09	14.3	9.9	18.9	100	20	20%	151.2
	04/26	05/09	12.6	11.1	15.8	100	35	35%	151.2
	04/27	05/12	14.9	12.8	16.0	100	28	28%	155.8
	04/28	05/14	16.1	13.1	19.2	99	29	29%	166.2
	04/29	05/12	13.2	12.7	16.6	100	25	25%	166.2
	04/30	05/11	11.0	9.8	12.2	102	29	28%	166.2
	05/01	05/11	10.4	9.1	11.1	100	32	32%	171.6
	05/02	05/13	10.8	10.0	12.1	101	35	35%	169.9
	05/03	05/13	9.7	8.9	10.1	100	33	33%	169.9
	05/04	05/15	11.0	9.1	12.0	102	36	35%	152.1
	05/05	05/15	9.5	8.1	11.7	98	28	29%	152.1
	05/07	05/18	10.8	9.1	11.0	100	31	31%	136.4
	05/08	05/18	9.8	8.8	10.0	100	37	37%	136.4
5/9-5/10	05/09	05/19	9.5	8.7	10.0	200	31	16%	130.9
5/11-5/12	05/12	05/21	9.2	8.0	10.1	199	35	18%	146.7
5/13-5/14	05/14	05/24	9.5	7.7	10.0	199	26	13%	153.1
5/15-5/16	05/15	05/25	9.8	8.8	11.1	200	32	16%	152.3
5/17-5/19	05/17	05/25	8.1	7.7	10.1	194	25	13%	153.9
5/20-5/25	05/21	05/31	9.9	6.9	16.0	137	9	7%	143.4

- Flow at Priest Rapids Dam is the average flow (kcfs) over the seven day period around the estimated median date of passage.
- Distance from Rock Island Dam to McNary Dam is 161.4 miles.

Table G-9. Travel time of PIT tagged hatchery steelhead smolts from Rock Island Dam to McNary Dam, 1990.

MULTI-DAY RELEASE	MEDIAN RELEASE	DATES RECAP	TRAVEL TIME (DAYS) MEDIAN	95% CI LIMITS LOWER	95% CI LIMITS UPPER	FISH NUMBER RELEASE	FISH NUMBER DETECTED	PERCENT DETECTED	PRD FLOW (KCFS)
4/21-4/23	04/22	05/01	8.8	7.5	11.0	120	22	18%	157.8
4/24-4/25	04/25	05/04	9.2	7.5	10.4	114	30	26%	154.6
4/26-4/27	04/26	05/06	9.6	7.6	10.9	139	34	24%	151.9
4/28-4/29	04/28	05/06	7.5	6.6	8.4	127	33	26%	152.1
4/30-5/1	05/01	05/09	7.9	6.7	8.7	138	44	32%	166.2
5/2-5/3	05/02	05/09	7.0	6.2	7.9	143	43	30%	166.2
5/4-5/5	05/04	05/12	7.6	6.8	9.7	142	44	31%	162.3
5/7-5/8	05/07	05/17	9.8	8.8	10.8	139	41	29%	139.2
5/9-5/10	05/09	05/17	7.6	7.0	8.7	140	43	31%	130.9
5/11-5/12	05/11	05/19	7.7	7.3	8.7	142	38	27%	137.7
5/13-5/15	05/14	05/23	8.9	7.2	9.8	209	36	17%	153.1
5/16-5/18	05/17	05/26	8.6	7.5	9.5	209	34	16%	153.9
5/19-5/21	05/20	05/28	7.6	6.6	8.9	159	15	9%	143.7
5/22-5/25	05/23	05/31	8.0	7.6	9.8	179	11	6%	139.0

- Flow at Priest Rapids Dam is the average flow (kcfs) over the seven day period around the estimated median date of passage.
- Distance from Rock Island Dam to McNary Dam is 161.4 miles.

Table G-10. Travel time of PIT tagged wild steelhead smolts from Rock Island Dam to McNary Dam, 1990.

MULTI-DAY RELEASE	MEDIAN RELEASE	DATES RECAP	TRAVEL TIME (DAYS) MEDIAN	95% CI LIMITS LOWER	95% CI LIMITS UPPER	FISH NUMBER RELEASE	FISH NUMBER DETECTED	PERCENT DETECTED	PRD FLOW (KCFS)
4/21-24	04/23	05/01	7.6	6.9	9.6	91	25	27%	157.9
4/25-4/27	04/26	05/04	7.8	7.0	9.0	80	28	35%	151.9
4/28-5/2	04/29	05/07	8.0	6.8	9.5	71	23	32%	155.8
5/3-5/5	05/04	05/11	6.7	6.1	8.0	85	33	39%	169.9
5/7-5/9	05/08	05/16	7.8	7.3	8.8	85	29	34%	136.4
5/10-5/12	05/11	05/18	7.4	6.9	8.0	87	30	34%	137.7
5/13-5/16	05/14	05/25	10.5	8.6	11.4	121	30	25%	152.3
5/17-5/19	05/18	05/26	8.4	7.6	9.8	87	29	33%	153.6
5/20-5/23	05/22	05/30	7.7	6.9	8.9	112	16	14%	140.7
5/24-5/25	05/24	06/01	7.7	6.9	8.8	65	19	29%	140.8

- Flow at Priest Rapids Dam is the average flow (kcfs) over the seven day period around the estimated median date of passage.
- Distance from Rock Island Dam to McNary Dam is 161.4 miles.

Table G-11. Travel time of freeze branded yearling chinook and steelhead hatchery smolts from release to Lower Granite Dam, 1990.

	RELEASE			LOWER GRANITE DAM						
BRAND	SITE	NUMBER	DATE	PASSAGE INDEX	CODE	RECAPTURE DATE	RECAPTURE TTIME	LGR FLOW	MILES TO LGR	SPEED (MI/DAY)
		SNAKE RIVER YEARLING CHINOOK								
LA-T-1	SAWTOOTH H	19,875	03/17	1,522	D	04/22	36	68.6	465.8	12.9
LA-T-3	SAWTOOTH H	18,675	03/17	1,140	E	04/23	37	68.5	465.8	12.6
LA-T-4	SAWTOOTH H	18,775	03/17	890	E	04/20	34	65.9	465.8	13.7
LD-T-1	SF SALMON R	20,200	03/21	329	E	05/25	65	60.0	287.9	4.4
LD-T-3	SF SALMON R	21,100	03/22	402	E	05/20	59	43.5	287.9	4.9
LD-T-4	SF SALMON R	20,900	03/22	442	E	05/19	58	44.1	287.9	5.0
RA-T-1	RAPID RIVER H	20,600	03/24 •	4,124	B	04/22	29	68.6	174.0	6.0
RA-T-2	RAPID RIVER H	20,175	03/24 *	4,515	B	04/22	29	68.6	174.0	6.0
RA-T-3	RAPID RIVER H	19,975	03/24 •	4,215	C	04/22	29	68.6	174.0	6.0
LD-7U-1	DWORSHAK H	19,730	04/05	4,554	B	05/06	31	70.2	72.5	2.3
RA-7U-1	DWORSHAK H	20,239	04/05	4,922	B	04/29	24	61.1	72.5	3.0
RA-7U-3	DWORSHAK H	19,900	04/05	5,500	B	04/25	20	67.1	72.5	3.6
LA-A-2	LOOKINGGLASS H	20,406	04/02	4,443	B	04/17	15	59.5	148.6	9.9
LA-A-4	LOOKINGGLASS H	20,738	04/02	4,038	B	04/19	17	64.4	148.6	8.7
RA-A-2	LOOKINGGLASS H	20,841	04/02	4,511	B	04/20	18	65.9	148.6	8.3
RA-A-4	LOOKINGGLASS H	20,801	04/02	4,382	B	04/18	16	62.4	148.6	9.3
LA-A-1	IMNAHA AP	20,815	03/30 *	2,864	C	04/23	24	68.5	133.8	5.6
RA-A-1	IMNAHA AP	20,170	03/30 *	5,259	B	04/23	24	68.5	133.8	5.6
		SNAKE RIVER STEELHEAD								
LA-PP-1	SAWTOOTH H	39,454	04/12 •	5,581	A	05/26	44	66.6	465.8	10.6
RA-PP-1	EF SALMON R	40,907	04/14	5,899	B	05/27	43	76.7	441.8	10.3
RA-Z-1	DWORSHAK H	30,000	05/03	12,066	A	05/11	8	84.5	72.5	9.1
RA-T-1	DWORSHAK H	30,000	05/04	11,150	A	05/11	7	84.5	72.5	10.4
LA-IC-4	ASOTIN CR	19,457	04/17	13,020	A	04/23	6	68.5	38.5	6.4
RA-IC-4	ASOTIN CR	18,793	04/18	12,166	A	04/25	7	67.1	38.5	5.5
LD-A-1	WALLOWA AP	24,233	04/17 *	8,057	A	05/05	18	66.2	182.6	10.1
LD-A-3	WALLOWA AP	24,903	04/17 *	5,786	B	05/03	16	61.1	182.6	11.4
RD-A-1	WALLOWA AP	25,478	04/17 •	6,843	B	05/04	17	62.4	182.6	10.7
RD-A-3	WALLOWA AP	25,426	04/17 *	6,292	B	05/04	17	62.4	182.6	10.7
LD-A-2	SPRING CR CHNL	24,569	04/19	4,777	B	05/05	16	66.2	182.6	11.4
RD-A-2	SPRING CR CHNL	24,228	04/19	6,174	A	05/06	17	70.2	182.6	10.7
LD-A-4	WILDCAT CR	24,739	04/25 *	5,502	B	05/05	10	66.2	114.5	11.5
RD-A-4	WILDCAT CR	22,983	04/25 •	6,968	A	05/07	12	74.4	114.5	9.5
LD-J-3	LI SHEEP CR	26,522	04/16 •	2,199	C	05/06	20	70.2	122.0	6.1
RD-J-3	LI SHEEP CR	24,500	04/16 •	2,408	C	05/01	15	61.1	122.0	8.1

- Release sites are designated H for on-site hatchery release and AP for on-site acclimation pond release. The remaining are stream releases from McCall H (SF Salmon R), Magic Valley H (Sawtooth H and EF Salmon R), Lyons Ferry H (Asotin Cr), Irrigon H (Spring Cr and Wildcat Cr), and Wallowa AP (Little Sheep Cr).
- An asterick designates a release made over a number of days for which an estimated median release date is shown. Release period of 5 days at Rapid River H; 2 days at Imnaha Ap, Sawtooth H, and Little Sheep Cr; and 3 days at Wildcat Cr.
- Code designates range for number of branded fish observed in sample: $A \geq 200$; $100 \leq B < 200$; $50 \leq C < 100$; $30 \leq D < 50$; and $E < 30$.
- TTIME is estimated median travel time in days.
- Flow at Lower Granite Dam is average flow (kcfs) over the seven day period around the estimated median date of passage.
- Use the distances reported here between release site and Lower Granite Dam to correct distances, and resulting migration speeds, used in previous annual reports before making comparisons with 1990 migration speeds.

Table G-12. Travel time of freeze branded yearling chinook and steelhead hatchery smolts from Lower Granite Dam to McNary Dam, 1990.

	RELEASE			LOWER GRANITE DAM			MCNARY DAM			INDEX	
BRAND	SITE	NUMBER	DATE	PASSAGE INDEX	CODE	MEDIAN DATE	PASSAGE INDEX	CODE	MEDIAN DATE	TRAVEL TIME	IHR FLOW
				SNAKE RIVER YEARLING CHINOOK							
LA-T-1	SAWTOOTH H	19,875	03/17	1,522	D	04/22	403	D	05/03	11	61.9
LA-T-3	SAWTOOTH H	18,675	03/17	1,140	E	04/23	509	D	05/05	12	62.3
LA-T-4	SAWTOOTH H	18,775	03/17	890	E	04/20	300	E	05/01	11	64.1
LD-T-1	SF SALMON R	20,200	03/21	329	E	05/25	478	E	06/01	7	97.0
LD-T-3	SF SALMON R	21,100	03/22	402	E	05/20	557	D	05/31	11	86.6
LD-T-4	SF SALMON R	20,900	03/22	442	E	05/19	494	E	06/01	13	86.6
RA-T-1	RAPID RIVER H	20,600	03/24 •	4,124	B	04/22	1,284	C	05/05	13	62.3
RA-T-2	RAPID RIVER H	20,175	03/24 *	4,515	B	04/22	1,309	C	05/08	16	61.0
RA-T-3	RAPID RIVER H	19,975	03/24 •	4,215	C	04/22	1,507	B	05/04	12	61.9
LD-7U-1	DWORSHAK H	19,730	04/05	4,554	B	05/06	1,234	C	05/19	13	67.4
RA-7U-1	DWORSHAK H	20,239	04/05	4,922	B	04/29	1,371	C	05/16	17	85.5
RA-7U-3	DWORSHAK H	19,900	04/05	5,500	B	04/25	1,401	C	05/11	16	70.7
LA-A-2	LOOKINGGLASS H	20,406	04/02	4,443	B	04/17	1,672	B	05/05	18	61.9
LA-A-4	LOOKINGGLASS H	20,738	04/02	4,038	B	04/19	1,862	B	05/04	15	62.1
RA-A-2	LOOKINGGLASS H	20,841	04/02	4,511	B	04/20	1,809	B	05/04	14	61.9
RA-A-4	LOOKINGGLASS H	20,801	04/02	4,382	B	04/18	1,837	B	05/04	16	62.1
LA-A-1	IMNAHA AP	20,815	03/30 •	2,864	C	04/23	1,836	B	05/10	17	67.1
RA-A-1	IMNAHA AP	20,170	03/30 *	5,259	B	04/23	1,748	B	05/09	16	63.7
				SNAKE RIVER STEELHEAD							
"A"	GRANDE RONDE R	196,559	4/19-4/25	50,399	A	05/05	1,556	C	05/19	14	67.4

- Release sites are designated H for on-site hatchery releases and AP for on-site acclimation pond releases. The remaining include stream releases from McCall H (SF Salmon R) and a pooling of eight ODFW brand groups released at Wallowa AP, Spring Creek channel and Wildcat Creek into a Grande Ronde River drainage group.
- An asterick designates a release made over a number of days for which an estimated median release date is shown. Release period of 5 days at Rapid River H; and 2 days at Imnaha AP.
- Code designates range for number of branded fish observed in sample: $A \geq 200$; $100 \leq B < 200$; $50 \leq C < 100$; $30 \leq D < 50$; and $E < 30$.
- TTIME is estimated median travel time in days.
- Flow at Ice Harbor Dam is average flow (kcfs) over the seven day period around the estimated median date of passage.
- Distance from Lower Granite Dam to McNary Dam is 140 miles.

Table G-13. Travel time of freeze branded steelhead and subyearling chinook hatchery smolts from release in the lower Snake River drainage (below Little Goose Dam) to McNary Dam, 1990.

	RELEASE				MCNARY DAM					
				PASSAGE		RECAPTURE		IHR	MILES TO	SPEED
BRAND	SITE	NUMBER	DATE	INDEX	CODE	DATE	TTIME	FLOW	MCNARY	(MI/DAY)
		LOWER SNAKE RIVER SUBYEARLING CHINOOK								
RA-UL-1	LYONS FERRY H	39,196	06/06	3,391	B	06/30	24	66.6	91.4	3.8
RA-UL-3	LYONS FERRY H	39,504	06/06	3,962	B	06/29	23	69.2	91.4	4.0
		LOWER SNAKE RIVER STEELHEAD								
LA-IC-1	TUCANNON AP	19,352	NA •	6,062	A	05/16	NA	NA	134.5	NA
RA-IC-1	TUCANNON AP	19,483	NA *	6,339	A	05/17	NA	NA	134.5	NA
LA-IC-2	TUCANNON R	19,219	04/25	3,219	A	05/12	17	70.7	111.5	6.6
RA-IC-2	TUCANNON R	18,853	04/25	4,055	A	05/11	16	67.1	111.5	7.0
LA-IC-3	LYONS FERRY H	17,170	04/27	4,901	A	05/11	14	67.1	91.4	6.5
RA-IC-3	LYONS FERRY H	20,327	04/27	5,268	A	05/12	15	67.1	91.4	6.1

- Release sites are designated H for on-site hatchery releases and AP for on-site acclimation pond releases. The remaining are stream releases from Lyons Ferry H in the Tucannon River at Marengo.
- An asterick designates a release made over a number of days for which an estimated median release date is shown. Release period of 16 days for Tucannon AP, which is too long for reliable median.
- Code designates range for number of branded fish observed in sample: A≥200; 100≤B<200; 50≤C<100; 30≤D<50; and E<30.
- TTIME is estimated median travel time in days.
- Flow at Ice Harbor Dam is average flow (kcfs) over the seven day period around the estimated median date of passage at this site.

Table G-14. Travel time of freeze branded chinook and steelhead hatchery smolts in Mid-Columbia River drainage from release to McNary Dam, 1990.

	RELEASE			MCNARY DAM						
BRAND	SITE	NUMBER	DATE	PASSAGE INDEX	SAMPLE CODE	RECAPTURE DATE	RECAPTURE TTIME	PRD FLOW	MILES TO MCNARY	SPEED (MI/DAY)
		MID-COLUMBIA RIVER YEARLING CHINOOK								
LD-7C-1	WINTHROP H	14,143	04/17	1,663	C	05/18	31	169.9	282.0	9.1
RA-7C-1	WINTHROP H	16,745	04/17	2,816	B	05/18	31	169.9	282.0	9.1
RA-7C-3	WINTHROP H	16,261	04/17	2,954	B	05/17	30	169.9	282.0	9.4
RA-7N-1	ENTIAT H	17,152	04/19	3,811	A	05/09	20	151.9	202.3	10.1
RA-7N-3	ENTIAT H	16,791	04/19	4,505	A	05/09	20	151.9	202.3	10.1
LA-7T-1	LEAVENWORTH H	16,785	04/18	4,416	A	05/15	27	152.1	204.6	7.6
LA-7T-3	LEAVENWORTH H	15,572	04/18	4,522	A	05/14	26	152.1	204.6	7.9
RD-7T-1	LEAVENWORTH H	15,521	04/18	4,029	A	05/14	26	152.1	204.6	7.9
RA-Y-1	LEAVENWORTH H	12,400	05/04	2,401	B	05/21	17	130.9	204.6	12.0
RA-Y-2	LEAVENWORTH H	12,100	05/04	2,806	B	05/22	18	133.1	204.6	11.4
RA-Y-3	LEAVENWORTH H	13,100	05/04	2,844	B	05/22	18	133.1	204.6	11.4
RA-Y-4	LEAVENWORTH H	14,200	05/04	2,532	B	05/21	17	130.9	204.6	12.0
LA-7S-1	RINGOLD H	19,711	03/31 •	8,132	A	04/08	8	150.7	56.0	7.0
LA-7S-3	RINGOLD H	20,125	03/31 •	8,785	A	04/07	7	151.9	56.0	8.0
		MID-COLUMBIA RIVER SUBYEARLING CHINOOK								
LA-H-1	WELLS H	46,425	05/23 *	2,814	B	07/02	40	240.0	223.6	5.6
LA-H-2	WELLS H	46,276	05/23 *	2,804	B	07/01	39	240.0	223.6	5.7
RA-H-1	PRIEST RAPIDS H	37,392	06/07	11,468	A	06/20	13	205.3	105.1	8.1
RA-H-2	PRIEST RAPIDS H	37,121	06/10	10,696	A	06/21	11	199.7	105.1	9.6
RD-H-1	PRIEST RAPIDS H	38,717	06/13	7,530	A	06/24	11	208.7	105.1	9.6
RA-UP-3	PRIEST RAPIDS H	39,924	06/16	13,958	A	06/26	10	225.1	105.1	10.5
RA-UP-1	PRIEST RAPIDS H	39,904	06/19	12,399	A	06/28	9	210.6	105.1	11.7
		MID-COLUMBIA RIVER STEELHEAD								
LD-7H-1	SIMILKAMEEN R	19,855	04/24 *	5,823	A	05/16	22	144.7	315.6	14.3
LD-7H-3	SIMILKAMEEN R	18,868	04/24 *	5,300	A	05/16	22	144.7	315.6	14.3
RA-7H-1	METHOW R	14,716	04/26	2,855	B	05/12	16	171.6	241.9	15.1
RA-7H-3	METHOW R	14,793	04/25 *	2,829	B	05/11	16	166.2	241.9	15.1
LA-S-1	TOUCHET AP	19,039	NA •	4,014	A	05/15	NA	NA	98.2	NA
RA-S-1	TOUCHET AP	18,870	NA *	3,557	A	05/12	NA	NA	98.2	NA
LA-S-2	WALLA WALLA R	19,168	04/24	2,708	B	05/18	24	NA	39.0	1.6
RA-S-2	WALLA WALLA R	19,094	04/25	2,644	B	05/16	21	NA	39.0	1.9

- Release sites are designated H for on-site hatchery releases and AP for on-site acclimation pond releases. The remaining are stream releases from Lyons Ferry H (Walla Walla R) and Wells Hatchery (Methow R and Similkameen R).
- An asterick designates a release made over a number of days for which an estimated median release date is shown. Release period of 8 days at Ringold H; 4 days at Wells H; 2 days for Similkameen and Methow rivers; and 16 days at Touchet AP, which is too long for reliable median.
- Code designates range for number of branded fish observed in sample: $A \geq 200$; $100 \leq B < 200$; $50 \leq C < 100$; $30 \leq D < 50$; and $E < 30$.
- TTIME is estimated median travel time in days.
- Flow at Priest Rapids Dam is average flow (kcfs) over the seven day period around the estimated median date of passage at this site.
- Flow for Ringold and Priest Rapids hatcheries is average of Priest Rapids Dam flow for release date and subsequent three days after release.

Table G-15. Travel time of freeze branded yearling chinook and steelhead smolts from McNary Dam (site of marking and release) to John Day Dam, 1990.

BRAND GROUP	RELEASE DATES ACTUAL	RELEASE DATES USED	RELEASE NUMBER ACTUAL	RELEASE NUMBER USED	JOHN DAY DAM SAMPLE NUMBER	JOHN DAY DAM PASSAGE INDEX	JOHN DAY DAM RECOVERY PERCENT	TRAVEL TIME MEDIAN	TRAVEL TIME 95% CI	JDA FLOW
					YEARLING CHINOOK					
"IX"	4/9-4/13	4/11-4/13	2,884	1,447	6	82	5.7%	NA	NA	NA
"10"	4/30-5/4	SAME	5,881	5,881	36	502	8.5%	5.3	4.5-7.5	234.4
"15"	5/7-5/11	SAME	5,900	5,900	31	409	6.9%	5.3	3.5-7.5	231.8
"ID"	5/14-5/18	SAME	5,900	5,900	24	293	5.0%	5.2	3.5-9.5	195.6
"IF"	5/21-5/25	5/21	5,179	1,180	9	112	9.5%	NA	NA	NA
					STEELHEAD					
"13"	4/30-5/5	SAME	6,000	6,000	53	731	12.2%	4.0	2.5-5.5	234.5
"17"	5/6-5/11	SAME	3,925	3,925	37	483	12.3%	4.5	2.5-7.5	230.1
"IV"	5/14-5/18	SAME	4,334	4,334	45	554	12.8%	4.6	3.5-6.5	193.0
"15"	5/21-5/25	5/21	1,506	357	4	49	13.7%	NA	NA	NA
"IM"	5/28-6/1	NONE	4,430	0	0	0	NA	NA	NA	NA

- Sample number, passage index, and recovery percent based on fish released during the "used" dates. Outages in Unit 5 precluded using data from releases made before April 11 and after May 21.

- NA designates that data is not available, because too few marked fish were recovered for estimation of median travel time. For these weeks, the range of the individual smolt travel times are shown below.

  (1) yearling chinook: "IX" 11.5-22.5 days;
  "IF" 3.5-6.5 days;
  (2) steelhead: "15" 3.5-6.5 days;
  "IM" had no recovered at John Day Dam.

- Distance from McNary Dam to John Day Dam is 76.4 miles.

- Flow at John Day Dam is computed in two steps: Initially, an average flow is computed over a period of days equal to the overall travel time estimate, beginning the midnight subsequent to each daily release. Finally, a weighted average, using number released each day as the weight, of these average flows is computed to represent the index reach flow for a particular week's marked group.

APPENDIX H: 1990 Migration Timing Plots and Smoltification Development (ATPase) Plots

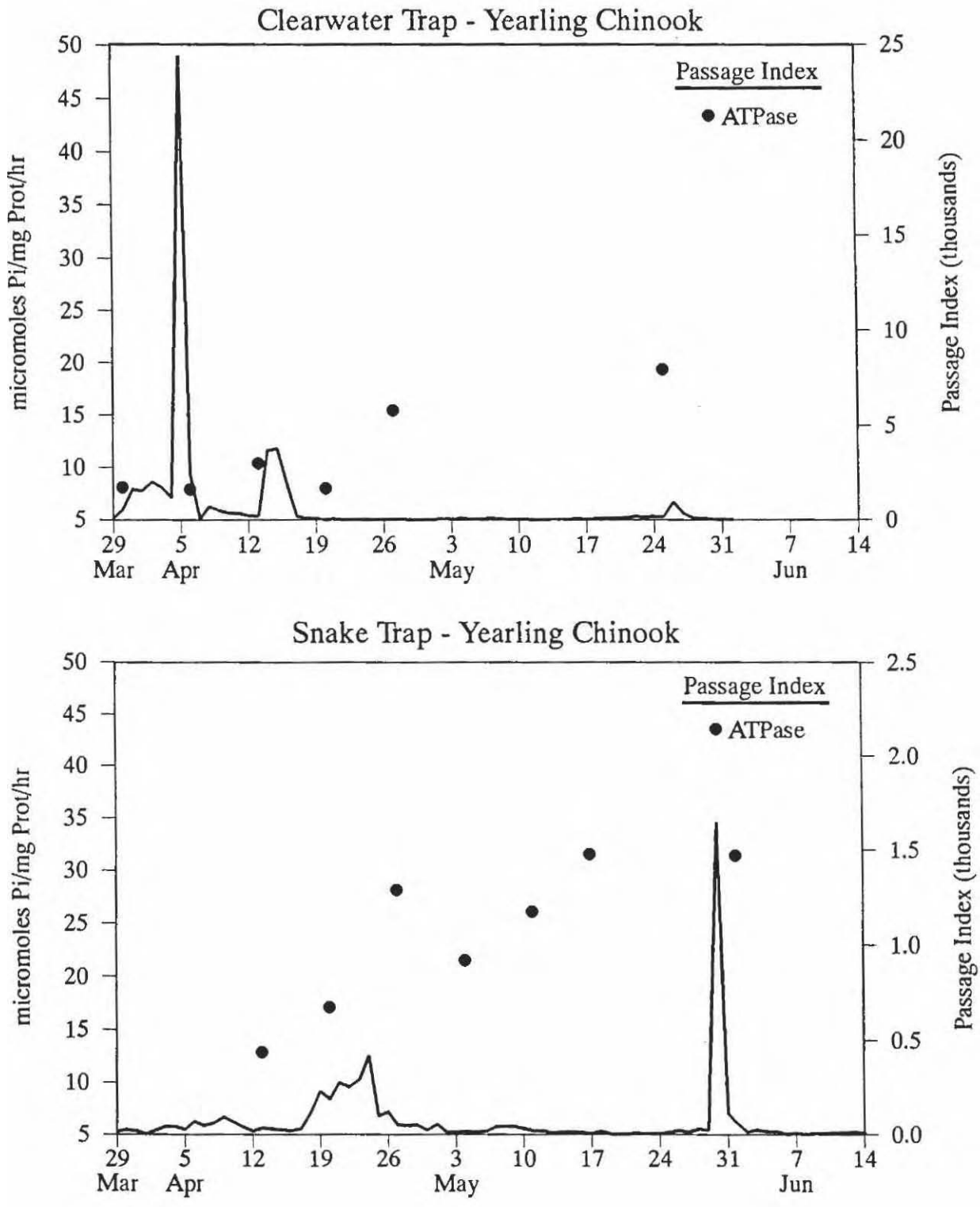


Figure H-1. Yearling chinook migration timing and smoltification development (ATPase) at the Idaho traps.

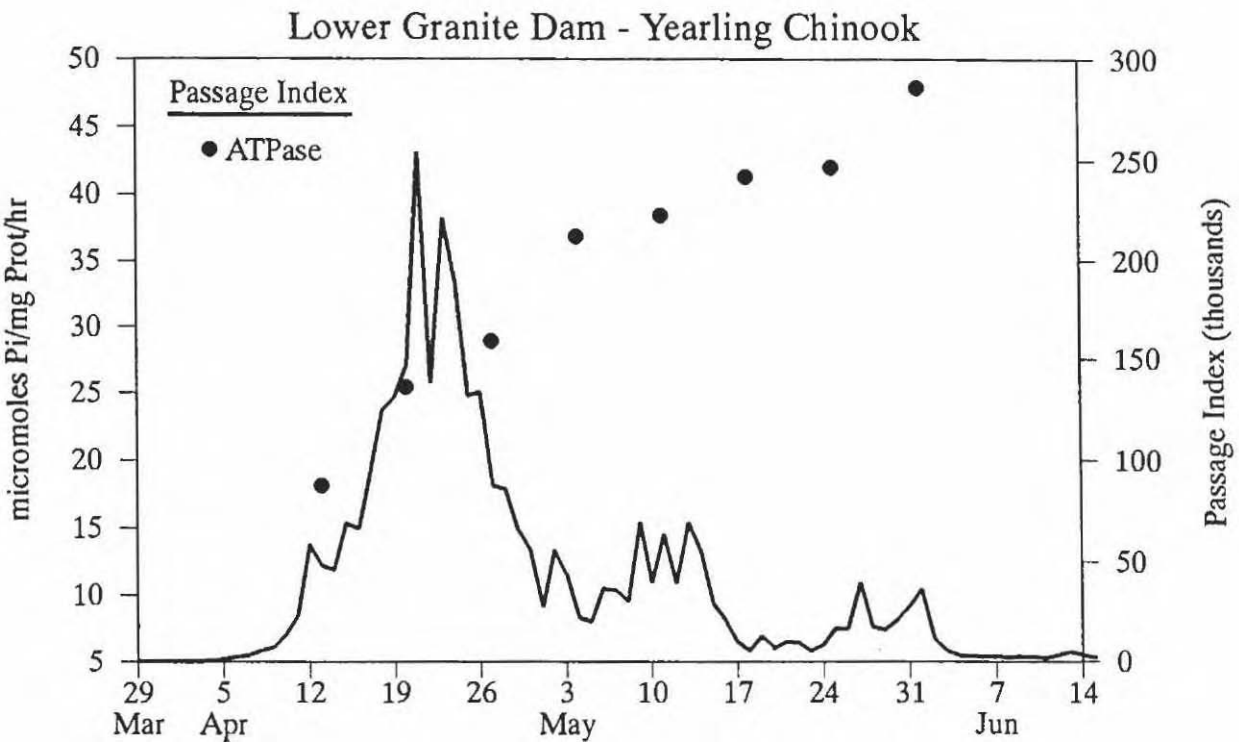


Figure H-2. Yearling chinook migration timing and smoltification development (ATPase) at Lower Granite Dam.

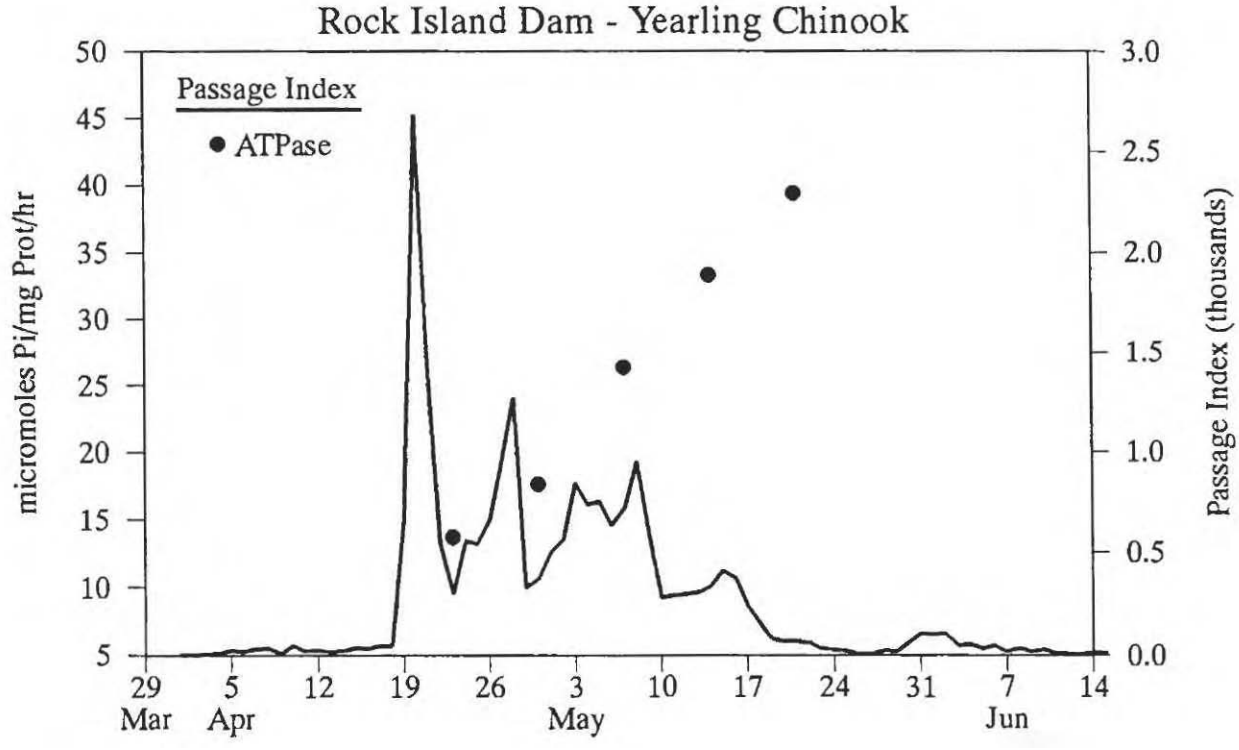


Figure H-3. Yearling chinook migration timing and smoltification development at Rock Island Dam.

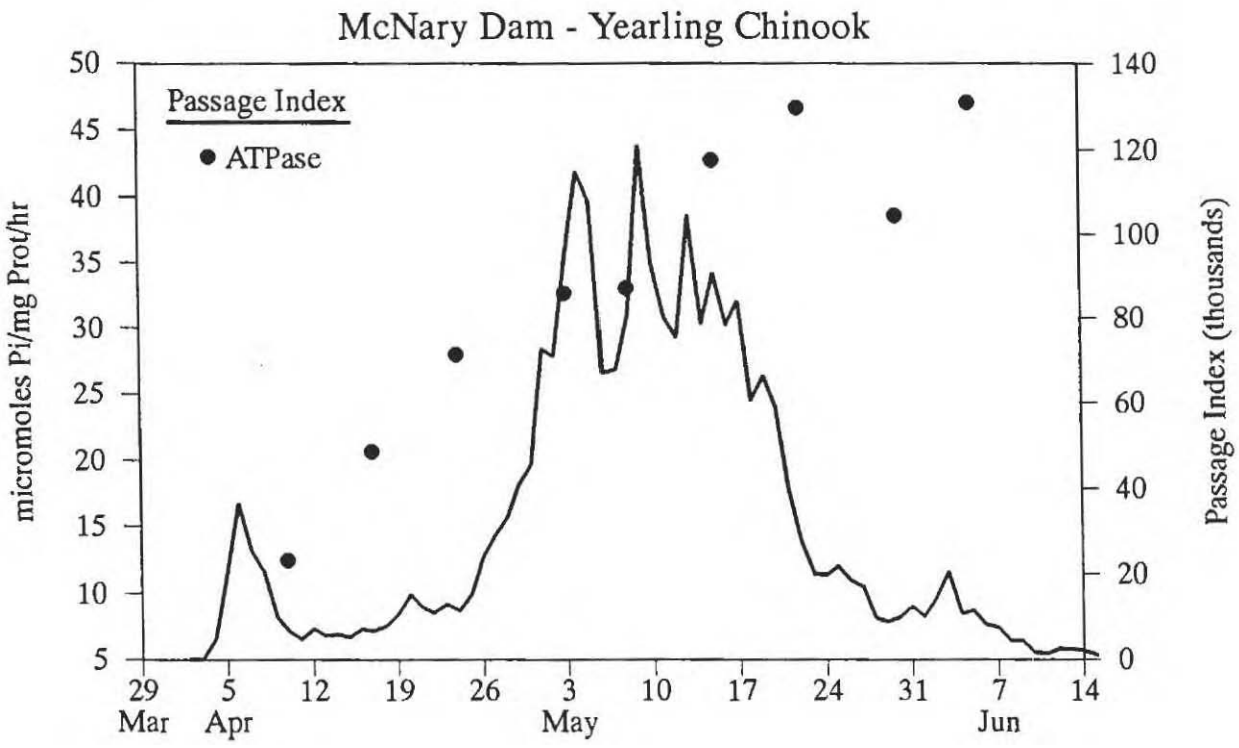


Figure H-4. Yearling chinook migration timing and smoltification development (ATPase) at McNary Dam.

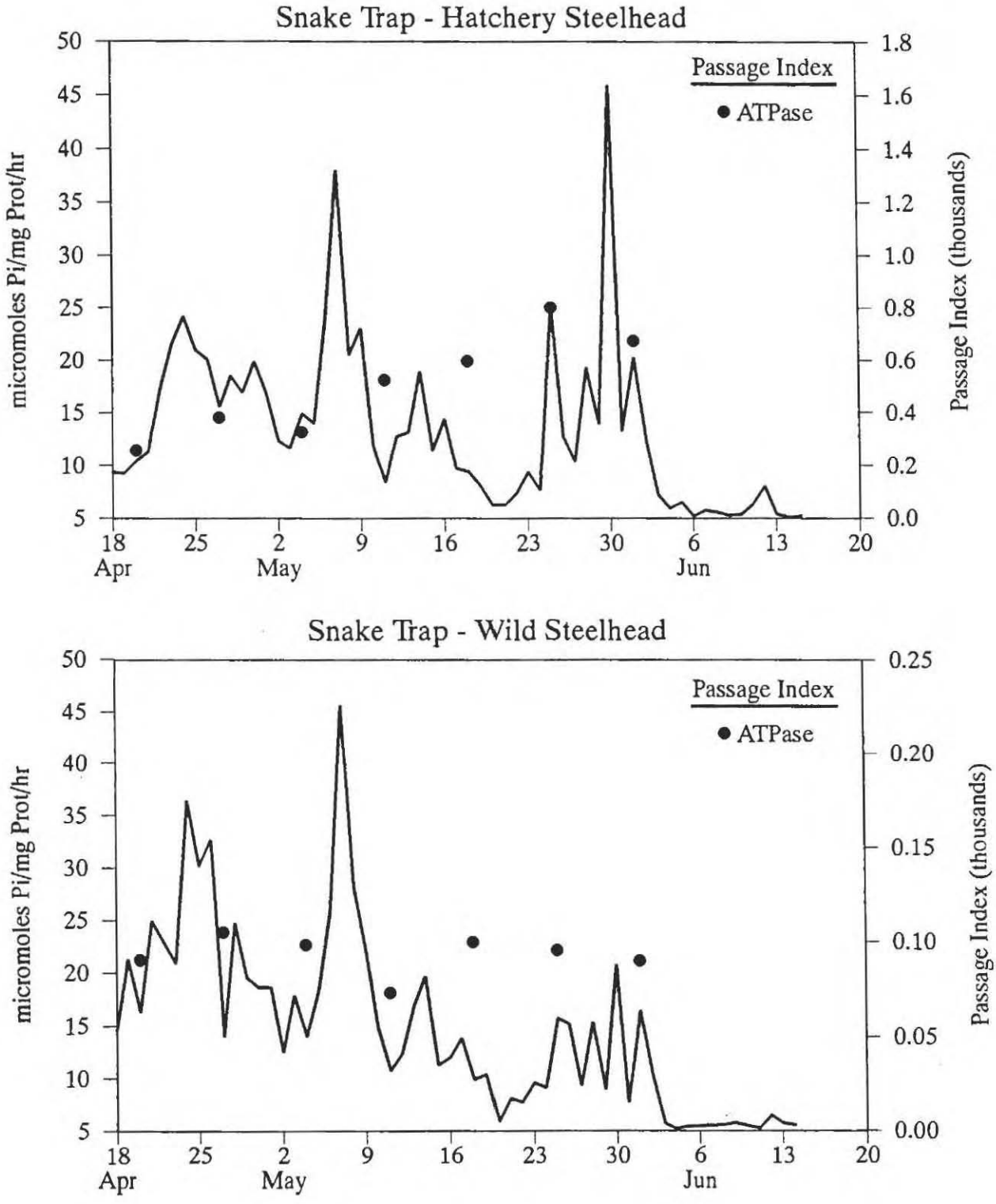
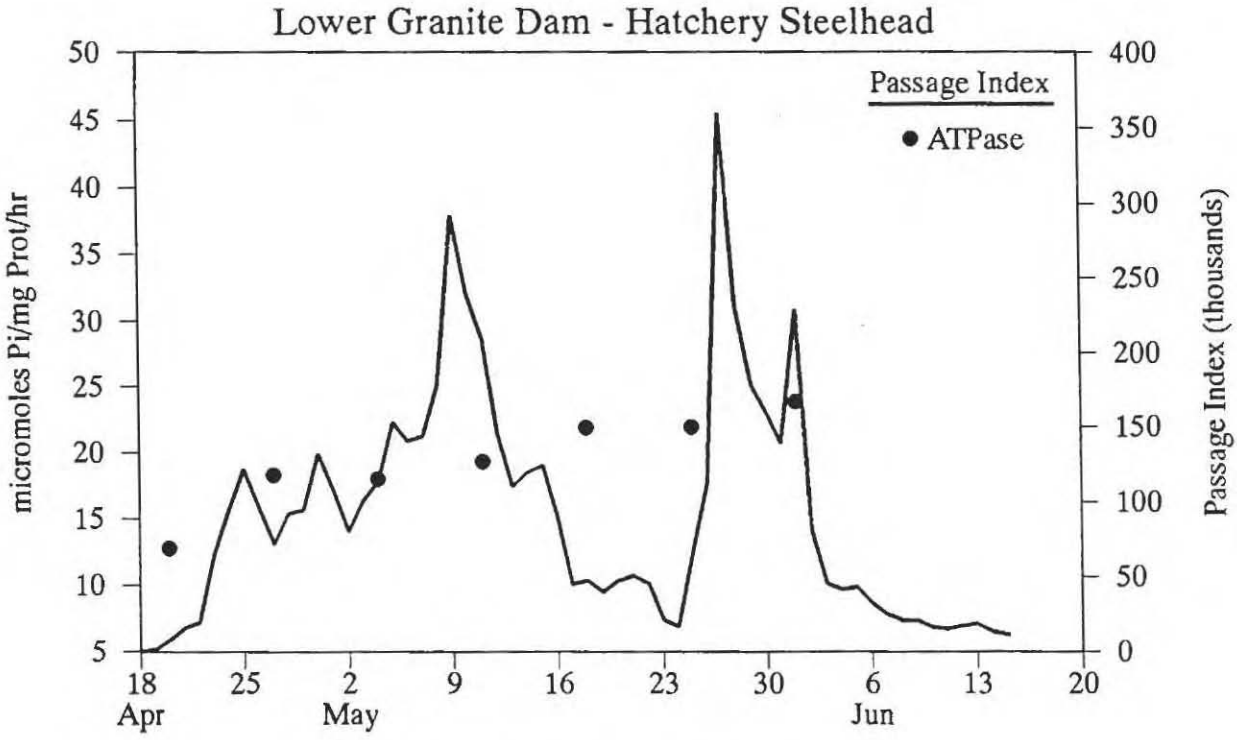


Figure 11-5. Steelhead migration timing and smoltification development (ATPase) at the Snake River (Lewiston) trap.



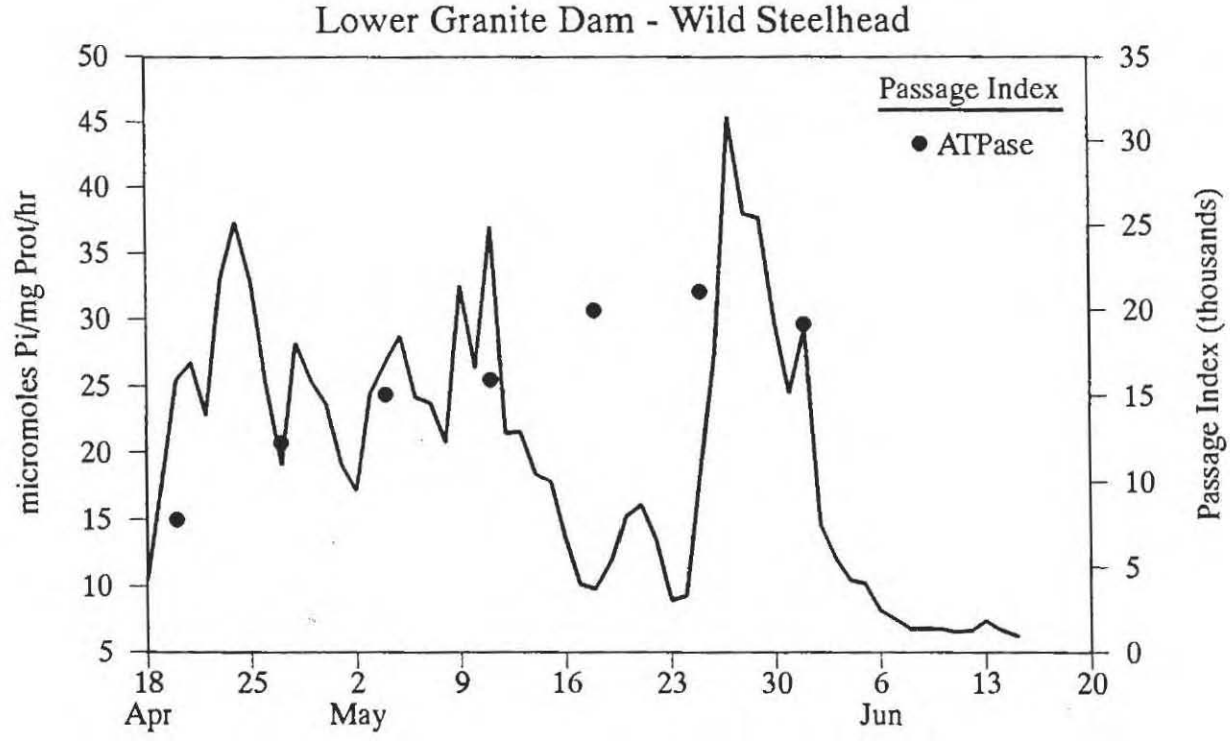


Figure H-6. Steelhead migration timing and smoltification development (ATPase) at Lower Granite Dam.

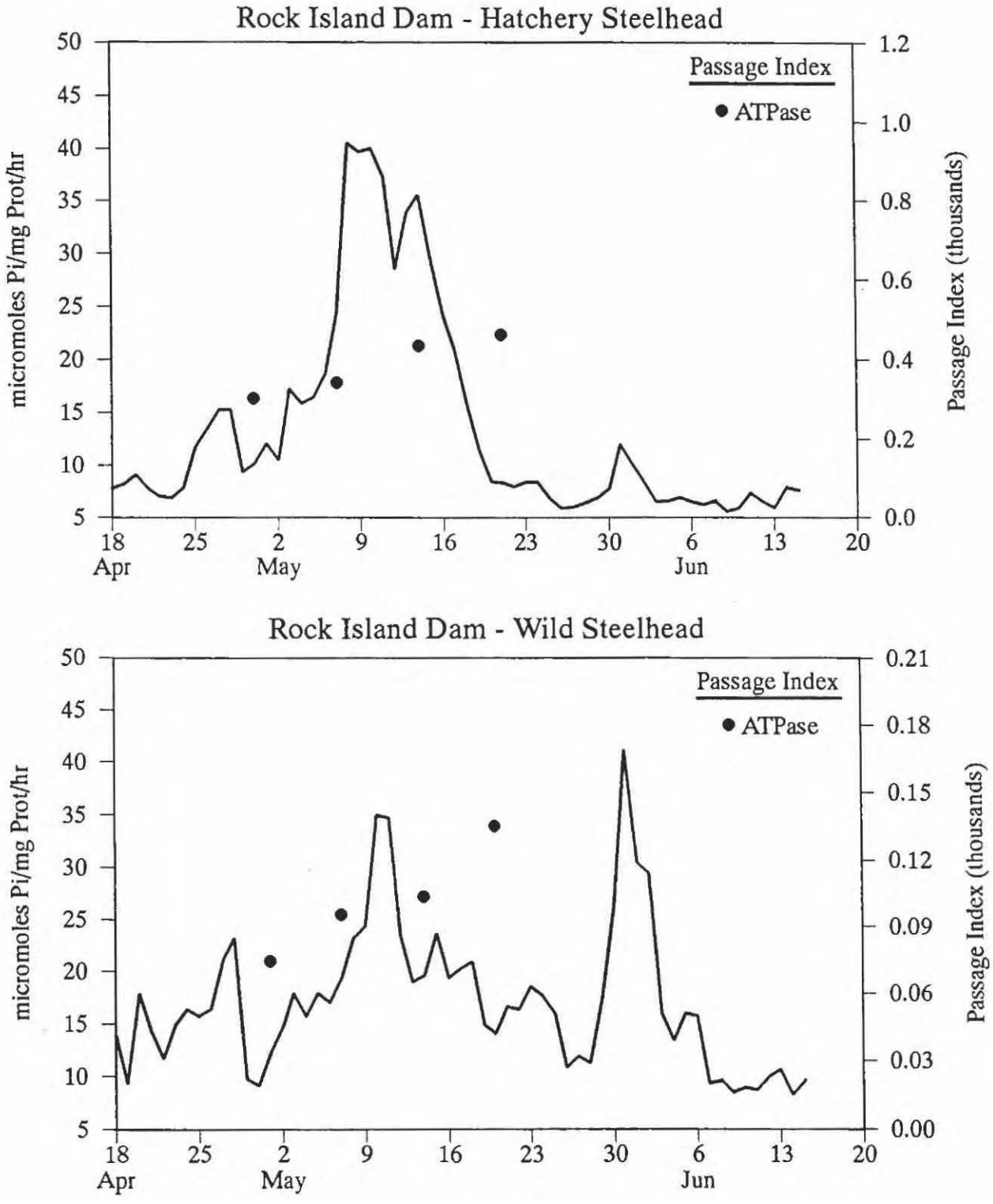


Figure H-7. Steelhead migration timing and smoltification development (ATPase) at Rock Island Dam.

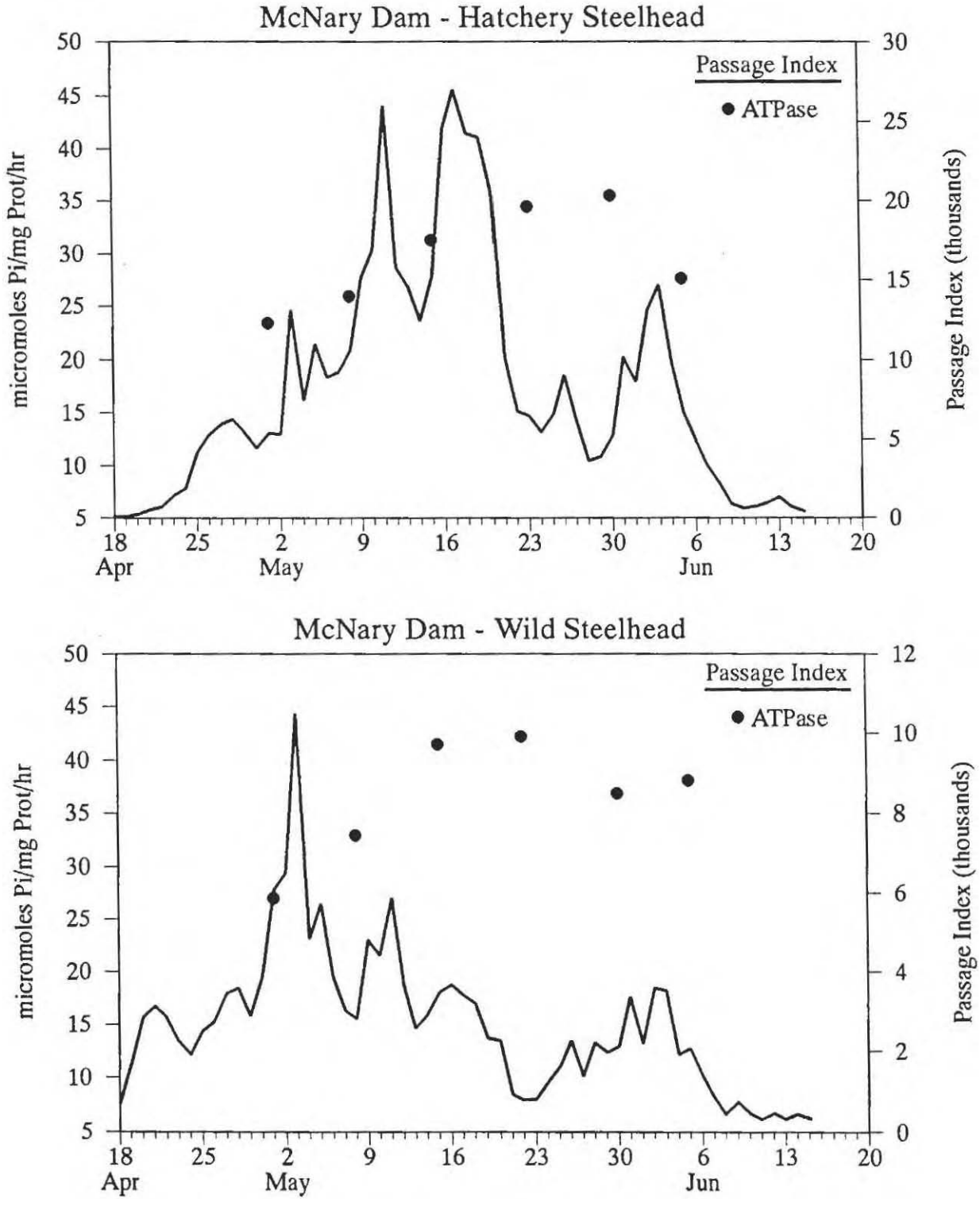


Figure H-8. Steelhead migration timing and smoltification development (ATPase) at McNary Dam.

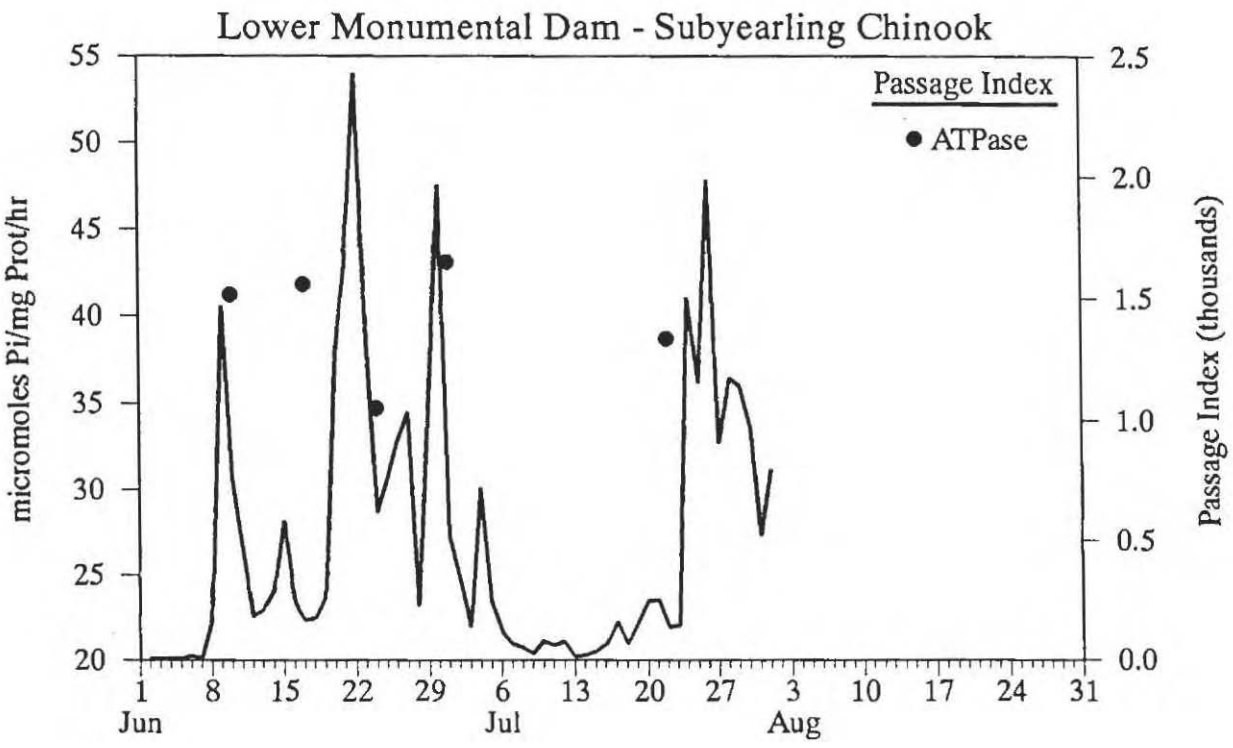


Figure H-9. Subyearling chinook migration timing and smoltification development (ATPase) at Lower Monumental Dam.

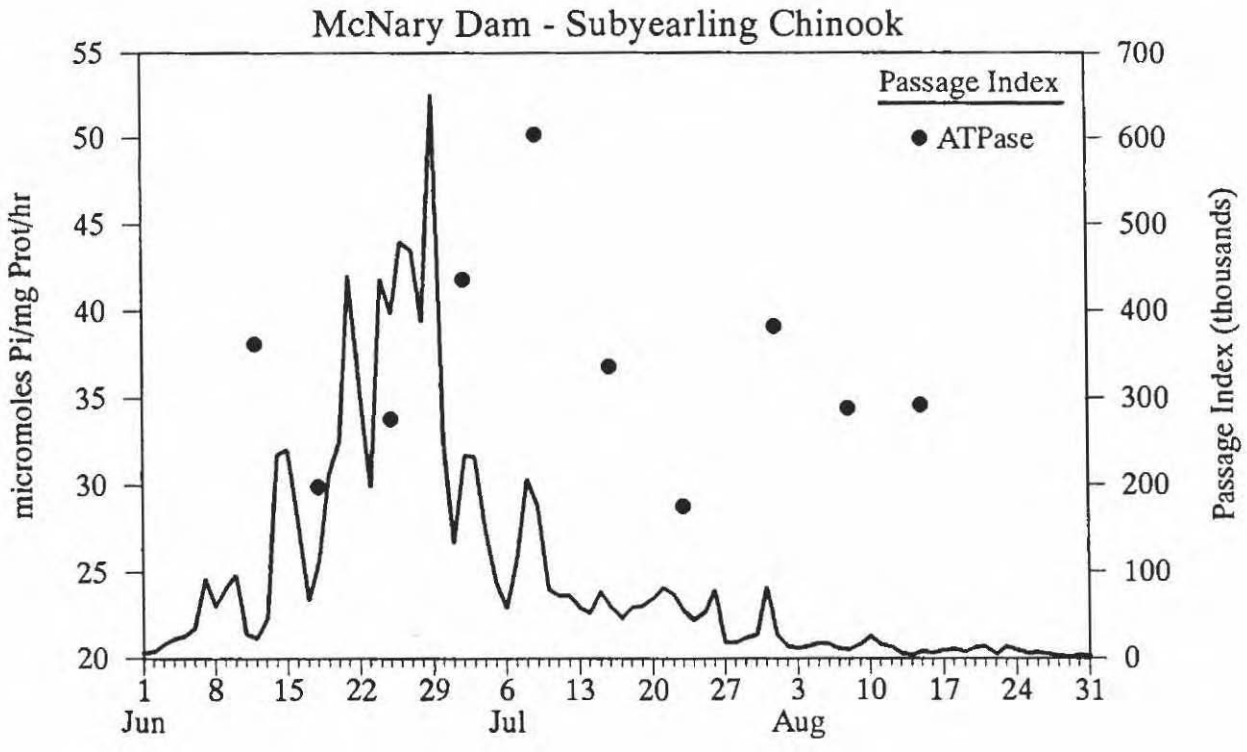


Figure H-10. Subyearling chinook migration timing and smoltification development (ATPase) at McNary Dam.

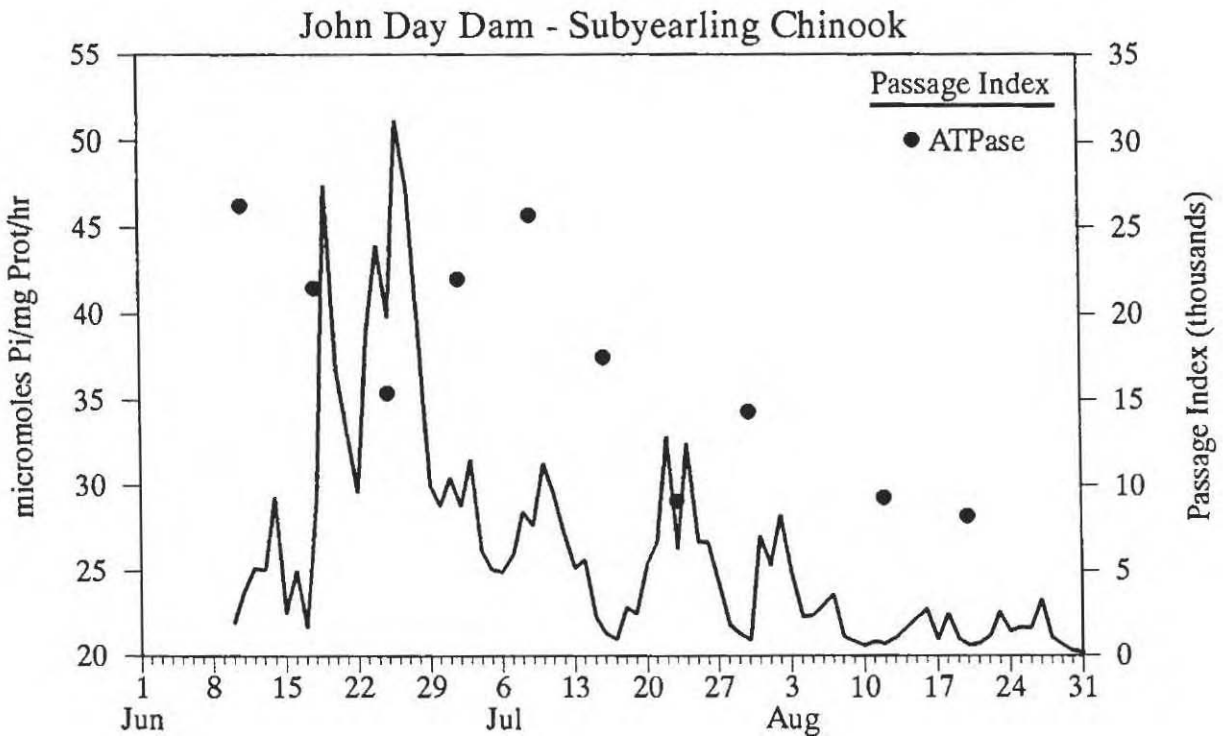


Figure H-11. Subyearling chinook migration timing and smoltification development (ATPase) at John Day Dam.

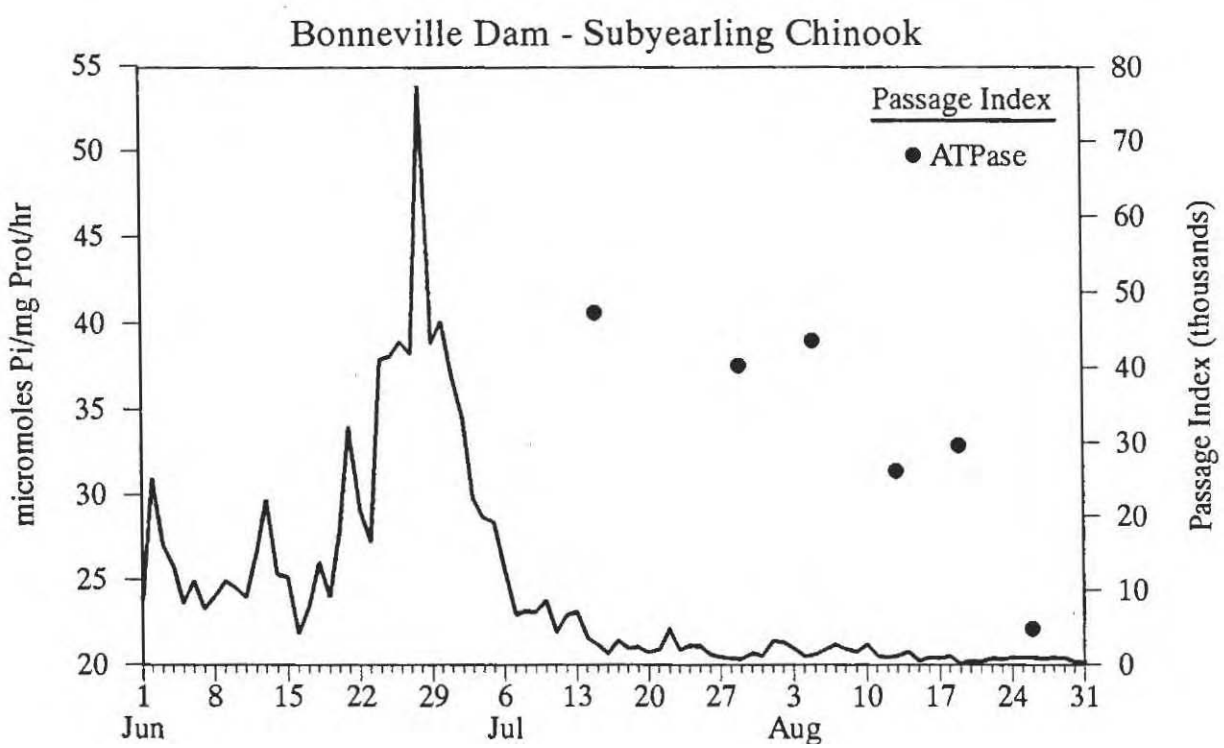


Figure H-12. Subyearling chinook migration timing and smoltification development (ATPase) at Bonneville Dam Powerhouse One.

APPENDIX I: 1990 Columbia River Hatchery Releases

```
Prog1  WRC602 1              FISH PASSAGE DATA SYSTEM          Workstation W1
 8.39.49              * H a t c h e r y   R e l e a s e s  *        6/10/91

                      1. Report Date........                 6/10/91

                      2. Include from Starting date          9/01/89
                         to Ending date                     12/31/90

                      3. Include Migration Year             00 - 00

                      4. Specific Agency - Hatchery

                      5. Specific Race and Species

                      6. Specific River/Rive Zone

                      7. Specific Release Site

                      8. Include Non-Hatchery               Y

                      9. Include Below Bonneville           N


                         Cmd-5  Job Jobqueued
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* These data are preliminary and have been derived from various sources. For *
* verification and/or origin of data, contact the operators of the Fish Passage Data *
* System at (503) 230-4289. *
****

FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
FPC	NON-HATCHERY	GP CHINOOK 1	89	18	90	4/09/90 5/25/90	29,500	BELOW MCN DAM	LOWER COLUMBIA	LCOL	90511	26K FB
		SU STEELHEAD	89	5	90	4/30/90 6/05/90	30,191	BELOW MCN DAM	LOWER COLUMBIA	LCOL	90512	20K FB
*				HATCHERY TOTAL.			59,691	FROM 2 RELEASES				*
**				AGENCY TOTAL....			59,691	FROM 2 RELEASES				**

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*****************************************************************************
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* verification and/or origin of data, contact the operators of the Fish Passage Data *
* System at (503) 230-4209.                                                   *
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FROM 9/01/89 TO 12/31/90

AGCY HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
IDFG MAGIC VALLEY	SU STEELHEAD B	89	61	90	9/11/89 9/12/89	163,000	SLATE CR	SALMON R	SNAK	90312	EXCESS PLANT
	SU STEELHEAD A	89	4	90	4/05/90 4/21/90	1,198,700	SAWTOOTH	SALMON R	SNAK	90315	45K CWT 10-40-59; 40K FB
	SU STEELHEAD B	89	5	90	4/09/90 4/23/90	924,200	E F SALMON R	E F SALMON R	SNAK	90316	120K CWT 10-42-33..38, 10-40-58; 41K FB
*			HATCHERY TOTAL.			2,285,900	FROM 3 RELEASES				*
MCCALL	SU CHINOOK 1 SOUTH FORK	88	21	90	3/16/90 3/22/90	1,032,500	S F SALMON R	S F SALMON R	SNAK	90309	300K CWT US CANADA 10-30-34,38; 62K FB
*			HATCHERY TOTAL.			1,032,500	FROM 1 RELEASES				*
NIAGARA SPRINGS	SU STEELHEAD A	89	50	90	9/19/89 9/22/89	603,000	SALMON R	SALMON R	SNAK	90311	EXCESS FISH PLANTED INTO TRIBS. OF SALMON R- YANKEE FK, HAZARD CR, FRENCH CR, MOYES CR, SPRING CR, AND INDIAN CR.
	SU STEELHEAD A	89	4	90	4/09/90 4/15/90	501,600	PAHSIMEROI R	PAHSIMEROI R	SNAK	90320	45K CWT 10-42-21..23
	SU STEELHEAD A	89	4	90	4/15/90 4/17/90	225,500	HAZARD CR	LITTLE SALMON R	SNAK	90319	45K CWT 10-42-24..26
	SU STEELHEAD A	89	5	90	4/18/90 4/20/90	229,000	SALMON R	SALMON R	SNAK	90317	REL NEAR MOUTH OF HAMMER CREEK
	SU STEELHEAD A	89	4	90	4/20/90 4/29/90	947,200	HELLS CANYON	SNAKE R	SNAK	90318	
*			HATCHERY TOTAL.			2,506,300	FROM 5 RELEASES				*
PAHSIMEROI	SU CHINOOK 1 PAHSIMEROI	88	17	90	3/15/90 3/22/90	1,058,000	PAHSIMEROI R	PAHSIMEROI R	SNAK	90310	
*			HATCHERY TOTAL.			1,058,000	FROM 1 RELEASES				*
POWELL	SP CHINOOK 1 CLEARWATER	88	18	90	10/17/89 10/19/89	314,500	LOCHSA R	CLEARWATER R	SNAK	90302	REL. AT POWELL HATCHERY
*			HATCHERY TOTAL.			314,500	FROM 1 RELEASES				*
RAPID RIVER	SP CHINOOK 1 RAPID RIVER	88	26	90	3/12/90 3/26/90	2,520,400	RAPID R	RAPID R	SNAK	90306	300K CWT US CANADA 10-32-13..18; 60K FB

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
IDFG	RAPID RIVER	SP CHINOOK 1 RAPID RIVER	88	29	90	3/20/90 3/22/90	551,200	HELLS CANYON	SNAKE R	SNAK	90307	
		SP CHINOOK 1 RAPID RIVER	88	28	90	3/20/90 3/20/90	250,000	LITTLE SALMON R	SALMON R	SNAK	90326	
*				HATCHERY TOTAL.			3,321,600	FROM 3 RELEASES				*
	RED RIVER	SP CHINOOK 1 CLEARWATER	88	35	90	10/16/89 10/18/89	240,500	RED R	S F CLEARWATER	SNAK	90301	
*				HATCHERY TOTAL.			240,500	FROM 1 RELEASES				*
	SAWTOOTH	SP CHINOOK 1 SALMON	88	35	90	10/12/89 10/12/89	395,400	SAWTOOTH	SALMON R	SNAK	90303	91.8K CWT 10-32-22,23
		SP CHINOOK 1 SALMON	88	23	90	3/17/90 3/21/90	1,500,200	SAWTOOTH	SALMON R	SNAK	90308	300K CWT US CANADA 10-32-20,21,24; 10-40-8 60K FB; 10K PIT
		SP CHINOOK 1 SALMON	88	21	90	3/19/90 3/20/90	200,800	YANKEE FORK	SALMON R	SNAK	90314	
		SP CHINOOK 1 SALMON	88	72	90	3/20/90 3/21/90	514,600	E F SALMON R	E F SALMON R	SNAK	90313	100K CWT 10-32-11,12
*				HATCHERY TOTAL.			2,611,000	FROM 4 RELEASES				*
**				AGENCY TOTAL...			13,370,300	FROM 19 RELEASES				**

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS.....
NMFS	MONTLAKE	SOCKEYE WENATCHEE	88	25	90	11/01/89 11/30/89	25,987	CLE ELEM LAKE	YAKIMA R	MCOL	90505	OUTMIGRATION FROM LAKE CLE ELUM DEPENDENT UPON WATER REACHING THE SPILLWAY (ELEV. 2223); 100% FB
		SOCKEYE WENATCHEE	88	25	90	11/20/89 6/01/90	12,069	CLE ELEM R.	YAKIMA R	MCOL	90508	100% FB
		SOCKEYE WENATCHEE	88	25	90	3/15/90 3/15/90	25,422	CLE ELEM LAKE	YAKIMA R	MCOL	90506	OUTMIGRATION FROM LAKE CLE ELUM DEPENDENT ON WATER REACHING THE SPILLWAY (ELEV. 2223); 100% FB
		SOCKEYE WENATCHEE	88	25	90	4/24/90 4/26/90	25,500	CLE ELEM LAKE	YAKIMA R	MCOL	90507	OUTMIGRATION FROM LAKE CLE ELUM DEPENDENT UPON WATER REACHING THE SPILLWAY (ELEV. 2223); 100% FB
*				HATCHERY TOTAL.			88,978	FROM 4 RELEASES				*
	NON-HATCHERY	SP CHINOOK 1	88		90	4/07/90 4/08/90	300	PROSSER TRAP	YAKIMA R	MCOL	90510	100% FB
		SP CHINOOK 1	88	15	90	4/16/90 4/16/90	500	PROSSER TRAP	YAKIMA R	MCOL	90513	100% FB
		FA CHINOOK 0	89		90	5/26/90 5/26/90	500	PROSSER TRAP	YAKIMA R	MCOL	90514	100% FB
*				HATCHERY TOTAL.			1,300	FROM 3 RELEASES				*
**				AGENCY TOTAL...			90,278	FROM 7 RELEASES				**

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* System at (503) 230-4289. *
****

FROM 9/01/89 TO 12/31/90

AGCY HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
ODFW BIG CANYON	SP CHINOOK 1 RAPID RIVER	88	17	90	3/31/90 3/31/90	91,433	BIG CANYON CR	WALLOWA R	SNAK	90124	ACCLIM
	SU STEELHEAD WALLOWA	89	5	90	4/19/90 4/20/90	223,379	BIG CANYON CR	WALLOWA R	SNAK	90116	ACCLIMATION POND
*			HATCHERY TOTAL.			314,812	FROM 2 RELEASES				*
BONNEVILLE	SP CHINOOK 1 CARSON	88	10	90	3/12/90 3/14/90	197,988	HOOD R	HOOD R	LCOL	90132	60K CWT 07-52-23
	FA CHINOOK 1 BONNEVILLE URB	88	8	90	3/19/90 3/26/90	255,614	UMATILLA R	UMATILLA R	LCOL	90100	UMATILLA TRIBAL RELEASE AT RM 70
	SP CHINOOK 1 CARSON	88	10	90	3/22/90 3/23/90	117,427	MEACHAM CR	UMATILLA R	LCOL	90171	77K CWT 07-51-09,10,11; REL NEAR BONIFER POND
	SP CHINOOK 1 CARSON	89	13	91	10/23/90 10/26/90	158,443	MEACHAM CR	UMATILLA R	LCOL	90814	REL NEAR BONIFER SPRINGS; 100% CWT 07-45-05..10
	SP CHINOOK 1 CARSON/LKGLASS	89	13	91	10/26/90 10/26/90	77,998	UMATILLA R	UMATILLA R	LCOL	90802	REL NEAR BONIFER ACCLIMATION POND; 100% CWT
*			HATCHERY TOTAL.			807,470	FROM 5 RELEASES				*
CASCADE	COHO TANNER CR	88	16	90	3/09/90 3/14/90	645,138	YAKIMA R	YAKIMA R	MCOL	90114	75K CWT 07-48-10..12; DIRECT STREAM PLANTS FOR YAKIMA TRIBE
	COHO TANNER CR	88	15	90	3/26/90 4/02/90	856,524	UMATILLA R	UMATILLA R	LCOL	90106	DIRECT STREAM PLANTS FOR UMATILLA TRIBE; 25K CWT 07-48-13 59682 REL NEAR MINTHORN ON 3/29 AT 13/LB 594.5K REL AT RM 70, 202.3K REL AT RM 23 SEE MINTHORN FOR ADDITIONAL REL INFO.
*			HATCHERY TOTAL.			1,501,662	FROM 2 RELEASES				*
GNAT CR	WI STEELHEAD BIG CREEK	89	6	90	5/09/90 5/09/90	24,030	HOOD R	HOOD R	LCOL	90786	PLANTED IN E. FK.
*			HATCHERY TOTAL.			24,030	FROM 1 RELEASES				*
IMNAHA	SP CHINOOK 1 IMNAHA	88	15	90	3/30/90 3/31/90	249,793	IMNAHA R	IMNAHA R	SNAK	90129	ACCLIM, 103K AT 12/LB; 128K CWT 07-47-29,30,33,34; 41K FR
*			HATCHERY TOTAL.			249,793	FROM 1 RELEASES				*

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****

FROM 9/01/89 TO 12/31/90

AGCY HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
ODFW IRRIGON	SU STEELHEAD IMNAHA	89	68	90	11/14/89 11/14/89	33,613	HELLS CANYON	SNAKE R	SNAK	90804	EXCESS PLANT; 9K WALLOWA STOCK
	SU STEELHEAD WALLOWA	89	5	90	4/12/90 4/17/90	200,013	GRANDE RONDE R	GRANDE RONDE R	SNAK	90119	REL. UPPER GRANDE RONDE
	SU STEELHEAD WALLOWA	89	5	90	4/18/90 4/27/90	83,137	WALLOWA R	WALLOWA R	SNAK	90117	INCLUDES 21.8K IMNAHA STOCK
	SU STEELHEAD WALLOWA	89	5	90	4/18/90 4/23/90	112,412	CATHERINE CR	GRANDE RONDE R	SNAK	90170	INCLUDES 27.2K IMNAHA STOCK
	SU STEELHEAD WALLOWA	89	5	90	4/19/90 4/19/90	53,747	SPRING CR CHNL	WALLOWA R	SNAK	90118	NON-ACCLIM GROUP; CWT 07-51-18,19; 49K FB
	SU STEELHEAD IMNAHA	89	6	90	4/23/90 4/26/90	81,902	IMNAHA R	IMNAHA R	SNAK	90122	
	SU STEELHEAD WALLOWA	89	5	90	4/24/90 4/26/90	97,605	WILDCAT CR	GRANDE RONDE R	SNAK	90120	48K FB
	SU STEELHEAD WALLOWA	89	5	90	4/26/90 4/26/90	50,036	BIG CANYON CR	WALLOWA R	SNAK	90172	
	FA CHINOOK 0 BONNEVILLE	89	88	90	5/11/90 6/01/90	2,425,681	UMATILLA R	UMATILLA R	LCOL	90101	200K CWT 07-54-03,4,5; 157K FB; 630K PRIEST STOCK
	FA CHINOOK 0 PRIEST RAPIDS	89	82	90	5/22/90 5/23/90	629,800	UMATILLA R	UMATILLA R	LCOL	90805	
	FA CHINOOK 0 BONNEVILLE	89	12	91	10/15/90 10/15/90	75,000	UMATILLA R	UMATILLA R	LCOL	90803	REL NEAR MINTHORN ACCLIMATION POND
	FA CHINOOK 0 BONNEVILLE	89	9	91	10/16/90 10/16/90	76,646	UMATILLA R	UMATILLA R	LCOL	90806	REL NEAR MINTHORN POND, 100% CWT
	FA CHINOOK 0 URB	89	9	91	10/16/90 10/16/90	76,905	UMATILLA R	UMATILLA R	LCOL	90813	REL NEAR MINTHORN POND FOR UMATILLA TRIBE 100% CWT 07-53-22..24
	SU STEELHEAD WALLOWA	90	54	91	11/20/90 11/20/90	140,787	HELLS CANYON	SNAKE R	SNAK	90811	EXCESS PLANT
	SU STEELHEAD IMNAHA	90	57	91	11/21/90 11/21/90	71,698	HELLS CANYON	SNAKE R	SNAK	90812	EXCESS PLANT

HATCHERY TOTAL. 4,208,982 FROM 15 RELEASES

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
ODFW	LOOKINGGLASS	SP CHINOOK 1 RAPID R	88	19	90	4/02/90 4/02/90	619,630	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	90123	279K AT 20/LB; 103K AT 12/LB; 237K AT 17/LB.; 83K FB
		SP CHINOOK 1 IMNAHA	88	19	90	4/02/90 4/02/90	79,947	BIG SHEEP CR	IMNAHA R	SNAK	90131	
		SP CHINOOK 1 IMNAHA	88	19	90	4/06/90 4/06/90	114,722	IMNAHA R	IMNAHA R	SNAK	90130	DIRECT STREAM AFTER 1-2 DAYS IN ACCLIMATION POND
		SP CHINOOK 1 RAPID R	88	20	90	4/09/90 4/09/90	80,043	GRANDE RONDE R	GRANDE RONDE R	SNAK	90127	PLANTED IN UPPER GRANDE RONDE
		SP CHINOOK 1 RAPID R	88	20	90	4/09/90 4/09/90	70,002	CATHERINE CR	GRANDE RONDE R	SNAK	90128	
		SP CHINOOK 1 RAPID R	88	21	90	4/10/90 4/10/90	26,438	HURRICANE CR	WALLOWA R	SNAK	90125	
		SP CHINOOK 1 RAPID R	88	21	90	4/10/90 4/10/90	26,442	WALLOWA R	WALLOWA R	SNAK	90126	
*				HATCHERY TOTAL.			1,017,224	FROM 7 RELEASES				*
	OAK SPRINGS	SU STEELHEAD S SANTIAM	89	6	90	4/04/90 4/11/90	81,795	HOOD R	HOOD R	LCOL	90195	66.3K PLANTED IN W FK.
		SU STEELHEAD UMATILLA	89	6	90	5/08/90 5/11/90	29,446	UMATILLA R	UMATILLA R	LCOL	90179	REL NEAR BONIFER POND FOR UMATILLA TRIBE 100% CWT 07-52-15,16,17
*				HATCHERY TOTAL.			111,241	FROM 2 RELEASES				*
	OXROW	SP CHINOOK 0 CLACKAMAS EARLY	89	131	91	5/08/90 5/08/90	7,860	HERMAN CR	LOWER COLUMBIA	LCOL	90787	
*				HATCHERY TOTAL.			7,860	FROM 1 RELEASES				*
	ROUND BUTTE	SP CHINOOK 1 DESCHUTES	88	10	90	4/16/90 5/17/90	201,249	DESCHUTES R	DESCHUTES R	LCOL	90153	67K CWT 07-50-58,59,60; LADDER EVALUATION
		SU STEELHEAD DESCHUTES	89	4	90	4/16/90 4/18/90	161,608	DESCHUTES R	DESCHUTES R	LCOL	90155	100% AD, LM OR RM CLIP
		SP CHINOOK 1 DESCHUTES	88	6	90	4/19/90 4/20/90	58,198	DESCHUTES R	DESCHUTES R	LCOL	90154	100% CWT 07-50-61,62; DIRECT RELEASE GROUP
				HATCHERY TOTAL.			421,055	FROM 3 RELEASES				*

FISH PASSAGE DATA SYSTEM
* Hatchery Releases *

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
ODFW	TROJAN POND	WI STEELHEAD BIG CREEK	89	5	90	4/12/90 4/12/90	12,009	HOOD R	HOOD R	LCOL	90196	PLANTED IN E AND M FK.
*				HATCHERY TOTAL.			12,009	FROM 1 RELEASES				*
	WALLOWA	SU STEELHEAD WALLOWA	89	5	90	4/15/90 4/23/90	495,875	WALLOWA R	WALLOWA R	SNAK	90115	ACCLIMATION POND; 100K FB & CWT 07-51-20..23
		SU STEELHEAD IMNAHA	89	5	90	4/16/90 4/21/90	249,564	LI SHEEP CR	IMNAHA R	SNAK	90121	ACCLIMATION POND; 53K FB & CWT 07-51-24,25
*				HATCHERY TOTAL.			745,439	FROM 2 RELEASES				*
**				AGENCY TOTAL...			9,421,577	FROM 42 RELEASES				**

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
UMTR	BONIFER	SP CHINOOK 1 CARSON	88	12	90	10/13/89 10/13/89	82,098	BONIFER POND	UMATILLA R	LCOL	90102	75K CWT 07-50-63; 07-51-01,02
		SP CHINOOK 1 CARSON	88	9	90	3/22/90 3/22/90	114,345	BONIFER	UMATILLA R	LCOL	90602	79.6K CWT
		SP CHINOOK 1 CARSON	88	19	90	4/18/90 4/18/90	99,775	UMATILLA R	UMATILLA R	LCOL	90251	REL AT STANFIELD BRIDGE
		SU STEELHEAD UMATILLA	89	7	90	5/07/90 5/07/90	59,747	BONIFER POND	UMATILLA R	LCOL	90607	30K CWT 07-52-12,13,14
		SP CHINOOK 1 CARSON	89	12	91	10/26/90 10/26/90	80,438	BONIFER POND	UMATILLA R	LCOL	90603	75K CWT
	*			HATCHERY TOTAL.			436,403	FROM 5 RELEASES				*
	MINTHORN	FA CHINOOK 0 URB	88	11	90	10/18/89 10/18/89	75,733	MINTHORN POND	UMATILLA R	LCOL	90104	75K CWT 07-47-53,54,57
		COHO TANNER CR	88	14	90	3/28/90 3/28/90	67,309	MINTHORN POND	UMATILLA R	LCOL	90604	25K CWT; REL IN UPPER RACEWAY
		COHO TANNER CR	88	11	90	4/12/90 4/12/90	65,095	MINTHORN POND	UMATILLA R	LCOL	90605	25K CWT 07-48-15; LOWER RACEWAYS
		FA CHINOOK 0 BONNEVILLE	89	9	91	10/16/90 10/16/90	71,864	MINTHORN POND	UMATILLA R	LCOL	90608	100% CWT 07-53-25..27
	*			HATCHERY TOTAL.			280,001	FROM 4 RELEASES				*
**				AGENCY TOTAL...			716,404	FROM 9 RELEASES				**

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FROM 9/01/89 TO 12/31/90

AGCY HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
USFW CARSON	SP CHINOOK 1 CARSON	88	19	90	4/12/90 4/13/90	2,105,281	CARSON	WIND R	LCOL	90201	50K CWT 5-22-19,20
*			HATCHERY TOTAL.			2,105,281	FROM 1 RELEASES				*
DWORSHAK	SP CHINOOK 1 CLEARWATER	88	18	90	3/21/90 4/05/90	12,684	CLRWTR @ HWY 95	CLEARWATER R	SNAK	90245	TRAP EFFICIENCY RELEASES; 1418 REL AT DWORSHAK H.; 100% FB
	SP CHINOOK 1 CLEARWATER	88	18	90	3/26/90 3/28/90	236,019	LOCHSA R	CLEARWATER R	SNAK	90238	PLANTED AT POWELL SITE
	SP CHINOOK 1 CLEARWATER	88	18	90	3/26/90 3/28/90	256,883	ELDORADO CR	CLEARWATER R	SNAK	90239	
	SP CHINOOK 1 CLEARWATER	88	18	90	4/04/90 4/05/90	1,238,743	DWORSHAK	N F CLEARWATER	SNAK	90203	480K CWT 5-21-62,63; 5-22-5,60..63; 5-23-5,6; 23-29-30,31 60K FB
	SU STEELHEAD B	89	7	90	4/16/90 4/30/90	374,040	KOOSKIA	M F CLEARWATER	SNAK	90231	
	SU STEELHEAD B	89	7	90	4/16/90 4/30/90	210,836	NEWSOME CR	S F CLEARWATER	SNAK	90232	
	SU STEELHEAD B	89	7	90	4/16/90 4/30/90	214,633	CROOKED R	S F CLEARWATER	SNAK	90233	
	SU STEELHEAD B	89	6	90	4/16/90 4/30/90	209,847	AMERICAN R	S F CLEARWATER	SNAK	90234	
	SU STEELHEAD B	89	7	90	4/16/90 4/30/90	207,830	MILL CR BRIDGE	S F CLEARWATER	SNAK	90235	
	SU STEELHEAD B	89	7	90	4/16/90 4/30/90	199,700	ELDORADO CR	CLEARWATER R	SNAK	90236	
	SU STEELHEAD B	89	6	90	5/03/90 5/04/90	1,166,664	DWORSHAK	N F CLEARWATER	SNAK	90204	120K CWT 5-20-44..49; 85K FB; 24.8K FB USED FOR IDFG CLEARWATER TRAP EFFICIENCY TESTS.
*			HATCHERY TOTAL.			4,407,879	FROM 11 RELEASES				*
ENTIAT	SP CHINOOK 1 ENTIAT	88	18	90	4/18/90 4/19/90	585,800	ENTIAT R	ENTIAT R	MCOL	90205	92K CWT 05-19-60,63; 05-21-44; 35K FB
*			HATCHERY TOTAL.			585,800	FROM 1 RELEASES				*

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY	SPECIES AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
USFW	HAGERMAN	SU STEELHEAD A	89	4	90	4/04/90 4/09/90	301,156	SAWTOOTH	SALMON R	SNAK	90206	45K CWT 10-42-14..16
		SU STEELHEAD A	88	4	90	4/09/90 4/11/90	200,295	SALMON R	SALMON R	SNAK	90241	REL AT CHALLIS (ELLIS BRIDGE)
		SU STEELHEAD B	89	4	90	4/11/90 4/11/90	64,150	E F SALMON R	E F SALMON R	SNAK	90247	
		SU STEELHEAD A	88	5	90	4/12/90 4/16/90	200,246	SHOUP BRIDGE	SALMON R	SNAK	90250	45K CWT 10-42-27,28,29
		SU STEELHEAD A	89	4	90	4/18/90 4/20/90	199,602	N F SALMON R	N F SALMON R	SNAK	90321	REL AT N.F. TRAP
		SU STEELHEAD A	89	4	90	4/23/90 4/23/90	80,465	HAZARD CR	LITTLE SALMON R	SNAK	90322	
		SU STEELHEAD B	89	4	90	4/23/90 5/01/90	393,352	HAZARD CR	LITTLE SALMON R	SNAK	90323	42K CWT 10-42-30,31,32
*					HATCHERY	TOTAL.	1,439,266	FROM	7 RELEASES			*
	KOOSKIA	SP CHINOOK 1 CLEARWATER	88	23	90	3/26/90 3/28/90	300,407	CROOKED R	S F CLEARWATER	SNAK	90237	
		SP CHINOOK 1 CLEARWATER	88	23	90	3/29/90 3/29/90	50,095	PAPOOSE CR	S F CLEARWATER	SNAK	90243	REL AT MOUTH OF PAPOOSE CR
		SP CHINOOK 1 CLEARWATER	88	23	90	3/29/90 3/29/90	53,287	WHITE SANDS CR	LOCHSA R	SNAK	90244	REL NEAR POWELL HATCHERY
		SP CHINOOK 1 CLEARWATER	88	21	90	4/12/90 4/12/90	403,701	KOOSKIA	M F CLEARWATER	SNAK	90208	120K CWT 05-09-27; 05-21-42,43
*					HATCHERY	TOTAL.	807,490	FROM	4 RELEASES			*
	LEAVENWORTH	SU STEELHEAD LEAVENWORTH	88	7	90	4/18/90 4/18/90	106,034	LEAVENWORTH	WENATCHEE R	MCOL	90210	
		SP CHINOOK 1 LEAVENWORTH	88	18	90	4/18/90 4/18/90	2,251,503	LEAVENWORTH	WENATCHEE R	MCOL	90325	51K FB, 184K CWT US/CANADA INDEX 5-21-36,37,38,39
		SP CHINOOK 0 LEAVENWORTH	89	40	90	4/19/90 4/19/90	273,968	LEAVENWORTH	WENATCHEE R	MCOL	90255	ACCELERATED REARING GROUP

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
USFW	LEAVENWORTH	SP CHINOOK 1 LEAVENWORTH	88	18	90	5/04/90 5/04/90	51,800	LEAVENWORTH	WENATCHEE R	MCOL	90248	100% FB; PARAMETRIX STUDY GROUP
		SP CHINOOK 0 LEAVENWORTH	89	30	90	5/04/90 5/04/90	125,100	LEAVENWORTH	WENATCHEE R	MCOL	90324	REARED AT WELLS H UNTIL JUST PRIOR TO RELEASE PARAMETRIX STUDY GROUP; 100% CWT 63-59-19-R3; 100% FB
*				HATCHERY TOTAL.			2,808,405	FROM 5 RELEASES				*
	LWHITE SALMON	SP CHINOOK 0 L W SALMON	89	1460	91	1/12/90 1/12/90	384,706	LWHITE SALMON R	LWHITE SALMON R	LCOL	90252	UNFED FRY
		SP CHINOOK 1 L W SALMON	88	15	90	4/18/90 4/18/90	461,446	LWHITE SALMON	LWHITE SALMON R	LCOL	90213	50K CWT 05-22-31,35
		FA CHINOOK 0 L.WH. URB	89	203	90	5/14/90 5/18/90	1,518,344	YAKIMA R	YAKIMA R	MCOL	90211	REL 200K NEAR UNION GAP, REMAINDER BELOW PROSSER 120K CWT 05-21-20, A501010206, A501010211
		FA CHINOOK 0 L.WH. URB	89	111	90	6/25/90 6/25/90	1,438,372	LWHITE SALMON	LWHITE SALMON R	LCOL	90212	50K CWT; 05-23-37,38
		SP CHINOOK 0 L W SALMON	89	36	90	6/25/90 6/25/90	1,050,126	LWHITE SALMON	LWHITE SALMON R	LCOL	90214	
*				HATCHERY TOTAL.			4,852,994	FROM 5 RELEASES				*
	SPRING CRK	SP CHINOOK 0 CARSON	89	1389	91	1/08/90 2/15/90	1,153,000	WHITE SALMON R	WHITE SALMON R	LCOL	90254	RELEASE DUE TO HIGH WATER. 100K REL ON 2/15 AT 875/LB
		FA CHINOOK 0 SPRING CREEK	89	90	90	3/15/90 3/15/90	2,700,974	SPRING CRK	LOWER COLUMBIA	LCOL	90215	200K CWT 45-22-(7-10) US CANADA INDEX
		FA CHINOOK 0 SPRING CREEK	89	63	90	4/12/90 4/12/90	3,518,071	SPRING CRK	LOWER COLUMBIA	LCOL	90216	US CANADA INDEX 5-22-(11-14)
		FA CHINOOK 0 SPRING CREEK	89	65	90	4/19/90 4/19/90	597,183	SPRING CRK	LOWER COLUMBIA	LCOL	90249	
		FA CHINOOK 0 SPRING CREEK	89	37	90	5/17/90 5/17/90	3,417,259	SPRING CRK	LOWER COLUMBIA	LCOL	90217	US CANADA 5-22-(15-18) DIET INDEX 5-23-35,36
		SP CHINOOK 0 SPRING CREEK	89	35	90	8/23/90 8/24/90	350,000	WHITE SALMON R	WHITE SALMON R	LCOL	90256	REL AT BIG WHITE POND
*				HATCHERY TOTAL.			11,736,487	FROM 6 RELEASES				*

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
USFW	WILLARD	COHO WILLARD	89	1500	91	1/24/90 1/24/90	254,500	LWHITE SALMON R	LWHITE SALMON R	LCOL	90253	UNFED FRY
		COHO WILLARD	88	14	90	4/17/90 4/18/90	2,898,140	WILLARD	LWHITE SALMON R	LCOL	90218	50K CWT 05-22-25,26
		COHO WILLARD	89	218	91	5/14/90 5/14/90	831,776	WILLARD	LWHITE SALMON R	LCOL	90258	FINGERLING OVERSTOCK RELEASE
*					HATCHERY TOTAL.		3,984,416	FROM 3 RELEASES				*
	WINTHROP	SP CHINOOK 1 WINTHROP	88	18	90	4/17/90 4/17/90	1,121,395	WINTHROP	METHOW R	MCOL	90219	50K FB
*					HATCHERY TOTAL.		1,121,395	FROM 1 RELEASES				*
	WARM SPRINGS	SP CHINOOK 1 WARM SPRINGS	88	9	90	9/27/89 9/27/89	162,978	WARM SPRINGS R	WARM SPRINGS R	LCOL	90242	80% CWT 05-20-26..31,61..63; 05-21-05,40,41; 05-40-20,21
		SP CHINOOK 1 WARM SPRINGS	88	9	90	11/15/89 11/15/89	5,000	WARM SPRINGS	WARM SPRINGS R	LCOL	90257	CWT 5-20-30
		SP CHINOOK 1 WARM SPRINGS	88	17	90	4/11/90 4/16/90	541,178	WARM SPRINGS	WARM SPRINGS R	LCOL	90220	83% CWT 05-20-26..31,36,61..63; 5-21-5,40,41; 5-40-19..21 100K LV CLIP
		SP CHINOOK 1 WARM SPRINGS	89	10	91	9/26/90 9/26/90	194,178	WARM SPRINGS	WARM SPRINGS R	LCOL	90221	80% CWT 05-19-48; 05-22-41..44; 05-23-39..46,50
*					HATCHERY TOTAL.		903,334	FROM 4 RELEASES				*
**					AGENCY TOTAL...		34,752,747	FROM 48 RELEASES				**

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	..... ZONE	FPC LOT ID	COMMENTS.....
WDF	EAST BANK	SOCKEYE WENATCHEE	89	25	91	10/24/90 10/24/90	260,400	LAKE WENATCHEE	WENATCHEE R	MCOL	90076	REARED IN NET PENS AT LAKE WENATCHEE
*				HATCHERY TOTAL.			260,400	FROM 1 RELEASES				*
	KLICKITAT	SP CHINOOK 1 KLICKITAT	88	27	90	10/03/89 10/03/89	29,500	UPPER KLICKITAT	KLICKITAT R	LCOL	90013	
		COHO TYPE-N	88	18	90	4/21/90 6/02/90	1,563,200	KLICKITAT R	KLICKITAT R	LCOL	90038	VOLITIONAL RELEASE; 47K CWT 63-11-37R3
		SP CHINOOK 1 KLICKITAT	88	7	90	5/01/90 5/01/90	783,200	KLICKITAT R	KLICKITAT R	LCOL	90035	
		FA CHINOOK 0 PRIEST RAPIDS	89	78	90	5/16/90 6/07/90	4,212,900	KLICKITAT R	KLICKITAT R	LCOL	90037	225K CWT, 3 MILLION REL AT HATCHERY ON 5/16/90 1.26M REL ON 6/7
		SP CHINOOK 0 KLICKITAT	89	54	90	6/28/90 6/29/90	139,600	UPPER KLICKITAT	KLICKITAT R	LCOL	90036	
*				HATCHERY TOTAL.			6,728,400	FROM 5 RELEASES				*
	LYONS FERRY	FA CHINOOK 1 SNAKE R	88	9	90	4/16/90 4/16/90	280,045	LYONS FERRY	SNAKE R	SNAK	90049	120K CWT 63-02-35,37R6
		FA CHINOOK 1 SNAKE R	88	11	90	4/17/90 4/17/90	156,309	BELOW IHR DAM	SNAKE R	SNAK	90050	120K CWT 63-02-31,32R6
		FA CHINOOK 0 SNAKE R	89	70	90	6/06/90 7/12/90	2,796,208	LYONS FERRY	SNAKE R	SNAK	90014	240K CWT 63-55-47R6; 63-55-44R6; 80K FB 100% CWT! 793K REL ON 6/18, 604K REL ON 6/25
		FA CHINOOK 0 SNAKE R	89	62	90	6/08/90 6/08/90	247,548	BELOW IHR DAM	SNAKE R	SNAK	90060	248K CWT 63-55-50R6; 63-55-49R6
*				HATCHERY TOTAL.			3,480,110	FROM 4 RELEASES				*
	PRIEST RAPIDS	FA CHINOOK 0 PRIEST RAPIDS	89	60	90	6/07/90 6/19/90	6,431,100	BELOW PRD DAM	MID COLUMBIA R	MCOL	90041	200K CWT 63-07-32, US/CANADA INDEX; 200K FB; 5 REL OF ABOUT 1.3 MILL. SPACED 3 DAYS APART! 6/7, 6/10, 6/13, 6/16 & 6/19
*				HATCHERY TOTAL.			6,431,100	FROM 1 RELEASES				*
	RINGOLD	SP CHINOOK 0 YAKIMA	89	80	90	3/19/90 3/19/90	13,000	RINGOLD	MID COLUMBIA R	MCOL	90079	INCIDENTAL RELEASE OF FINGERLING SP CH FROM A RESEARCH STUDY
		SP CHINOOK 1 KLICKITAT	88	7	90	3/28/90 4/04/90	870,000	RINGOLD	MID COLUMBIA R	MCOL	90040	40K FB, BULK REL ON MONDAY 4/2
*				HATCHERY TOTAL.			883,000	FROM 2 RELEASES				*

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
WDF	ROCKY REACH	FA CHINOOK 0 WELLS	89	373	90	3/21/90 3/21/90	679,800	BELOW RRH	MID COLUMBIA R	MCOL	90048	
		FA CHINOOK 1 PRIEST RAPIDS	88	8	90	4/27/90 4/27/90	230,000	ABOVE RRH DAM	MID COLUMBIA R	MCOL	90042	
		COHO TYPE-N	88	16	90	5/01/90 5/01/90	473,000	ABOVE RRH DAM	MID COLUMBIA R	MCOL	90043	
	*			HATCHERY TOTAL.			1,382,800	FROM 3 RELEASES				*
	TUCANNON	SP CHINOOK 1 TUCANNON	88	11	90	3/30/90 4/10/90	145,146	TUCANNON R	TUCANNON R	SNAK	90039	100% CWT 63-01-55R3, 63-01-42R3
	*			HATCHERY TOTAL.			145,146	FROM 1 RELEASES				*
	WASHOUGAL	COHO TYPE-N	88	20	90	4/02/90 4/05/90	2,500,000	KLICKITAT R	KLICKITAT R	LCOL	90032	60K CWT 63-11-61,62R3; REL AT RM 32.1
	*			HATCHERY TOTAL.			2,500,000	FROM 1 RELEASES				*
	WELLS	SU CHINOOK 1 WELLS	88	8	90	4/09/90 4/28/90	391,579	BELOW WELLS DAM	MID COLUMBIA R	MCOL	90044	155K CWT 63-02-62R6
		SU CHINOOK 0 WELLS	89	55	90	5/22/90 5/25/90	1,310,656	BELOW WELLS DAM	MID COLUMBIA R	MCOL	90046	180K CWT 63-13-47R3, 63-13-52R3; 100K FB MAJORITY RELEASED ON 5/25/90
		SU CHINOOK 0 WELLS	89	16	90	7/19/90 7/20/90	210,473	BELOW WELLS DAM	MID COLUMBIA R	MCOL	90047	45K CWT 63-11-49R3
	*			HATCHERY TOTAL.			1,912,708	FROM 3 RELEASES				*
**				AGENCY TOTAL....			23,723,664	FROM 21 RELEASES				**

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MOR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
WDW	CHELAN	SU STEELHEAD WELLS	89	7	90	4/03/90 4/13/90	150,500	WENATCHEE R	WENATCHEE R	MCOL	90406	4/4-5 40K REL IN UPPER WENATCHEE RIVER
		SU STEELHEAD WELLS	89	7	90	4/10/90 4/11/90	16,100	PERSHASTIN CR	WENATCHEE R	MCOL	90466	
	*			HATCHERY TOTAL.			166,600	FROM 2 RELEASES				*
	EAST BANK	SU STEELHEAD WELLS	89	7	90	4/16/90 4/24/90	130,710	WENATCHEE R	WENATCHEE R	MCOL	90407	
		SU STEELHEAD WELLS	89	7	90	4/17/90 4/18/90	36,915	ENTIAT	ENTIAT R	MCOL	90405	
	*			HATCHERY TOTAL.			167,625	FROM 2 RELEASES				*
	LYONS FERRY	SU STEELHEAD WALLOWA	89	5	90	4/15/90 4/30/90	239,000	GRANDE RONDE R	GRANDE RONDE R	SNAK	90411	REL FROM COTTONWOOD ACCLIM. POND
		SU STEELHEAD PAHSIMEROI	89	5	90	4/15/90 4/30/90	119,264	TUCANNON R	TUCANNON R	SNAK	90413	40K CWT 63-08-38,41-R3 REL AT MARENG ON 4/25 40K CWT 63-39-12,13 R3, 63-50-49R3 REL AT CURL LAKE, 39K AD ONLY REL.; 77K FB
		SU STEELHEAD RINGOLD	89	4	90	4/15/90 4/30/90	116,345	TOUCHET R	WALLA WALLA R	MCOL	90416	40K CWT 63-39-7,8; 38K FB 6600 REL 8 MI D/S OF ACCLIM. POND ON 4/23
		SU STEELHEAD PAHSIMEROI	89	5	90	4/17/90 4/30/90	137,847	ASOTIN CR	SNAKE R	SNAK	90412	40K CWT 63-07-25-R3, 63-14-22R3; 38K FB
		SU STEELHEAD RINGOLD	89	4	90	4/18/90 4/25/90	130,217	WALLA WALLA R	WALLA WALLA R	MCOL	90415	40K CWT 63-39-9,10; 38K FB
		SU STEELHEAD RINGOLD	89	4	90	4/18/90 4/20/90	32,200	MILL CR	WALLA WALLA R	MCOL	90457	
		SU STEELHEAD PAHSIMEROI	89	6	90	4/27/90 4/30/90	43,479	LYONS FERRY	SNAKE R	SNAK	90414	40K CWT 63-08-21,42-R3; 37K FB 4524 AD CLIP ONLY REL ON 4/30
	*			HATCHERY TOTAL.			818,352	FROM 7 RELEASES				*
	NACHES	SU STEELHEAD YAKIMA	89	5	90	4/07/90 4/21/90	56,448	NACHES R	NACHES R	MCOL	90409	REL FROM NELSON SPRINGS
	*			HATCHERY TOTAL.			56,448	FROM 1 RELEASES				*

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FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER ..... NAME	ZONE	FPC LOT ID	COMMENTS.....
WDW	RINGOLD	SU STEELHEAD RINGOLD	89	7	90	4/20/90 4/27/90	184,098	RINGOLD	MID COLUMBIA R	MCOL	90410	
	*			HATCHERY TOTAL.			184,098	FROM 1 RELEASES				*
	SKAMANIA	SU STEELHEAD SKAMANIA	89	5	90	4/21/90 4/21/90	9,828	WHITE SALMON R	WHITE SALMON R	LCOL	90460	REL FROM NW RESERVOIR NET PEN
		WI STEELHEAD SKAMANIA	89	5	90	4/21/90 4/21/90	9,854	WHITE SALMON R	WHITE SALMON R	LCOL	90479	REL FROM NW RESER. NET PEN
	*			HATCHERY TOTAL.			19,682	FROM 2 RELEASES				*
	VANCOUVER	SU STEELHEAD SKAMANIA	89	5	90	4/16/90 4/25/90	50,038	KLICKITAT R	KLICKITAT R	LCOL	90417	PLANTED AT RM 18 AND 31
		SU STEELHEAD SKAMANIA	89	5	90	4/16/90 4/18/90	20,125	WIND R	WIND R	LCOL	90420	PLANTED AT STABLER
	*			HATCHERY TOTAL.			70,163	FROM 2 RELEASES				*
	WELLS	SU STEELHEAD WELLS	89	6	90	4/18/90 4/25/90	97,494	SIMILKAMEEN R	OKANOGAN R	MCOL	90402	40K FB AND CWT 23-11-47
		SU STEELHEAD WELLS	89	6	90	4/23/90 4/23/90	28,800	CHEWACK R	METHOW R	MCOL	90470	
		SU STEELHEAD WELLS	89	6	90	4/24/90 5/09/90	487,239	METHOW R	METHOW R	MCOL	90403	30K FB AND CWT 23-11-57
		SU STEELHEAD WELLS	89	6	90	4/30/90 5/01/90	28,500	TWISP R	METHOW R	MCOL	90469	
		SU STEELHEAD WELLS	89	6	90	5/01/90 5/07/90	98,400	OKANOGAN R	OKANOGAN R	MCOL	90401	
	*			HATCHERY TOTAL.			740,433	FROM 5 RELEASES				*
	YAKIMA	SU STEELHEAD YAKIMA	89	12	90	4/25/90 5/09/90	6,720	YAKIMA R	YAKIMA R	MCOL	90408	REL AT PROSSER: USED FOR COLLECTION EFFICIENCY AT PROSSER TRAP
		SU STEELHEAD YAKIMA	89	11	90	5/09/90 5/10/90	18,032	YAKIMA R	YAKIMA R	MCOL	90467	REL AT WIDE HOLLOW CREEK
		SU STEELHEAD YAKIMA	89	12	90	5/09/90 5/09/90	12,480	NACHES R	NACHES R	MCOL	90468	REL NEAR NELSON SPR.
	*			HATCHERY TOTAL.			37,232	FROM 3 RELEASES				*
**				AGENCY TOTAL....			2,260,633	FROM 25 RELEASES				**

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****

FROM 9/01/89 TO 12/31/90

AGCY	HATCHERY.....	SPECIES..... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS.....
YATR	NILE POND	SU STEELHEAD YAKIMA	89	10	90	4/30/90 6/30/90	85,259	NACHES R	NACHES R	MCOL	90705	REARED AT NILE POND, VOLITIONAL RELEASE 10.4K REL BY 5/30.
		FA CHINOOK 0 URB	89	104	90	5/18/90 5/18/90	479,734	YAKIMA R	YAKIMA R	MCOL	90704	REARED IN NET PENS AT WAPATO CANAL
*				HATCHERY TOTAL.			564,993	FROM 2 RELEASES				*
	NON-HATCHERY	SP CHINOOK 1	88	30	90	11/15/89 12/12/89	3,916	WAPATOX	YAKIMA R	MCOL	90703	100% FB
		SP CHINOOK 1	88	30	90	12/12/89 1/16/90	1,303	ROZA	YAKIMA R	MCOL	90701	100% FB
		SP CHINOOK 1	88	30	90	1/17/90 3/01/90	3,272	ROZA	YAKIMA R	MCOL	90702	100% FB
*				HATCHERY TOTAL.			8,491	FROM 3 RELEASES				*
**				AGENCY TOTAL...			573,484	FROM 5 RELEASES				**
****				TOTAL RELEASE..			84,968,778	FROM 178 RELEASES				****

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* L A S T P A G E *
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APPENDIX J: 1990 Brand Releases

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Prog: WRC608 1                FISH PASSAGE DATA SYSTEM          Workstation: W1
 8.19.18                 *     B r a n d   R e l e a s e s    *          6/05/91

                         1. Report Date........                 6/05/91

                         2. Include from Starting date          9/01/89
                            to Ending date                     12/31/90

                         3. Specific Agency - Hatchery

                         4. Specific Race and Species

                         5. FPC Brand Only

                         6. Specific Recapture Site

                         7. Specific Brand

                         8. Error Listing                       Y

                         9. Below Bonneville                    Y


                            Cmd-5  Job Jobqueued
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AGCY	HATCHERY.....	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER ..... NAME	ZONE	COMMENTS.....	FPC BRAND
FPC	NON-HATCHERY	SP CHINOOK	1	4/09/90	5/25/90	29,500	90511	01	RA	IX	1	4/09/90	4/09/90	862	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								02	LA	IX	2	4/10/90	4/10/90	20	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								03	RA	IX	2	4/10/90	4/10/90	555	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								04	RA	IX	3	4/11/90	4/11/90	368	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								05	RD	IX	1	4/12/90	4/12/90	615	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								06	RD	IX	3	4/13/90	4/13/90	464	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								07	RA	10	1	4/30/90	4/30/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								08	RA	10	2	5/01/90	5/01/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								09	RA	10	3	5/02/90	5/02/90	1,161	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								10	RD	10	1	5/03/90	5/03/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								11	RD	10	3	5/04/90	5/04/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								12	RA	15	1	5/07/90	5/07/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								13	RA	15	2	5/08/90	5/08/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								14	RA	15	3	5/09/90	5/09/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								15	RD	15	1	5/10/90	5/10/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								16	RD	15	3	5/11/90	5/11/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								17	RA	ID	1	5/14/90	5/14/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								18	RA	ID	2	5/15/90	5/15/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								19	RA	ID	3	5/16/90	5/16/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								20	RD	ID	1	5/17/90	5/17/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								21	RD	ID	3	5/18/90	5/18/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								22	RA	IF	1	5/21/90	5/21/90	1,180	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								23	RA	IF	2	5/22/90	5/22/90	1,042	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								24	RA	IF	3	5/23/90	5/23/90	783	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								25	RD	IF	1	5/24/90	5/24/90	1,029	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								26	RD	IF	3	5/25/90	5/25/90	1,145	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
												LOT ID TOTAL.		25,744	FROM 26 RELEASES				
		SU STEELHEAD		4/30/90	6/05/90	30,191	90512	01	LA	13	1	4/30/90	6/01/90	711	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								02	LA	13	2	5/01/90	5/01/90	1,007	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								03	LA	13	3	5/02/90	5/02/90	1,038	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								04	LD	13	1	5/03/90	5/03/90	1,564	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								05	LD	13	3	5/04/90	5/04/90	989	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								26	LD	13	4	5/05/90	5/05/90	691	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								06	LA	17	1	5/07/90	5/07/90	588	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								07	LA	17	2	5/08/90	5/08/90	621	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								08	LA	17	3	5/09/90	5/09/90	850	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								09	LD	17	1	5/10/90	5/10/90	885	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								10	LD	17	3	5/11/90	5/11/90	981	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								21	LA	IV	1	5/14/90	5/14/90	526	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								22	LA	IV	2	5/15/90	5/15/90	669	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								23	LA	IV	3	5/16/90	5/16/90	1,063	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								24	LD	IV	1	5/17/90	5/17/90	1,092	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								25	LD	IV	3	5/18/90	5/18/90	984	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								11	LA	15	1	5/21/90	5/21/90	357	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								12	LA	15	2	5/22/90	5/22/90	223	BELOW MCN DAM	LOWER COLUMBIA	LCOL		

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AGCY	HATCHERY.......	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER NAME	ZONE	COMMENTS...............	FPC BRAND
FPC	NON-HATCHERY	SU STEELHEAD		4/30/90	6/05/90	30,191	90512	13	LA	15	3	5/23/90	5/23/90	226	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								14	LD	15	1	5/24/90	5/24/90	301	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								15	LD	15	3	5/25/90	5/25/90	390	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								16	LA	IM	1	5/28/90	5/28/90	402	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								17	LA	IM	2	5/29/90	5/29/90	588	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								18	LA	IM	3	5/30/90	5/30/90	1,543	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								19	LD	IM	1	5/31/90	5/31/90	847	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								20	LD	IM	3	6/01/90	6/01/90	1,050	BELOW MCN DAM	LOWER COLUMBIA	LCOL		

* LOT ID TOTAL. 20,186 FROM 26 RELEASES *

** HATCHERY TOTAL. 45,930 FROM 52 RELEASES **

*** AGENCY TOTAL... 45,930 FROM 52 RELEASES ***

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AGCY	HATCHERY.....	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID #	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER ..... NAME	ZONE	COMMENTS.....	FPC BRAND
IDFG	MAGIC VALLEY	SU STEELHEAD		4/05/90	4/21/90	1,198,700	90315 01	LA	PP	1	4/12/90	4/13/90	39,620	SAWTOOTH	SALMON R	SNAK	CWT 10-40-59	
*											LOT ID TOTAL.		39,620	FROM 1 RELEASES				*
		SU STEELHEAD		4/09/90	4/23/90	924,200	90316 01	RA	PP	1	4/14/90	4/14/90	40,907	E F SALMON R	E F SALMON R	SNAK	CWT 10-40-58	
*											LOT ID TOTAL.		40,907	FROM 1 RELEASES				*
**											HATCHERY TOTAL.		80,527	FROM 2 RELEASES				**
	MCCALL	SU CHINOOK	1	3/16/90	3/22/90	1,032,500	90309 01	LD	T	1	3/21/90	3/21/90	20,200	S F SALMON R	S F SALMON R	SNAK	CWT 10-30-38	
							02	LD	T	4	3/21/90	3/21/90	20,900	S F SALMON R	S F SALMON R	SNAK	CWT 10-30-38	
							03	LD	T	3	3/22/90	3/22/90	21,100	S F SALMON R	S F SALMON R	SNAK	CWT 10-30-38	
*											LOT ID TOTAL.		62,200	FROM 3 RELEASES				*
**											HATCHERY TOTAL.		62,200	FROM 3 RELEASES				**
	RAPID RIVER	SP CHINOOK	1	3/12/90	3/26/90	2,520,400	90306 01	RA	T	1	3/22/90	3/26/90	20,600	RAPID R	RAPID R	SNAK		
							02	RA	T	2	3/22/90	3/26/90	20,175	RAPID R	RAPID R	SNAK		
							03	RA	T	3	3/22/90	3/26/90	19,975	RAPID R	RAPID R	SNAK		
*											LOT ID TOTAL.		60,750	FROM 3 RELEASES				*
**											HATCHERY TOTAL.		60,750	FROM 3 RELEASES				**
	SAWTOOTH	SP CHINOOK	1	3/17/90	3/21/90	1,500,200	90308 01	LA	T	1	3/17/90	3/17/90	19,875	SAWTOOTH	SALMON R	SNAK		
							03	LA	T	3	3/17/90	3/17/90	18,675	SAWTOOTH	SALMON R	SNAK		
							02	LA	T	4	3/17/90	3/17/90	18,875	SAWTOOTH	SALMON R	SNAK		
*											LOT ID TOTAL.		57,425	FROM 3 RELEASES				*
**											HATCHERY TOTAL.		57,425	FROM 3 RELEASES				**
***											AGENCY TOTAL...		260,992	FROM 11 RELEASES				***

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AGCY	HATCHERY.....	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID #	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER NAME.....	ZONE	COMMENTS.....	FPC BRAND
NMFS	MONTLAKE	SOCKEYE		11/01/89	11/30/89	25,987	90505 01	RA	TL	1	11/01/89	11/30/89	9,863	CLE ELEM LAKE	YAKIMA R	MCOL	PIT TAG 503 CWT 23-29-32	
							02	RA	TL	3	11/01/89	11/30/89	8,018	CLE ELEM LAKE	YAKIMA R	MCOL	PIT TAG 503 CWT 23-29-33	
							03	RA	UX	1	11/01/89	11/30/89	8,106	CLE ELEM LAKE	YAKIMA R	MCOL	PIT TAG 505 CWT 23-29-34	
*											LOT ID TOTAL.		25,987	FROM 3 RELEASES				*
		SOCKEYE		11/20/89	6/01/90	12,069	90508 01	LA	IN	1	11/20/89	11/20/89	3,021	CLE ELEM R.	YAKIMA R	MCOL	PIT TAG 507 CWT 23-29-35	
							02	LA	LC	1	3/15/90	3/15/90	1,503	CLE ELEM R.	YAKIMA R	MCOL	PIT TAG 511 CWT 23-29-42	
							03	LA	XH	1	4/01/90	4/01/90	1,529	CLE ELEM R.	YAKIMA R	MCOL	PIT TAG 500 CWT 23-29-43	
							04	LA	9T	1	4/15/90	4/15/90	1,500	CLE ELEM R.	YAKIMA R	MCOL	PIT TAG 501 CWT 23-29-44	
							05	LA	LC	3	5/01/90	5/01/90	1,500	CLE ELEM R.	YAKIMA R	MCOL	PIT TAG 498 CWT 23-29-45	
							06	LA	XH	3	5/15/90	5/15/90	1,513	CLE ELEM R.	YAKIMA R	MCOL	PIT TAG 502 CWT 23-29-46	
							07	LA	9T	3	6/01/90	6/01/90	1,503	CLE ELEM R.	YAKIMA R	MCOL	PIT TAG 500 CWT 23-29-47	
*											LOT ID TOTAL.		12,069	FROM 7 RELEASES				*
		SOCKEYE		3/15/90	3/15/90	25,422	90506 03	RA	XJ	1	3/15/90	3/15/90	8,500	CLE ELEM LAKE	YAKIMA R	MCOL	PIT TAG 501 CWT 23-29-38	
							01	RA	2F	1	3/15/90	3/15/90	8,400	CLE ELEM LAKE	YAKIMA R	MCOL	PIT TAG 500 CWT 23-29-36	
							02	RA	2F	3	3/15/90	3/15/90	8,522	CLE ELEM LAKE	YAKIMA R	MCOL	PIT TAG 500 CWT 23-29-37	
*											LOT ID TOTAL.		25,422	FROM 3 RELEASES				*
		SOCKEYE		4/24/90	4/26/90	25,500	90507 03	RA	UO	1	4/24/90	4/26/90	8,500	CLE ELEM LAKE	YAKIMA R	MCOL	PIT TAG 512 CWT 23-29-41	
							01	RA	14	1	4/24/90	4/26/90	8,500	CLE ELEM LAKE	YAKIMA R	MCOL	PIT TAG 499 CWT 23-29-39	
							02	RA	14	3	4/24/90	4/26/90	8,500	CLE ELEM LAKE	YAKIMA R	MCOL	PIT TAG 508 CWT 23-29-40	
*											LOT ID TOTAL.		25,500	FROM 3 RELEASES				*
**											HATCHERY TOTAL.		88,978	FROM 16 RELEASES				**
	NON-HATCHERY	SP CHINOOK	1	4/03/90	6/08/90	70,000	90503 01	RA	L	1	4/13/90	4/18/90	7,000	BELOW BON DAM	COLUMBIA R.	BRON	CWT 23-24-29	

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AGCY HATCHERY.....	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER ..... NAME	ZONE	COMMENTS.....	FPC BRAND
NMFS NON-HATCHERY	SP CHINOOK	1	4/03/90	6/08/90	70,000	90503	04	RA	L	4	4/17/90	4/21/90	7,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-30	
							02	RA	L	2	4/21/90	4/25/90	7,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-31	
							05	RA	V	1	4/25/90	5/02/90	7,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-32	
							06	RA	V	2	5/02/90	5/14/90	7,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-33	
							07	RA	V	3	5/14/90	5/29/90	7,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-34	
							08	RA	V	4	5/29/90	6/08/90	2,708	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-35	
*											LOT ID TOTAL.		44,708	FROM 7 RELEASES				*
	SP CHINOOK	1	4/07/90	4/08/90	300	90510	03	LA	2X	1	4/08/90	4/08/90	75	PROSSER TRAP	YAKIMA R	MCOL		
							04	LA	2X	3	4/08/90	4/08/90	75	PROSSER TRAP	YAKIMA R	MCOL		
							01	RA	2X	1	4/08/90	4/08/90	75	PROSSER TRAP	YAKIMA R	MCOL		
							02	RA	2X	3	4/08/90	4/08/90	75	PROSSER TRAP	YAKIMA R	MCOL		
*											LOT ID TOTAL.		300	FROM 4 RELEASES				*
	SP CHINOOK	1	4/16/90	4/16/90	500	90513	03	LA	RT	1	4/16/90	4/16/90	120	PROSSER TRAP	YAKIMA R	MCOL		
							04	LA	RT	3	4/16/90	4/16/90	140	PROSSER TRAP	YAKIMA R	MCOL		
							01	RA	RT	1	4/16/90	4/16/90	120	PROSSER TRAP	YAKIMA R	MCOL		
							02	RA	RT	3	4/16/90	4/16/90	120	PROSSER TRAP	YAKIMA R	MCOL		
*											LOT ID TOTAL.		500	FROM 4 RELEASES				*
	FA CHINOOK	0	5/26/90	5/26/90	500	90514	03	LA	+	1	5/26/90	5/26/90	125	PROSSER TRAP	YAKIMA R	MCOL		
							04	LD	+	1	5/26/90	5/26/90	125	PROSSER TRAP	YAKIMA R	MCOL		
							01	RA	+	1	5/26/90	5/26/90	125	PROSSER TRAP	YAKIMA R	MCOL		
							02	RD	+	1	5/26/90	5/26/90	125	PROSSER TRAP	YAKIMA R	MCOL		
*											LOT ID TOTAL.		500	FROM 4 RELEASES				*
	SU STEELHEAD		4/10/90	5/25/90	30,000	90504	01	RA	L	1	4/10/90	4/24/90	5,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-45	
							02	RA	L	2	4/24/90	5/03/90	5,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-46	
							03	RA	L	3	5/03/90	5/07/90	5,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-47	
							04	RA	L	4	5/08/90	5/10/90	5,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-48	
							05	RA	4	1	5/10/90	5/15/90	5,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-49	
							06	RA	4	2	5/16/90	5/25/90	5,000	BELOW BON DAM	COLUMBIA R.	BBON	CWT 23-24-50	
*											LOT ID TOTAL.		30,000	FROM 6 RELEASES				*
**											HATCHERY TOTAL.		76,008	FROM 25 RELEASES				**
***											AGENCY TOTAL...		164,986	FROM 41 RELEASES				***

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AGCY	HATCHERY.....	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID #	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER ..... NAME	ZONE	COMMENTS.....	FPC BRAND
ODFW	BONNEVILLE	FA CHINOOK	0	6/30/90	8/03/90	1,876,669	90788 05	RD	F	1	6/30/90	7/03/90	89,755	BELOW BON DAM	COLUMBIA R.	BBON	REL EGRESS CWT 232453,56,59	
							02	RD	U	1	6/30/90	6/30/90	1,806	BELOW BON DAM	COLUMBIA R.	BBON	REL TURB 17 (LOWER) CWT 232451	
							01	RD	Z	1	6/30/90	7/03/90	87,370	BELOW BON DAM	COLUMBIA R.	BBON	REL TURB 17 (LOWER) CWT 232451,54,57	
							03	RD	2	1	6/30/90	6/30/90	2,103	BELOW BON DAM	COLUMBIA R.	BBON	REL BYPASS SYSTEM CWT 232452	
							04	RD	3	1	6/30/90	7/03/90	84,972	BELOW BON DAM	COLUMBIA R.	BBON	REL BYPASS SYSTEM CWT 232452,55,58	
							08	RD	F	3	7/05/90	7/06/90	59,416	BELOW BON DAM	COLUMBIA R.	BBON	REL EGRESS CWT 232462,232505	
							06	RD	Z	2	7/05/90	7/06/90	59,489	BELOW BON DAM	COLUMBIA R.	BBON	REL TURB 17 (LOWER) CWT 232460,63	
							07	RD	3	3	7/05/90	7/06/90	60,922	BELOW BON DAM	COLUMBIA R.	BBON	REL BYPASS SYSTEM CWT 232461,232503	
							11	LD	F	1	7/10/90	7/13/90	119,275	BELOW BON DAM	COLUMBIA R.	BBON	REL EGRESS CWT 232510,17,23,29	
							09	LD	U	1	7/10/90	7/13/90	119,102	BELOW BON DAM	COLUMBIA R.	BBON	REL TURB 17 (LOWER) CWT 232506,12,18,24	
							10	LD	2	1	7/10/90	7/13/90	119,183	BELOW BON DAM	COLUMBIA R.	BBON	REL BYPASS SYSTEM CWT 232509,15,20,27	
							14	LD	F	3	7/17/90	7/21/90	119,275	BELOW BON DAM	COLUMBIA R.	BBON	REL EGRESS CWT 232534,40,46,53	
							12	LD	U	3	7/17/90	7/21/90	119,107	BELOW BON DAM	COLUMBIA R.	BBON	REL TURB 17 (LOWER) CWT 232530,36,43,48	
							13	LD	2	3	7/17/90	7/21/90	118,841	BELOW BON DAM	COLUMBIA R.	BBON	REL BYPASS SYSTEM CWT 232533,39,45,51	
							15	RD	)H	1	7/24/90	7/27/90	119,442	BELOW BON DAM	COLUMBIA R.	BBON	REL TURB 17 (LOWER) CWT 232554,60,232605,10	
							16	RD	)K	1	7/24/90	7/27/90	119,455	BELOW BON DAM	COLUMBIA R.	BBON	REL BYPASS SYSTEM CWT 232557,63,232606,12	
							17	RD	)X	1	7/24/90	7/27/90	119,387	BELOW BON DAM	COLUMBIA R.	BBON	REL EGRESS CWT 232558,232603,09,15	
							18	RD	)H	3	7/31/90	8/03/90	119,219	BELOW BON DAM	COLUMBIA R.	BBON	REL TURB 17 (LOWER) CWT 232617,23,29,34	
							19	RD	)K	3	7/31/90	8/03/90	119,403	BELOW BON DAM	COLUMBIA R.	BBON	REL BYPASS SYSTEM CWT 232618,24,30,36	
							20	RD	)X	3	7/31/90	8/03/90	119,147	BELOW BON DAM	COLUMBIA R.	BBON	REL EGRESS CWT 232620,27,33,39	
*											LOT ID TOTAL.		1,876,669	FROM 20 RELEASES				*
**											HATCHERY TOTAL.		1,876,669	FROM 20 RELEASES				**
	IMNAHA	SP CHINOOK	1	3/30/90	3/31/90	249,793	90129 02	LA	A	1	3/30/90	3/31/90	20,815	IMNAHA R	IMNAHA R	SNAK	CWT 07-47-29	
							01	RA	A	1	3/30/90	3/31/90	20,170	IMNAHA R	IMNAHA R	SNAK	CWT 07-47-30	
*											LOT ID TOTAL.		40,985	FROM 2 RELEASES				*
**											HATCHERY TOTAL.		40,985	FROM 2 RELEASES				**

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AGCY	HATCHERY.......	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER NAME	ZONE	COMMENTS...............	FPC BRAND
ODFW	IRRIGON	FA CHINOOK	0	5/11/90	6/01/90	2,425,681	90101	01	LD	B	2	5/23/90	5/23/90	157,058	UMATILLA R	UMATILLA R	LCOL	CWT 07-54-(03-05)	
*												LOT ID TOTAL.		157,058	FROM 1 RELEASES				*
		SU STEELHEAD		4/19/90	4/19/90	53,747	90118	01	LD	A	2	4/19/90	4/19/90	24,569	SPRING CR CHNL	WALLOWA R	SNAK	CWT 07-51-18,19	
								02	RD	A	2	4/19/90	4/19/90	24,228	SPRING CR CHNL	WALLOWA R	SNAK	CWT 07-51-18,19	
*												LOT ID TOTAL.		48,797	FROM 2 RELEASES				*
		SU STEELHEAD		4/24/90	4/26/90	97,605	90120	02	LD	A	4	4/24/90	4/26/90	24,739	WILDCAT CR	GRANDE RONDE R	SNAK		
								01	RD	A	4	4/24/90	4/26/90	22,983	WILDCAT CR	GRANDE RONDE R	SNAK		
*												LOT ID TOTAL.		47,722	FROM 2 RELEASES				*
**												HATCHERY TOTAL.		253,577	FROM 5 RELEASES				**
	LOOKINGGLASS	SP CHINOOK	1	4/02/90	4/02/90	619,630	90123	04	LA	A	2	4/02/90	4/02/90	20,406	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	CWT 07-47-45	
								01	LA	A	4	4/02/90	4/02/90	20,738	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	CWT 07-47-39	
								03	RA	A	2	4/02/90	4/02/90	20,841	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	CWT 07-47-43	
								02	RA	A	4	4/02/90	4/02/90	20,801	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	CWT 07-47-45	
*												LOT ID TOTAL.		82,786	FROM 4 RELEASES				*
**												HATCHERY TOTAL.		82,786	FROM 4 RELEASES				**
	WALLOWA	SU STEELHEAD		4/15/90	4/23/90	495,875	90115	01	LD	A	1	4/15/90	4/19/90	24,233	WALLOWA R	WALLOWA R	SNAK	CWT 07-51-20	
								03	LD	A	3	4/15/90	4/19/90	24,903	WALLOWA R	WALLOWA R	SNAK	CWT 07-51-22	
								02	RD	A	1	4/15/90	4/19/90	25,478	WALLOWA R	WALLOWA R	SNAK	CWT 07-51-21	
								04	RD	A	3	4/15/90	4/19/90	25,426	WALLOWA R	WALLOWA R	SNAK	CWT 07-51-23	
*												LOT ID TOTAL.		100,040	FROM 4 RELEASES				*
		SU STEELHEAD		4/16/90	4/21/90	249,564	90121	01	LD	J	3	4/16/90	4/17/90	26,522	LI SHEEP CR	IMNAHA R	SNAK	CWT 07-51-24,25	
								02	RD	J	3	4/16/90	4/17/90	24,500	LI SHEEP CR	IMNAHA R	SNAK	CWT 07-51-24,25	
*												LOT ID TOTAL.		51,022	FROM 2 RELEASES				*
**												HATCHERY TOTAL.		151,062	FROM 6 RELEASES				**
***												AGENCY TOTAL...		2,405,079	FROM 37 RELEASES				***

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AGCY	HATCHERY.....	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID #	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER ..... NAME	ZONE	COMMENTS.....	FPC BRAND
USFW	DWORSHAK	SP CHINOOK	1	3/21/90	4/05/90	12,684	90245 01	LD	K	1	3/21/90	3/21/90	2,609	CLRWTR @ HWY 95	CLEARWATER R	SNAK	EFFICIENCY RELEASE	
							03	LD	K	3	3/26/90	3/26/90	2,266	CLRWTR @ HWY 95	CLEARWATER R	SNAK	EFFICIENCY RELEASE	
							05	LA	K	1	3/28/90	3/28/90	2,195	CLRWTR @ HWY 95	CLEARWATER R	SNAK	EFFICIENCY RELEASE	
							02	LD	K	2	3/30/90	3/30/90	2,061	CLRWTR @ HWY 95	CLEARWATER R	SNAK	EFFICIENCY RELEASE	
							04	LD	K	4	4/02/90	4/02/90	2,135	CLRWTR @ HWY 95	CLEARWATER R	SNAK	EFFICIENCY RELEASE	
							06	LA	K	2	4/05/90	4/05/90	1,418	CLRWTR @ HWY 95	CLEARWATER R	SNAK	EFFICIENCY RELEASE	
*											LOT ID TOTAL.		12,684	FROM 6 RELEASES				*
		SP CHINOOK	1	4/04/90	4/05/90	1,238,743	90203 03	LD	7U	1	4/05/90	4/05/90	19,730	DWORSHAK	N F CLEARWATER	SNAK		
							01	RA	7U	1	4/05/90	4/05/90	20,239	DWORSHAK	N F CLEARWATER	SNAK		
							02	RA	7U	3	4/05/90	4/05/90	19,900	DWORSHAK	N F CLEARWATER	SNAK		
*											LOT ID TOTAL.		59,869	FROM 3 RELEASES				*
		SU STEELHEAD		5/03/90	5/04/90	1,166,664	90204 03	RA	K	1	5/03/90	5/04/90	4,052	DWORSHAK	N F CLEARWATER	SNAK		
							04	RA	K	2	5/03/90	5/04/90	4,410	DWORSHAK	N F CLEARWATER	SNAK		
							02	RA	Z	1	5/03/90	5/03/90	30,000	DWORSHAK	N F CLEARWATER	SNAK		
							05	RD	K	1	5/03/90	5/04/90	4,120	DWORSHAK	N F CLEARWATER	SNAK		
							06	RD	K	2	5/03/90	5/04/90	4,010	DWORSHAK	N F CLEARWATER	SNAK		
							07	RD	K	3	5/03/90	5/04/90	4,160	DWORSHAK	N F CLEARWATER	SNAK		
							08	RD	K	4	5/03/90	5/04/90	4,080	DWORSHAK	N F CLEARWATER	SNAK		
							01	RA	T	1	5/04/90	5/04/90	30,000	DWORSHAK	N F CLEARWATER	SNAK		
*											LOT ID TOTAL.		84,832	FROM 8 RELEASES				*
**											HATCHERY TOTAL.		157,385	FROM 17 RELEASES				**
	ENTIAT	SP CHINOOK	1	4/18/90	4/19/90	585,800	90205 01	RA	7N	1	4/19/90	4/19/90	17,152	ENTIAT R	ENTIAT R	MCOL		
							02	RA	7N	3	4/19/90	4/19/90	16,791	ENTIAT R	ENTIAT R	MCOL		
*											LOT ID TOTAL.		33,943	FROM 2 RELEASES				*
**											HATCHERY TOTAL.		33,943	FROM 2 RELEASES				**
	LEAVENWORTH	SP CHINOOK	1	4/18/90	4/18/90	2,251,503	90325 01	LA	7T	1	4/18/90	4/18/90	16,785	LEAVENWORTH	WENATCHEE R	MCOL		
							02	LA	7T	3	4/18/90	4/18/90	15,572	LEAVENWORTH	WENATCHEE R	MCOL		
							04	LD	7T	1	4/18/90	4/18/90	1,161	LEAVENWORTH	WENATCHEE R	MCOL	GROUP MIS-BRANDED FROM RD-7T-1 GROUP	
							03	RD	7T	1	4/18/90	4/18/90	15,521	LEAVENWORTH	WENATCHEE R	MCOL		
*											LOT ID TOTAL.		49,039	FROM 4 RELEASES				*
		SP CHINOOK	1	5/04/90	5/04/90	51,800	90248 01	RA	Y	1	5/04/90	5/04/90	12,400	LEAVENWORTH	WENATCHEE R	MCOL		
							02	RA	Y	2	5/04/90	5/04/90	12,100	LEAVENWORTH	WENATCHEE R	MCOL		
							03	RA	Y	3	5/04/90	5/04/90	13,100	LEAVENWORTH	WENATCHEE R	MCOL		
							04	RA	Y	4	5/04/90	5/04/90	14,200	LEAVENWORTH	WENATCHEE R	MCOL		
*											LOT ID TOTAL.		51,800	FROM 4 RELEASES				*

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USFW	LEAVENWORTH	SP CHINOOK	0	5/04/90	5/04/90	125,100	90324 01	LA	Y	1	5/04/90	5/04/90	31,200	LEAVENWORTH	WENATCHEE R	MCOL		
							02	LA	Y	2	5/04/90	5/04/90	31,700	LEAVENWORTH	WENATCHEE R	MCOL		
							03	LA	Y	3	5/04/90	5/04/90	31,000	LEAVENWORTH	WENATCHEE R	MCOL		
							04	LA	Y	4	5/04/90	5/04/90	31,200	LEAVENWORTH	WENATCHEE R	MCOL		
*											LOT ID TOTAL.		125,100	FROM 4 RELEASES				*
**											HATCHERY TOTAL.		225,939	FROM 12 RELEASES				**
	WINTHROP	SP CHINOOK	1	4/17/90	4/17/90	1,121,395	90219 03	LD	7C	1	4/17/90	4/17/90	14,143	WINTHROP	METHOW R	MCOL		
							01	RA	7C	1	4/17/90	4/17/90	16,745	WINTHROP	METHOW R	MCOL		
							02	RA	7C	3	4/17/90	4/17/90	16,261	WINTHROP	METHOW R	MCOL		
*											LOT ID TOTAL.		47,149	FROM 3 RELEASES				*
**											HATCHERY TOTAL.		47,149	FROM 3 RELEASES				**
***											AGENCY TOTAL...		464,416	FROM 34 RELEASES				***

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* System at (503) 230-4289. *
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AGCY	HATCHERY.....	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID #	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER ..... NAME	ZONE	COMMENTS.....	FPC BRAND
WDF	LYONS FERRY	FA CHINOOK	0	6/06/90	7/12/90	2,796,208	90014 01	RA	UL	1	6/06/90	6/06/90	39,196	LYONS FERRY	SNAKE R	SNAK	100% CWT NO AD CLIP LYFE U BRAND	
							02	RA	UL	3	6/06/90	6/06/90	39,504	LYONS FERRY	SNAKE R	SNAK	100% CWT NO AD CLIP LYFE U BRAND	
*											LOT ID TOTAL.		78,700	FROM 2 RELEASES				*
**											HATCHERY TOTAL.		78,700	FROM 2 RELEASES				**
	PRIEST RAPIDS	FA CHINOOK	0	6/07/90	6/19/90	6,431,100	90041 01	RA	H	1	6/07/90	6/07/90	37,392	BELOW PRD DAM	MID COLUMBIA R	MCOL		
							02	RA	H	2	6/10/90	6/10/90	37,121	BELOW PRD DAM	MID COLUMBIA R	MCOL		
							05	RD	H	1	6/13/90	6/13/90	38,717	BELOW PRD DAM	MID COLUMBIA R	MCOL		
							03	RA	UP	3	6/16/90	6/16/90	39,924	BELOW PRD DAM	MID COLUMBIA R	MCOL	PRIEST R U BRAND	
							04	RA	UP	1	6/19/90	6/19/90	39,904	BELOW PRD DAM	MID COLUMBIA R	MCOL	PRIEST RAPIDS U BRAND	
*											LOT ID TOTAL.		193,058	FROM 5 RELEASES				*
**											HATCHERY TOTAL.		193,058	FROM 5 RELEASES				**
	RINGOLD	SP CHINOOK	1	3/28/90	4/04/90	870,000	90040 01	LA	7S	1	3/28/90	4/04/90	19,711	RINGOLD	MID COLUMBIA R	MCOL		
							02	LA	7S	3	3/28/90	4/04/90	20,125	RINGOLD	MID COLUMBIA R	MCOL		
*											LOT ID TOTAL.		39,836	FROM 2 RELEASES				*
**											HATCHERY TOTAL.		39,836	FROM 2 RELEASES				**
	WELLS	SU CHINOOK	0	5/22/90	5/25/90	1,310,656	90046 01	LA	H	1	5/22/90	5/25/90	46,425	BELOW WELLS DAM	MID COLUMBIA R	MCOL		
							02	LA	H	2	5/22/90	5/25/90	46,276	BELOW WELLS DAM	MID COLUMBIA R	MCOL		
*											LOT ID TOTAL.		92,701	FROM 2 RELEASES				*
**											HATCHERY TOTAL.		92,701	FROM 2 RELEASES				**
***											AGENCY TOTAL....		404,295	FROM 11 RELEASES				***

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* System at (503) 230-4289. *
****

AGCY	HATCHERY.....	SPECIES...	AGE	MAJOR RELEASE STARI	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID #	LOC	BRND	ROT	BRAND RELEASE STARI	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER ..... NAME	ZONE	COMMENTS.....	FPC BRAND
WDW	LYONS FERRY	SU STEELHEAD		4/15/90	4/30/90	119,264	90413 03	LA	IC	1	4/15/90	4/30/90	19,352	TUCANNON R	TUCANNON R	SNAK	CWT 63-39-12 REL AT CURL LAKE	
							04	RA	IC	1	4/15/90	4/30/90	19,483	TUCANNON R	TUCANNON R	SNAK	CWT 63-39-11 REL AT CURL LAKE	
							01	LA	IC	2	4/25/90	4/25/90	19,219	TUCANNON R	TUCANNON R	SNAK	CWT 63-08-41R3 REL AT MARENGO	
							02	RA	IC	2	4/25/90	4/25/90	18,853	TUCANNON R	TUCANNON R	SNAK	CWT 63-08-38R3 REL AT MARENGO	
*											LOT ID TOTAL.		76,907	FROM 4 RELEASES				*
		SU STEELHEAD		4/15/90	4/30/90	116,345	90416 01	LA	S	1	4/15/90	4/30/90	19,039	TOUCHET R	WALLA WALLA R	MCOL	CWT 63-39-08	
							02	RA	S	1	4/15/90	4/30/90	18,870	TOUCHET R	WALLA WALLA R	MCOL	CWT 63-02-49	
*											LOT ID TOTAL.		37,909	FROM 2 RELEASES				*
		SU STEELHEAD		4/17/90	4/30/90	137,847	90412 01	LA	IC	4	4/17/90	4/17/90	19,457	ASOTIN CR	SNAKE R	SNAK	CWT 63-07-25R3	
							02	RA	IC	4	4/18/90	4/18/90	18,793	ASOTIN CR	SNAKE R	SNAK	CWT 63-14-22R3	
*											LOT ID TOTAL.		38,250	FROM 2 RELEASES				*
		SU STEELHEAD		4/18/90	4/25/90	130,217	90415 01	LA	S	2	4/24/90	4/24/90	19,168	WALLA WALLA R	WALLA WALLA R	MCOL	CWT 63-39-10	
							02	RA	S	2	4/25/90	4/25/90	19,094	WALLA WALLA R	WALLA WALLA R	MCOL	CWT 63-39-09	
*											LOT ID TOTAL.		38,262	FROM 2 RELEASES				*
		SU STEELHEAD		4/27/90	4/30/90	43,479	90414 01	LA	IC	3	4/27/90	4/27/90	17,170	LYONS FERRY	SNAKE R	SNAK	CWT 63-14-21R3	
							02	RA	IC	3	4/27/90	4/27/90	20,327	LYONS FERRY	SNAKE R	SNAK	CWT 63-08-42R3	
*											LOT ID TOTAL.		37,497	FROM 2 RELEASES				*
**											HATCHERY TOTAL.		228,825	FROM 12 RELEASES				**
	WELLS	SU STEELHEAD		4/18/90	4/25/90	97,494	90402 01	LD	7H	1	4/24/90	4/25/90	19,855	SIMILKAMEEN R	OKANOGAN R	MCOL	100% CWT 62-31-14	
							02	LD	7H	3	4/24/90	4/25/90	18,868	SIMILKAMEEN R	OKANOGAN R	MCOL	100% CWT 62-31-14	
*											LOT ID TOTAL.		38,723	FROM 2 RELEASES				*
		SU STEELHEAD		4/24/90	5/09/90	487,239	90403 02	RA	7H	3	4/25/90	4/26/90	14,793	METHOW R	METHOW R	MCOL	REL AT CARLTON 100% CWT 62-31-15	
							01	RA	7H	1	4/26/90	4/26/90	14,716	METHOW R	METHOW R	MCOL	REL AT CARLTON 100% CWT 62-31-15	
*											LOT ID TOTAL.		29,509	FROM 2 RELEASES				*
**											HATCHERY TOTAL.		68,232	FROM 4 RELEASES				**
***											AGENCY TOTAL....		297,057	FROM 16 RELEASES				***

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* System at (503) 230-4289. *
****

AGCY	HATCHERY.....	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID #	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER ..... NAME	ZONE	COMMENTS.....	FPC BRAND
YATR	NON-HATCHERY	SP CHINOOK	1	11/15/89	12/12/89	3,916	90703 01	LA	+J	1	11/15/89	11/27/89	661	WAPATOX	YAKIMA R	MCOL		
							03	LA	+J	3	11/15/89	11/27/89	678	WAPATOX	YAKIMA R	MCOL		
							02	LP	+J	1	11/15/89	11/27/89	668	WAPATOX	YAKIMA R	MCOL		
							04	LP	+J	3	11/15/89	11/27/89	666	WAPATOX	YAKIMA R	MCOL		
							05	RA	+J	1	11/29/89	12/12/89	329	WAPATOX	YAKIMA R	MCOL		
							07	RA	+J	3	11/29/89	12/12/89	324	WAPATOX	YAKIMA R	MCOL		
							06	RP	+J	1	11/29/89	12/12/89	294	WAPATOX	YAKIMA R	MCOL		
							08	RP	+J	3	11/29/89	12/12/89	296	WAPATOX	YAKIMA R	MCOL		
*											LOT ID TOTAL.		3,916	FROM 8 RELEASES				*
		SP CHINOOK	1	12/12/89	1/16/90	1,303	90701 01	RA	+F	1	12/12/89	1/16/90	337	ROZA	YAKIMA R	MCOL		
							03	RA	+F	3	12/12/89	1/16/90	322	ROZA	YAKIMA R	MCOL		
							02	RP	+F	1	12/12/89	1/16/90	336	ROZA	YAKIMA R	MCOL		
							04	RP	+F	3	12/12/89	1/16/90	308	ROZA	YAKIMA R	MCOL		
*											LOT ID TOTAL.		1,303	FROM 4 RELEASES				*
		SP CHINOOK	1	1/17/90	3/01/90	3,272	90702 01	RA	+I	1	1/17/90	3/01/90	881	ROZA	YAKIMA R	MCOL		
							03	RA	+I	3	1/17/90	3/01/90	792	ROZA	YAKIMA R	MCOL		
							02	RP	+I	1	1/17/90	3/01/90	808	ROZA	YAKIMA R	MCOL		
							04	RP	+I	3	1/17/90	3/01/90	791	ROZA	YAKIMA R	MCOL		
*											LOT ID TOTAL.		3,272	FROM 4 RELEASES				*
**											HATCHERY TOTAL.		8,491	FROM 16 RELEASES				**
***											AGENCY TOTAL...		8,491	FROM 16 RELEASES				***

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* L A S T P A G E *
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APPENDIX K: Comments on Draft Annual Report and FPC Responses

FISH PASSAGE CENTER

2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

May 31, 1991

Rod Woodin
WDF
115 General Administration Bldg.
Olympia, WA 98504

Dear Rod:

Thank you for taking the time to review the 1990 Fish Passage Center Annual Report. The error that you noted in the text was corrected.

Sincerely,

Michele DeHart
Fish Passage Center Manager

304-91.*

JOSEPH R. BLUM
Director

STATE OF WASHINGTON

DEPARTMENT OF FISHERIES

115 General Administration Building, M.S. AX-11 • Olympia, Washington 98504 • (206) 753-6600 • (SCAN) 234-6600

FEB 1

February 14, 1991

Fish Passage Center
ATTENTION: Michelle DeHart
2501 SW First Avenue, Suite 230
Portland, Oregon 97201-4752

SUBJECT: Draft 1990 Fish Passage Center Annual Report

Congratulation's to you and your staff for producing another excellent document. Your report provided clear, concise, and comprehensive documentation of an exceptionally complex program. The only error which I noted in my review was on page 63, line 6, where you report two recovery rates for wild Clearwater River steelhead. I assume that one of these rates is for some other group.

Keep up the good work. We look forward to working with you on the 1991 program.

Sincerely,

Rod Woodin

Rod Woodin
Biologist
Habitat Management Division

RW:dlm

FISH PASSAGE CENTER

2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

May 31, 1991

Steve Pettit
IDFG
1540 Warner Ave.
Lewiston, ID 83507

Dear Steve:

Thank you for your comments on the 1990 Fish Passage Center Annual Report. Because of the amount of data that would be used in each graphic we were not able to incorporate the graphics you suggested into the present report. However, we will be looking at ways to develop these graphics in a concise and understandable format for possible inclusion in future reports.

Sincerely,

Michele DeHart
Fish Passage Center Manager

304-91.*

FISH PASSAGE CENTER
2501 S.W. First Ave., Suite 230
Portland, Oregon 97201-4752

TELEPHONE LOG #91-20:

CALL DATE: February 27, 1991 TIME: 2:00 pm

CALL FROM: Steve Pettit, IDFG

CALL TO: Michele DeHart, FPC PHONE #:

RE: Comments on the 1990 Fish Passage Managers Annual Report

Steve called and advised that two additional graphics might be helpful in the annual report. First, a graphic that compares volume runoff relative to percent of normal for key sites such as Grand Coulee, Rock Island, the Dalles, Dworshak, Brownlee and Lower Granite.

Steve also requested that we include a graphic that illustrates the time period the Snake River Water Budget was used, and the flows that resulted for all years.

FISH PASSAGE CENTER

2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

May 31, 1991

Ed Buettner
IDFG - Region 2
1540 Warner Ave.
Lewiston, ID 83501

Dear Ed:

Thank you for the very constructive comments you provided on sections of the draft 1990 Fish Passage Center Annual Report, pertaining to travel time in Lower Granite pool. From your comments, it could be seen that the discussions of smoltification effects were confusing, and as a result Section 2.a. (pages 62-68) have been extensively re-written. Health on the three Dworshak Hatchery steelhead groups could also affect recovery proportion, but we have no information of IHN in each raceway. The corrections you noted on PIT tag tables G-1 to G-6 were reviewed. Purse seine fish from April 17 remain excluded from the Snake River trap tables and comment to this fact is given in the footnotes. Your corrections on release and recovery numbers were incorporated. The three days before April 18 when only one hatchery steelhead per day was tagged, remain excluded from table G-5. The freeze brand release data in Table G-11 was updated to show corrected release numbers for LA-PP-1, RD-A-2 (steelhead), and LA-T-4; the median release date of Wallowa AP steelhead was corrected resulting in changes to travel time and migration speeds for that group. Trap efficiency groups (K brands) remain excluded. The release number corrections you showed for Asotin Cr. steelhead were in error, because they have not been adjusted for brand loss (unreadable brand proportion), as all other groups have been. The adjustment factors are 0.966 for LA-IC-4 and 0.942 for RA-IC-4. In addition, the unadjusted release number for RA-IC-4 was 19950 instead of 19905.

Thank you again for your review.

Sincerely,

Michele DeHart

Michele DeHart
Fish Passage Center Manager

304-91.*

FISH PASSAGE CENTER

2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

May 31, 1991

Merritt E. Tuttle,
Division Chief
NMFS
911 NE 11th Ave., Room 620
Portland, OR 97232

Dear Merritt:

Thank you very much for your comments on the 1990 Fish Passage Center Annual Report. Your comments were constructive and were useful in improving the report. Most of the comments were accommodated by making the suggested changes and additions. Our specific responses to some of the comments are as follows:

Page 59, paragraph 4: The 30 fish was not a specific goal for the analysis. The precision of the estimated median was increased by increasing the numbers of fish available for analysis by blocking groups when possible. The text has been revised to reflect this intent.

Page 62, Table 13: This table was simply meant to be a presentation of the data collected for 1990. A review of the pooled data could be accomplished in a different publication.

Page 71, Table 14: Again the intent was to present the data collected for 1990. The suggested multiyear analysis would best be conducted for a specific group of fish across several years.

Page 74, paragraph 3: For the purpose of estimating travel time from a recovered group of PIT tagged fish, where the estimate of travel time is the median time of the recovered fish, an adjustment is not necessary for spill at McNary. By not expanding fish the computation of the 95% confidence interval was computed. You are correct that any further analyses concerning the recovery proportions would necessitate an adjustment for spill.

Page 78, paragraph 3: The number of fish was added to the text.

Page 82, paragraph 3: The suggested discussion has been included.

Sincerely,

Michele DeHart
Fish Passage Center Manager

304-91.*

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
ENVIRONMENTAL & TECHNICAL SERVICES DIVISION
911 NE 11th Avenue - Room 620
PORTLAND, OREGON 97232
503/230-5400 FAX 503/230-5435

April 2, 1991 F/NWR5:301

APR 1991

Ms. Michele DeHart
Fish Passage Center
2501 S.W. First Ave, Suite 230
Portland, OR 97201-4752

Dear Ms. DeHart:

Thank you for the opportunity to review the 1990 Fish Passage Center Annual Report Draft. We found it to be an excellent report and our limited number of comments reflect that. We have the following comments for your consideration.

1. Page 3, paragraph 4, sentence 2: We suggest that the Mainstem Executive Committee be defined.

2. Page 10, paragraph 3, sentence 2: We recommend re-wording the second part of this sentence to read - illustrates the impact of the Water Budget on the reservoirs.

3. Page 37, Figure 5: We suggest that the nomenclature for DAF be specified in the Figure and text.

4. Page 39, paragraph 4, sentence 2: Please cite the reference(s) which indicates that levels above 115% dissolved nitrogen subject fish to gas bubble disease.

5. Page 45, paragraph 2, sentences 2 & 3: We propose the following alternate sentences - Significant numbers of sockeye, coho, and steelhead exhibited symptoms of the disease, with the highest incidence recorded in the group of steelhead released from the barge above John Day Dam. These fish passed John Day when 100% of the flow at the project was being spilled and dissolved gas levels reached 135% supersaturation. (The data reveal that other groups of fish in the river at that time were indeed impacted by the high levels of nitrogen, e.g. coho.)

6. Page 48, paragraph 2, sentence 8: We suggest re-wording this sentence to read - The 1990 annual passage index for each species was expected to be lower than in prior years, since passage levels tend to decrease at units farther from the Oregon Shore at John Day Dam.

7. Page 59, paragraph 4, sentence 2: Question - Why are recovery numbers of >30 fish used at Lower Granite while only >20 fish are used at McNary and John Day dams?

8. Page 62, Table 13: We found this table to be an adept presentation of the data. As an aside, we would like to see this with confidence intervals using data pooled from all years.

9. Page 71, Table 14: Question - Why is there no flow/travel time analysis for the groups of fish listed in this table?

10. Page 74, paragraph 3, sentence 5: Question - Why was there no adjustment for spill at McNary Dam in 1990?

11. Page 78, paragraph 3, sentence 3: We suggest you include the actual recovered numbers rather than merely referring to them as "low".

12. Page 82, paragraph 3: Please consider including a discussion of the system operational requests made for adult passage in 1990.

Sincerely,

For Merritt E. Tuttle
Division Chief

FISH PASSAGE CENTER

2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

May 31, 1991

Russell L. George, P.E.
Chief, COE - RCC
P.O. Box 2870
Portland, OR 97208-2870

Dear Russ:

Thank you for reviewing the 1990 Fish Passage Center Annual Report. Where appropriate your suggested comments were incorporated into the text. In particular, activities relative to adult fish passage are authorized through a Memorandum of Understanding between the Columbia Basin Indian Tribes and the participating agencies of the Columbia Basin Fish and Wildlife Council dated July 7, 1986. This document assigns the Fish Passage Center the responsibility for "implementation of adult and juvenile fish passage (hereinafter fish passage) at federal hydroelectric projects". In addition, the funding for the adult passage related activities has been provided to the FPC by the Fish and Wildlife Agencies since 1984.

With respect to spill monitoring and the determination of 90% passage dates, the prediction of a 90% date in-season or post-season is virtually impossible at some projects because of the way the projects are operated during the spill hours, which are coincident with the primary fish passage hours. Consistent monitoring of the population is not possible when there is no powerhouse passage. However, it is highly unlikely that spill occurred later than the 90% passage dates. The 90% passage dates developed for the Spill MOA were based on the historic monitoring information and represent an average of all previous data collected. In the case of summer spill periods they do not necessarily represent the historic 90% passage date, but a negotiated "improvement over status quo" 7 day addition to the arbitrary end date of July 15 in the Snake and August 15 in the Lower Columbia.

Sincerely,

Michele DeHart

Michele DeHart
Fish Passage Center Manager

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION, CORPS OF ENGINEERS
P.O. BOX 2870
PORTLAND, OREGON 97208-2870

REPLY TO
ATTENTION OF:

March 18, 1991

Water Management Division

Ms. Michele DeHart
Fish Passage Manager
Fish Passage Center
2501 S.W. First Ave., Suite 320
Portland, OR 97201-4752

Dear Ms. DeHart:

Our comments on your draft report are provided below, as requested in your letter dated January 23, 1991.

1. Title Page: Date of publication should be 1991.

2. "Introduction" section, page 1, paras. 1-3: Discussion states that FPC is assigned responsibilities on matters related to both adult and juvenile fish migrations. This should be clarified. FPC is established and its mission defined in Section 303 of the NPPC Fish & Wildlife Program. The Program specifies that FPC's responsibilities are related to the juvenile outmigration. How are activities related to adult fish passage authorized?

3. Page 2, bottom sentence: Sentence should be revised to read: "The primary purpose of the Work Group is to develop a Coordinated Plan of Operation (CPO) for using both the mid-Columbia River and Snake River Water Budgets for the current year."

4. Page 3, Section 1, para. 1, last sentence: Sentence should be revised to read: "The January water supply outlook indicated that 1990 would be a below average runoff year, but there was more water in storage than at this time in 1989."

5. Page 3, Section 1, para. 2: First sentence should be revised to read: "Water supply forecasts available at the second Work Group meeting...". Last sentence should be revised to read: "This action was expected to impact streamflows..." and "...Water Budget requests, and were considerations...".

6. Water Budget section: Your report should note that the draft 1990 CPO contained a stronger Corps commitment to provide flow augmentation for fish than had been stated in previous CPOs.

The draft 1990 CPO, Section 6.a.(3), stated that "DWR discharges in excess of the 10 kcfs powerhouse hydraulic capacity may be requested by the Fish Passage Managers subject to Water Budget availability. These higher flows up to a maximum release of 25 kcfs will be provided if required to achieve flows of up to 85 kcfs at LWG. Spill may be permitted at DWR to achieve LWG flows greater than 85 kcfs based on a case-by-case evaluation of hydrologic, power, biological conditions, and nonpower project uses."

7. Page 5, para. 1, "The final 1990 Water Budget CPO": Suggest deleting "...which means that all other recommendations by other work group members were rejected by the COE". Many of the "rejected" recommendations reflected agency positions that have resurfaced every year during Water Budget discussions. Sentence conveys unnecessary negative connotation.

8. Section II.C.1., pages 10 - 11: Sentences 2 and 3 of this paragraph should be moved to the previous section. These statements describe the Water Budget volume for the entire season, not just the first week.

9. Page 11, section 2.a., para. 2, line 3: Text should be revised to read: "...volume indicated by the April forecast could lead to reduction of flood control requirements."

10. "Water Quality" sections, pages 18, 20, 22, 25, 27, 29, 31, and 33: Report states that dissolved gas levels were consistently above 110% in the mid-Columbia River, without any concern expressed until the John Day spill at the end of May boosted levels up as high as 135% at The Dalles. If observed supersaturation levels less than the John Day spill extremes are not a concern to the Fish Passage Center, this should be so stated and explained.

11. Page 19, para. 3, line 11: "near 100 kcfs" should be 10 kcfs; this phrase refers to Dworshak rather than Lower Granite outflow.

12. Page 45, para. 1: According to the text, insufficient data were generated in 1990 to determine 90% passage dates. In implementing the NPPC spill amendments in 1990, all four spill projects had nightly spill until the latest possible date, rather than the 90% passage date. Considering the lack of data at some of the spill projects, is it possible that spill occurred more days than required by the spill amendments?

Thank you for the opportunity to review your report. Contact Bolyvong Tanovan or Rudd Turner of this office (326-3764) if you have questions on our comments.

Yours truly,

G K Delwiche

for Russell L. George, P.E.
Chief, Reservoir Control Center

FISH PASSAGE CENTER

2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

May 31, 1991

Paul Winborg,
Chief, Operations Div.
COE - Walla Walla
Bldg. 602, City-Cty Airport
Walla Walla, WA 99362

Dear Mr. Winborg:

Thank you for your comments on the draft 1990 Fish Passage Center Annual Report. Your suggestion was noted and the acknowledgement section now recognizes the COE as providing facilities.

Sincerely,

Michele DeHart
Fish Passage Center Manager

304-91.*

DEPARTMENT OF THE ARMY
WALLA WALLA DISTRICT, CORPS OF ENGINEERS
WALLA WALLA, WASHINGTON 99362-9265

REPLY TO
ATTENTION OF:

February 22, 1991

Operations Division

FEB 1991

Ms. Michele DeHart, Manager
Fish Passage Center
2501 SW. 1st Avenue, Suite 230
Portland, Oregon 97201-4752

Dear Ms. DeHart:

This letter is in answer to your general memorandum of February 22, 1991, requesting comments on your "Draft of the 1990 Fish Passage Center Annual Report." We only have two comments, both pertaining to the Acknowledgement Section:

a. Acknowledgement of our cooperation through the fish transportation program is appreciated.

b. We also provide facilities and accommodations for smolt monitoring activities at several of our dams. Mention of that cooperation would also be appreciated.

Thank you for the opportunity to comment on your draft annual report.

Sincerely,

Paul F. Winborg
Chief, Operations Division

FISH PASSAGE CENTER

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PHONE (503) 230-4099 • FAX (503) 230-7559

May 31, 1991

Al Wright,
Executive Director
PNUCC
101 SW Main St., Suite 810
Portland, OR 97204-3216

Dear Al:

We thank you for taking the time to review the 1990 Fish Passage Center Annual Report. In response to you general comments we offer the following:

Water Budget Section:
It is true that hatchery releases are occurring during much of the migration season and are reflected in increasing passage indices at downstream projects. However, when the Fish Passage Center considers responses in passage indices relative to changes in flow we look at both increasing and decreasing trends of all species at the time of the flow change relative to any hatchery releases. This will be addressed more fully when we speak directly to your specific comments.

Spill Implementation:
The Fish Passage Center disagrees with the PNUCC regarding their statement as to the objective of the Spill MOA. The Spill MOA recognizes that load factoring can significantly affect the amount of spill at some projects. The MOA accounts for this in the calculation that allows for increasing the instantaneous spill percentage based on the percentage of daily average flow. The percent of daily average flow was the objective of the agencies and tribes who only agreed to the instantaneous flow when safeguards were built in to account for load factoring. The intent of the description in the Annual Report is to illustrate that the implementation of the spill agreement is often achieved with less than what the agencies and tribes intended. Furthermore, it is the responsibility of the FPC to provide the agencies and tribes with assessments of the implementation of the Spill Agreement, and to suggest additions or changes based of the past year's experience.

Smolt Monitoring Program:
The conclusions drawn in the Smolt Monitoring Section are developed incorporating all the impacts of the assumptions. The Fish Passage Center cautions the reader to be aware of the assumptions, and that they have differing magnitudes of impact on the conclusions that can be drawn. These assumptions do not affect the "credibility" of the data collected in the SMP as insinuated by PNUCC.

Smoltification Indices:
The FPC will continue to collect data and analyze the relationship between smoltification, flow and travel time. The FPC believes that smoltification plays an important role in determining how quickly smolts migrate through the system at different times in their development. This, however, does not imply that smoltification is more important than flow in determining a smolt's travel time.

In response to your specific comments:

Page 4 - The second bullet refers to a method of Water Budget accounting that is preferred by the agencies and tribes. In this method the actual releases of water from Grand Coulee that are necessary to augment the present base flow, to the level requested for fish migration, would be debited to the Water Budget account. At present, all water above an arbitrary base flow of 76 kcfs at Priest Rapids is charged to the account.

Page 4 - You apparently misunderstand the priority that we are addressing. The FPC does not ask for reservoir operating constraints to be violated. We have simply asked that reservoir refill be assigned a lower priority than fish migration needs.

Page 6 - Incorporation of this type of language will be considered for future reports.

Page 6 - We do not believe that is our place to change the base period used by the water management agencies, but to be consistent with what the water resource agencies are using.

Page 6 - The runoff forecasts indicate what is available in the watershed for runoff into the mid-Columbia drainage for that year. No significant input of water occurs between these two projects. The official runoff volume forecasts are provided by the Columbia River Water Management group. You might ask them to change their reporting sites if this is necessary for your needs.

Page 7 - See the above comment.

Pages 10-33 - To the extent possible the discussion is limited to the week stated. However, the decisions made for a particular week are often influenced by conditions that occurred in the past, or are expected to occur in the future. It was the intention of this report to present for the uninformed reader all information that was used to derive a decision regarding Water Budget implementation.

Page 11 - You will note that the 33 million refers to the number of hatchery fish released, not the number of fish transported.

Page 14 - There is no sampling program at Priest Rapids Dam. The agencies and tribes will support only one monitoring site in the mid Columbia because of the dewatering, handling etc. necessary to sample fish. Furthermore, the intent of the mid Columbia Water Budget releases are to facilitate passage through the mid Columbia and to augment flow in the lower river. As stated previously the only particular significance of the Priest Rapids site is for the present accounting practice - one which would be far better if replaced with the actual release from Coulee.

Page 14 - For your benefit we reiterate Section 302 of the NWPPC's Fish and Wildlife Program "...This larger water budget for Priest Rapids Dam increases the total size of the water budget from 67.8 kcfs-months to 78 kcfs-months and, together with the ability to shape the flows, improves the region's ability to meet optimum flows below the confluence of the Snake and the Columbia rivers."(emphasis added).

Page 19 and 22 - The transport numbers were revised to match the 1990 FTOT report. They did not necessarily match the numbers you provided.

Page 22 - The passage index data is reported for all species and stocks migrating. While it is true that there was a large increase of hatchery steelhead that may have been attributable to this release, there was also a large increase in the chinook and wild steelhead passage indices that could not be attributed to this release and were the response of the migrants to an increase in flow. Conclusions should not be drawn from only a portion of the information.

Page 25 - See our previous comment regarding this subject. Once again, the point of the 220 kcfs at The Dalles is not accounting, but a lower river flow objective for fish migration.

Page 26 - We are not sure of your interpretation of our statement regarding the reversion of these steelhead to parr. However, we wish to accommodate you in providing references to this subject which might help your understanding of the process. The suggested reading material includes:

Adams *et al.*, 1975. Inhibition of salt water survival and NAK-ATPase elevation in steelhead trout (*Salmo gairdneri*) by moderate water temperature. Transactions of the American Fishery Society 104:766-769.

The authors provide the data for steelhead trout that indicates saltwater resistance was transient, and if fish were retained in freshwater after the usual time of migration they lose their ability to live in sea-water. This post-smolt decline in seawater tolerance has also been observed in coho and sockeye salmon and can be reviewed in the following:

Adams *et al.*, 1973. Temperature effect on parr-smolt transformation in steelhead trout (*Salmo gairdneri*) as measured by gill sodium-potassium stimulated ATP. Comparative Biochemistry and Physiology. 44A: 1333-1339.

Baggerman,B. 1960. Factors in the diadromous migration of fish. Symp. Zool. Soc (London), 1:33-60.

McInerney, J.E. 1964. Salinity Preference: an orientation mechanism in salmon migration. J.Fish. Res. Bd Canada 21: 995-1018.

Page 27 - As stated previously there is language in the Program that addresses the need for lower River flows.

Page 29 - Once again, it is important to consider all species. Subsequent to the increase in flow the passage indices for yearling chinook, sockeye and steelhead also increased. The increased smolt passage of these groups was not due to a hatchery release and it is this data in total that is considered before attributing an increase in passage indices to an increase in flow.

Page 31 - Statements should not be taken out of the context in which they were placed. The week of June 4-10 is being discussed relative to what has happened previously i.e., the higher flows that began increasing at the end of May. The intent here is to build for the reader the scenario whereby the higher flows had moved the fish into the lower river. Peaks in fish had coincided with the higher flows.

Page 32 - Once again it must be pointed out that the Fish and Wildlife Program does contain language referring to "optimum flows below" the confluence of the Snake and mid Columbia rivers.

Page 33 - We believe that we have adequately demonstrated to you the extent of the information that is being considered when considering passage indices. We are uncertain of why you would think we were unaware of a particular hatchery release when we report weekly the hatchery releases in the Basin.

Page 34 - See our general response to your comments.

Page 35 - As stated previously, the interpretation of the "intent" of the Spill MOA appears to differ. The calculation of an instantaneous percent is based on the daily average flow. The report is intended to provide the reader with information regarding the past year's implementation. The FPC believes it has identified two areas where improvement could be made in the implementation of the MOA. First, the reliance on after the fact data to essentially guess what future flow and flow shaping

would be is insufficient when the agency that could more accurately predict the evening flow will not be responsible. Secondly, the practice of extreme load factoring in the Snake that results in spill at 100% of instantaneous flow. We are not sure of the impact of this very low nighttime flow on the movement of fish through the reservoir. These problems are best illustrated by comparing the actual with the anticipated percent of daily average flow.

Page 36 - As above.

Page 36 - The Lyons Ferry release numbers have been added.

Page 39 - Your questions regarding fliplips and the Flow Proposal are best addressed to the Columbia Basin Fish and Wildlife Agencies. They are beyond the scope of this report.

Page 39 - The appropriate citations have been included in the text.

Page 42 - The need to monitor and the monitoring program at The Dalles was developed by the Parties to the SPILL MOA. If PNUCC is not pleased with this program we suggest that you approach the Parties.

Page 45 - The table has been corrected.

Page 46 - The FGE estimate is based on the best available information and represents an average value over the season, weighted to the number of fish passing the project. The use of an "average" FGE value is consistent with the practice of the COE for determining spill levels at other projects. The "average" FGE was also used for determining spill levels that were then negotiated in the MOA.

Page 48 - We disagree that conclusions drawn from trends in fish passage indices are questionable. The assumptions made are clearly outlined in the text, no further additions have been made to the language.

Page 48 and Page 50 - Fish passage indices are used to evaluate changes in trends of species within and among years. We are aware of the changes that could be due to the occurrences you mention. However, as we stated previously changes in passage indices are interpreted in the context of many factors, going somewhat beyond the level you suggest.

Page 63 - The language in the text has been altered.

Page 75 - The referenced flows apply to the late April-May periods when PIT tagged groups were passing the project. This distinction has been added to the text.

Page 82 - We are unsure of your objective in calling adult salmonid counts "artifacts". It is true that dam counts reflect changes in harvest and are actively used by salmon managers to adjust harvest to assure a particular escapement count over the dam. The management of fisheries on adults is closely monitored and is reflected in prompt changes in fishing seasons, catch limits, gear sizes, etc. If harvest rates are decreased and dam counts do not increase then the cause of the decline in stocks must be attributed to some other cause, possibly one that occurred during the downstream migration.

The sampling periods (8-hour, 16-hour, 24-hour) are dam specific, and are geared to yield a 95% accuracy of the particular count. The dates set for distinction between species are not arbitrary, but are based on data collected to date which is constantly being improved to reflect the new information. Perhaps we could forward your comments to the Technical Advisory Committee of U.S. vs Oregon for further comment. Keep in mind that the dam counts probably represent far better escapement data than is available for most other salmon fisheries.

Page 83 - Jacks account for 10% or less of the spring and summer chinook runs. However, they can account for up to 50% of the fall chinook run. Since the purpose of the adult report is to compare adults they were removed from the fall chinook counts. We believe that if you would consult the report for the inclusive dates for the steelhead counts you would better understand the adult count data.

Page 83 - There is no biological basis for comparing salmon and shad since shad are members of the clupeidae family, and are similar to herring. They share little in common with salmon other than that they are both anadromous fish. Lamprey also spawn and rear in fresh water and migrate to the sea, yet we would not want to base salmonid mitigation on that species. Shad are successful in reservoir habitats and tend to have wide geographic spawning grounds, spawn in open reservoirs and have a high fecundity (300,000 eggs per large female) whereas, salmon often migrate long distances to their natal streams, and have a much lower fecundity (up to 5000 eggs per chinook female). In other words, salmonids have evolved over thousands of years in free-flowing riverine environments and are not as well suited to reservoir environments as are shad.

There are no identified populations of shad that spawn a considerable distance up the Snake and migrate through eight hydroelectric projects on their journey to the sea as is the case for certain endangered salmon stocks. Furthermore, it is unclear if the increase in shad population can be attributed to the shad that migrate as far as Ice Harbor Dam, or are simply resulting from the population that spawns immediately above one or more of the lower Columbia dams.

Sincerely,

Michele DeHart

Michele DeHart
Fish Passage Center Manager

PNUCC

PACIFIC NORTHWEST UTILITIES CONFERENCE COMMITTEE

February 25, 1991

FEB 1991

Ms. Michele DeHart
Fish Passage Center
825 N.E. 20th Avenue, Suite 336
Portland, Oregon 97232-2295

Dear Ms. DeHart:

PNUCC wishes to thank the Fish Passage Center for the opportunity to review the 1990 Draft Fish Passage Center Annual Report. We found the report to be informative and well written. The following comments focus on areas of the report we feel could use additional work. Specific comments are included in the attachment.

The FPC on several occasions draws the conclusion that increased passage indices are the result of increased flows. In our specific comments, we have cited FPC data which shows in many cases that a large hatchery release preceded an increase in passage at a downstream project. It is highly probable that the increase in passage is the result of a release, and that the Water Budget augmentation was requested by the FPC due to that release. We ask, is the increase in passage the cause or the effect of increased flow? Conclusions drawn in the Water Budget section should address the possible effects of hatchery releases on downstream passage indices.

In the spill section, the FPC uses daily average spill levels as the objective of the Spill Memorandum of Agreement. It is not the objective of the Spill MOA to achieve a predetermined daily average spill percentage. The objective of the Spill MOA is to achieve a specific instantaneous spill percentage outlined in the MOA (spill table - page 6, and adjusted by sections III B, 6 and 7). Any language in your annual report eluding to a daily average spill objective should be edited to address the objective of meeting the instantaneous spill level in the MOA. In your draft report on page 36, you conclude that:

> *"The instantaneous spill percentage specified in the Agreement is 70%. With flat loading of the project, and a 12-hour spill period, this translates to 35% of daily average flow. The daily average spill percentage averaged approximately 32.4% of the daily average flow during the spring spill period (Figure 5). An instantaneous spill percentage of at least 70% had been implemented, but did not always result in the 35% daily average."*

This statement may give the impression that the Spill MOA was not successful, when in fact it has been implemented very successfully.

In the Smolt Monitoring section you qualify yourselves in the beginning by stating that there are a number of general assumptions to be made when analyzing data on a year to year basis, as well as from day to day. PNUCC agrees with the assumptions outlined in your report, but due to the limited explanation, we are unable to determine if all factors have been addressed. We understand the difficulty of drawing conclusions given our incomplete knowledge of fish biology, therefore we feel conclusions drawn from the SMP should be approached cautiously. It would be helpful if you could be more specific in regard to how you came to your conclusions.

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PNUCC applauds your objective review of the relationship between release date (ATPase levels), and travel time. PNUCC feels very strongly that there is a much more complex relationship between flows, smoltification, travel time, and survival than what has been acknowledged in the past. We hope that future research and analysis is designed to evaluate these relationships and others which may or may not affect smolt survival during their migration to the ocean.

In summary, PNUCC encourages the FPC to address other variables which may induce smolt passage in the section regarding Water Budget implementation; rewrite the section on the Spill MOA to assess the objective of meeting instantaneous spill levels instead of daily average flows; qualify the credibility of the data collected in the SMP; and encourage the FPC to continue analyzing other variables which may affect travel time and smolt survival.

Once again, thank you for the opportunity to review your draft report.

Sincerely,

Al Wright

Al Wright,
Executive Director

Attachment

FPC ANNUAL REPORT
PNUCC COMMENTS

Page	Par	Line	Comments
4	3rd section		What does the second bullet mean? Will flows be increased out of Grand Coulee?
4	3rd section		How will a lower reservoir priority impact resident fish and resident fish measures currently under way, such as the Lake Roosevelt Kokanee Salmon Facilities being developed by the UCUTs, or the Hungry Horse measures being proposed by the MDFWP?
6	1	3	When referring to critical periods which occurred in the 1930s and 1940s, it may be helpful if you explain that there are several critical periods, such as the four-year period of 1929 to 1932, the two-year period of 1944 and 1945, the one-year period of 1937, etc.
6	2	2	Why not use 1973-1985 or 1990 as a base period for the mid-Columbia? This reflects upstream storage and how the water is managed now for flood control, power generation, and the Water Budget.
6	Table 1		Since Priest Rapids is the recognized accounting site in the mid-Columbia, why not use it in January to July runoff forecasts?
7	Table 2		See the above comment.
10-33	W.B. section		It would be much easier to follow the weekly reviews if you would only address issues which occurred during the week of discussion, and not the previous week.
11	3	1	The total number of fish transported by April 12 should total 37,018,610 rather than 33 million (see the first seven FPC weekly reports of 1990).
14	Fig. 3		Why show Priest Rapids flows and Water Budget usage compared to Rock Island passage indices? Wouldn't it be better to use Priest Rapids indices?
14	Fig. 3		As stated in past years by PNUCC, The Dalles is not recognized as a lower river control point in NWPPC's Fish and Wildlife program. Therefore it is inappropriate to give the reader the impression that it is. Please omit this and all material which refers to The Dalles as a Water Budget accounting project.

Page	Par	Line	Comments
19	4	2	According to the Corps of Engineers' data, the total number of fish transported by April 26 was 2,225,737 fish.
22	1	2	By May 3, the COE reported that a total of 5,420,241 fish had been transported (LWG - 3,771,122 fish, LGS - 735,420 fish, and MCN - 913,699 fish).
22	2		In this paragraph, you discuss how passage indices responded to increased flow due to a Water Budget request. You failed to mention that of the 383,000 fish reported at Lower Granite on May 9, nearly 314,000 of them were steelhead. These fish were likely the result of the Dworshak hatchery summer steelhead releases of May 3 and May 4 which totalled 1,224,832 fish (FPC weekly report 90-12, page 5). It is difficult to draw objective conclusions when all the data is not reported.
25	2	5	Your comment that the COE's decision to provide flows of 140 at PRD rather than the 220 at The Dalles is inappropriate. As stated many times before, The Dalles is not a Water Budget accounting site.
26	4	9	Please provide a literature citation which supports your claim that survival is decreased with a reduced level of smoltification (not just reverting to parr, but reduced smoltification).
27	6	3	Please see previous comments regarding a lower river Water Budget request.
29	2		As stated earlier, an increase in smolt passage does not necessarily reflect benefits of increased flow. In your statement you claim that increased Rock Island indices on May 31 were the result of high flows at Priest Rapids. Again you fail to mention that a substantial number of fish were released upriver. In this case, a total of 1,310,656 smolts were released from the Wells hatchery between May 22 and May 25. Please address these important issues objectively.
31	4	1	Please see your FPC weekly report 90-16, where you show subyearling chinook passage indices at The Dalles decreasing steadily from June 1 to June 8 (going from 5,090 fish to 367 fish). Likewise, both the index and collection counts at the Bonneville powerhouses are inconclusive.
32	1	3	The statement that the unused portion of the Priest Rapids account could have been used to augment flows at The Dalles the week of May 21 to May 28 should be deleted. It is not consistent with the language of the NWPPC Fish and Wildlife Program.

Page	Par	Line	Comments
33	2	3	You state that the plots in figure 3 illustrate the correlation between flows, and decreases and increases in smolt passage. As stated in earlier comments, you fail to acknowledge the influence of hatchery releases on smolt passage at downstream dams. In many cases the FPC requested flow augmentation due to these releases. The question can be asked, are passage indices increases the cause or the effect of increased flows?
34	Spill section		It is not the objective of the Spill MOA to achieve a predetermined daily average flow. The objective of the Spill MOA is to achieve a specific instantaneous spill percentage outlined in the MOA (spill table - page 6). Any language in your annual report eluding to a daily average flow objective should be edited to address the objective of meeting the instantaneous spill level in the MOA. By doing so, it will allow the reader to effectively evaluate the implementation of the Spill MOA.
35	2	6-10	The intent of the statement regarding BPA's and the A&T's definition of success is unclear. In the Spill MOA, it states: "The Parties shall honor requests by the Agencies and Tribes that are necessary for the implementation of this Agreement and consistent with this Agreement." Therefore, it appears that if BPA achieves the A&T's requested spill amounts, they have indeed been successful.
36	2	8-9	To say that "the adjusted spill percentage for fish averaged only 15.2% of the daily average flow for the summer spill period" is misleading. See the above comment.
36	4		It would be helpful to the reader if Lyons Ferry release numbers were given.
39	2	4	With increased flows (A&T's proposal) for fish, will fliplips be required at all dams in the future?
39	3	3-4	When referring to literature, please cite it in the text.
42	1	2	One gatewell at one unit does not constitute a reasonable, reliable method of indexing or monitoring smolts.
45	Table 7		The amount of spill for fish at Ice Harbor for the summer spill season should be 175 ksfd instead of 156 ksfd.
46	2	11	Since FGEs are so variable from day to day, and year to year, how can the level of spill for Bonneville Dam in last paragraph on page 43 be determined with any level of confidence?

Page	Par	Line	Comments
48	SMP section		You acknowledge that there are a number of assumptions to be made in order to compare indices from year to year, and from project to project. You should make it very clear that any conclusions drawn from these indices are questionable, and that the reader should focus on trends rather than actual numbers.
48	2	15	It may be helpful to the reader if you expand on the shortcomings of the Rock Island smolt collection system (i.e., the collection bias due to size).
50	1	10	Variance in collection efficiency could be due to high flows, size of fish, poor sampling procedures, or faulty freeze brands. Therefore, evaluation of passage indices year to year, and day to day make it difficult to interpret the results.
63	1	13	Increased survival due to decreased travel time is not supported by the literature, therefore it is pure speculation.
75	1	6-7	Priest Rapids flows averaged 129 kcfs from April 16 to April 22, and 234 kcfs from June 4 to June 10.
82	3	1	Adult salmonid counts are merely artifacts of offshore or downstream harvest management practices. Counts vary due to partial sampling periods (16 of 24 hours daily); arbitrary dates for identifying spring, summer, and fall chinook; gillnet or sea mammal losses; poaching, navigation lock passage, and sport fishing. In addition, delays caused by the enormous shad runs have not been studied yet.
83	Table 16		Why are jacks included for spring and summer chinook runs, and excluded from fall chinook runs? Steelhead counts for 1989 (COE published report) are inaccurate for McNary (170,500), Ice Harbor (151,100), and Priest Rapids (10,700).
83	Table 16		You should include shad counts. Shad are a non-indigenous species which are subject to turbine passage problems and predation common to salmon and steelhead. Unlike salmon, they are not subject to heavy commercial fisheries and are increasing. These trends may provide valuable insight to increase salmonid populations.

Shad	1990	1989	10-Year Average
Dalles	3,706,400	2,917,000	1,242,423
McNary	866,900	1,076,500	438,200
Ice Harbor	90,200	119,200	30,300
Priest Rapids	23,600	30,887	36,600

Page	Par	Line	Comments
82	5	10	Please include how many "surplus" eggs are transferred to other stations for reprogramming, or that are sold to net pen owners from lower Columbia River Mitchell Act hatcheries (Priest Rapids URB eggs 7.9 millon/yr for 1989-90).
General			Throughout the report, subjective comments are made. This is not consistent with scientific reporting practices. Please remove these comments, or place them in a discussion section of the report.
			Please cite literature.

FISH PASSAGE CENTER

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May 31, 1991

Dennis Rondorf
USFWS
Willard National Fish Hatchery
Cook, WA 98605

Dear Dennis:

Thank you for your helpful comments on the travel time section in the draft 1990 Fish Passage Center Annual Report. The legend in Figure 11 was reversed and has been corrected, and sections were re-written where you noted confusion. You asked why the equations in Figure 11 for wild and hatchery steelhead did not have the race variable.

Actually, they do. The model was $\ln TT = \ln B_0 + B_1 * Race + B_2 * \ln FLOW$. When Race = ϕ, the intercept is simply $\ln B_0$; but when Race = 1 , the intercept is increased by B_1. Taking the antilog of these equations resulted in the two equations shown in Figure 11 that have different intercepts and a common slope.

Sincerely,

Michele DeHart
Fish Passage Center Manager

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