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Columbia Basin Fish and Wildlife Authority

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FISH PASSAGE CENTER

ANNUAL REPORT

2003

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.

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FINAL

Fish Passage Center 2003 Annual Report

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We appreciate the efforts of the field crews at each of the monitoring sites. Sampling and reporting were carried out by WDFW at Ice Harbor, McNary, Lower Monumental, and Lower Granite dams; by ODFW at Little Goose Dam and Grande Ronde River trap; by Pacific States Marine Fisheries Commission (PSMFC) at John Day and Bonneville dams; by WDFW (subcontractor for Chelan County Public Utility District (PUD) at Rock Island Dam); by NPT at Imnaha River trap; and by IDFG at the traps on the Salmon and Snake rivers.

In addition to the aforementioned monitoring supported under the SMP, related activities by others, such as the fish transportation program supported by the U.S. Army Corps of Engineers (COE), provided valuable information at various monitoring sites. The COE also provided facilities and accommodations for smolt monitoring activities at their projects. This report was prepared by the Fish Passage Center (FPC) staff: Michele DeHart, Tom Berggren, Margaret Filardo, Larry Basham, David Benner, Henry Franzoni, Sergei Rassk, Jerry McCann, Deidre Wood, Chris McCarty and Dona Watson.

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2003 Executive Summary

The runoff volumes in 2003 were below average for the January to July period above Lower Granite Dam (79%) and The Dalles Dam (82%). The year 2003 hydrosystem operations and runoff conditions resulted in flows that met the spring seasonal Biological Opinion flow objectives at Lower Granite Dam, McNary Dam and Priest Rapids Dam. However, summer seasonal flows at Lower Granite Dam and McNary Dam were considerably below the Biological Opinion objectives of 50.7 Kcfs at Lower Granite Dam and 2000 Kcfs at McNary Dam. Actual summer seasonal flows were just 32.3 Kcfs and 135.5 Kcfs, respectively.

In most instances spill was provided as described by the Biological Opinion program for fish passage, within the constraints of the State waivers for total dissolved gas supersaturation levels. Spill was altered during spill testing and most notably during the month of August at Ice Harbor dam. At this project spill was modified from a 24-hour program to a 12-hour nightly spill period pending the evaluation of studies being conducted in-season. Spill was not returned to full implementation of the Biological Opinion levels even after data showed that spillway passage had the highest associated fish survival. This experience demonstrated the difficulty of managing the hydrosystem for fish passage based on preliminary data and data collected in-season.

Increased hatchery releases and higher wild fish production resulted in a population of yearling chinook at Lower Granite Dam being one of the highest observed in recent years. However, the increased hatchery production may have been offset to some extent by decreased survival from release to Lower Granite Dam as suggested by the lower than average survival observed for the PIT tagged trap released fish to Lower Monumental Dam. Travel times were also longer for hatchery spring chinook compared to recent past years. The short duration of high flows that occurred in the Lower Snake River was too late for yearling chinook, but likely was a benefit for steelhead. Survivals for spring fish in the Lower Granite to McNary Dam and the McNary to Bonneville Dam reach were similar to recent years.

Returning numbers of adult spring and summer chinook, coho and steelhead were less than observed in 2002, but far exceeded the ten-year average return numbers. Sockeye numbers were less than both the 2002 returning adults and the ten-year average number. However, fall chinook numbers surpassed all previous counts at Bonneville Dam since 1938.

In 2003, about 81 million juvenile salmon were released from Federal, State, tribal or private hatcheries into the Columbia River Basin above Bonneville Dam. This was slightly less than the number released last year, but about average for the past several years.

I. 2003 WATER SUPPLY

A. *Water Supply*

Water Year 2003 was below average in terms of runoff volumes throughout the Columbia Basin. At The Dalles Dam, the observed runoff volume recorded between January and July of 2003 was 87.7 MAF, which was 82% of the average runoff volume between 1971 and 2000 (Table 1). Runoff volumes at other Columbia Basin locations were similar, ranging between 77 and 83% of average. In terms of the 75-year historic runoff record, the 2003 January-July runoff at Lower Granite and The Dalles ranked 51st and 58th, respectively (Table 2).

TABLE 1. January and April Final Water Supply Forecasts and observed runoff at Libby, Hungry Horse, Grand Coulee, Dworshak, Lower Granite, and The Dalles over various time periods in Water Year 2003. Data taken from the River Forecast centers website at http://www.nwrfc.noaa.gov/water_supply/ ws_verif.cgi.

Site	January Final Water Supply Forecast (Maf)	April Final Water Supply Forecast (Maf)	Observed Runoff (Maf)	Percent of 1971-2000 Average (%)
Libby (Apr-Sep)	5.16	5.27	5.34	80
Hungry Horse (Apr-Sep)	1.49	1.71	1.69	80
Grand Coulee (Apr-Aug)	48.30	49.80	50.24	83
Dworshak (Apr-July)	1.87	2.39	2.30	87
Lower Granite (Jan-July)	22.0	24.2	23.8	79
Lower Granite (Apr-Aug)	16.8	18.2	17.65	77
The Dalles (Jan-July)	80.50	85.30	87.70	82

TABLE 2. Observed Runoff at Lower Granite and The Dalles from January-July from 1990 to 2003 along with each years rank in terms of the 75-year record between 1929 and 2003 (lower rank = higher water year).

		Lower Granite (Jan-July)			The Dalles (Jan-July)	
Year		Runoff (Maf)	Rank		Runoff (Maf)	Rank
1990		20.2	59		99.7	43
1991		18.9	63		107.1	32
1992		14.1	74		70.4	67
1993		26.7	36		88.1	57
1994		15.9	72		75.0	65
1995		29.4	32		104.0	39
1996		42.4	8		139.3	5
1997		49.5	1		159.0	1
1998		31.3	26		104.1	38
1999		36.1	17		124.1	12
2000		24.6	46		98.0	44
2001		18.4	66		58.2	74
2002		24.0	49		103.8	40
2003		23.8	51		87.7	58

As one would expect in a generally below average water year, precipitation was also below average in Water Year 2003. Seasonal (October through September) precipitation was: 80 percent of average (1971-2000) at Columbia above Coulee, 89 percent of average at the Snake River above Ice Harbor, and 85 percent of average at Columbia above the Dalles (Table 3).

TABLE 3. Seasonal precipitation from October 1, 2002 to September 30th, 2003 at select locations within the Columbia Basin. Data taken from the RFC website at http://www.nwrfc.noaa.gov/water_supply/ws_precip.cgi.

Location	Water Year 2003 Totals October 1, 2002 to September 30, 2003	
	Observed (inches)	% Average
Columbia Above Coulee	20.53	80
Snake River Above Ice Harbor	16.04	89
Columbia Above The Dalles	19.98	85
Kootenai	19.34	74
Clark Fork	14.99	84
Flathead	17.49	74
Pend Oreille/Spokane	28.04	89
Central Washington	8.76	96
Snake River Plain	8.15	70
Salmon/Boise/Payette	19.00	94
Clearwater	30.02	96
SW Washington Cascades/Cowlitz	59.29	83
Willamette Valley	53.40	89

Snow pack throughout the Columbia Basin began building slowly. By the March 1, most basins were well below the 1971-2000 average. However, several late storms added to the snow packs. By the end of April many Columbia sub-basins were near average (1971-2000) snowpack (Table 4). For the most part, Snake River basins and Columbia basins above the Columbia-Snake River confluence had slightly below average snowpack and the lower Columbia River basins were generally well below average.

TABLE 4. Seasonal snow water equivalents at select basins during various points of Water Year 2003. Data from ftp://ftp.wcc.nrcs.usda.gov/data/snow/update/columbia/

Basin	3-1-03 Snow Water Equivalent (% Avg.)	3-31-03 Snow Water Equivalent (% Avg.)	4-28-03 Snow Water Equivalent (% Avg.)
Columbia Above the Snake River Confluence			
Kootenai River in Montana	73	91	92
Flathead River	70	90	84
Upper Clark Fork River	85	102	100
Bitterroot	88	109	106
Lower Clark Fork River	65	82	77
Idaho Panhandle Region	67	79	78
Columbia Above Methow	78	79	106
Chelan, Entiat, Wenatchee	72	81	83
Yakima, Ahtanum	72	86	87
Average*	***74***	***89***	***90***
Snake River			
Snake Above Palisades	84	96	83
Henry Fork, Teton, Willow, Blackfoot, Portneuf	77	76	68
Big and Little Wood	89	92	101
Big and Little Lost	84	79	94
Raft, Goose, Salmon Falls, Bruneau	57	57	69
Weiser, Payette, Boise	81	92	100
Owyhee Malheur	51	46	61
Grande Ronde, Powder, Burnt, Imnaha	65	76	86
Clearwater and Salmon	81	97	101
Average*	***74***	***79***	***85***
Lower Columbia Between Bonneville and McNary			
Umatilla, Walla Walla, Willow	60	64	72
Deschutes, Crooked, John Day	56	59	67
Lower Columbia, Hood River	27	51	67
Average*	**48**	**58**	**69**

* The averages presented in the table above are straight averages; they are not weighted by area.

B. Water Supply/Management Impacts to Biological Opinion Measures

The following sections outline water management and/or with supply relative to the implementation of Biological Opinion (Opinion) measures during Water Year 2003.

1. Chum Spawning Operations

The planning dates in the Opinion for the chum spawning period starts on November 1.

The 2002/2003 Chum Spawning Operation began on November 5, 2002 at 7 a.m. with a targeted Bonneville tailwater elevation of 11.0 feet and an operating minimum of 10.8 feet (November 1st Technical Management Team (TMT) Notes, Figure 1). At this time, the Bonneville tailwater elevation was set below the Opinion recommended minimum of 11.5 feet due to early low runoff forecasts predicted for (or approximately 125 Kcfs of outflow) the 2003 Water Year. On November 6, 2002 the Chum Operation was modified to target a tailwater elevation of 11.3 feet with an operating range between 11.1 and 11.5 feet (TMT Notes 11-06-03). On November 13th, the Chum Operation was again modified to a targeted 11.5 foot Bonneville tailwater with a range between 11.3 and 11.7 feet (Figure 1); this operation was maintained until the January 24th, 2003 TMT Meeting.

Previous to the January 24th, 2003 TMT meeting, the Action Agencies indicated that it was unlikely that the 11.5-foot tailwater at Bonneville could be maintained at the same time that Vernita Bar flows were met and Grand Coulee had a reasonable probability of reaching its April 10 flood control elevation. At the January 24th TMT meeting, National Oceanic and Atmospheric Administration Fisheries suggested that the Bonneville tailwater be operated to a target of 11.2 feet with a minimum of 11.0 feet and a 70 Kcfs flow below Priest Rapids Dam to meet the Vernita Bar Settlement Agreement. The majority of the Salmon Managers did not agree with this operation and requested a BPA explanation every time the Bonneville tailwater went above 11.2 feet.

Flows in the Columbia River increased significantly towards the end of January resulting in an average tailwater elevation at Bonneville of 14.8 feet from February 1st to April 9, 2003. Throughout the general Chum Operation period (November 1st to April 9th) flows at Bonneville averaged 138.6 Kcfs, which exceeds the Opinion recommended operation of 125 Kcfs (or 11.5 feet) throughout the entire period. This resulted in a total water volume of 4.34 MAF in excess of

Opinion recommendations. Grand Coulee easily reached its April 10th Flood Control Elevation of 1283.3 feet, despite early season Action Agency concerns. The water volume utilized in exceeding the 11.5 feet after February 1, might have been better used to prevent the reduction of minimum tailwater elevation to 11.2 feet.

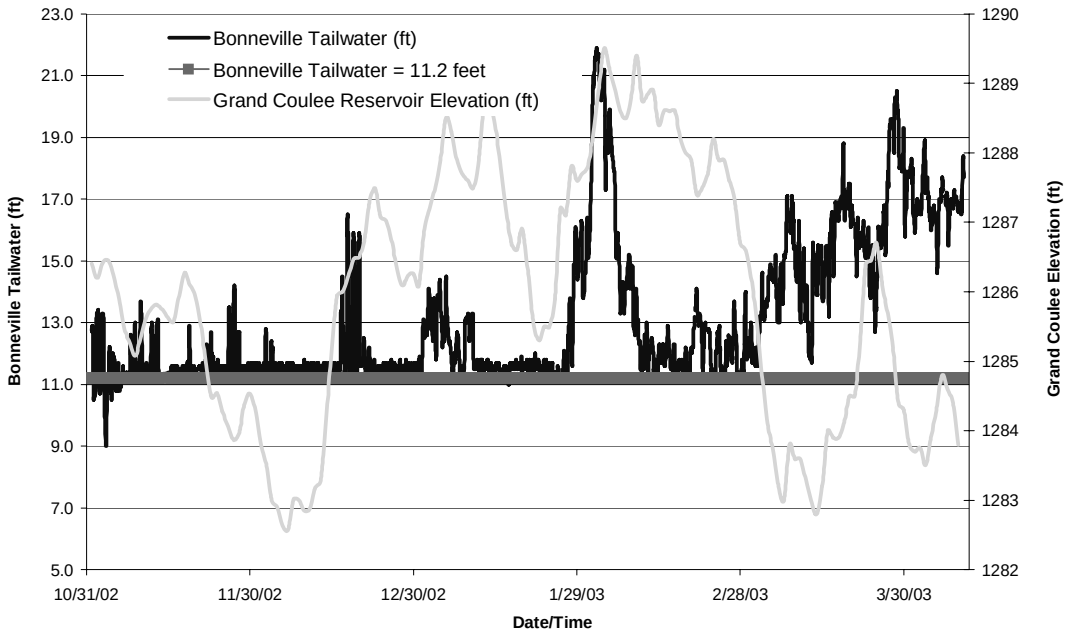

FIGURE 1. 2002/2003 Chum Operation from 11-1-02 to 4-09-03: hourly Bonneville tailwater elevations and Grand Coulee Reservoir Elevations.

2. Winter/Spring Reservoir Operations- Flood Control

Grand Coulee

Grand Coulee began the 2003 Water Year several feet from full (1287.6 feet) and generally drafting. Operators continued to draft Grand Coulee for chum operations in November and early December (Figure 2) until reaching an elevation of 1282.6 feet on December 7, 2002; the operators were reluctant to draft below this elevation because of tribal and resident fish concerns. Overall, for most of the Opinion Chum Spawning Operation (11-1-02 to 4-09-03) Grand Coulee was at or above an elevation of 1283 feet.

Throughout most of the winter/spring period Grand Coulee reservoir was operated within 5 feet flood control elevations set by the US Army Corps of Engineers (COE) (Figure 2). The Biological Opinion calls for Columbia River projects to be within one half foot of their April 10th flood control elevation to ensure a high probability of refill by June 30th. On April 10, 2003, Grand Coulee was at an elevation of 1283.4 feet, one tenth of a foot above its Opinion target elevation (Table 5).

Grand Coulee was drafted continuously through May 24th, to meet Spring Opinion Flow Objectives at both Priest Rapids and McNary and in response to slightly increasing Water Supply Forecasts (Table 1) which lowered late spring flood control elevations. Grand Coulee began refilling on May 24th and continued through July 6th, reaching an elevation of 1289.1 feet.

The Biological Opinion calls for a variable summer draft at Grand Coulee for summer flow augmentation, either 1280 or 1278 feet depending on the July final water supply forecast. Because in 2003, the forecast was below 92 MAF, the Biological Opinion requires draft of Grand Coulee to 1278 feet by August 31st, the actual August 31 elevation was 1278.3 feet at Grand Coulee.

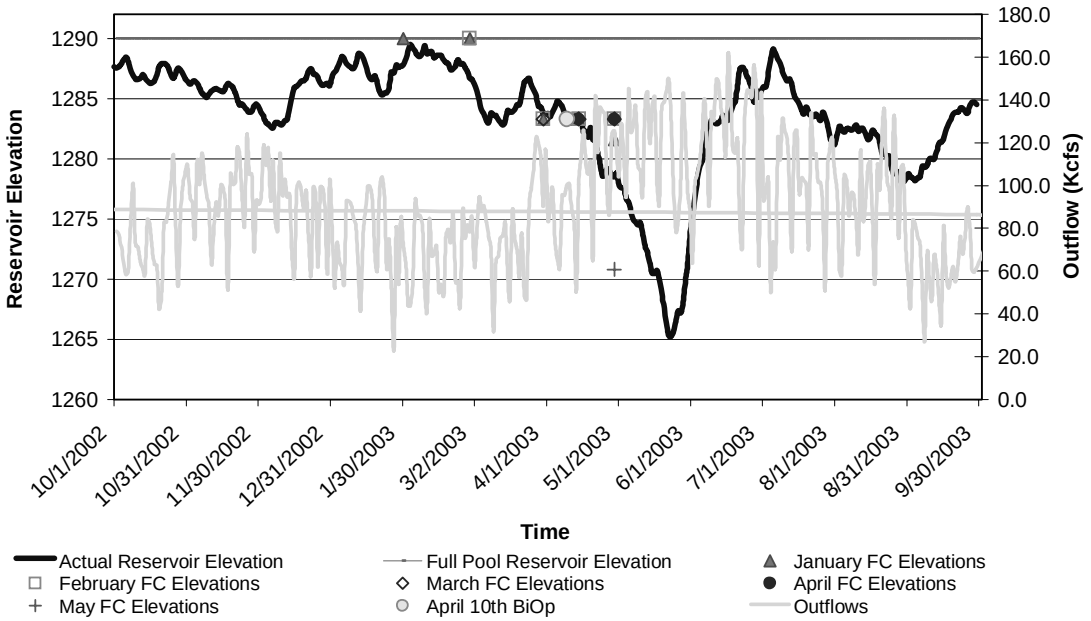

FIGURE 2. Reservoir operations at Grand Coulee Dam during Water Year 2003 (October 1, 2002 to September 30th, 2003.

TABLE 5. April 10th Biological Opinion elevations at Grand Coulee, Libby, Dworshak, Hungry Horse, and Brownlee along with actual elevations on April 10th, 2003.

Site	April 10th BiOp Elevation	Actual April 10th Elevation
Grand Coulee	1283.3	1283.4
Libby	2451.0	2404.7
Dworshak	1583.3	1576.1
Hungry Horse	3553.4	3511.6
Brownlee	2076.6	2070.0

** April 10th Opinion Elevations were linearly interpolated between the April 1st and April 15th flood control elevations issued in March of 2003.

Libby

Libby began the Water Year at an elevation of 2040.5 feet with outflows ranging between 6.0 and 8.0 Kcfs. On September 25, 2002, the USFWS submitted System Operational Request (SOR) B-1 (Appendix J) to the action agencies, that requested releases from Libby for the migration and spawning of burbot in the Kootenai River. The request was for low river flows (between 4.0 and 10.6 Kcfs, preferably below 7.3 Kcfs) from December 15th to January 31st, a forty-five day operation. This request was elevated from the TMT to the Implementation Team (IT) level, where BPA declared that it could not guarantee a 45-day burbot operation, due to its financial situation. In terms of the burbot SOR, the Action Agencies began implementing the request on December 25, 2002; the operators released 7.3 Kcfs for four days then immediately ramped down to the project minimum of 4.0 Kcfs. Libby drafted to its December 31st flood control limit of 2411 feet.

Early season water supply forecasts were below average (Table 1) at Libby, leading to relatively high flood control elevations (Figure 3). Despite the fact that Libby was at minimum project outflows (4.0 Kcfs) throughout much of the burbot operation (SOR B-1), Libby was already over eighteen feet below its flood control elevation by January 31, 2003 (Figure 3) due to December flood control draft. As the winter/early spring months progressed; 1) water supply forecasts at Libby continued to decrease (February and March Final forecasts); 2) resulting flood control elevations increased; 3) Libby had to be drafted to meet the 4.0 Kcfs minimum outflows. By April 10th, Libby was 46.3 feet below the April 10th Biological Opinion flood control elevation (Table 5), therefore not meeting the Opinion elevation requirement. Late season storms helped the water supply above Libby (April and May Final WSF) and despite being far below flood con-

trol elevations for the entire winter/spring period (Figure 3) Libby refilled to within one foot of full by July 1, 2003.

On July 1, 2003, the State of Montana submitted SOR 2003 MT-1 (Appendix J) to the Action Agencies, which asked for, among other things, only a ten-foot draft from Hungry Horse and Libby for summer, flow augmentation by the end of September. After being raised to both the IT and Federal Executive levels, a decision was made to operate Hungry Horse to the Biological Opinion specified 20-foot draft by the end of August for summer flow augmentation. Libby held near full for the first two weeks of July and began drafting for summer flow augmentation July 15, 2003 and continued to draft throughout the summer months, reaching 2438.8 feet by August 31st. In 2003, the Action Agencies were unable to negotiate a Libby-Canadian exchange due to hydrologic conditions in Canada.

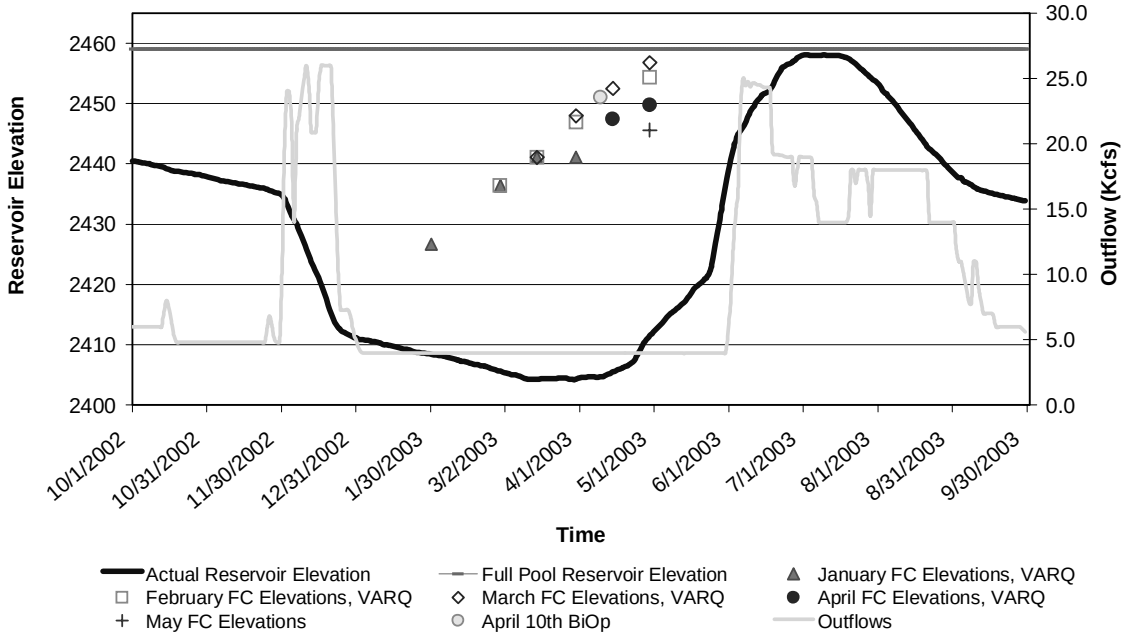

FIGURE 3. Reservoir operations at Libby Dam during Water Year 2003 (October 1, 2002 to September 30th, 2003).

Hungry Horse

Hungry Horse began Water Year 2003 at an elevation of 3537.1 feet. Throughout much of the water year, Hungry Horse was operating to meet the Columbia Falls minimum flow. Toward the end of 2002 and early 2003, meeting the Columbia Falls minimum meant releasing 2-

3 Kcfs of water and drafting a steady 0.2-0.3 feet per day (Figure 4). The River Forecast Center's January Final Water Supply Forecast was 70% of average, which led to relatively high flood control elevations. As a combined result of the high flood control elevations and a need to draft to meet the Columbia Falls minimum through much of the winter, Hungry Horse was 34.9 feet below its flood control elevation by January 31, 2003. As the winter and early spring months progressed, the water supply forecasts at Hungry Horse continued to decrease to 66% of average (March Jan-July Final WSF) and Hungry Horse continued to draft to meet the Columbia Falls minimum flows. By mid-March inflows were high enough that Hungry Horse could meet the Columbia Falls minimum and refill slightly (Figure 4). Similar to that seen at other projects, late season storms helped to increase the WSF and Hungry Horse ended up refilling to within two feet of full (3558 feet) by June 30, 2003.

As previously mentioned, the State of Montana submitted SOR 2003 MT-1 (Appendix J) to the Action Agencies, which asked for only a ten-foot draft from Hungry Horse and Libby for summer flow augmentation by the end of September. After being raised to both the IT and Federal Executive levels, a decision was made to operate Hungry Horse to the Biological Opinion specified 20-foot draft to 3540 feet by the end of August for summer flow augmentation. Hungry Horse was drafted to an elevation of 3539.8 feet by August 31st.

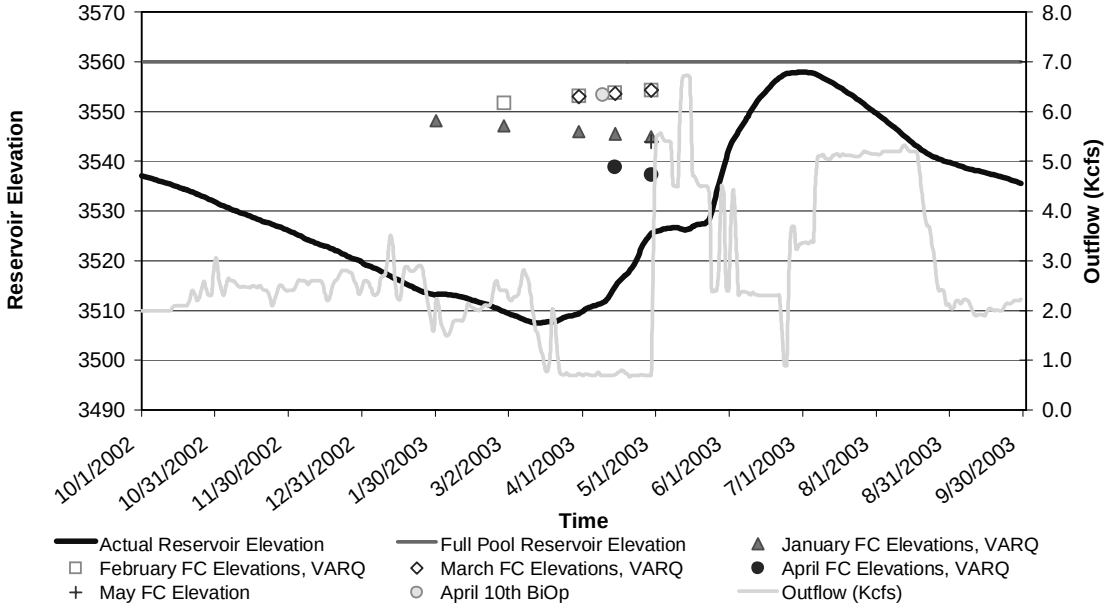

FIGURE 4. Reservoir operations at Hungry Horse Dam during Water Year 2003 (October 1, 2002 to September 30th, 2003).

Dworshak

Dworshak began the water year at an elevation of 1518.5 feet with outflows at the project minimum of 1.5 Kcfs. Dworshak reached a minimum Water Year 2003 elevation of 1515.5 feet on December 13, 2002 (Figure 5).

The January Final Water Supply forecast at Dworshak (April-July) was 1.87 MAF, 71% of average. By January 31st, Dworshak was 29.9 feet below its flood control elevation. As the winter/early spring months progressed, February and March water supply forecasts continued to fluctuate around 70% of average; however, during this period inflows increased to the point where Dworshak could release the minimum flow and begin to refill. Due to late season storms, the April Final Water Supply Forecast increased to 2.39 MAF (90% of average), an increase of 0.5 MAF relative to the January forecast.

On March 26, 2003, the Salmon Managers submitted SOR 2003-4 to the Action Agencies, which asked for Dworshak to refill above its local flood control elevation to save water for the spring migration period. Essentially, the Salmon Managers did not want Dworshak to draft too deep, to avoid forcing the project to minimum outflows during part of the spring migration to meet the Opinion refill target by June 30th. The action agencies did fill above the end of March flood control elevation and were able to release between 14.5 and 16.3 Kcfs in April to improve flows in the Lower Snake River, which were below the Opinion targets. Over the first 25 days of May, outflows at Dworshak were also well above the minimum outflow ranging between 7.3 and 15.6 Kcfs. Dworshak decreased outflows to near minimums over the last week in May and first week of June; however, during this period flows in the Lower Snake River were already very high (108-208 Kcfs at Lower Granite). Dworshak was less than three feet from full by June 17, 2003 and remained at or above this elevation to July 9, 2003.

Two different SORs were submitted to the Action Agencies on July 8, 2003 concerning summer Dworshak releases, the first by ODFW and USFWS and the second by the IDFG and the Nez Perce Tribe. The ODFW and USFWS plan consisted of holding 14 Kcfs outflows as long as possible after July 8, 2003 while still drafting to elevation 1520 feet by August 31st. The IDFG and Nez Perce Plan gradually ramped outflows down from 13.5-14 Kcfs to 8 Kcfs by the end of August and reserved 200 KAF of water from Dworshak for use in the first two weeks of September. There was no consensus on operations at Dworshak and therefore the federal action agencies decided to implement an operation similar to that proposed by IFDG and the Nez Perce Tribe.

Overall in 2003, Dworshak was drafted to 1533.0 feet by August 31st, leaving 173.3 KAF of water in the reservoir to supplement flows over the first half of September. Moving this volume into September decreased summer flows by approximately 1.4 kcfs therefore increasing the magnitude of the miss of the summer flow target.

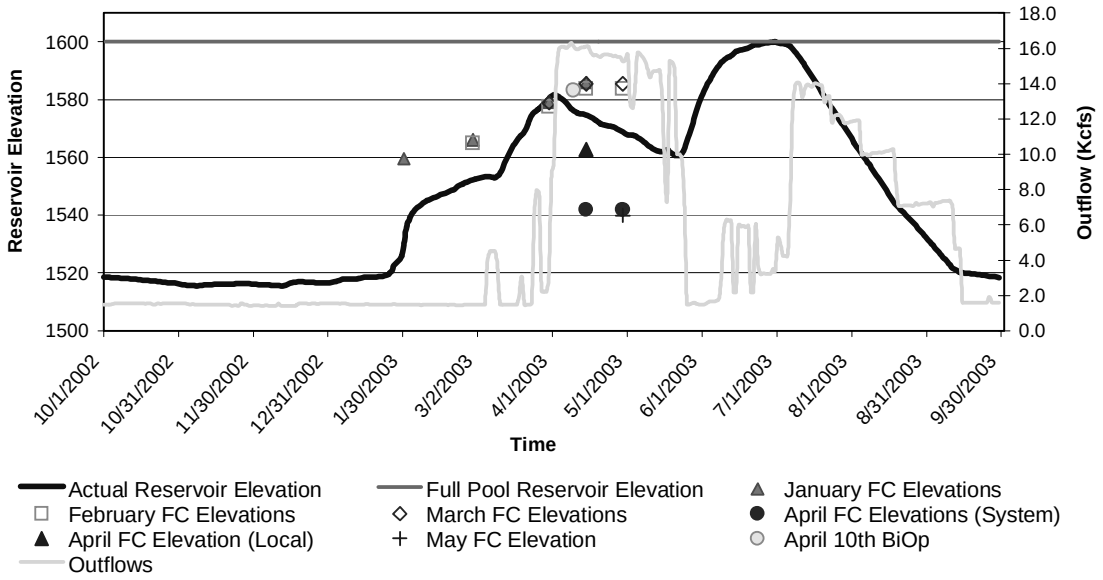

FIGURE 5. Reservoir operations at Dworshak Dam during Water Year 2003 (October 1, 2002 to September 30th, 2003).

Brownlee/Hells Canyon

Brownlee began the Water Year at an elevation of 2041.3 feet. Brownlee began to restrict outflows for the fall chinook spawning operation below Hells Canyon on October 11, 2002, after which point Brownlee was able to steadily refill. At Hells Canyon, the fall chinook spawning outflow was set at 8.4-8.8 Kcfs, beginning on October 14, 2002 and ending on January 7, 2003 (Information regarding Hells Canyon fall chinook spawning outflows can be found at http://www.idahopower.com/riversrec/relicensing/hellscanyon/operations/fall.asp). Early season water supply forecasts for inflow to Brownlee were between 55% and 62% of average (January and February Final forecast), therefore early flood control elevations at Brownlee were set high. The January 31, 2003 flood control elevation was set at full pool (2077 feet), at this time Brownlee

was only 1.7 feet below its flood control point. Throughout the entire winter and spring period, Brownlee remained within 13 feet of full (Figure 6), and refilled by the end of May. Brownlee began drafting on July 10, 2003 and continued to the end of September.

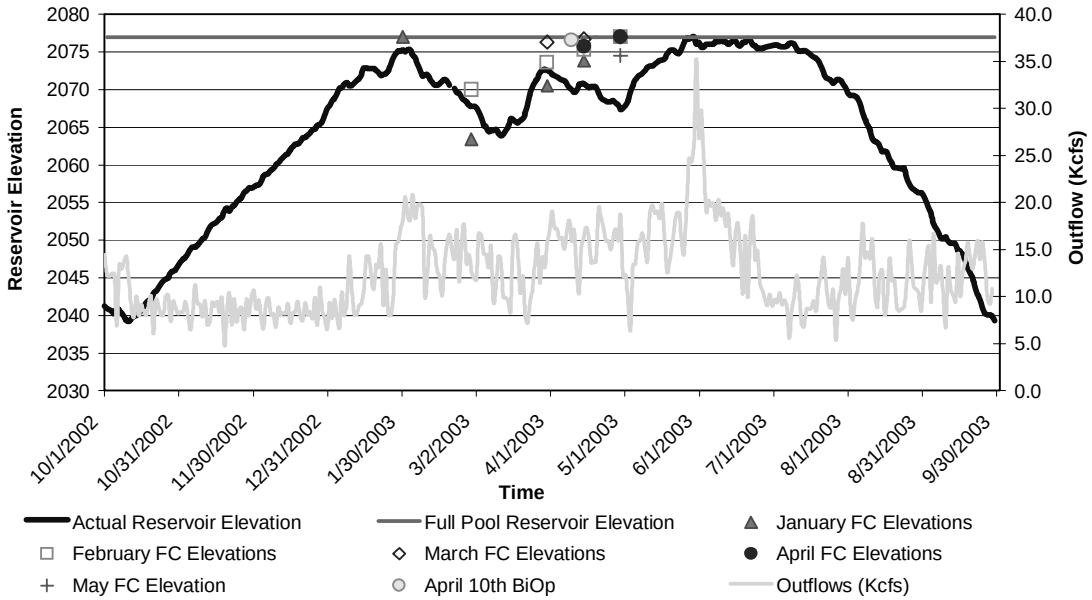

FIGURE 6. Reservoir operations at Brownlee Dam during Water Year 2003 (October 1, 2002 to September 30th, 2003).

3. Spring/Summer Flow Objectives

The following table summarizes the spring and summer Biological Opinion flow objectives and actual flows for 2003 at Lower Granite, Priest Rapids, and McNary.

TABLE 6. Spring and Summer flow averages at Lower Granite, McNary, and Priest Rapids during their respective spring and summer Biological Opinion periods.

	2003			
	Spring Flow Objective	Spring Average	Summer Flow Objective	Summer Average
Lower Granite	**89.1**	**90**	50.7	32.3
McNary	**220**	**231.4**	200	135.5
Priest Rapids	**135**	**141.4**	Na	Na

Overall, taking into account all of the projects with Opinion flow objectives (all blocks in the above table), Biological Opinion flow objectives were met 60% of the time in 2003. More specifically, Spring Flow Objectives were met at all projects; where as, Summer Flow Objectives were not met at all projects. Figure 7 and Figure 8 display similar information regarding flow objectives as Table 7. Figure 7 displays the shape of the runoff over the spring and summer at McNary Dam along with the spring and summer flow objectives; Figure 8 displays the same information at Lower Granite.

TABLE 7. Weekly average flows at Lower Granite, McNary, and Priest Rapids from April 3rd to August 31st, 2003.

	Weekly Average Flows (Kcfs)		
	Lower Granite	McNary	Priest Rapids
4-3 to 4-9	66.8	NA	NA
4-10 to 4-16	72.4	177.8	104.8
4-17 to 4-23	68.6	208.9	128.6
4-24 to 4-30	78.6	216.8	139.3
5-1 to 5-7	68.0	212.8	141.5
5-8 to 5-14	69.2	213.5	142.5
5-15 to 5-21	81.4	226.5	148.4
5-22 to 5-28	118.4	259.2	140.4
5-29 to 6-4	172.2	319.3	143.3
6-5 to 6-11	111.7	279.3	164.4
6-12 to 6-18	87.3	265.3	171.0
6-19 to 6-25	63.2	193.4	128.0
6-16 to 7-2	40.6	186.5	146.4
7-3 to 7-9	34.3	134.6	NA
7-10 to 7-16	34.7	157.3	NA
7-17 to 7-23	32.2	140.8	NA
7-24 to 7-30	29.0	137.0	NA
7-31 to 8-6	28.2	125.2	NA
8-7 to 8-13	29.4	125.7	NA
8-14 to 8-20	25.1	127.5	NA
8-21 to 8-26	23.6	138.3	NA
8-27 to 8-31	22.9	114.0	NA

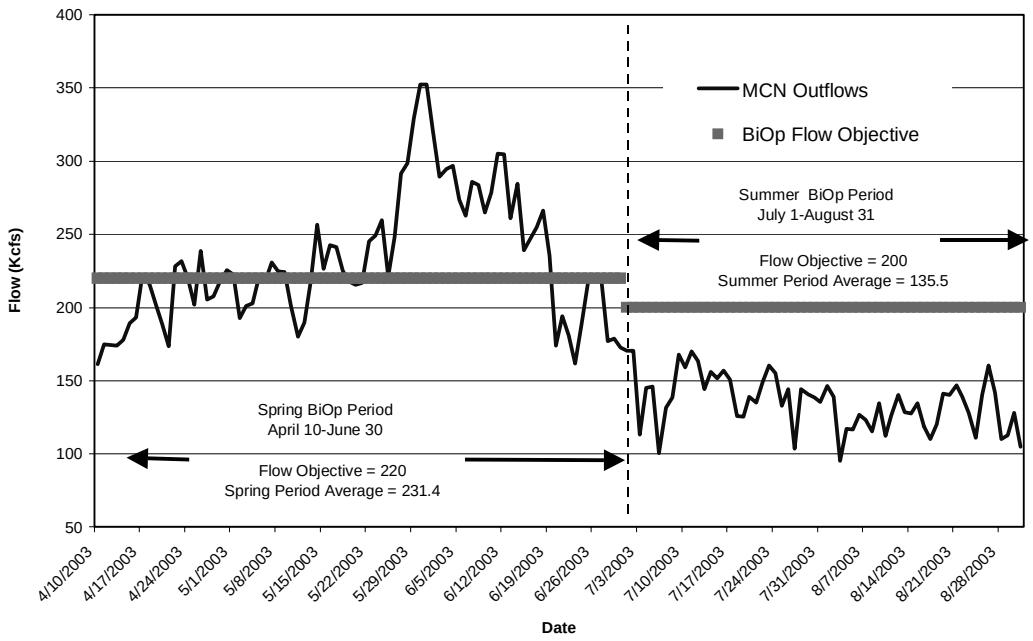

FIGURE 7. Spring and summer Biological Opinion flow objectives and actual flows at McNary Dam over the Opinion period.

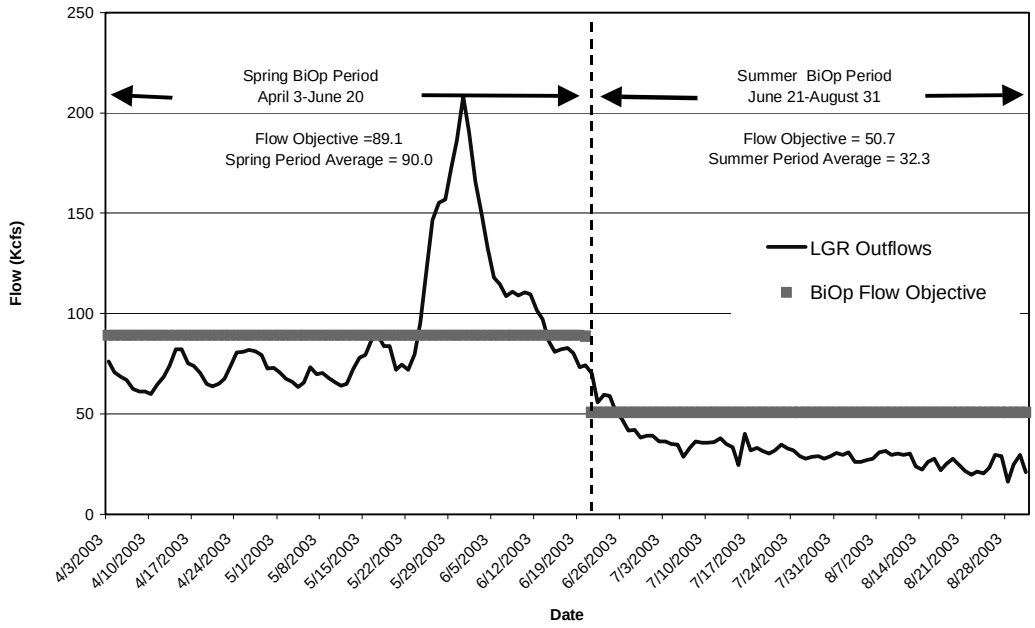

FIGURE 8. Spring and summer Biological Opinion flow objectives and actual flows at Lower Granite Dam over the Opinion period.

4. Dworshak Operations for Temperature Regulation at Lower Granite

Water temperatures in the Lower Granite Tailwater exceeded the 68° F temperature standard 2% of the time (33 hours) between July 1st and August 31st. Figure 9 displays tailwater temperatures at Lower Granite as well as the temperature and magnitude of discharges from Dworshak Reservoir.

Two different SORs were submitted to the action agencies in 2003 concerning the release of summertime water from Dworshak reservoir. One was submitted by ODFW and USFWS (SOR 2003-11) and asked for releases of 14 Kcfs for as long as possible with a maximum draft elevation of 1520 feet by August 31st. The second SOR, 2003 C-4 (Appendix J), was submitted by Columbia River Tribes and the State of Idaho and asked for a release scenario that gradually ramped flows down from 14 Kcfs through the summer months to 8 Kcfs by the end of August with a minimum draft elevation of 1535 feet. Over the summer of 2003, the Action Agencies operated Dworshak in accordance with SOR 2003 C-4, the Tribal and State of Idaho Plan (Table 9), although the flow targets were not achieved.

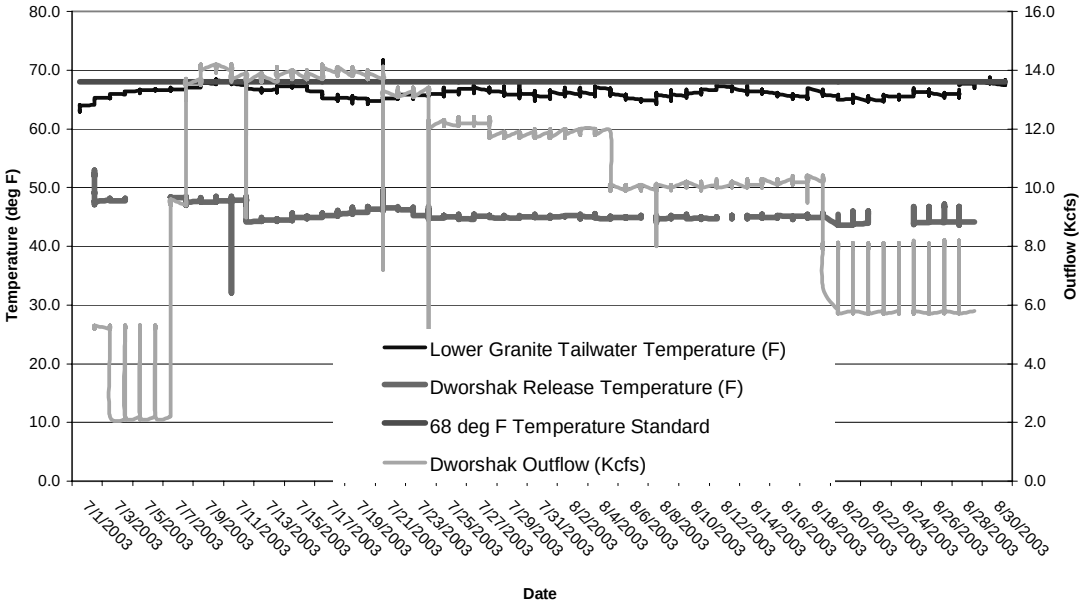

FIGURE 9. Tailwater temperatures at Lower Granite Dam as well as the temperature and magnitude of discharges from Dworshak Reservoir from July 1st to August 31st, 2003.

5. Canadian Operations

Coordination of the Pacific Northwest and British Columbia (BC) Hydro systems was initiated in 1964 with the ratification of the Columbia River Treaty (Treaty). Under the Treaty, Canada was required to construct 15.5 MAF of storage at the Mica, Arrow and Duncan projects for optimum power generation and flood control downstream in Canada and the United States. The Treaty also allowed the US to construct the Libby project on the Kootenai River in Montana for flood control and other benefits. BC Hydro also built storage on the Columbia River system beyond what was required by the Treaty, termed Non-Treaty Storage (NTS). The Canadian storage projects are Mica, with 7 MAF of usable Treaty Storage and 5 MAF of Non-Treaty Storage, Arrow Lakes, with 7.1 MAF of Treaty Storage and 0.26 MAF of Non-Treaty Storage, and Duncan, with 1.4 MAF of Treaty Storage.

Non-Treaty Storage Operations

The NTS agreement allows BC Hydro and BPA to adjust Treaty flows on a daily basis to improve the coordination of the combined system. Non-Treaty transactions are zero-sum over time (i.e. in the long run, releases must equal storage transactions). There is an agreement between the Federal and Canadian parties that allows Canadian projects to store water in the spring (May 1 to June 30) for release in the summer (July 1 to August 31). Release of stored non-treaty water is limited by agreements precluding spill at either Mica or Revelstoke, flooding downstream of Arrow Dam. The hydraulic capacity of Mica is 41.6 Kcfs and Revelstoke is 56.0 Kcfs. In the spring of 2003, the US stored 335 Ksfd (664 KAF) and BC Hydro stored 335 Ksfd (664 KAF) of non-treaty storage in the Mica Reservoir. According to the agreement, all of the US water and half of the BC Hydro water must be released in July and August of 2003. The 2003 total release volume between the US and BC Hydro water was 559 Ksfd (1109 KAF) in July and August. According to BPA accounting, all of the non-treaty storage water was released from Canada by the August 31, 2003.

Treaty Storage Operations

The Treaty requires Canada to operate with at least 8.45 MAF of storage for flood control in Canada and the United States. The U.S. downstream power benefits from Canadian Treaty

storage are to be shared equally between the two countries. Each year the U.S. and Canadian Entities (BC Hydro, BPA and the COE) prepare an Assured Operating Plan with agreed Determinations of Downstream Power Benefits for a six year planning period. Beginning with the 1997 through 1998 Assured Operating Plans, additional loads were included in June to assist meeting U.S. flow augmentation objectives. Each year a Detailed Operating Plan is prepared for the upcoming operating year that implements the Assured Operating Plan. Since 1993, the Entities have agreed only to mutual beneficial deviations from the Detailed Operating Plan, generally to meet U.S. salmon flow augmentation and Vernita Bar needs, in return for meeting Canadian trout and white fish spawning required and to avoid reservoir elevations which result in problems with erosion.

In 2003, storage was 251 Ksfd (498 KAF) short of the Treaty Storage Regulation (TSR). Apparently, 2003 was a special case where the TSR[1] increased dramatically in March due to increased water supply forecast. At the time the forecasts increased, major Canadian projects were already releasing minimum flows and could not store additional water. Because of the late season increase in water supply forecast along with a limited ability to store more water treaty storage was 251 Ksfd (498 KAF) below the TSR.

6. Snake River

The BOR released approximately 282 KAF of water for summer flow augmentation by the end of August 2003. Of the 282 KAF total, 160 KAF was released from the Payette River system, 60 KAF from the Boise River system, and 62 KAF was released from a combination of Lemhi, Oregon, and the Snake River High Lift Pumpers. The NOAA Biological Opinion and the NWPPC Fish and Wildlife program call for the BOR to provide up to 427 KAF of volume from Upper Snake River reservoirs for summer flow augmentation. Therefore, during the summer of 2003, 145 KAF less water was released from Upper Snake reservoirs.

1. Treaty Storage Regulation (TSR) is a study performed at least twice a month that is used to determine the Canadian Treaty Storage draft points. The regulation is based upon plant loads, thermal and hydro-independent resources, critical rule curves, non-power requirements and other operating data from the Assured Operating Plan for the current operating year.

C. Conclusions:

- Water Year 2003 run-off volume was below average throughout the Columbia Basin. At The Dalles Dam, the observed runoff volume recorded between January and July of 2003 was 87.7 MAF, which was 82% of the average.
- Seasonal (October through September) precipitation was: 80 percent of average (1971-2000) at the Columbia above Grand Coulee, 89 percent of average at the Snake River above Ice Harbor, and 85 percent of average at Columbia above the Dalles.
- In 2003, the Snake River basins and Columbia Basins above the Columbia-Snake River confluence had only slightly below average snowpack and basins on the lower Columbia River were generally well below average.
- During portions of the 2002/2003 chum season, the Bonneville tailwater was operated to a target of 11.2 feet with a minimum of 11.0 feet. The majority of the Salmon Managers did not agree with this operation. In retrospect, an 11.5 foot Bonneville tailwater elevation could have easily been maintained through out the 2002/2003 chum season with an additional 4.34 MAF to spare.
- Grand Coulee was a tenth of a foot above its April 10th Opinion elevation and Brownlee was 6.6 feet above its April 10th elevation.
- Libby was 46.3 below its April 10th Biological Opinion flood control elevation; Hungry Horse was 41.8 feet below its April 10th elevation; and Dworshak was 7.2 feet below its April 10th elevation.
- All major storage projects (Grand Coulee, Hungry Horse, Libby, Dworshak, and Brownlee) were at or within several feet of full by the end of June/early July.
- The summer draft limit at Grand Coulee was 1278 feet by August 31st. The BOR drafted Grand Coulee to an elevation of 1278.3 feet on August 31st.
- On July 1, 2003, the State of Montana submitted SOR 2003 MT-1 (Appendix J) to the Action Agencies, which asked for, among other things, only a ten-foot draft from Hungry Horse and Libby for summer flow augmentation by the end of September. After being raised to both the IT and Federal Executive levels, a decision was made to operate Hungry Horse to the Biologi-

cal Opinion specified 20-foot draft by the end of August for summer flow augmentation. Libby drafted to 2438.8 feet and Hungry Horse drafted to 3539.8 feet by August 31, 2003.

- In 2003, the Action Agencies were unable to negotiate a Libby-Canadian exchange due to hydrologic conditions in Canada.
- Two different SORs were submitted to the Action Agencies on July 8, 2003 concerning summer Dworshak releases, the first by ODFW and USFWS and the second by the IDFG and the Nez Perce Tribe. Action Agencies decided on an operation similar to that proposed IFDG and the Nez Perce; Dworshak was drafted to 1533.0 feet by August 31st, leaving 173.3 KAF of water in the reservoir to supplement flows over the first half of September.
- Overall, taking into account all of the projects with Opinion flow objectives, Biological Opinion flow objectives were met 60% of the time in 2003. More specifically, Spring Flow Objectives were met at all projects; where as, Summer Flow Objectives were not met at all projects.
- The total Non-Treaty release volume between the US and BC Hydro water was 559 Ksfd (1109 KAF) in July and August. According to BPA accounting, all of the non-treaty storage water was released from Canada by the 31st of August 2003.
- In 2003, Treaty Storage was 251 Ksfd (498 KAF) short of the Treaty Storage Regulation (TSR). Apparently, 2003 was a special case where the TSR increased dramatically in March due to increased water supply forecast.
- The BOR released approximately 282 KAF from the Snake River for summer flow augmentation by the end of August 2003. Of the 282 KAF total, 160 KAF was released from the Payette River system, 60 KAF from the Boise River system, and 62 KAF was released from a combination of Lemhi, Oregon, and the Snake River High Lift Pumpers

II. 2003 SPILL MANAGEMENT

A. *Spill*

1. Overview

In March of 1995, an ESA Section 7 Biological Opinion (Opinion) on the operation of the Federal Columbia River Power System was issued. The Opinion established a set of reasonable and prudent alternatives (RPA) with the objective of improving the operation and configuration of the federal power system as one component in a larger set of measures to meet a no jeopardy requirement of the Endangered Species Act (ESA), and to fulfill the United States commitment to uphold tribal treaty fishing rights. One of the RPA established a Biological Opinion spill program for fish passage.

A Supplemental Biological Opinion (Supplemental Opinion) was signed on March 2, 1995 in part to address the needs of the newly listed as threatened Snake River steelhead and the Lower Columbia River steelhead, as well as the endangered Upper Columbia River steelhead. The Supplemental Biological Opinion called for additional spill to the gas caps on a system-wide basis and modified the planning dates for the initiation and duration of the spill program. To the extent that the fish passage efficiency (FPE) at some projects exceeded 80%, the additional spill supplemented 1995 RPA Measure 2 for an interim period pending decisions regarding biologically based performance standards for project passage.

The NOAA Fisheries again modified spill in the 2000 Biological Opinion issued in December of 2000. In the Biological Opinion spill at Lower Monumental Dam was increased from a 12-hour period to a 24-hour period. At The Dalles Dam the instantaneous spill level was decreased from 64% of instantaneous flow to 40% of instantaneous flow. Spill at John Day and Bonneville dams remained unchanged from the 1998 Supplemental Opinion, but called for the initiation of a daytime spill test at John Day Dam and a test of increasing daytime spill volume at Bonneville Dam.

The purpose of the spill program is to improve the downstream passage of ESA listed stocks by providing a route with less associated mortality than turbine passage. It is recognized that spilling water generates atmospheric gas supersaturation of the river that can have detrimental effects on fish. In providing spill as an alternate passage route the associated mortality due to

dissolved gas supersaturation needs to be balanced against mortality of turbine passage.

2. Spill Planning

The 2003 Water Year was characterized at the April 1 forecast to be 79% of average April through July (1971-2000) runoff volume above Lower Granite Dam, and 79% of average above The Dalles Dam for the January to July time period. This runoff volume trend increased slightly through the spring with the final July runoff volume forecast calling for 82% of average above Lower Granite and 83% of average runoff volume above The Dalles.

The flows during the 2003 migration season were less than those observed during recent past years, with the exception of the 2001 drought year. The pre-season forecast was for a runoff volume that was close to the 16 MAF April through July runoff forecast volume at Lower Granite Dam referred to in Biological Opinion as the volume needed to provide a spring flow objective of 85 Kcfs. Below this objective spill in the Snake River would be eliminated and transportation of juvenile salmonids would be maximized. Since the runoff volume forecast was close, but not less than 16 MAF other variables were taken into consideration. These included: the trend in the water supply forecast; the trend in runoff; environmental conditions; fish condition; species composition; and the runoff in the two river systems. Given consideration of these other variables the decision was made to implement the Snake River spill program during 2003. The average monthly flows that occurred at Lower Granite and McNary Dams are contained in Table 8.

TABLE 8. Average monthly flows at Lower Granite and McNary dams in 2003.

Month	Average Monthly Flow (kcfs)	
	Lower Granite	McNary
April	72.2	192.6
May	94.4	239.3
June	89.4	244.4
July	32.8	144.0
August	25.9	127.0

3. Total Dissolved Gas Waivers

The dissolved gas levels observed in 2003 reflected the range of flows observed. A multi-year waiver for the total dissolved gas standard was requested from the Oregon Department of

Environmental Quality (DEQ), and the Washington Department of Ecology (DOE). The Idaho Department of Environmental Quality and the Nez Perce Tribe did not consider a waiver of the water quality standard for total dissolved gas supersaturation (TDGS). Because of the risk associated with dissolved gas supersaturation, the requested waiver was for a twelve-hour average of 115 and 120 percent TDGS in the forebay and tailrace of a project, respectively. Without a waiver the total dissolved gas levels were limited to the 110% level below Dworshak Dam.

The Oregon DEQ granted a waiver request from the USFWS for the ten-day spill period associated with the Spring Creek Hatchery fall chinook March 8th release, as did the Washington Department of Ecology for the provision of spill up to the 120% total dissolved gas criteria

4. Spill Implementation

The water conditions during 2003 were below average in terms of runoff volume. In general, except for a short period of uncontrolled flow, spill was managed to meet the TDGS waivers. Therefore, spill during the spring passage season could be manipulated such that total dissolved gas levels were generally at, or below, the waivers during most all of the migration season.

Snake and Clearwater Rivers

The allowable levels of TDGS below the project dictated spill at Dworshak. Those levels were limited to 110% TDGS because of the lack of a dissolved gas waiver from Idaho or the Nez Perce Tribe. Spill began early in April and for the most part ended in early June at Lower Granite and Little Goose dams, while continuing through August at Ice Harbor Dam. Modifications to Biological Opinion spill programs are discussed below.

Dworshak

No spill occurred at this project throughout March for flood control. Spill began on April 3 as flows were increased in order to prevent the project from filling too quickly (Figure 10). There was no spill from May 21 until after the July 4th weekend. At this time flows were increased for summer flow augmentation. This spill ended on August 4, 2003.

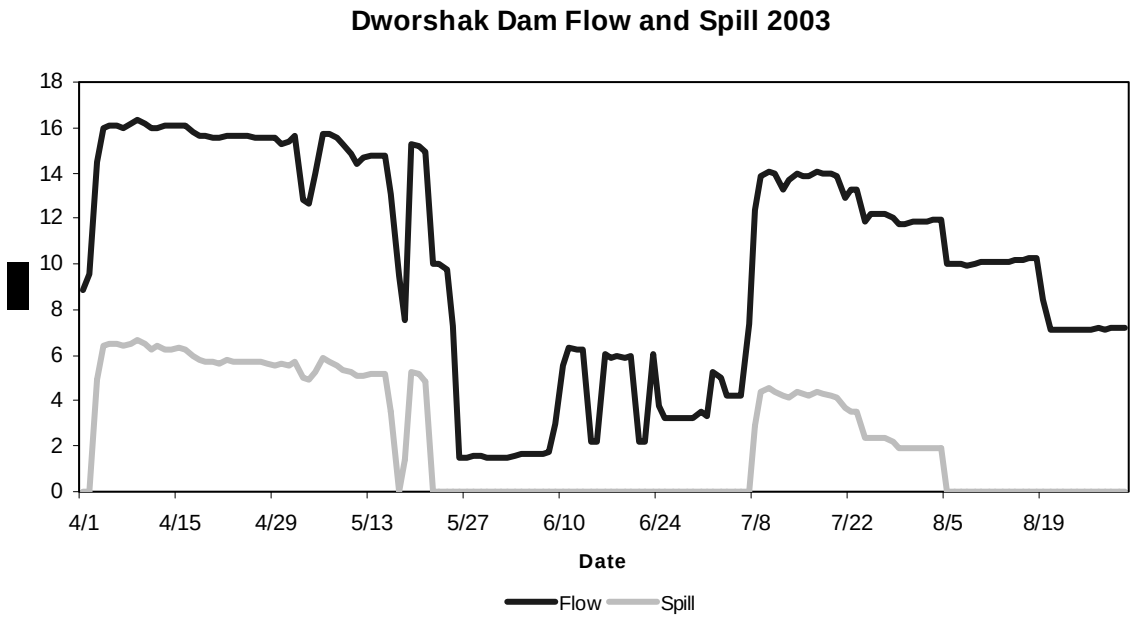

FIGURE 10. Dworshak Dam flow and spill for spring and summer of 2003.

Lower Granite Dam

Spill was initiated on April 3, 2003 based on increasing numbers of juvenile migrants passing Lower Granite Dam (Figure 11). In the 2000 Biological Opinion NOAA Fisheries set a spill equal to the gas cap at a level of 60 Kcfs for 12 hours (1800 to 0600 hours) however, gas cap levels were reached at spill levels somewhat lower . Spill was implemented at about this level (limited by total dissolved gas concentrations) until the removable spillway weir (RSW) testing began on April 14, 2003. After the initiation of the test, spill was more variable based on the test condition. The test compared Opinion spill levels to RSW operation with training spill for 24 hours. There is no spill requirement for summer spill at this project, as transportation is maximized for subyearling migrants. Spill ended on June 20.

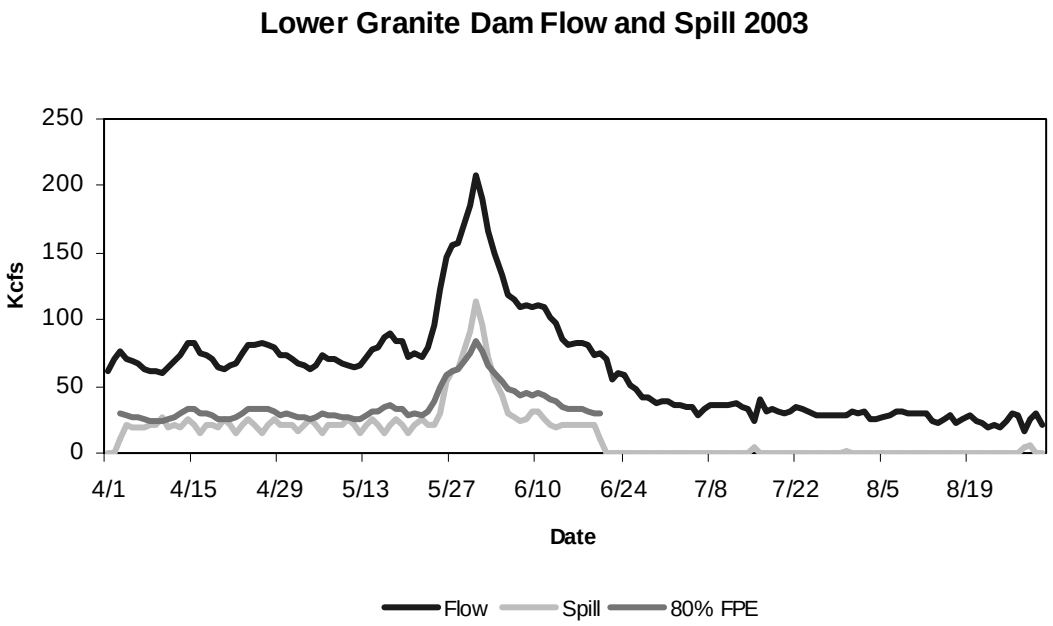

FIGURE 11. Lower Granite Dam flow and spill for spring and summer of 2003.

Little Goose Dam

The 2000 Biological Opinion sets spill at this project to 45 Kcfs for a 12-hour period. Spill was initiated on April 5, 2003. Spill occurred for a 12 -hour period (while managing dissolved gas) until June 20. At this project the 80 % FPE was only met during the high excess hydraulic capacity spill period (Figure 12) during late May and early June. There is no Biological Opinion spill requirement for this project during the summer.

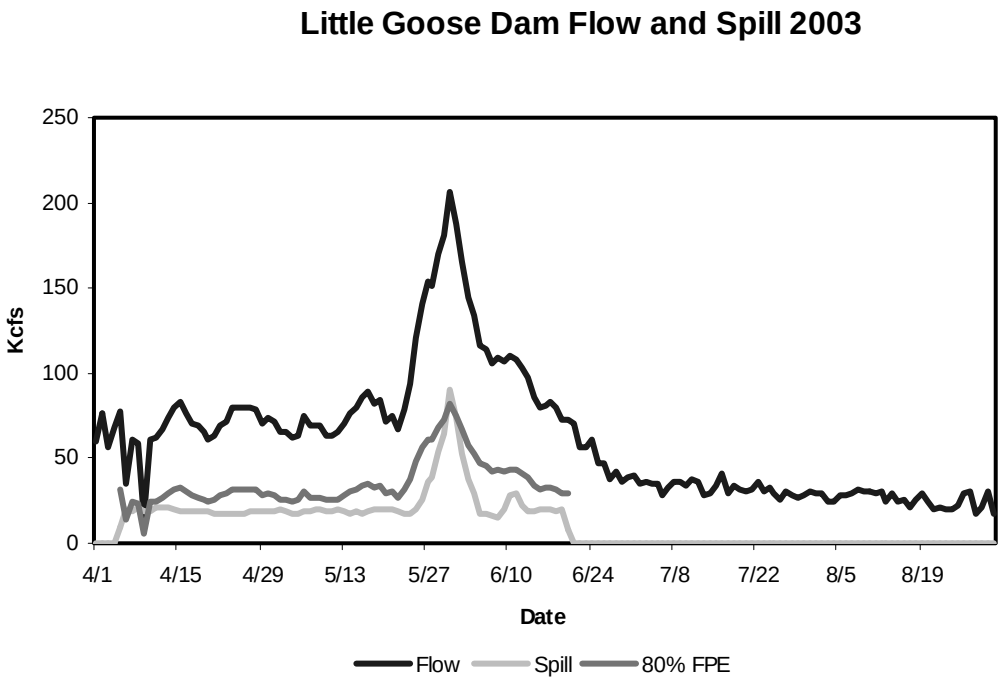

FIGURE 12. Little Goose Dam flow and spill for spring and summer of 2003.

Lower Monumental Dam

The Biological Opinion calls for spill to the gas cap (approximately 40 Kcfs) for 24 hours daily. In 2003 the project was operated with a modified spill schedule (50% spill/ 50% powerhouse) (Figure 13), which was based on the results of physical model studies at the COE's Waterways Experiment Station (WES). The objective of the new spill was to improve tailrace egress conditions. This change in operation in the 2003 water year resulted in approximately a 10 Kcfs per day reduction in spill volume from the Biological Opinion.

Spill began on April 7 and ended on June 20, 2003. There is no Biological Opinion spill requirement for this project during the summer.

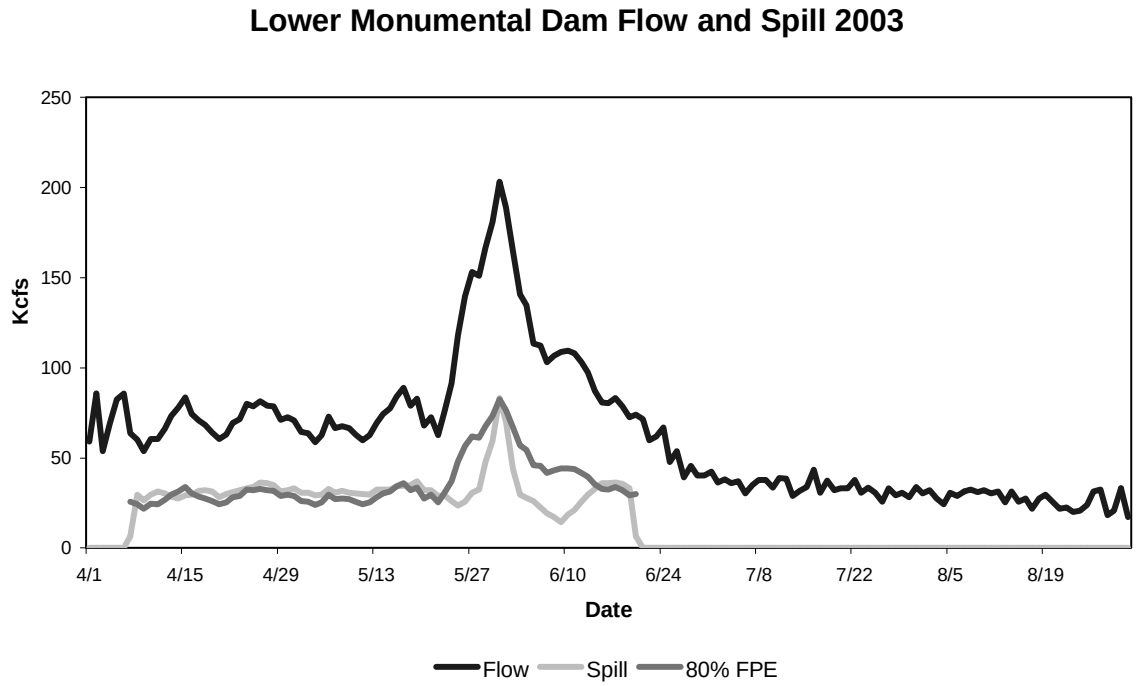

FIGURE 13. Lower Monumental Dam flow and spill for spring and summer of 2003.

Ice Harbor Dam

The Biological Opinion specifies an instantaneous spill level of 100 Kcfs during nighttime hours and 45 Kcfs during the day. Spill began on April 9, 2002 because of observed fish passage and ended on August 31, 2003. During 2003 the project was run in a research mode where tests were being conducted of Opinion spill versus a 50% of flow for 24 hours using a block spill design.

The Salmon Managers had discussed the Ice Harbor spill for fish passage operations since the summer studies concluded on July 13. Ice Harbor was constrained from implementing the Biological Opinion Spill Program based on preliminary information and data, combined with assumptions on turbine passage survival that suggested survival through the spillway was lower than survival through the turbine units at this project. The fishery agencies and tribes have previously documented concern regarding these applications of preliminary research data (memo from Joint Technical Staffs dated July 21, 2003) and concerns regarding the use of controversial research results as a basis for in-season management decisions.

The decision was made by NOAA Fisheries to alter spill (spill was decreased from a 24-hour program to a 12-hour program) at Ice Harbor Dam from the end of the summer study until the results from the summer spill studies were analyzed, assuring the agencies and tribes that study results would be available the following week. Subsequent spill for fish passage operations were to be determined based on this information. A considerable amount of time had lapsed and NOAA Fisheries' had not provided the study results for review. The potential for increased mortality to subyearling migrants from the implementation of less than the Opinion spill measures by reduction in spill, and the delay in providing the data prompted the following a review of the publicly available data from the Ice Harbor studies.

PIT-tag data were downloaded from PTAGIS data base and survival estimates from release to McNary Dam tailrace were calculated for each group (see FPC memo dated August 6, 2003.) The point estimates of survival indicated that survival through the spillway was higher than survival through the turbine units. The low estimates of survival through the turbine added validity to the concerns expressed in the state and tribal fish and wildlife managers letter dates July 21, regarding the Ice Harbor study design and the appropriate use of preliminary data. These data confirmed the need to implement the Opinion spill program.

NOAA Fisheries finally reported the preliminary survival data on August 13. They confirmed that the PIT tag studies showed the highest survival was observed for fish passing over the spillway. Given this information it was expected that the decision to return spill to full Biological Opinion levels would occur immediately. However, internal discussions within NOAA Fisheries dragged on until the season was over. This whole situation illustrates the difficulty of trying to manage spill based on preliminary and controversial information from earlier studies and the impossibility of using in season information for changing a program that is in place. The net result was that more fish were likely lost due to an incorrect restriction of spill.

The 80% FPE was exceeded through most of the spring migration (Figure 14) and was not met during most of the summer period.

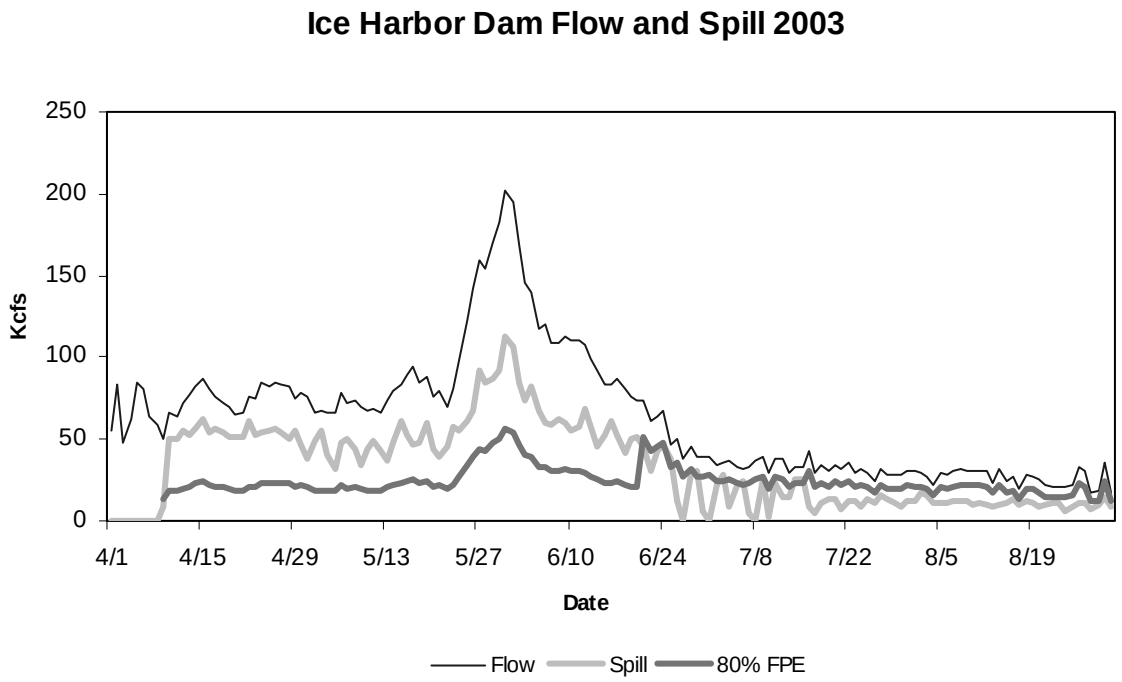

FIGURE 14. Ice Harbor Dam flow and spill for spring and summer of 2003.

Lower Columbia River

The 2003 water year was below average in the lower Columbia River. Spill was a product of Biological Opinion planned spill and over generation spill during the spring and Biological Opinion spill during the summer.

McNary Dam

Spill for fish passage began on April 14. Spring spill was to be to the gas cap for 12 hours during the night. The gas cap spill levels were anticipated to increase to 160 - 180 Kcfs due to the installation of new spillway deflectors at the project. Spill occurred at this project throughout the spring and effectively ended on June 28, 2003 (Figure 15). During the spring migration the project often exceeded the 80% FPE. There is no summer spill requirement in order to maximize transportation.

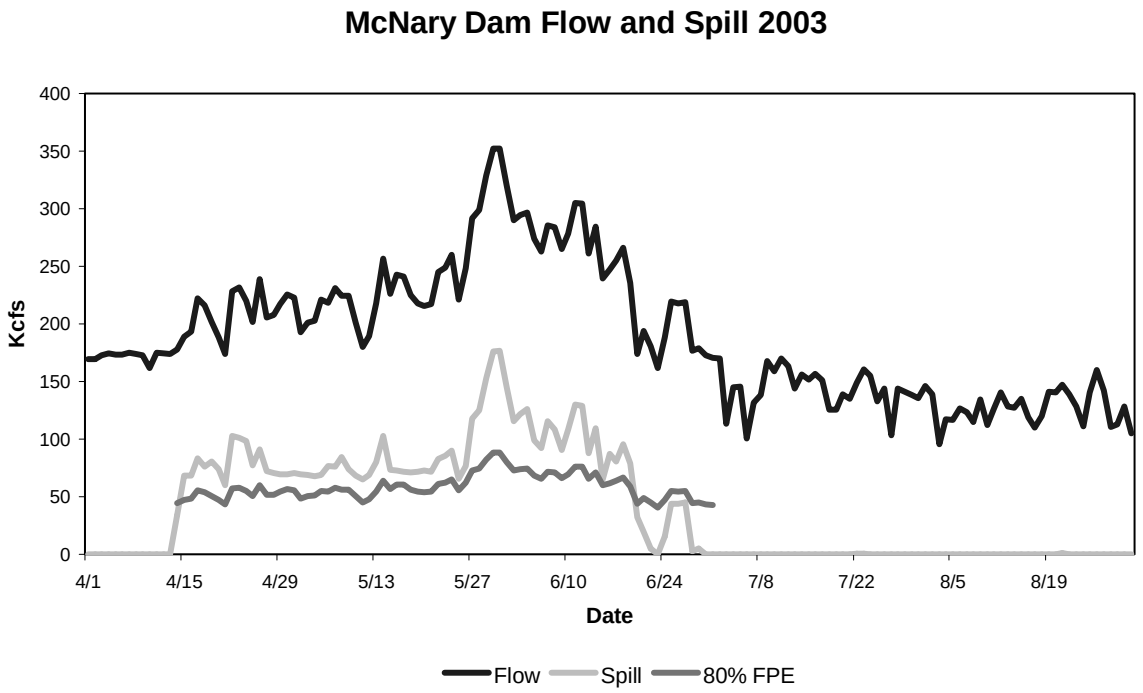

FIGURE 15. McNary Dam flow and spill for spring and summer of 2003.

John Day Dam

Opinion spill began April 14 and continued until April 27. The Biological Opinion specifies a level of spill up to the gas cap (approximately 160 Kcfs) for a period from one hour before sunrise to one hour after sunset. Beginning on April 28, 2003 a spring test of 60% of flow (Opinion) versus 45 % of nighttime flow was conducted. No planned daytime spill occurred at the project. During the summer test period (6/13 to 7/30) a test of 60% of flow during nighttime hours versus 24-hour spill of 30% of flow was conducted. After that time the Opinion spill program was implemented (Figure 16). The project never achieved the 80% FPE objective.

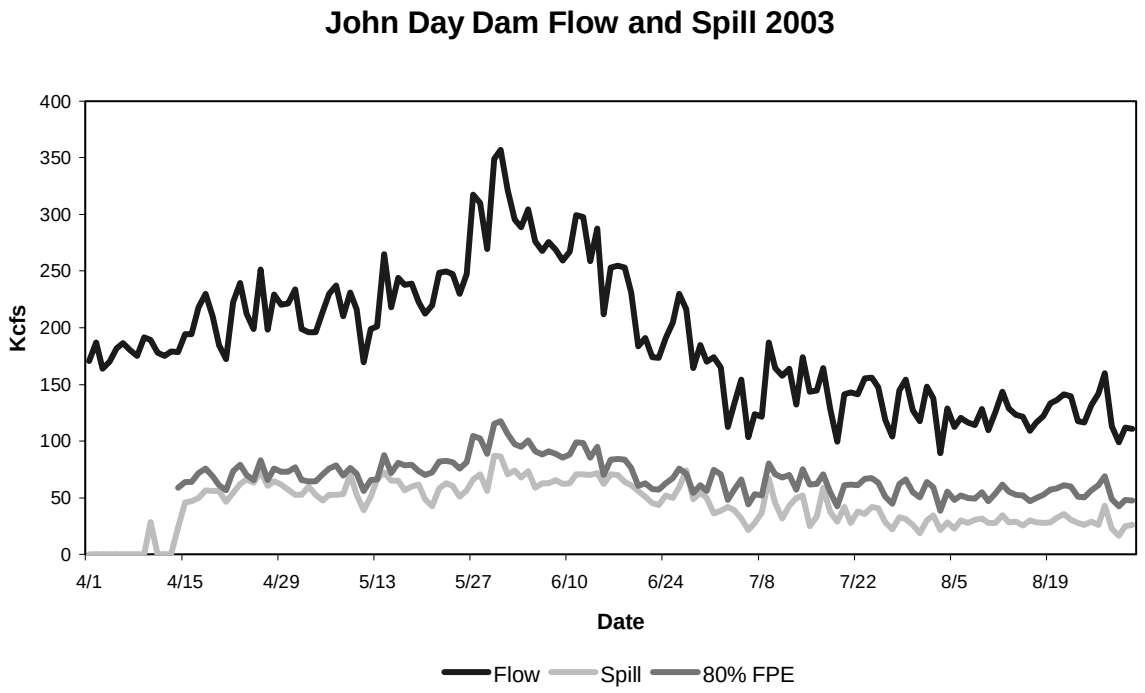

FIGURE 16. John Day Dam flow and spill for spring and summer of 2003.

The Dalles Dam

The plan for spill at The Dalles Dam was 40% of instantaneous flow for 24 hours daily for both the spring and summer spill periods. Spill began on April 14, 2003 and ended on August 31, 2003. Over the season spill averaged 38% of average daily flow. As seen in the graph (Figure 17) spill never came close to meeting the 80% FPE.

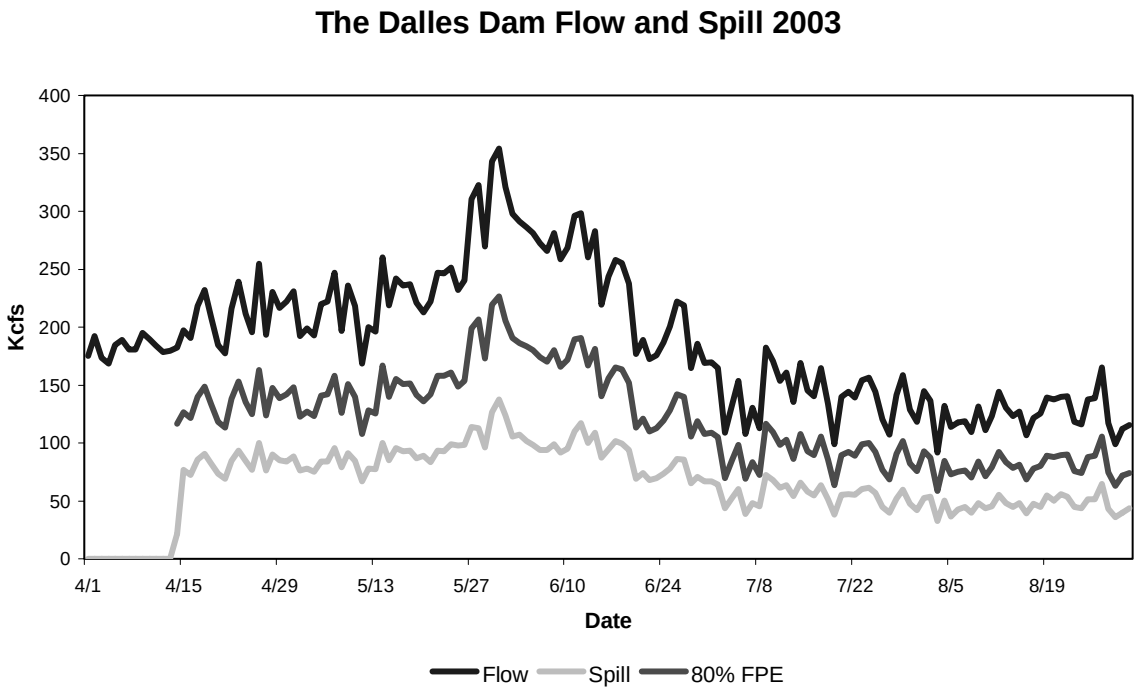

FIGURE 17. The Dalles Dam flow and spill for spring and summer of 2003.

Bonneville Dam

Spring Creek Pre-Biological Opinion Season Spill

As in past years', spill to facilitate the passage of Spring Creek subyearling fall chinook was requested subsequent to the March hatchery release. Listed chum redds below the Bonneville project prompted a request for an increase in flow to allow for adequate depth compensation to assure that the spill generated gas levels over the redds was not lethal to emerging chum. The operation was requested for a 36-hour period following the release. Not all the state and tribal fishery managers supported the reduced request.

The Biological Opinion calls for a spill level to the gas cap during nighttime hours (90-150 Kcfs) and limiting spill to 75 Kcfs during daylight hours. At Bonneville Dam the daytime spill is limited to prevent adult fallback. Under these restrictions the 80% FPE is not achievable. The 2003 operation was to implement a test of the Opinion condition versus 24-hour spill to the gas cap during the spring and to implement the Opinion during the summer (Figure 18). Spill was initiated on April 14 and continued through August 31.

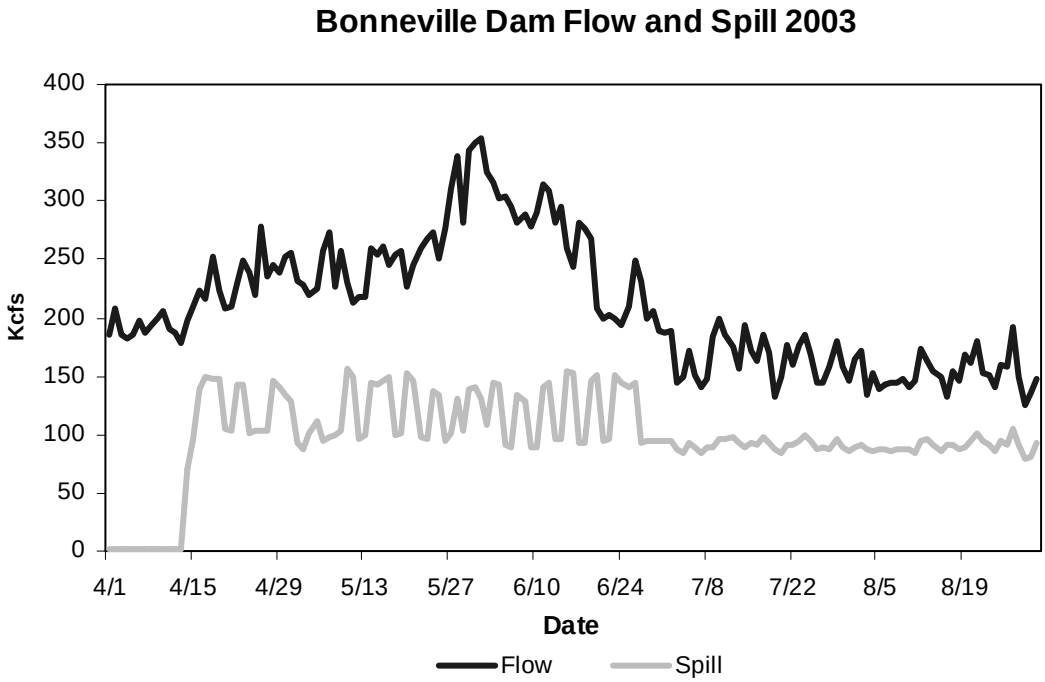

FIGURE 18. Bonneville Dam flow and spill 2003

5. Summary and Conclusions

- The provision of spill for fish released from the Spring Creek Hatchery continued to be contentious because they are hatchery fish released outside of the Biological Opinion spill program. Spill was allowed for these fish up to the 120% TDGS levels with approval from the States' of Oregon and Washington, but was limited to a 36-hour period.
- In most instances spring and summer spill were provided as described by the Biological Opinion spill program for fish passage, within the constraints of the State waivers for TDGS. However, notable exceptions include spill test periods and the month of August at Ice Harbor Dam.
- Spill at Ice Harbor Dam was modified to a nighttime 12-hour spill program after July 31 over the objection of most of the fishery agencies and tribes.

- Spill was not returned to full implementation of the Biological Opinion levels even after data collected showed that the spillway passage had the highest associated survival.
- The experience that occurred around Ice Harbor in 2004 demonstrates the inability to manage based on preliminary data collected in-season. Data was not analyzed within a timely manner, and even after the information was released internal discussions within NOAA Fisheries precluded decisions from being made.

B. Gas Bubble Trauma Monitoring and Data Reporting for 2003

1. Overview

Monitoring of juvenile salmonids in 2003 for Gas Bubble Trauma (GBT) was conducted at Bonneville Dam and McNary Dam on the Lower-Columbia River, and at Rock Island Dam on the Mid-Columbia River. The Snake River monitoring sites were Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam. Sampling of fish began the first full week of April at all sites and continued through mid-June at the Snake River sites, when the numbers of steelhead and yearling chinook were too few to sample effectively. Subyearling chinook were not sampled in the Lower Snake River due to their endangered status and because the Biological Opinion does not call for the implementation of summer spill at the Snake River collector projects. Sampling of subyearling chinook did occur at Columbia River sites to the end of August.

Sampling occurred two days per week at the Lower Columbia sites and once a week at Lower Granite, Little Goose and Lower Monumental in the Snake River. In previous years fish were sampled every other day (3 to 4 days per week) at most facilities. The number of sampling days was reduced in 1999, in order to decrease the number of fish handled. It was determined that the reduced sampling effort would not significantly diminish the capability to detect the presence of GBT in the migrating population.

The goal was to sample 100 salmonids of the most prevalent species (limited to chinook and steelhead) during each day of sampling at each site, the proportion of each species dependent upon their prevalence at the time of sampling. Examinations of fish were done using variable magnification (6x to 40x) dissecting scopes. The eyes, and unpaired fins were examined for the presence of bubbles. The bubbles present in the fins were quantified using a ranking system based on the percent area of the fins covered with bubbles. A rank of 0 was recorded when no bubbles were present; rank 1 was recorded when up to 5% of a fin area was covered with bubbles; rank 2 was for 6% to 25%; rank 3 indicated 26% to 50% fin area was bubbled; and rank 4 indicated greater than 50% of a fin was covered with bubbles. The eyes of the fish were also examined and the eye with the highest amount of bubbles in it was ranked using the same criteria as was used for the fins. Additional information was recorded for each fish including, species, age, race, rearing disposition, fork length, fin clips, and tags. The examination procedures were simi-

lar to those used in past years of the program (see the GBT Monitoring Protocol for details of exam procedures).

Sampling techniques varied somewhat based on the location. This year all sampling sites were at dams, where fish could be collected from the juvenile fish bypass system. At those dams where fish crossed separators the fish were collected as they entered the separator. Rock Island Dam is the only site where fish were held in a tank (up to 24 hours) prior to examination.

2. Results

A total of 12,420 juvenile salmonids were examined for GBT between April and August (Table 9). A total of 104 or 0.8% showed some signs of GBT in fins or eyes (Table 10).

TABLE 9. Number of juvenile salmonids examined for signs of GBT at dams on the Lower Snake River and on the Columbia River from April to August 2003 as part of the GBT Monitoring Program.

	Site						
Species	**BON**	**MCN**	**LMN**	**LGS**	**LGR**	**RIS**	**Total**
Chinook Subyearlings	1,731	2,173				1,007	4,911
Chinook Yearlings	1,324	1,330	408	539	424	659	4,684
Steelhead	256	248	548	455	676	642	2,825
Total	**3,311**	**3,751**	**956**	**994**	**1,100**	**2,308**	**12,420**

Fin signs were found in 101 or 0.8% of the fish sampled at all sites. No fish were found with severe fin signs (rank 3 or higher) while, 5 fish had fin rank 2, with the remainder (96 having rank 1 signs). The prevalence of GBT signs at Rock Island Dam was higher than any other Columbia River site during the 2003 monitoring season as is typically the case each season. Because the Rock Island data may obscure other interannual trends in the occurrence of GBT signs among sites, it will be treated separately in the remainder of this report.

TABLE 10. Number of juvenile salmonids found with fin GBT at dams on the Lower Snake River and on the Columbia River from April to August 2003 as part of the GBT Monitoring Program.

Species	Site						
	BON	MCN	LMN	LGS	LGR	RIS	Total
Chinook Subyearlings	0	0	N/A	N/A	N/A	20	20
Chinook Yearlings	0	3	1	5	0	17	26
Steelhead	0	1	28	13	0	13	55
Total	**0**	**4**	**29**	**18**	**0**	**50**	**101**

At the Lower Columbia River and Snake River sites (i.e. excluding Rock Island) a total of 10,112 fish were examined with 54 (0.5%) exhibiting signs of GBT, compared to 0.7% in 2002, 0.1% in 2001, 0.2% in 2000, 1.4% in 1999, 1.6% in 1998, 4.3% in 1997, 4.2% in 1996 and 1.3% in 1995. Fifty-one fish were found with fin signs in 2003 (0.5%), comparable to 1999 when 0.3% were found with fin signs. The percent signs over the past several years has been 0.7% in 2002, 0.001% in 2001, 0.2% in 2000, 0.3% in 1999, 1.0% in 1998, 3.2% in 1997 and 3.3% in 1996. No fish were found with severe fin GBT in Lower Snake and Lower Columbia sampling. This is similar to 2002, 2001, 2000, 1999, and 1995 when no severe fin GBT was found. Other years showed higher incidence of severe fin GBT; in 1998 four (0.01%) fish displayed severe fin signs, 1997 when 117 fish (0.27%) had severe fin signs (again excluding Rock Island) and 47 fish (0.12%) in 1996.

The Biological Opinion Spill Program was managed using the data collected for total dissolved gas levels. However, signs of GBT in fins of juvenile fish, examined as part of the biological monitoring, were used to compliment the physical monitoring program. The NOAA Fisheries set the action criteria for the biological monitoring program at 15% prevalence of fish having fin signs **or** 5% with severe signs (rank 3 or greater) in fins. The NOAA Fisheries action criteria were never exceeded. This is similar to 2002, 2001, 2000, 1999, 1998 or 1995 when no exceedances occurred. But contrasts with 23 dates when GBT levels surpassed the action criteria in 1997, 20 in 1996.

The prevalence and severity of fin signs in juvenile salmonids sampled in the Lower Snake and Lower Columbia rivers reflects changes in TDGS conditions in the river from year to year. The occurrence of severe signs in 1996 and 1997, and the increase in exceedences of the NOAA Fisheries action criteria, reflected a significant increase in the number of days when TDGS rose above 125% in the forebays of these dams (see Table 11 and Table 12). In other years few fish were observed with severe signs of GBT reflecting the more moderate conditions found in the river.

TABLE 11. The number of days when TDGS levels were above 120% and 125% at representative forebay monitors in the Lower Snake and Lower Columbia Rivers from April 1 to August 31.

	2003		2002		2001		2000		1999		1998		1999	
TDGS Monitor	**days >120**	**days >125**	**days >120**	**days >125**	**days >120**	**days >125**	**days >120**	**days >125**	**days >120**	**days >125**	**days >120**	**days >125**	**days >120**	**days >125**
Low er Granite	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Goose	7	2	1	0	0	0	0	0	5	0	8	3	23	8
Low er Monumental	7	2	5	0	0	0	0	0	7	2	14	8	61	31
Ice Harbor	4	0	0	0	0	0	1	0	5	1	14	4	52	19
McNary (Oregon)[a]	1	1	0	0	0	0	0	0	3	0	0	0	46	0
John Day	1	1	0	0	0	0	0	0	0	0	7	0	47	15
Bonneville	0	0	0	0	0	0	0	0	0	0	3	0	65	27

[a] 2002 data used Washington monitor at McNary due to missing data from Oregon monitor during July and August.

TABLE 12. The number of days when NOAA Fisheries GBT criteria of 15% prevalence or 5% severe signs were exceeded at sites in the Lower Snake and Lower Columbia rivers from April 1 to August 31.[ab]

Site	2003	2002	2001	2000	1999	1998	1997
Lower Granite	0	0	0	0	0	0	0
Little Goose	0	0	0	0	0	0	1
Lower Monumental	0	2	0	0	0	0	7
Ice Harbor	0	0	0	0	0	0	3
McNary	0	0	0	0	0	0	2
John Day	0	0	0	0	0	0	1
Bonneville	0	0	0	0	0	0	11
Total	**0**	**2**	**0**	**0**	**0**	**0**	**25**

[a] Based on dates when at least 30 fish of the species exhibiting signs were captured.

[b] More than 5% of fish showed severe signs on only 1 date in each year 1996 & 1997 and on those same dates the prevalence of fin signs was greater than 15%.

3. Discussion

This year, as in previous years, the proportion of fish showing fin signs appears to be proportional to the levels of TDGS experienced by fish. Lower Monumental Dam was the only location in the Lower Snake and Lower Columbia where signs of GBT approached the NOAA Fisheries action criteria, when on June 2 and June 9, 10 and 7 of 100 fish examined (respectively) were found with fin GBT. It is also the location, along with Little Goose with the greatest number of days when TDGS exceeded 120% at the forebay monitor (Table 12). These two sites showed the highest number of fish with fin signs in 2003, with 29 fish found with signs at Lower Monumental and 18 at Little Goose (Table 10). The incidence of GBT signs was related to a spike in flows exceeding 200 Kcfs that occurred around May 31 that was accompanied by high spill levels due to flow in excess of hydraulic capacity and consequently high TDGS levels in the Lower Snake River. Most of the fish affected were steelhead.

III. 2003 SMOLT MONITORING

A. *Smolt Monitoring Sites and 2003 Schedules*

Information on the juvenile salmon out-migration is collected each year to aid the Fisheries Agencies and Tribes in making management decisions beneficial to smolt survival as they move down-river from natal streams, through the hydro-system and on toward the ocean. The SMP provides data on the initiation of the juvenile out-migration, estimates of relative fish abundance at the dams, migration timing at traps and dams, fish travel time through key river reaches both prior to and within the hydrosystem, and estimates of survival for key groups of fish through index reaches. Portions of the data are gathered on the run-at-large migrating population, such as the passage indices, while other data such as travel time and survival estimates, target specific mark-groups of fish. All of the data is collected for the purpose of providing, both in-season information for management of flows and spills, and for post-season evaluation of the effects of the year's management actions on migrating juvenile salmonids. Because the SMP has been carried out over the course of 15 years or more at some locations, the program also provides a historic perspective for comparing in-season data with past years and for combining recent data with historic data for retrospective analyses.

Data were gathered at eleven monitoring sites in the Columbia River Basin (See Table 13 for sites and dates of operation for 2003). Monitoring was conducted at four traps in the Snake River Basin above Lower Granite Dam, at three dams in the Lower Snake River, Rock Island Dam in the mid-Columbia River, and three dams in the Lower Columbia River. Data from all sites were transmitted to FPC daily during the sampling season where it was archived as well as compiled for reporting. The information was made available to all interested parties via the Fish Passage Center web page at **www.fpc.org**. Data was also available through the Fish Passage Center's weekly reports or by data requests from Fish Passage Center Staff.

In addition to the activities described above, fish are also collected and PIT-tagged at SMP traps, Rock Island Dam and at selected hatcheries for more specific evaluations.

TABLE 13. Smolt Monitoring Sites and Schedules for 2003.

Site	Sampling Method	Dates of Operation	Primary Fish Data*
Bonneville Dam	PH2: Timed subsample from bypass PH1: trap sample	March 11 to October 31	C, FQ, GBT(2)
John Day Dam	Timed subsample from bypass	April 1 to September 15	C, FQ
McNary Dam	Timed subsample from bypass	April 2 to October 1	C, FQ, GBT(2)
Lower Monumental Dam	Timed subsample from bypass	April 1 to October 1	C, FQ, GBT(1)
Little Goose Dam	Timed subsample from bypass	April 1 to October 31	C, FQ, GBT(1)
Lower Granite Dam	Timed subsample from bypass	March 25 to October 31	C, FQ, GBT(1)
Rock Island Dam	PH2: Census of fish captured in volitional bypass	April 1 to August 31	C, FQ, GBT(2), PIT
Snake River Trap (rkm 225)	Dipper Trap	March 10 to May 27	C, FQ, PIT
Salmon River Trap (rkm 123)		March 10 to May 31	C, FQ, PIT
Grande Ronde Trap	Scoop Trap	March 10 to June 5	C, FQ, PIT
Imnaha Trap		March 10 to May 31	C, FQ, PIT

* C = fish counts recorded
FQ = fish quality including descaling and injury data obtained
PIT = PIT tagging and release from site
GBT(k) = gas bubble trauma measurements taken "k" days per week

B. Collection Counts and Relative Abundance

The daily passage index is computed by dividing the daily collection by the proportion of water passing through the powerhouse where the sampling takes place (Table 14). The daily passage indices adjust for daily changes in spill proportion under the conservative assumption that the proportion of fish passing through spill will be close to the proportion of water being spilled.

Estimates of fish guidance efficiency of the screens or of spill effectiveness (proportion of fish passing through spill) are not necessary using this method. As long as the daily index remains highly correlated to daily population abundance at each site the index remains useful for gauging passage timing and magnitude of passage. For these reasons, the daily passage index was chosen over attempts to estimate daily absolute abundance. Post-season, the daily passage indices are summed for the season at each site to provide an annual passage index for each species and rearing type available. The passage index is not applicable to trap sites because collection efficiencies of the traps are not calculated and likely very low (less than 5%); therefore only collection counts are reported for the four SMP traps.

Since 1984 the passage index has been used for calculation of within season relative abundance. In the past several years changes in the methods of sampling at Bonneville and John Day dams have evolved to a point where collection methods are very similar to other COE dams. Since 1998, sampling at John Day Dam has been carried out using a timed sample for the entire powerhouse bypass system instead of samples from a single gatewell slot as in prior years. At Bonneville Dam, the index sampling is a timed sample at Powerhouse II bypass since 2000 (previously, the timed trap samples were taken in Powerhouse I).

The index is based on an estimate of total daily collection at each monitoring site. Where a sample timer is used to systematically divert collected fish into a sample tank for processing, the resulting enumeration is divided by the sample rate to arrive at estimated collection.

TABLE 14. Formulas to compute passage indices (collection/flow expansion factor) at dams.

Sampling Site	Years	Collection	Flow expansion factor
Rock Island Dam (PH 2)	1985-2003	Catch / 1	PH2/(PH1+PH2+SP)
Lower Granite Dam Little Goose Dam Lower Monumental Dam McNary Dam	1984-2003 1984-2003 1993-2003 1984-2003	Catch / sample rate	PH/(PH+SP)
John Day Dam (bypass) John Day Dam Unit 3	1998-2003 1984-97	Catch / sample rate Catch / 1	PH/(PH+SP) Unit3/(PH+SP)
Bonneville Dam (PH 1)	1986-92 1993-95 1996-99	8 hr catch / sample rate 24 hr catch / sample rate 8 hr catch / sample rate	PH1/(PH1+PH2+SP)
Bonneville Dam (PH 2)	2000-2003	24 hr catch / sample rate	PH2/(PH1+PH2+SP)

Legend: PH=powerhouse flow; PH1=first powerhouse flow; PH2=second powerhouse flow; SP=spill flow; and Unit3=turbine unit 3 flow (note: all flows are 24-hr averages over the sample interval).

1. Project Specific Actions Affecting SMP

Rock Island Dam

The Rock Island bypass continued to have problems in 2003 causing fish mortality and injury at a much higher rate than other sites. This year early spring mortality was so high that PIT-tag operations were cancelled at the site due to concerns about the quality of fish available for tagging. The Chelan PUD, operators of the project, spent much of the spring identifying and repairing structures within the bypass. In addition to relatively high injury rates, the site routinely has reported the highest incidence of gas bubble trauma, well above what would typically be seen at other sites given similar TDGS levels, that is again, likely caused by the bypass.

Lower Granite Dam

Research operation of the RSW was ongoing in 2003. The RSW test compared RSW on with 18 kcfs training spill for 24 hours compared to RSW off and 12 hours of Opinion spill to the gas cap (60 Kcfs). The operation began April 14. The spill operations, RSW with training spill in combination with Opinion spill , likely affected collection efficiency of spring migrants. Seasonal estimates based on PIT-tag survival data, put collection efficiency about 30% for yearling chinook. The COE transported juvenile salmonids collected throughout the spring and summer migration seasons so that numbers of in-river migrants were significantly reduced at downriver projects.

Little Goose Dam

Operations at Little Goose Dam, were typical of recent years, and reflected Opinion recommended levels of spill; 12-hour spill during the spring migration. This operation lead to a collection efficiency that averaged about 30% (but ranged from 20% to 60% from early season to late) for yearling chinook and about 20% for steelhead (ranged from 16% to 60% early season to late). Since all collected fish were transported during spring, the number of in-river migrants downstream of Little Goose were reduced considerably, by this operation.

Lower Monumental Dam

Spring operations called for spill 24 hours per day at Lower Monumental Dam according to the Opinion. Fish collection was very low during spring migration compared to Lower Granite and Little Goose dams, with yearling chinook collection averaging 11% for the season and steelhead collection averaging 26%. The combined collection efficiency of the three projects meant that of fish migrating from above Lower Granite Dam, the proportion of fish destined for transport was 0.63 for chinook and 0.67 for steelhead.

McNary Dam

Spring operations called for alternate day sampling and primary bypass operations for NOAA transportation studies. During summer no spill occurred and collection and sampling occurred every day as transportation was maximized at the project.

2. Snake River Smolt Monitoring

The cumulative counts of salmonids at the four traps above Lower Granite Dam were summarized over the scheduled operation dates in 2003 (Table 15). For SMP these traps operated primarily on a five day per week schedule (Sunday afternoon to Friday morning). Sampling on the Imnaha River often involved two traps to increase collection of fish for PIT-tag marking. Trap counts reflect total fish collected and handled for either timing, fish condition or PIT-tagging purposes. Trap efficiencies were not estimated in 2003.

TABLE 15. Sampled numbers of composite wild/hatchery chinook, steelhead, coho, and sockeye at the four traps used in the Smolt Monitoring Program in 2003.

Species	No. of Fish Sampled	Species	No. of Fish Sampled
Salmon River Trap (aboveWhitebird)		**Snake River Trap (at Lewiston)**	
Chinook 1's	32,064	Chinook 1's	2,417
Steelhead	2,347	Steelhead	5,601
Sockeye	1	Sockeye	11
Chinook 0's	1	Coho	17
		Chinook 0's	355
Imnaha River Trap		**Grande Ronde River Trap**	
Chinook 1's	34,028	Chinook 1's	11,123
Steelhead	48,404	Steelhead	2,521
Chinook 0's	118	Chinook 0's	74

At all monitoring sites, SMP crews reported smolt sample counts at the level of clipped and unclipped fish. Because not all hatchery fish were fin clipped in the Snake and Columbia River basins, the FPC has, since 2000, reported all sample collection and passage index data for

TABLE 16. Sample, collection, and passage indices of salmonids at Snake River dams in 2003 and comparison with 2002, 2001 and the previous 3-yr average (1998-2000) annual passage indices.

Dam	Species	2003			2002	2001	1998-2000
		Sample	Collected	Passage Index	Passage Index	Passage Index	Average Index
Lower Granite	Chinook Age 0	58,661	1,169,812	1,413,192	753,573	740,553	382,929
	Chinook Age 1	25,800	2,577,031	3,599,259	2,460,813	1,958,276	2,931,109
	Coho	1,226	90,072	132,928	124,067	58,273	169,905
	Steelhead	22,564	2,337,150	3,355,830	2,603,071	5,580,777	6,311,861
	Sockeye/kokanee	113	9,760	16,399	77,820	4,851	34,948
Little Goose	Chinook Age 0	36,871	603,567	685,932	335,795	178,854	207,725
	Chinook Age 1	45,709	2,635,863	3,644,755	2,847,393	751,911	2,566,948
	Coho	1,413	86,758	116,669	104,590	21,893	97,320
	Steelhead	37,202	1,938,462	2,583,409	2,274,786	841,837	2,555,234
	Sockeye/kokanee	77	5,441	8,126	66,825	9,857	19,736
Lower Monumental	Chinook Age 0	81,497	290,325	341,254	306,204	53,516	132,263
	Chinook Age 1	20,058	463,390	785,329	2,220,450	553,436	1,305,623
	Coho	1,101	26,554	37,604	66,185	2,691	47,944
	Steelhead	22,038	1,229,842	1,865,478	1,793,280	360,511	1,663,729
	Sockeye/kokanee	154	3,307	4,543	38,999	1,026	15,165

each species at the level of combined hatchery and wild fish in our weekly reports and annual report tables (Table 16). However, since all hatchery yearling chinook released in tributaries above Lower Granite Dam are either fin clipped or implanted with a wire tag, we did attempt to collect supplemental data at several sites to help differentiate between hatchery and wild stocks for yearling chinook and in some cases for steelhead (see Table 17 through Table 19). The data for the Salmon River trap and Snake River (Lewiston) included counts of unclipped yearling chinook with a coded wire tag (CWT) and counts of unclipped yearling chinook and steelhead with fin erosion typical of a hatchery fish. These data were necessary at the traps in order to provide valid PIT-tag codes for PTAGIS and could be used to differentiate wild and hatchery yearling chinook and steelhead smolts for travel time and survival estimates.

Coded wire tag detectors were also used at Lower Granite, Little Goose and Lower Monumental dams to separate the unclipped hatchery chinook from wild chinook. The FPC makes annual estimates of the hatchery and wild yearling chinook migrating past Lower Granite Dam each year as well as total numbers of steelhead (Table 17, Table 18 and Table 19). Sockeye data

are also presented in this report at the combined hatchery and wild level, even though hatchery sockeye were 100% fin clipped, because the numbers of hatchery sockeye collected at SMP sites are very small.

At Lower Granite Dam the RSW was again in operation in 2003. The increased collection efficiency compared to 2002 may to some extent be an artifact of spill study designs being tested, the limited amount of training spill provided during the spring study and the late runoff. The RSW study in 2003 compared 24 hour RSW operation with 19 kcfs spill to 12 hour spill to the gas cap without the RSW. But the late runoff was probably more important in determining the collection efficiency in 2003. The highest flows, and highest spill levels, began the last week of May, after the 90% passage of yearling chinook. Most yearling chinook passing Lower Granite Dam did not benefit from the increased spill associated with the late peak of high flows.

TABLE 17. Hatchery yearling chinook population index at Lower Granite Dam in 2003 with comparison to prior five years and hatchery production.

Year	Collection efficiency	Collection	Passage index	Population index	Hatchery release [a]
1998	0.49	1,317,500	1,723,600	2,700,000	4,058,393
1999	0.26	1,762,700	2,768,100	6,800,000	9,676,126
2000	0.38	2,035,000	2,725,400	5,400,000	7,317,023
2001	0.75	1,547,700	1,547,700	2,100,000	4,076,080
2002	0.22	1,288,102	2,075,234	5,900,000	10,822,876
2003	0.32	2,014,435	2,813,499	6,300,000	12,111,740

[a] We did not include releases before September 1 of year prior to migration year in either the total hatchery release or the % fall release data.

Year to year changes in the hatchery yearling chinook population index at Lower Granite would be an effect of both hatchery production and survival upstream of Lower Granite Dam. Hatchery releases of yearling chinook reached 12 million in 2003, and that record level release was reflected in the high estimated population size in 2003 (Table 17). The estimated wild yearling chinook population size at Lower Granite Dam in 2003 was 1.3 million smolts. This is similar to estimates from other recent years (excluding 2001) where the average has been 1.1 million (Table 18).

TABLE 18. Wild yearling chinook population index at Lower Granite Dam in 2003 with comparison to prior five years.

Year	Collection efficiency	Collection	Passage index	Population index
1998	0.49	287,200	374,500	600,000
1999	0.26	410,800	636,600	1,600,000
2000	0.38	415,100	565,100	1,100,000
2001	0.82	410,600	410,600	500,000
2002	0.22	249,200	385,579	1,100,000
2003	0.42	562,595	785,759	1,300,000

Steelhead collection efficiency at Lower Granite Dam was likely affected by similar factors as yearling chinook; RSW operation reduced collection efficiency, while research operations that artificially constrained spill and reduced the operation of the RSW may have had the opposite effect. Also steelhead passage was later than chinook with the 90% passage date on May 29, and 27 percent of the steelhead passage occurred during the highest flows (between May 25 and June 5 when flows were above 120 kcfs) so that those late steelhead likely benefited (resulting in greater spill passage and lower collection efficiency) from the higher spill volumes associated with the late spike in flows (Table 19).

TABLE 19. Steelhead population index at Lower Granite Dam in 2003 with comparison to prior five years and hatchery production.

Year	Collection efficiency	Collection	Passage index	Population index[1]	Hatchery release
1998	0.59	5,085,525	6,918,462	8,600,000	8,956,100
1999	0.36	3,355,187	5,234,736	9,400,000	9,573,500
2000	0.59	5,039,620	6,782,359	8,500,000	9,568,500
2001	0.89	5,580,471	5,580,776	6,300,000	9,442,600
2002	0.24	1,698,933	2,342,800	7,100,000	9,225,257
2003	0.32	2,337,143	3,355,823	7,300,000	9,627,940

[1] Steelhead have not been distinguishable by clip status as hatchery or wild since 2000 with the relative average split of about 10% wild and 90% hatchery.

3. Columbia River Smolt Monitoring

The cumulative number of fish sampled at each dam in 2003, along with expanded annual collection and passage indices, were summarized for the Columbia River dams (Table 20). Passage indices were generally lower at Rock Island Dam in 2003 than in other recent years especially for spring migrants. This may have been due to malfunctions in the collection bypass system, which was shut down for several days during the season as repairs were made. The subyearling chinook passage index was actually higher than other recent years. At McNary Dam, sampling occurred every other day from April 3 to June 28. During the spring, on alternate days fish were either sampled and run through the full facility, or fish were bypassed through the primary bypass. The passage indices at McNary were adjusted to account for every other day sampling by using the previous day's total for those days when the facility was in primary bypass. The 2003 subyearling index at McNary was higher than 2002, but similar to 2001 and in the same range as the recent average. The yearling chinook index was very similar to 2002 both of which were higher than other recent years. The coho passage index was relatively unchanged compared to 2002, but lower than the 1998 to 2000 average. The steelhead index was much lower than in other recent years. Sockeye indices showed a marked increase over 2002, while nearly doubling the average of recent years.

At John Day Dam the subyearling chinook index was lower than 2002 but in the similar to other recent years. The yearling chinook index showed a similar trend to McNary with 2003 being slightly lower than 2002, but substantially higher than other recent years. The passage index for coho was down compared to all recent years except 2001. Steelhead numbers were well below recent average, but similar to 2002, while sockeye numbers were below 2002 but well above recent average.

At Bonneville Dam indices were all below 2002 levels, while only the steelhead index was lower than the 2001 value.

TABLE 20. Sample, collection, and passage indices of salmonids at Columbia River dams in 2003 and comparison with 2002, 2001 and 3-yr average (1998-2000) annual passage indices.

Dam	Species	2003			2002	2001	1998-2000
		Sample	Collected	Passage Index	Passage Index	Passage Index	Average Index
Rock Island Dam	Chinook Age 0	20,074	20,074	28,113	25,466	22,639	19,744
	Chinook Age 1	11,186	11,186	15,355	28,982	6,572	30,191
	Coho	28,900	28,900	41,690	86,227	45,425	45,848
	Steelhead	11,183	11,183	15,507	28,714	17,852	28,273
	Sockeye/kokanee	7,760	7,760	10,306	20,632	3,022	14,087
McNary Dam [a]	Chinook Age 0	90,148	7,028,584	10,678,975	806,828	10,774,712	9,858,790
	Chinook Age 1	16,051	1,041,821	3,242,581 [a]	3,336,001	2,299,417	2,473,747
	Coho	737	71,927	218,467 [a]	200,556	147,051	261,183
	Steelhead	3,050	155,032	490,024 [a]	771,115	563,078	732,343
	Sockeye/kokanee	5,657	546,131	1,645,224 [a]	1,362,086	285,379	849,925
John Day Dam	Chinook Age 0	109,404	2,020,393	2,713,873	3,465,726	2,849,770	2,599,219
	Chinook Age 1	36,096	1,557,865	2,074,671	2,104,938	1,005,994	1,387,688
	Coho	3,532	195,591	258,282	315,280	81,586	459,909
	Steelhead	9,356	420,854	553,522	545,814	191,089	945,432
	Sockeye/kokanee	7,821	547,403	726,177	934,108	103,905	385,913
Bonn. Power-house 2	Chinook Age 0	33,987 [b]	2,709,500 [b]	6,265,644 [b]	6,993,964 [b]	2,940,644 [b]	N/A
	Chinook Age 1	20,927	1,616,876	4,043,776	5,269,226	2,451,747	N/A
	Coho	8,764	861,351	2,116,570	3,328,201	1,687,847	N/A
	Steelhead	7,169	654,415	1,635,181	2,331,599	2,164,019	N/A
	Sockeye/kokanee	3,349	487,186	1,261,375	1,455,004	489,400	N/A

[a] McNary sampled every other day from April 3 to June 28, 2003 so this years' passage indices were adjusted for comparison to historic data by interpolating values for dates not sampled (project operated primary bypass) between two sample dates. As and example, for yearling chinook the unadjusted passage index was 1,624,087 compared to adjusted value of 3.2 million which is more comparable to recent historic indices.

[b] Upper brights annual values were summed commencing May 15 in 2003, May 10 in 2002, May 1 in 2001 since tule chinook releases from Spring Creek Hatchery a week prior to that date in each year.

C. Migration Timing

The distribution of daily passage indices provides a measure of migration timing at a given site. From the passage distributions as Lower Granite, Rock Island, McNary and Bonneville dams, the dates of passage of key cumulative percentiles of 10%, 50%, and 90% were summarized for each species in Table 21. This timing data was also plotted for the run-at-large for these sites in Appendix D.

In the Snake River at Lower Granite Dam, the yearling chinook timing was similar to recent years and only a few days later than historic average, but due to a very late peak in runoff, the 90% passage date was reached prior to the freshet, which occurred between May 25 and June 6. Steelhead timing was later than 2002, but about the same as 2001. Steelhead seem to respond to higher flows, and this year there was a substantial spike in numbers coinciding with the late spring freshet. The fifty percent date of May 16 was nearly two weeks behind historic average, with the late freshet the ninety percent date occurred only a day later than average. Coho and sockeye timing both were later than 2002, with both showing peak migrant numbers during the late freshet. The sockeye/kokanee run typically begins earlier with fish exiting Dworshak Reservoir early in the season. In 2003, due in part to a decreased gas cap which reduces early season outflows at Dworshak, that early season kokanee passage did not occur and that, in turn, contributed to the lateness of the run. The 2003 timing reflects the passage of sockeye from the upper Salmon River. The subyearling chinook migration, which is now predominantly hatchery released fish, showed a much earlier migration than other recent years, as well as much earlier than historic average, with the 90% data occurring in the second week of July.

At Rock Island Dam the data must be viewed with caution, because the bypass system did not function properly for a large portion of the spring migration and there were several dates when the bypass was shut down as Chelan PUD made repairs. For subyearling chinook it appeared that timing was earlier in 2003 than recent years as well as being earlier than historic average.

Timing at McNary Dam for yearling chinook was similar to 2002 and historic average but earlier when compared to 2001. For steelhead, the 2003 run began later than more recent years but reached 90% at a similar date to 2001 and 2002. Steelhead passage was aided by the peak flows which occurred between May 26 and June 14; during the period May 26 to June 4 over 40% of the steelhead passage occurred. Coho timing was a week later than 2002, but similar to 2001, suggesting 2003 was a late migration for this species. In contrast, sockeye timing appeared similar to 2002 and earlier than 2001.

At Bonneville Dam the yearling chinook run was similar to 2002 and historic average, but began later with more fish appearing later in the run though 90% passage occurred by June 1. For steelhead the run appeared similar to 2002 and 2001 but was later than historic average.

TABLE 21. Migration timing of salmonids at Lower Granite, Rock Island McNary, and John Dam dams in 2003 compared to 2002 and 2001.

Dam	Species	2003			2002			2001		
		10%	50%	90%	10%	50%	90%	10%	50%	90%
Lower Granite	Chinook Age 0	6/1	6/18	7/12	6/18	7/7	7/27	6/11	7/4	8/10
	Chinook Age 1	4/21	5/6	5/22	4/18	5/5	5/21	4/26	5/5	5/18
	Coho	5/14	5/27	6/19	5/18	5/23	6/7	5/18	6/4	7/13
	Steelhead	4/25	5/16	5/29	4/20	5/12	5/30	4/29	5/10	5/27
	Sockeye and kokanee	5/22	5/31	6/5	4/27	5/18	6/1	4/21 5/13[a]	5/23	6/16
Rock Island	Chinook Age 0	6/6	7/8	7/31	6/18	7/13	8/9	6/25	7/15	7/29
	Chinook Age 1	4/24	5/8	5/31	4/28	5/15	6/7	4/20	5/6	5/30
	Coho	5/24	6/3	6/11	5/20	5/28	6/10	5/19	5/24	6/8
	Steelhead	5/6	5/26	6/3	5/7	5/24	6/3	5/12	5/26	6/17
	Sockeye	4/20	5/11	5/28	4/22	5/10	6/8	5/22	5/25	6/4
McNary[b]	Chinook Age 0	6/13 (6/18)	6/27 (7/10)	7/25 (7/29)	6/20	7/2	8/8	6/20	7/2	7/28
	Chinook Age 1	4/30	5/14	5/29	5/1	5/17	5/27	5/11	5/26	6/7
	Coho	5/26	6/3	6/15	5/15	5/31	6/9	5/24	6/3	6/20
	Steelhead	4/29	5/26	6/3	4/21	5/20	6/4	4/27	5/23	6/9
	Sockeye	5/3	5/15	5/27	5/4	5/14	5/26	5/27	6/1	6/9
Bonneville PH 2	Chinook Age 0 "upriver brights"	6/14[c]	7/1[c]	7/19[c]	6/19[c]	7/2[c]	7/19[c]	5/30[d]	7/6[d]	8/14[d]
	Chinook Age 1	4/22	5/14	5/31	4/25	5/18	6/1	4/26	5/11	6/6
	Coho	4/29	5/17	6/9	5/6	5/19	6/6	5/15	5/24	6/3
	Steelhead	5/6	5/29	6/10	5/2	5/27	6/11	5/4	5/19	6/10
	Sockeye	5/12	5/20	6/5	5/13	5/23	6/9	6/3	6/10	6/25

[a] Low numbers result in cumulative passage index taking over three weeks to collect next fish after 10% point reach on April 21, so "true" date of 10% could occur later during the extended range shown.

[b] Because there was every other day sampling from April 1 to June 26 passage indices were adjusted by filling in the non-sampled days total with the previous days total. This adjustment made a relatively significant difference for subyearling chinook, especially the 50% date (the dates in parentheses are the unadjusted values).

[c] Upper brights annual values are summed commencing May 10 in 2002, since tule chinook releases from Spring Creek Hatchery occurred on March 11, March 29 and April 30).

[d] Upper brights annual values are summed commencing May 1 in 2001, since only two tule chinook releases from Spring Creek Hatchery (March 8 and April 15).

D. Travel Time

The PIT tag allows determination of date and time of passage of individual fish at dams with PIT tag detection equipment in place. From these data, travel times of individual fish within reaches of interest may be computed. Travel time is estimated from release to first detection site, and between series of dams, by subtracting the upstream detection date and time from the downstream detection date and time for PIT-tag fish. From the distribution of travel times for each group, minimum, maximum and median travel time and associated 95% confidence intervals are computed. Flow and temperature data are also calculated associated with the travel time for each group of interest. These environmental parameters are computed at a key dam within the reach of interest as the average across a series of days equal to the number of days estimated as the median travel time. This series of days begins with the date of release for travel times estimated from hatchery release to first monitoring site and begin with the dates of re-release at the upstream dam for travel times estimated between two dams (e.g., Lower Granite Dam to McNary Dam, Rock Island Dam to McNary Dam, or McNary Dam to Bonneville Dam). The detailed travel time data for groups of PIT tagged fish released from the four Snake River basin traps, selected hatcheries, and Rock Island Dam, or re-released from Lower Granite and McNary dams are presented in Appendix E.

1. Snake River Basin

Hatchery Site to Lower Granite Dam Reach

As part of the SMP, juvenile salmonids are PIT-tagged at several select hatcheries within the Snake River basin. In some cases other tagging studies such as Comparative Survival Study have assumed tagging efforts at these sites. FPC continues to report these data for historic comparison. Travel time of yearling chinook and steelhead from hatcheries in the Snake River basin are to Lower Granite and are presented in Table 22. Median travel times for yearling chinook were longer in 2003 than in other recent years for Dworshak and Imnaha releases. While McCall values were shorter than to 2002, those travel times were still longer than other recent years. A comparison of release dates, average flows, temperatures and size at release for yearling chinook released from McCall for the years listed in Table 22, showed that later release dates generally

result in the shortest travel times. This is reasonable, given that later released fish experience higher flows, slightly warmer temperatures, and were larger and likely more smolted. For yearling chinook released from Dworshak Hatchery, similar patterns in travel time show up, but not as clearly as for McCall. For Dworshak releases, 2003 was the earliest release of any of the years listed in Table 22, which corresponded with the longest travel times, while 1999 and 2000 had the latest release dates and the shortest travel times.

Of the other hatchery releases of yearling chinook, release dates are based on median dates of volitional releases and are not as readily analyzed in relation to factors affecting travel times. Rapid River median travel time was identical to 2002 and also longer than other recent years. Similarly, Dworshak steelhead travel time was faster than 2002 but longer than other recent years. While Imnaha releases showed the longest travel times of any recent years.

TABLE 22. Median travel time from release to Lower Granite Dam for Snake River basin hatchery yearling chinook and steelhead in 2003 compared to the past four years.

Hatchery	Species	Median travel time release site to Lower Granite Dam					
		2003	2002	2001	2000	1999	1998
Dworshak Hatchery	Chinook	49.4	38.1	30.4	27.3	27.7	28.1
Imnaha Acclimation Pond	Chinook	34.6 [a]	31.7 [a]	29.1 [a]	29.3 [a]	23.7 [a]	26.2
McCall Hatchery	Chinook	42.0	51.4	48.5	34.1	39.9	36.5
Rapid River Hatchery	Chinook	47.4 [b]	47.4 [b]	32.3 [b]	29.0 [b]	37.1 [c]	19.5 [c]
Dworshak Hatchery	Steelhead	7.2	7.8	6.8	3.5	6.2	4.7

[a] Midpoint of volitional release period used in calculation.

[b] Monitored median date of volitional release period used in calculation.

[c] Projected median date of volitional release period used in calculation.

Lower Granite Dam to McNary Dam Index Reach

Yearling chinook travel time

Weekly average travel time estimates were generated for yearling chinook released or detected at Lower Granite Dam for the Lower Granite Dam to McNary Dam index reach and are presented in Appendix E. The weekly travel time estimates were plotted against a cumulative

water transit time (WTT) for the reach of interest for the years 1998 to 2002 (Figure 19). Water transit time is the average time a particle of water takes to exit a reservoir. The WTT's for each reservoir in the reach were added to calculate a cumulative WTT. Data from 2003 was plotted with the data 1998 to 2002 for comparison. Yearling chinook travel times were similar to recent historic data given the water transit times fish migrated experienced in 2003 in the Lower Granite to McNary Dam reach. The majority of 2003 points in the plot appear below the trend line suggested slightly better than average travel times than expected based on the historic relationship, but nothing outside what would be considered normal.

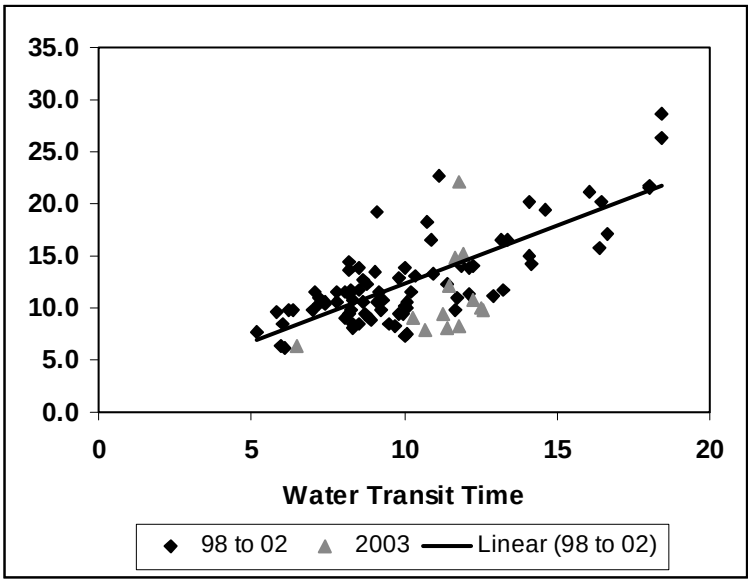

FIGURE 19. Yearling Chinook Travel Time from versus Water Transit Time from Lower Granite to McNary Dam 1998 to 2003.

Steelhead travel time

Steelhead travel times were also calculated in weekly blocks with corresponding water transit times. As can be seen in Figure 20 the relation between travel time and WTT appears to hold true for 2003; with data points falling near the regression line in all cases.

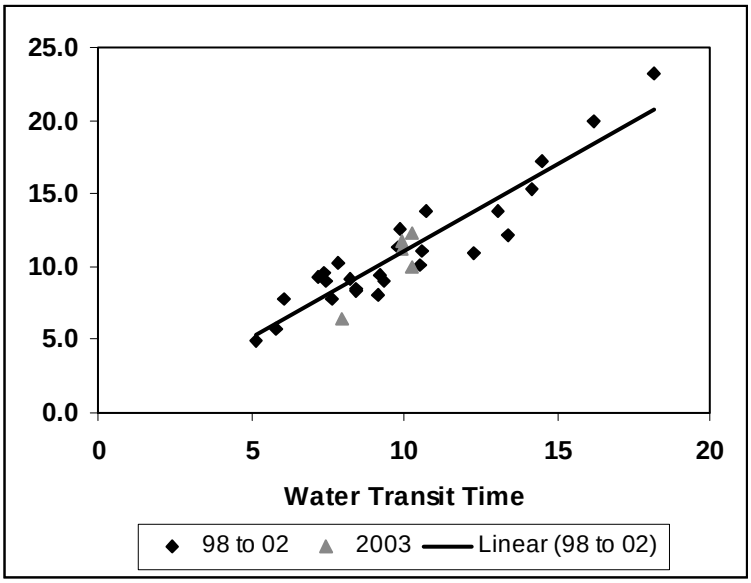

FIGURE 20. Steelhead Travel Time from versus Water Transit Time from Lower Granite to McNary Dam 1998 to 2003.

Subyearling chinook travel time

Weighted estimates of travel time were generated for subyearling chinook within Lower Granite Dam passage periods of 17 to 20 days in duration. These temporal blocks were wider than the weekly blocks used with yearling chinook and steelhead because fewer subyearling chinook were PIT-tagged and available for analysis. PIT tagged Lyons Ferry Hatchery subyearling chinook released in the three acclimation ponds (Captain John Rapids, Pittsburg Landing, and Big Canyon acclimation ponds) and in the weekly direct stream releases near those acclimation ponds were used in the analysis. The average travel time estimates for each temporal block were generated for subyearling chinook in the Lower Granite Dam to McNary Dam index reach from daily median travel time estimates presented in Appendix E. A multi-week averaging of the daily median travel times and their associated Ice Harbor Dam flow data was made using the number of PIT tagged smolts for each daily median travel time estimate as the weighting factor. In 2003, as in the prior six years, the general trend of decreasing average travel time over time was observed (Table 23). In 2003, the average travel time in the earliest period was relatively low compared to other recent years. The trend toward, not only faster travel times, but also earlier migration tim-

ing, with few fish available for later season blocks in the past two years, is an artifact both of release timing and the emphasis on supplementation released PIT-tagged fish. Supplementation releases tend to migrate much faster than wild marked fish captured by Fish and Wildlife Service in the Lower Snake River and by Nez Perce Tribe in the lower Clearwater River. The wild marked fish also tend to remain above Lower Granite Dam later, with the 95% passage date occurring well into August for those groups.

TABLE 23. Weighted average travel time[1] for subyearling chinook from Lower Granite Dam to McNary Dam within temporal blocks across seven years, 1995 to 2003, and corresponding weighted average flow.

	Date of passage at Lower Granite Dam							
	6/5-6/24		6/25-7/11		7/12-7/31		8/1-8/20	
Year	Travel time	Flow	Travel time	Flow	Travel time	Flow	Travel time	Flow
1995			19.7	63.9	14.1	46.3	14.2	38.1
1996			22.7	49.4	15.2	39.9	14.0	38.3
1997	28.5	98.7	25.4	74.2	17.6	64.1	12.8	54.4
1998	20.1	87.8	12.3	66.9	10.8	58.6	10.9	40.5
1999	21.3	105.1	23.1	63.9	15.6	51.2	13.5	42.9
2000	15.6	52.1	20.3	43.6	16.5	37.7	15.8	30.3
2001	39.5	29.2	27.9	27.4	35.5	26.2	18.1	23.7
2002	17.2	67.4	15.9	47.1				
2003	12.4	68.3	24.7	33.2				

[1]For each block within a year, weighted average travel times and flows are estimated by weighting the daily median travel time estimates and their corresponding flows (data in Appendix Table E-17) by number of fish used to generate each daily median travel time estimate.

2. Mid-Columbia River Basin

Hatchery site to McNary Dam Reach

Travel time of yearling and subyearling chinook from hatcheries in the Mid-Columbia River basin to McNary Dam is presented in Table 24. Median travel times to McNary Dam were 27.6 and 22.9 days in 2003 for yearling spring chinook from Leavenworth, and Winthrop hatcheries respectively. Those estimates were shorter than in most recent years, being comparable to the high flow year of 1999. Subyearling summer chinook from Wells Hatchery had a median travel time of approximately 24 days in 2002, similar to 2002, but much lower than in other recent years. The median travel time of subyearling chinook released from Priest Rapids hatchery has ranged within 10 to 14 days across the five years, with 2003 being the lowest of those recent years.

TABLE 24. Median travel time for Mid-Columbia River hatchery chinook from hatchery site to McNary Dam in 2003 compared to 1999 to 2002.

		Migration Year									
		2003		2002		2001		2000		1999	
Hatchery	Age	TT	Flow	TT	Flow	TT	Flow	TT	Flow	TT	Flow
Leavenworth	1	27.6	73	28.2	151	37.0	64	36.1	185	27.8	171
Winthrop	1	22.9	73	27.8	163	36.9	64	30.2	182	26.4	163
Wells	0	23.9	50	25.8	225	37.8	71	35.3	133	30.6	193
Priest Rapids[1]	0	10.5	69.7	12.2	227	13.7	95	12.3	137	11.7	189

[1] Priest Rapids Hatchery's median travel time and flow is computed as average of three releases separated 3-5 days apart starting mid-June (individual release data shown in appendix E of each annual report).

Rock Island Dam to McNary Dam Index Reach

Yearling Chinook and Steelhead travel time

Due to malfunctions that occurred in the bypass system at Rock Island Dam in 2003 no spring migrants were PIT-tagged.

Subyearling Chinook travel time

Subyearling chinook had relatively fast travel times between Rock Island Dam and McNary Dam in 2003 compared to the prior four years, in the month long period before July 15 (Table 25). It appears that the fast travel times were achieved, despite the relatively lower flows in 2003. Insufficient data were available in 2003 to calculate reliable travel time estimates in the later time period.

TABLE 25. Weighted average travel time1 for subyearling chinook (combined hatchery and wild) from Rock Island Dam to McNary Dam within temporal blocks across three years, 1999 to 2002, and corresponding weighted average flow.

Year	Date of release at Rock Island Dam			
	6/16 - 7/15		7/16 - 8/20	
	Travel time	Flow	Travel time	Flow
1999	17.0	188.5	14.8	166.2
2000	20.9	129.6	15.3	128.9
2001	25.9	57.1	22.3	67.1
2002	11.6	206.7	14.2	129.9
2003	12.4	107.9		

[1]For each block within a year, weighted average travel times and flows are estimated by weighting the daily median travel time estimates and their corresponding flows (data in Appendix Table E-16) by number of fish used to generate each daily median travel time estimate.

McNary Dam to Bonneville Dam Index Reach

Yearling chinook travel time

Yearling chinook travel time was calculated over two-week detection periods for the McNary Dam to Bonneville Dam reach (Figure 21). The 2003 data was plotted against data from 1999 to 2002 for comparison. Again the 2003 data suggest that the historic relationship held true for these fish compared to travel times other recent years.

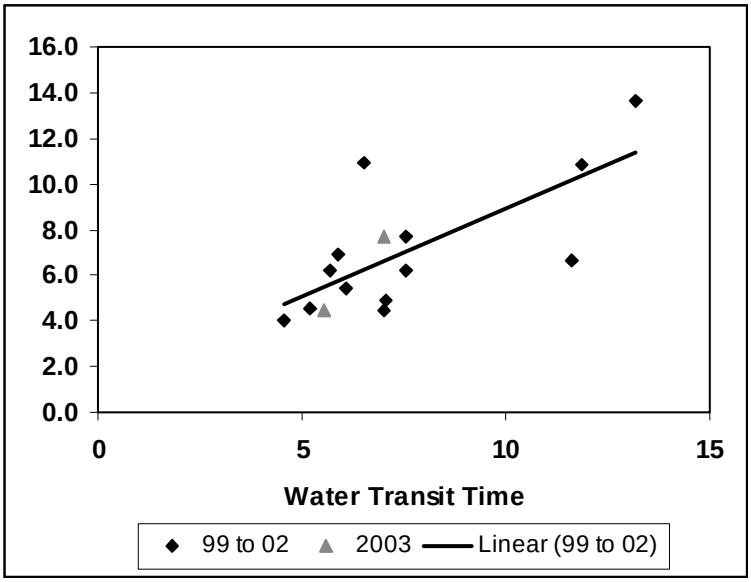

FIGURE 21. Yearling Chinook Travel Time versus Water Transit Time from McNary Dam to Bonneville Dam 1999 to 2003.

Steelhead travel time

Steelhead travel times in the McNary Dam to Bonneville Dam reach were grouped over the time period May 11 to June 8 each year due to the small number of detections at Bonneville Dam resulting in a single annual estimate of travel time. Steelhead travel times were comparable to those observed in 1999, 2000, and 2002. The only year that stands out in the comparison was 2001, during which travel times were protracted due to extremely low flows. In 2003, flows were similar to, but slightly lower than 2002.

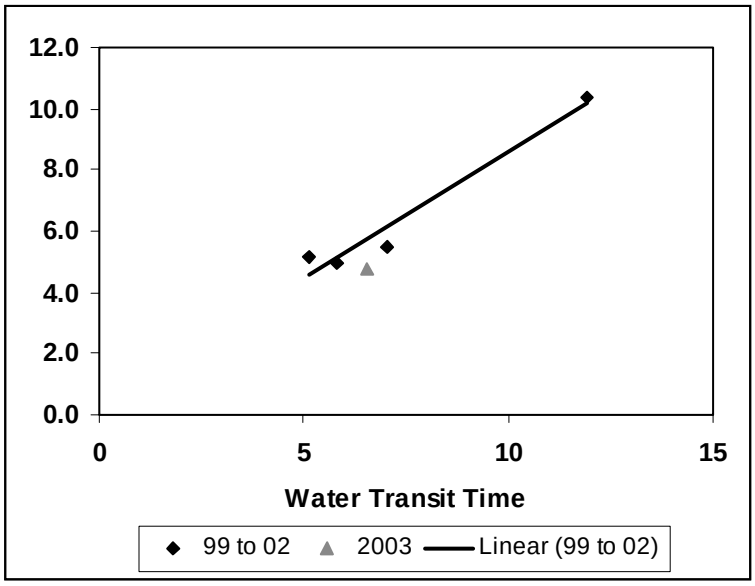

FIGURE 22. Steelhead Travel Time versus Water Transit Time from McNary Dam to Bonneville Dam 1999 to 2003.

Subyearling chinook travel time

Weighted monthly average travel time estimates were generated for subyearling chinook in the McNary Dam to Bonneville Dam index reach from daily median travel time estimates presented in Appendix E (Table 26). Travel times in 2003 were the longest of recent years in comparison, except for 2001, in the time period June 20 to July 20. Flows during the early summer block in 2003 were also lower than any year since 1997, again excepting the extremely low flow year of 2001. As in 2002, there were insufficient data to calculate late summer travel times in 2003.

TABLE 26. Weighted average travel time1 for subyearling chinook from McNary Dam to Bonneville Dam within temporal blocks across five years, 1997 to 2002, and corresponding weighted average flow.

Year	Date of passage at McNary Dam			
	6/20-7/20		7/21-8/31	
	Travel time	Flow	Travel time	Flow
1997	4.3	277.5	5.8	207.8
1998	5.2	199.5	7.2	159.7
1999	4.6	269.0	5.4	209.9
2000	5.3	170.8	6.1	152.2
2001	17.3	95.2	13.0	86.4
2002	5.3	262.0	NA	NA
2003	6.3	151.0	NA	NA

[1]For each block within a year, weighted average travel times and flows are estimated by weighting the daily median travel time estimates and their corresponding flows (data in Appendix Table E-20) by number of fish used to generate each daily median travel time estimate.

E. Estimates of Survival:

1. Methods

Survival is estimated from release to first detection site, and between series of dams, by the Cormack-Jolly-Seber (CJS) release-recapture method outlined in American Fisheries Society Monograph 5, *Design and analysis methods for fish survival experiments based on release-recapture*, by K.P. Burnham, D.R. Anderson, G.C. White, C. Brownie, and K.H. Pollock, 1987. This methodology is used to estimate survivals both to and between the dams in the hydro system possessing PIT tag detection capabilities, along with an estimate of collection efficiency at these dams. The CJS method is based on mark release-recapture theory in which the subsequent detection histories on a known number of marked fish re-released at a particular dam is used to estimate the number of fish that past that particular dam alive but undetected. The software program MARK (White and Burnham 1999) was used to perform the survival estimates with the “identity “design matrix and “identity” link function set. The program MARK provides estimates of survival between the tailraces of each detection site. Generating extended multi-dam reach survival estimates requires taking the product of a set of these shorter reach estimates. The associated variance for the extended reach estimate is computed using formulas for propagation of error in prod-

ucts of non-independent estimates (Meyer 1975). Extended reach survival estimates with associated 95% confidence intervals are obtained for each species, and release location and period of interest.

Sets of survival estimates are computed each year for various river reaches. In the Snake River basin, estimates of survival are made from key hatcheries to John Day Dam tailrace, from SMP traps to Lower Monumental Dam tailrace, and from Lower Granite Dam tailrace to McNary Dam tailrace. In the Columbia River basin, estimates of survival are made from key hatcheries to McNary Dam tailrace, from Rock Island Dam (release site) to McNary Dam tailrace, and from McNary Dam tailrace to John Day Dam tailrace, and specifically for yearling chinook from McNary Dam tailrace to Bonneville Dam tailrace utilizing the NOAA Fisheries trawl in the lower Columbia River as the final detection site. The goal is to have at least 600 PIT tagged smolts released (or detected and re-released at the starting site) in each group for which survival estimates are desired. Generally, release period of a week are attempted, but in some instances release periods of up to 15 consecutive days were required in order to try to achieve the target release size. Detailed results for the individual release (or detected and released) groups of interest are present in Appendix F.

For SMP traps and key dams, the 2003 survival data is summarized to annual averages for comparison to recent past years. A single seasonal average survival estimates is obtained for those PIT tagged groups released over time that do not differ significantly. To determine any significant differences occurred within a year, a test of whether the “between group” variance component was significantly greater than zero (Burnham 1987 *et al*., Chapter 4). This is a chi-square test equal to [empirical variance of mean survival*(1-degrees of freedom)]/ [theoretical variance of mean survival]. In cases where the chi-square test was not significant at the 95% confidence level, then the average was computed for the season, along with the average theoretical variance. In cases where the chi-square test was significant, then the season was split into periods showing the different survival levels.

2. Results

The 2003 seasonal survival estimate for PIT tagged wild and hatchery chinook released from the four traps to Lower Monumental Dam tailrace averaged between 55.4% and 78.6%

(Table 27), and that of wild and hatchery steelhead averaged between 65.5% and 89.8% (Table 28). The 2003 estimates for chinook were variable from basin to basin while steelhead tended to have the highest estimates observed in recent years. What likely made 2003 so favorable for steelhead were the high flows during the peak of the run. Also, these high survivals may in part, have been attributable to operational changes at Lower Granite Dam, where low collection efficiency estimates suggested that spillway passage was higher due to operation of the RSW. Research results from 2003 demonstrated high spillway efficiency, which was consistent with low collection efficiency estimates for PIT-tagged chinook and steelhead.

The most marked trends in yearling chinook survival for 2003, were the decreased survival for both hatchery and wild releases in the Salmon River, as well as a generally poorer survival for wild yearling chinook in all but the Grande Ronde releases for which there were too few recaptured to generate an estimate. Hatchery yearling chinook in the Grande Ronde showed lower survival than 2002, but better than 2001.

TABLE 27. Annual average reach survival estimates of Snake River basin PIT tagged yearling chinook from trap release sites to Lower Monumental Dam tailrace in 2003 compared to 2000 - 2002.

Tag Site	Species	Rearing type	Year	Date Range	No. of Blocks	Average Survival	Lower Limit	Upper Limit
Salmon River trap								
	Chinook	Wild	2000	3/27-4/21	4	0.763	0.69	0.835
		Wild	2001	3/19-5/4	4	0.583	0.547	0.619
		Wild	2002	3/30-4/22	6	0.808	0.772	0.844
		Wild	2003	3/14-5/07	7	0.645	0.587	0.702
		Hatchery	2000	3/13-5/5	8	0.69	0.602	0.777
		Hatchery	2001	3/19-5/17	8	0.629	0.605	0.653
		Hatchery	2002	3/14-5/7	8	0.74	0.706	0.774
		Hatchery	2003	3/18-5/1	4	0.554	0.458	0.65
Snake River trap								
	Chinook	Wild	2000	4/10-4/28	3	0.916	0.779	1.052
		Wild	2002	4/12-4/18	1	0.887	0.811	0.962
		Wild	2003	5/25-5/27	1	0.775	0.85	0.701
		Hatchery	2000	4/10-5/5	4	0.77	0.672	0.868
		Hatchery	2001	4/27-5/4	1	0.745	0.666	0.825
		Hatchery	2002	4/12-4/18	1	0.894	0.808	0.979
		Hatchery	2003	4/15-5/27	2	0.786	0.62	0.952
Imnaha River trap								
	Chinook	Wild	2000	3/13-4/23	4	0.757	0.699	0.815
		Wild	2001*	3/14-4/27	14	0.683	0.669	0.697
		Wild	2001*	4/29-5/12	1	0.529	0.475	0.583
		Wild	2002	3/25-4/29	3	0.8	0.751	0.849
		Wild	2003	3/15-4/26	5	0.66	0.583	0.737
		Hatchery	2000	3/20-4/16	4	0.535	0.445	0.626
		Hatchery	2001*	3/23-3/28	1	0.611	0.556	0.665
		Hatchery	2001*	3/29-4/27	5	0.712	0.684	0.74
		Hatchery	2002	3/23-4/29	4	0.704	0.655	0.753
Grande Ronde River trap								
	Chinook	Wild	2000	4/3-5/5	5	0.775	0.65	0.9
		Wild	2001	3/28-5/3	2	0.764	0.694	0.835
		Wild	2002	4/17-4/24	1	0.839	0.713	0.966
		Hatchery	2001	4/2-4/26	3	0.624	0.578	0.67
		Hatchery	2002	4/8-4/23	2	0.724	0.658	0.79
		Hatchery	2003	3/17-4/1	2	0.695	0.504	0.885

* Identifies a year with a significant “between blocks (temporal releases)” variance component. For those years, survival estimates are presented separately for each set of blocks that differ significantly. No survival estimates are available for wild chinook from the Snake River trap in 2001 and hatchery chinook from the Grande Ronde River trap in 2000 due to not enough PIT tagged fish being released.

For steelhead, the trend was for higher survivals for both hatchery and wild mark groups. Hatchery marked groups faired better than wild releases for all three sites that marked both (excluding only the Salmon River, where only estimates for hatchery steelhead were available) (Table 28). The survivals were highest for releases from the Snake River Trap which is to be expected since it is located at the head of Lower Granite Pool at Lewiston, while other releases have roughly twice (or more) the distance to travel to arrive at Lower Granite Dam.

TABLE 28. Annual average reach survival estimate of Snake River basin PIT tagged steelhead from trap release sites to Lower Monumental Dam tailrace in 2003 compared 2000 - 2002.

Tag Site	Species	Rearing Type	Year	Date Range	No. of Blocks	Average Survival	Lower Limit	Upper Limit
Salmon River trap								
	Steelhead	Wild	2001	4/23-5/4	1	0.476	0.367	0.585
		Hatchery	2000	4/17-5/19	4	0.514	0.398	0.629
		Hatchery	2001	4/9-5/18	3	0.413	0.329	0.496
		Hatchery	2002	4/13-5/19	4	0.556	0.483	0.629
		Hatchery	2003	4/28-5/12	2	0.725	0.618	0.832
Snake River trap								
	Steelhead	Wild	2000	4/17-5/5	3	0.743	0.622	0.865
		Wild	2001	4/27-5/21	2	0.452	0.392	0.513
		Wild	2002	5/20-5/26	1	0.787	0.661	0.913
		Wild	2003	4/18-5/27	3	0.795	0.597	0.992
		Hatchery	2000	4/17-5/26	4	0.692	0.58	0.803
		Hatchery	2001	4/27-5/21	3	0.465	0.365	0.565
		Hatchery	2002	4/12-6/6	6	0.764	0.685	0.844
		Hatchery	2003	4/12-5/20	5	0.898	0.796	1
Imnaha River trap								
	Steelhead	Wild	2000	4/17-5/21	5	0.611	0.508	0.714
		Wild	2001*	3/20-4/1 & 5/1-5/15	5	0.445	0.405	0.484
		Wild	2001*	4/15-4/30	2	0.637	0.555	0.719
		Wild	2002	4/17-5/29	6	0.701	0.656	0.746
		Wild	2003	4/21-5/23	5	0.71	0.644	0.775
		Hatchery	2000	4/17-5/21	5	0.551	0.463	0.639
		Hatchery	2001	4/15-5/15	6	0.45	0.376	0.525
		Hatchery	2002	4/12-5/29	3	0.755	0.668	0.843
		Hatchery	2003	4/12-5/22	5	0.834	0.77	0.899
Grande Ronde River trap								
	Steelhead	Wild	2000	4/5-4/28	4	0.729	0.614	0.843
		Wild	2001*	4/23-5/1	1	0.547	0.401	0.692
		Wild	2001*	5/7-5/21	1	0.298	0.199	0.397
		Wild	2003	5/24-6/02	1	0.655	0.493	0.817
		Hatchery	2000	4/10-5/12	4	0.561	0.489	0.633
		Hatchery	2001	4/23-5/17	3	0.511	0.408	0.614
		Hatchery	2002	4/8-5/7	2	0.827	0.688	0.966
		Hatchery	2003	4/14-6/04	4	0.788	0.693	0.883

* Identifies a year with a significant “between blocks (temporal releases)” variance component. For those years, survival estimates are presented separately for each set of blocks that differ significantly.

Survivals for yearling chinook released from Winthrop Hatchery were lower than other recent years (except 2001), while those released from Leavenworth Hatchery were the highest measured in recent years (Table 29). Wells hatchery subyearling chinook had the highest survival in 2003 compared to other recent years, while releases from Priest Rapids Hatchery were about average compared to recent years.

TABLE 29. Annual average reach survival estimates of Mid-Columbia River basin PIT tagged yearling and subyearling hatchery chinook from release site to McNary Dam tailrace in 2003 compared to 1999 - 2002.

Tag Site	Species	Age	Year	Release Date Range	Survival	Lower Limit	Upper Limit
Winthrop NFH							
	Chinook	1	1999	15-Apr	0.568	0.527	0.609
			2000	10-Apr	0.483	0.419	0.546
			2001	17-Apr	0.427	0.409	0.445
			2002	15-Apr	0.495[a]	0.468	0.522
			2003	14-Apr	0.453	0.406	0.499
Leavenworth NFH							
	Chinook	1	1999	19-Apr	0.586	0.55	0.622
			2000	18-Apr	0.593	0.52	0.667
			2001	17-Apr	0.501	0.484	0.517
			2002	22-Apr	0.518	0.505	0.531
			2003	21-Apr	0.662	0.655	0.669
Wells SFH							
	Chinook	0	1999	19-Jun	0.373	0.281	0.465
			2000	19-Jun	0.21	0.168	0.253
			2001	20-Jun	0.211	0.166	0.257
			2002	17-Jun	0.449	0.395	0.503
			2003	17-Jun	0.456	0.406	0.506
Priest Rapids SFH							
	Chinook	0	1999	6/14-6/23	0.757	0.679	0.836
			2000	6/15-6/27	0.666	0.577	0.755
			2001	6/11-6/19	0.746	0.67	0.794
			2002	6/11-6/19	0.697	0.627	0.767

[a] Includes releases of SMP and NOAA Fisheries research PIT-tagged fish.

No spring migrants were PIT-tagged at Rock Island Dam in 2003 because the bypass malfunctioned for long periods of time. However, some repairs were made that improved fish condition to the point where it was decided that subyearling chinook could be marked for travel time and survival estimation (Table 30). The earliest mark group had significantly higher survival than later groups.

TABLE 30. Annual average reach survival estimates of Mid-Columbia River basin PIT tagged smolts (mixture of wild and hatchery fish) from release at Rock Island Dam to McNary Dam tailrace in 2003 compared to 1998 - 2002.

Tag Site	Species	Year	Date Range	No. of Blocks	Average Survival	Lower Limit	Upper Limit
Rock Island Dam							
	Sockeye	1998	4/15-5/19	6	0.682	0.559	0.805
		1999*	4/20-5/3	1	0.65	0.561	0.739
		1999*	5/4-5/22	1	0.456	0.381	0.532
		2000	4/21-5/24	2	0.634	0.183	1.085
		2001	5/23-6/1	1	0.636	0.35	0.922
		2002	4/25-5/24	3	0.53	0.433	0.626
		2003[a]	NA	NA	NA	NA	NA
Rock Island Dam							
	Chinook	1998	6/24-7/21	5	0.616	0.541	0.69
	Age 0	1999	6/17-7/31	3	0.549	0.469	0.63
		2000	6/19-8/19	5	0.596	0.516	0.676
		2001*	6/26-7/18	3	0.329	0.281	0.377
		2001*	7/20-7/27	1	0.22	0.164	0.277
		2002	7/1-8/5	5	0.618	0.566	0.67
		2003*	6/28-7/4	1	0.719	0.521	0.918
		2003*	7/5-7/28	3	0.349	0.1	0.598

* Identifies a year with a significant "between blocks (temporal releases)" variance component. For those years, survival estimates are presented separately for each set of blocks that differ significantly.

[a] No marking in Spring 2003 due to trap malfunctions at Rock Island Dam

F. Summary

The population of yearling chinook arriving at Lower Granite Dam was one of the highest in recent years and reflected both increased hatchery releases as well as higher wild fish production. The increase in hatchery production may have been offset to some extent by decreased survival from hatchery to Lower Granite Dam as suggested by lower than average survivals from trap releases to Lower Monumental Dam. Travel times were also longer than average for hatchery yearling chinook above Lower Granite Dam in 2003 compared to other recent years.

The short duration of high flows in the Lower Snake River were too late to benefit yearling chinook passage at Lower Granite Dam, since over 90% passed by May 22, while steelhead likely benefited more since 25% of the migration passed Lower Granite during the freshet.

Subyearling chinook passage timing at Lower Granite was much earlier in 2003 (and in other recent years as well) than historic average because the run is now predominantly supplementation releases of hatchery fish.

Survivals in the reaches Lower Granite Dam to McNary Dam, and McNary Dam to Bonneville Dam, for yearling chinook and steelhead, were similar to other recent years especially in relation to flows available for spring migrants, based on our historic comparison of survival versus water transit time.

IV. 2003 ADULT FISH PASSAGE

A. Overview

Adult fish will encounter from one to nine mainstem dams on their migration to spawning grounds in the Columbia River basin. Fish passage facilities were incorporated into thirteen mainstem dams on the Columbia and Snake rivers. Fish passage facilities are to be operated within standards and criteria to safely pass adult fish past each dam. These standards are placed in Fish Passage Plans or Habitat Conservation Plans that are required as part of the Biological Opinion set forth by NOAA Fisheries. Adult fish passage was blocked upstream of Wells Dam at Chief Joseph and Grand Coulee (completion by 1941) dams in the Columbia River and blocked upstream of Lower Granite Dam at the Brownlee, Oxbow, Hells Canyon dams (completion by 1958) in the Snake River.

Adult salmon migrating from the Columbia River mouth and up to spawning areas pass through numerous potential hazards along their journey. Initially, the adult salmon must adapt to freshwater after spending from several months to 4-years in the saltwater ocean environment. Up to Bonneville Dam, salmon can still fall prey to larger marine mammals such as sea lions primarily or harbor seals. Because of increased numbers of salmon returning to the Columbia River, commercial and sport fishers also can capture a portion of these fish during designated seasons. Once the fish reach Bonneville Dam, they must search for the fishway entrances that lead to a fishladder where they can swim to the forebay and exit from the dam. Depending on the fish's destination, a series of reservoirs and dams must be negotiated as well as passage through a tribal commercial fishery and normally a series of sports fisheries. Environmental conditions change dramatically from the ocean, with fish passing through or holding in wide ranges of water temperatures.

To assess passage of adult fish at the mainstem dams, the operating agencies are required to fund fish counting programs at the COE and PUD projects. These counting programs normally run from early spring through late fall to encompass most of the fish passage that occurs throughout the year. WDFW contracts to count fish at COE projects while the PUD directly contract with personnel to count adult fish at the Mid-Columbia River projects. Fish counts may be assessed by directly counting fish as they swim through the counting slot or videotaped through the slot. Daily

counts from each dam are reported to the COE and final data are compiled and incorporated in an annual Fish Passage Report by the COE. The fish counts are daily updated on the FPC Web site during the fish passage season. The FPC Weekly Report incorporates adult fish counts for that season and compares that total to the previous year as well as the 10-year average through the same block of time.

The Fish Passage Center publishes an annual report titled **Adult Fishway Inspections** that summarizes inspections made at the COE and PUD projects during a fish passage season. This fishway inspection program has been in place since 1984 with fishway inspections completed by State and Federal fish agencies on at least a monthly basis to assure that adult fishways are maintained at or near acceptable criteria levels throughout the fish passage season. In addition, the FPC assists with coordination of operations that would affect passage of adult salmon at the mainstem dams.

Most fishway equipment such as fish turbines, fish pumps, or other water supply equipment operated satisfactorily throughout most of the fish passage season. Flow levels were reduced from the previous year, but were far improved from the extreme low flows experienced in 2001. Water temperatures were satisfactory through the early summer until the reduction in water flow and an accompanying hot dry summer that resulted in very warm water temperatures from late July through mid-September. Warm/hot water temperatures remain a problem for salmon species during the mid to late summer season in the Columbia and Snake Rivers.

B. Adult Fish Counts

In 2003, numbers of adult salmon returning to the Columbia River were well above average levels for all species of salmon counted at Bonneville Dam and upriver dams with exception of sockeye salmon. About 917,200 adult chinook salmon, 125,700 adult coho salmon, 39,300 sockeye salmon and 361,400 steelhead were counted at Bonneville Dam in 2003. The adult chinook returns were greater than the previous two years when 871,000 and 868,000 were reported in respective 2002 and 2001 fish passage seasons. The summer chinook run again topped 100,000 with the fall chinook total greater than 600,000, a record high level in 2003. Sockeye salmon counts were less than the 2002 and 10-year average for the 2003 Return year. The total steelhead count at Bonneville Dam was reduced from the record returns of 2001 and 2002, but was still

129% of the 10-year average. Adult returns to mainstem dams are summarized for the various species and runs of salmon for year 2003 and shown with the 2002 and the 10-year average counts.

1. Spring Chinook Salmon

In 2003, a total of 192,010 adult spring chinook salmon was counted at Bonneville Dam, about 157% of the 10-year average and ranked 3rd highest count at Bonneville Dam since 1938. The 2003 return of spring chinook included a sports fishery downstream of Bonneville Dam, only the third since the 1970s. In fact, the average count of spring chinook for the years 2001-2003 was about 297,000 compared to the average count for years 1994-1996 of about 30,000 spring chinook. Note that this equates to about a 10-fold increase. This year's adult run was comprised of a mixture of 3-, 4- and 5-year old fish that spend one to three years of their life cycle in the ocean. About 54% of the 2003 adult spring chinook run was comprised of 5-year old chinook, 38% of the run was 4-year old fish, and 7% of the run was 3-year old fish (Jacks) based on sampling results completed at the Bonneville Dam adult trapping facility by Columbia River Intertribal Fish Commission (CRITFC). The 5-year old return was a real bonus to the Columbia River and tributaries. Most of the spring chinook run up to April 17 at Bonneville Dam was comprised of these larger, 5-year old fish.

The Bonneville count of 14,258 spring chinook (jack) salmon was greater than double the 2002 and the 10-year average. The Technical Advisory Committee (TAC) is projecting the upriver run (Bonneville Dam and above) to exceed 360,000 in 2004. Figure 23 illustrates the increase in numbers of adult spring chinook that began in 2000 and continued through 2003 after record low numbers of less than 40,000 fish in 1998 and 1999.

Approximately 68.3% of the fish passing Bonneville were counted at The Dalles Dam in 2003. The Klickitat, Little and Big White Salmon, Wind, and Hood rivers all support spring chinook via hatchery programs or programs to establish "natural" runs in these Basins. A limited commercial Tribal fishery on adult spring chinook was again allowed as well as a sport fishery, in the tributaries only, this season.

About 59.6% of the spring chinook counted at The Dalles Dam chose the Snake River. This percentage was about 12% increased from the 2002 returns when a much lower percentage chose the Snake River basin. The fish count at Lower Granite Dam was 70,609, only 4,500 less

than the 2002 return, and about double the 10-year average. Estimated **hatchery** chinook at Lower Granite Dam comprised a minimum of 62% of the run [note that this percentage is based only on the absence of the adipose fin]. Personal Communication, Steve Richards, WDFW. The unclipped fish should be considered as be "wild" or "natural" fish, or in some cases, as a hatchery fish. Not all hatcheries clip fins, but rather place a CWT/BWT in the fish without a clipped fin. As recent as 1995, the spring chinook run in the Snake River was at an all-time low of only 1,500 fish, but the past three years has seen gigantic increases to hatchery returns with the wild/natural chinook also showing increases in this Region. The number of "jack" spring chinook salmon that returned to the Snake River was greater than 8,000 and should lead to further increased adult chinook returns in 2004 and 2005.

The spring chinook count at Priest Rapids Dam was 18,136 with about 17,000 arriving at Rock Island Dam. The 2003 count was about 53.2% and 117% of the respective 2002 and 10-year average adult spring chinook count at Priest Rapids. The Yakama River had an adult return of 4,635 (3,400 wild) for the 2003 migration, well below the previous year. Most spring chinook returning to the Mid-Columbia River were of hatchery origin. In the Mid-Columbia not all hatchery spring chinook were fin clipped to signify being of hatchery origin and no hatchery/wild adult return estimates were made from the fish counts. Numbers of "wild" chinook in the tributaries located above Rock Island Dam remain at extremely low levels.

Spring chinook "jack" salmon count at Rock Island Dam was 753, about 91% of the 2002 "jack" return and 140% of the 10-year average. Expected return of adult salmon to the upper Columbia River in 2004 should be near 31,600 based on TAC estimates.

2. Summer Chinook

The summer chinook count at Bonneville Dam was 114,808, about 90% and 302% of the respective 2002 and 10-year average. This year's return of summer chinook salmon ranked closely behind large return of the preceding year that was largest return to the Columbia River basin since the 1950s. A limited commercial and sports fishery occurred again in 2003. The summer chinook count at McNary Dam reduced to 93,844, about 81.7% of the Bonneville Dam count (Note: No juvenile summer chinook from hatchery programs are released in tributaries below McNary Dam; hence no spawning of summer chinook occurs between Bonneville and McNary dams.

About 20,700 adult summer chinook were counted at Ice Harbor Dam with 16,400 passing Lower Granite Dam in 2003. Based on fish counts at Ice Harbor Dam that are recorded from 1962 to present, the 2003 return of adult summer chinook was within the range of summer chinook returning in the 1962-72 era which ranged from about 15,000 to 30,000 per year. The summer chinook count at Lower Granite was about 74% and 235% of the respective 2002 and 10-year average. Snake River summer chinook are mainly destined for the South Fork of the Salmon River and its tributaries and the Pahsimeroi River. This year's count of summer chinook "jacks" was 4,137 at Lower Granite Dam, about 2.2 and 3.3 times greater than the respective 2002 and 10-year average at the project. The 2004 forecast by TAC was estimated to be 33,700 adult summer chinook for the Snake River.

The Mid-Columbia count of adult summer chinook at Priest Rapids Dam was 82,904, and this total was about 86.1% and 303% of the respective 2002 and 10-year average. The passage of summer chinook at Rock Island Dam was 81,543 with 63,167 recorded at Rocky Reach Dam. Summer chinook destined for the Wenatchee River basin comprised about 22.5% of the Summer Run with the remaining 77.5% passing upstream of Rocky Reach Dam. Summer chinook can be either trapped at Wells Dam or volitionally enter Wells Hatchery for their hatchery program. The return of "jack" summer chinook was about twice the 2002 return of "jack" chinook at the PUD projects. The overall summer chinook run to this Reach should remain fairly strong as TAC is projecting about 69,100 adult summer chinook will return to the Mid-Columbia in 2004.

3. Fall Chinook

The number of adult fall chinook counted at Bonneville Dam was 610,336 with an additional 47,728 jack chinook salmon also counted. The 2003 adult count surpassed the 2002 total and was 2.6 times greater than the 10-year average. This year's count again surpassed all previous counts of fall chinook at Bonneville Dam back to 1938. The number of adult fall chinook (Bright component) that arrived at McNary Dam was about 179,000 (Figure 24), and exceeded the 2002 and 10-year average. Most fall chinook passing McNary Dam are "wild" origin and are destined for the Hanford Reach to spawn. Numbers counted at Rock Island and upstream dams continued to increase over the past few years as noted when compared to the 10-year average. The Yakima River also supports a fair sized Run of upriver bright fall chinook.

Tule fall chinook estimated from the fish counts at Bonneville Dam totaled near 170,000 with almost 60,000 adult chinook arriving at Spring Creek National Fish Hatchery (NFH), located in the Bonneville Dam pool (Figure 25). This component of the fall chinook run was record high and bolstered the overall record fall chinook count at Bonneville Dam. Most Tule fall chinook spawn in the Bonneville pool and as such, these fish do not make the lengthy migration journeys of the upriver bright stocks.

The Snake River component of the fall chinook run has been increasing during the past few years as a result of the hatchery and supplementation efforts in the Snake and Clearwater River basins. Almost 19,000 adult fall chinook were counted past Lower Monumental Dam with about 11,700 counted above Lower Granite Dam. These adult returns are about 3-times greater than the 10-year averages at these Snake River projects. The jack chinook counts were record high during 2003 and should indicate continued excellent adult counts at the Snake River projects during the next few years.

4. Sockeye Salmon

The number of sockeye salmon returning to Bonneville Dam was again reduced from the previous year's count, with 39,291 counted for the season. Columbia River sockeye are primarily destined for the upper Mid-Columbia River with approximately 29-30,000 sockeye destined for Lake Osoyoos and only 5,000 destined for Lake Wenatchee in 2003. This ratio of fish returning to each basin has not been consistent the past few years and likely will change with environmental conditions that affect migration timing and spawning rates and winter survival rates during the years. This year's return was about 7,000 fish average less than the 10-year average at Rock Island and lower river projects.

Sockeye salmon recovery efforts in the upper Salmon basin continued with captive brood stock, habitat and other enhancement efforts in Red Fish, Alturas, and Pettit Lakes. In 2003, only 11 adult sockeye were counted at Lower Granite Dam.

5. Coho Salmon

The combined return of adult and jack count of coho salmon in 2003 was approximately 134,000. This total was about 141% and 207% of the respective 2002 and 10-year average at Bonneville Dam. Additional juvenile coho from hatchery plants have been released and that along

with supplementation and natural spawning of adult fish has increased migrants in river basins above the Bonneville Pool. The overall result has been increased adult coho returns in recent years at the upriver projects. The majority of coho passing Bonneville Dam still "home" into rivers and hatcheries located in the Bonneville pool. Based on dam counts, about 16,000 more adult coho were counted at John Day Dam than at McNary Dam with most of these coho destined for the Umatilla River. The count at McNary Dam exceeded 19,800 with about 6,000 passing into the upper Columbia area. Based on fish counts at Rock Island and Rocky Reach dams, about 5,000 adult/jack coho may have returned to the Wenatchee River with a small number, less than 500, passing Wells project and likely ending in the Methow River. Adult coho salmon returning to the Yakima River showed strong returns in 2003. Close to 12,000 coho could have used the Yakima River based on the differential between the McNary Dam count and the counts at Priest Rapids and Ice Harbor dams. The Prosser Dam count on the Yakima River was near 3,000 coho for the season.

About 1,400 coho entered the Snake River basin. Adult return numbers are increasing as on-going efforts to establish coho continue in this basin. To date most of the hatchery supplementation efforts have been in the Clearwater River basin.

6. Steelhead

The count of steelhead at Bonneville Dam totaled 361,360 and ranked 4th highest recorded at Bonneville Dam since 1938. The 2001 and 2002 counts ranked 1st and 2nd in total steelhead past Bonneville Dam. The count at The Dalles Dam was 273,172, John Day reported 286,176, and McNary Dam was 230,418. Most adult steelhead returning to the Bonneville pool tributaries are Skamania stock fish, either summer or winter Run with the Hood River receiving winter and summer Run stocks from Oak Springs Hatchery. The Deschutes River in The Dalles pool has a large return of summer Run steelhead, both hatchery and wild. The John Day River remains a "Wild" stream with no hatchery releases in that river basin. Steelhead returns to the Umatilla River are mainly from hatchery reared steelhead planted as juvenile fish in the basin.

The Snake River continues to contribute the bulk of adult steelhead returning to the Columbia River basin. In 2003, the turnoff into the Snake River was about 186,500 or 81% of the total counted at McNary Dam. The Snake River steelhead counts were about 1.6 times greater than the 10-year average. Adult returns of steelhead to the Snake River are comprised mainly of

hatchery-reared fish and support a sport fishery while the "wild" steelhead remain depressed and are listed as "Threatened" under the ESA. Numbers of "wild" steelhead (non-clipped status only) ranged between 45-46,000 at the Snake River projects in 2003.

The Mid-Columbia count of steelhead at Priest Rapids Dam was 17,652, about 111% and 170% of the respective 2002 and 10-year average. Of the 17,500 above Rock Island Dam, 13,641 steelhead were counted at Rocky Reach with 9,963 above Wells Dam. Wild steelhead and Wells stock hatchery steelhead in the upper Mid-Columbia River remain depressed and are listed as "Threatened" under the ESA.

TABLE 31. Adult Salmonid Totals.

Cumulative Adult Passage at Mainstem Dams

	Spring Chinook						Summer Chinook						Fall Chinook					
	2003		2002		10-Yr Avg.		2003		2002		10-Yr Avg.		2003		2002		10-Yr Avg.	
DAM	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack
BON	192,010	14,258	268,813	6,477	122,177	6,086	114,808	13,358	127,436	7,952	38,022	5,207	610,336	47,728	474,554	40,220	238,357	35,695
TDA	131,207	11,522	181,176	3,870	80,975	4,136	101,490	10,441	113,069	5,743	32,585	3,775	313,697	39,708	245,928	33,369	129,747	24,834
JDA	101,436	10,206	139,887	2,403	67,822	3,122	95,542	10,073	105,354	5,615	30,300	3,298	215,483	34,327	164,920	29,550	96,467	20,101
MCN	95,550	11,123	129,357	3,872	62,536	3,162	93,844	11,104	109,937	6,810	31,244	3,358	178,951	30,031	141,682	25,432	81,166	18,147
IHR	78,170	8,020	85,207	1,826	38,964	1,925	20,742	4,601	26,607	2,437	7,616	1,067	20,998	10,666	15,248	6,079	5,984	3,912
LMN	70,603	7,344	76,304	1,537	38,073	1,899	18,718	3,589	23,744	1,710	7,642	945	13,796	9,055	15,193	6,185	5,370	3,596
LGS	69,017	7,079	77,232	1,815	37,097	2,034	14,340	3,537	20,854	2,254	6,945	1,196	14,260	6,658	12,905	4,264	4,027	2,470
LWG	70,609	8,295	75,025	2,089	35,689	2,016	16,422	4,137	22,159	1,953	6,987	1,260	11,732	8,481	12,351	5,727	3,555	2,660
PRD	18,136	656	34,083	196	15,528	317	82,904	3,933	96,326	1,455	27,332	1,075	48,546	6,258	26,819	2,628	18,476	2,699
RIS	16,881	753	24,017	827	11,565	538	81,543	6,858	86,825	3,216	24,224	3,420	21,804	4,328	14,514	1,092	7,252	2,054
RRH	4,216	450	9,999	161	4,017	126	63,167	6,195	73,104	2,807	16,932	1,550	11,262	2,718	11,372	1,313	5,021	1,431
WEL	4,504	198	7,585	41	2,377	152	44,503	1,888	62,595	412	12,816	1,120	7,355	898	6,241	231	2,384	580

	Coho						Sockeye			Steelhead			
	2003		2002		10-Yr Avg.				10-Yr			10-Yr	Wild
DAM	Adult	Jack	Adult	Jack	Adult	Jack	2003	2002	Avg.	2003	2002	Avg.	2003
BON	125,743	8,127	88,459	6,830	60,140	4,401	39,291	49,610	46,748	361,360	481,203	279,675	112,347
TDA	42,563	2,811	9,765	3,021	13,653	1,489	34,176	40,554	37,479	273,172	387,920	207,920	85,287
JDA	34,453	4,124	7,669	1,603	11,008	1,181	35,417	41,915	40,486	286,176	390,300	204,186	83,959
MCN	18,095	1,735	2,144	1,048	5,273	547	32,037	39,177	36,935	230,418	286,805	155,491	66,554
IHR	1,362	69	199	32	235	13	37	61	17	186,474	202,173	115,628	46,001
LMN	991	113	138	11	135	14	14	46	24	176,541	212,639	110,694	45,268
LGS	784	80	109	24	80	0	23	38	26	166,046	203,494	100,502	44,284
LWG	1,135	130	248	149	206	10	11	55	24	180,672	218,718	110,659	45,391
PRD	4,803	413	1,143	412	1,129	116	36,551	47,883	45,469	17,652	15,895	10,383	***
RIS	5,869	0	1,750	1	1,348	0	34,779	44,320	41,025	17,509	15,282	9,438	11,456
RRH	993	0	481	0	226	0	30,355	12,372	24,256	13,641	11,842	7,037	8,772
WEL	168	0	132	0	72	0	28,977	10,586	23,919	9,963	9,475	5,333	5,952

Non-clipped steelhead are counted as wild. Wild steelhead numbers are included in the total.
From 2000 to 2003 about 9 to 11% of the hatchery steelhead released into the Snake and Mid-Columbia River were unclipped.
**PRD is not reporting Wild Steelhead numbers.
These numbers were collected from the COE's Running Sums text files, except where otherwise noted.
Historic counts (pre-1996) were obtained from CRITFC and compiled by the FPC.
Historic counts 1997 to present were obtained from the Corps of Engineers.

Page last updated on: 4/29/2004

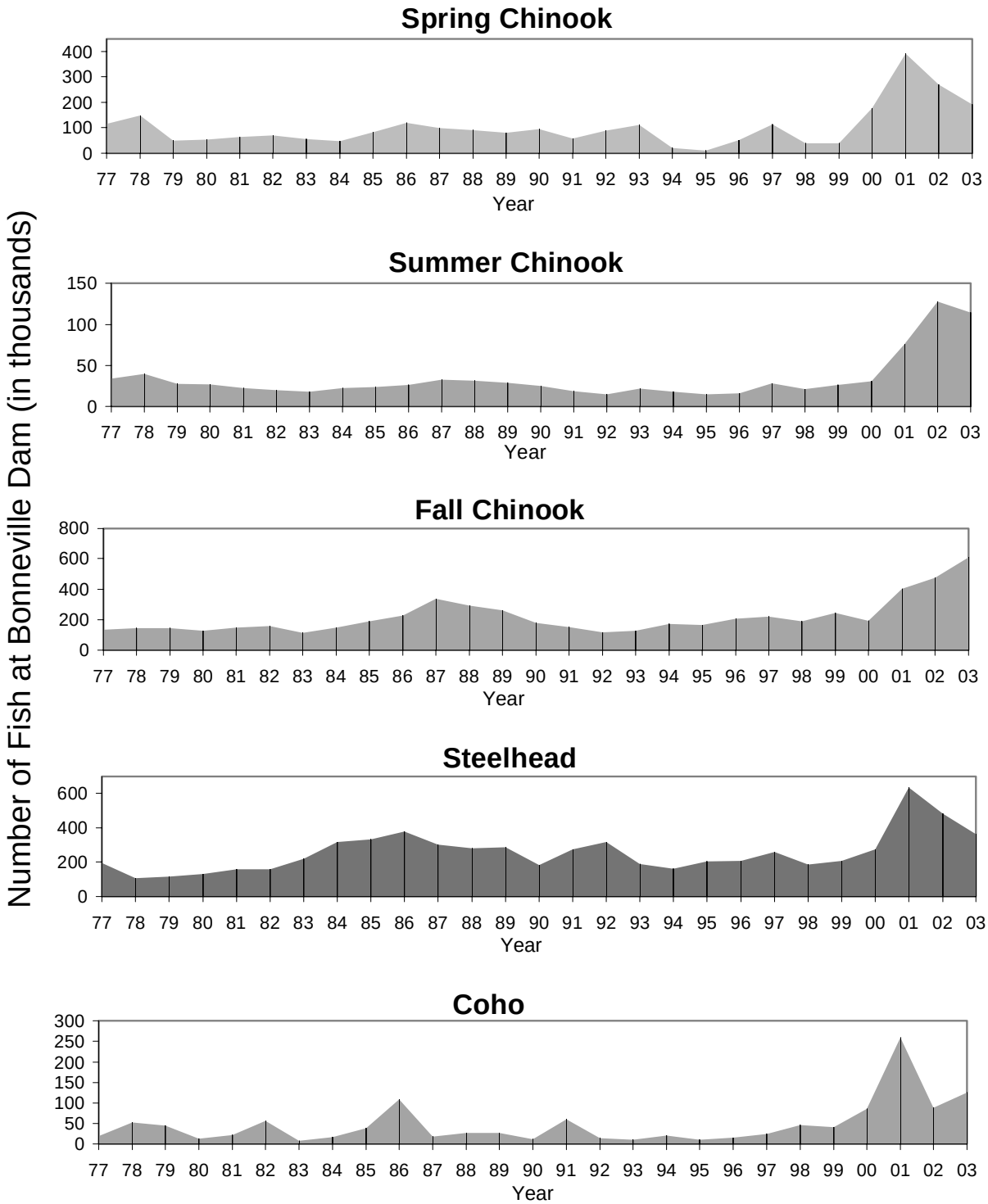

FIGURE 23. Adult Counts at Bonneville Dam, through 2003.

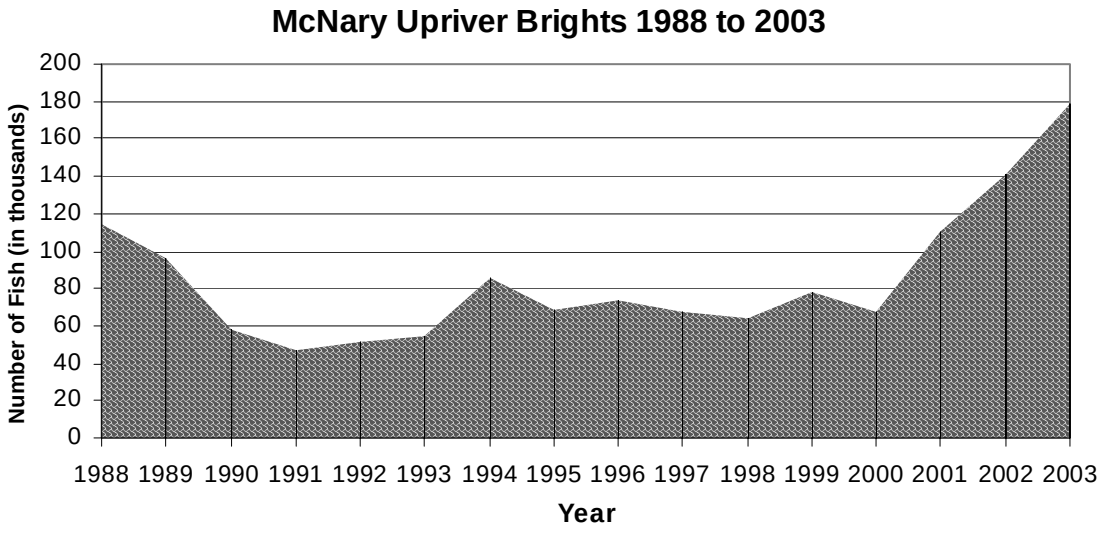

FIGURE 24. Upriver bright Fall Chinook passage at McNary Dam, 1988 to 2003.

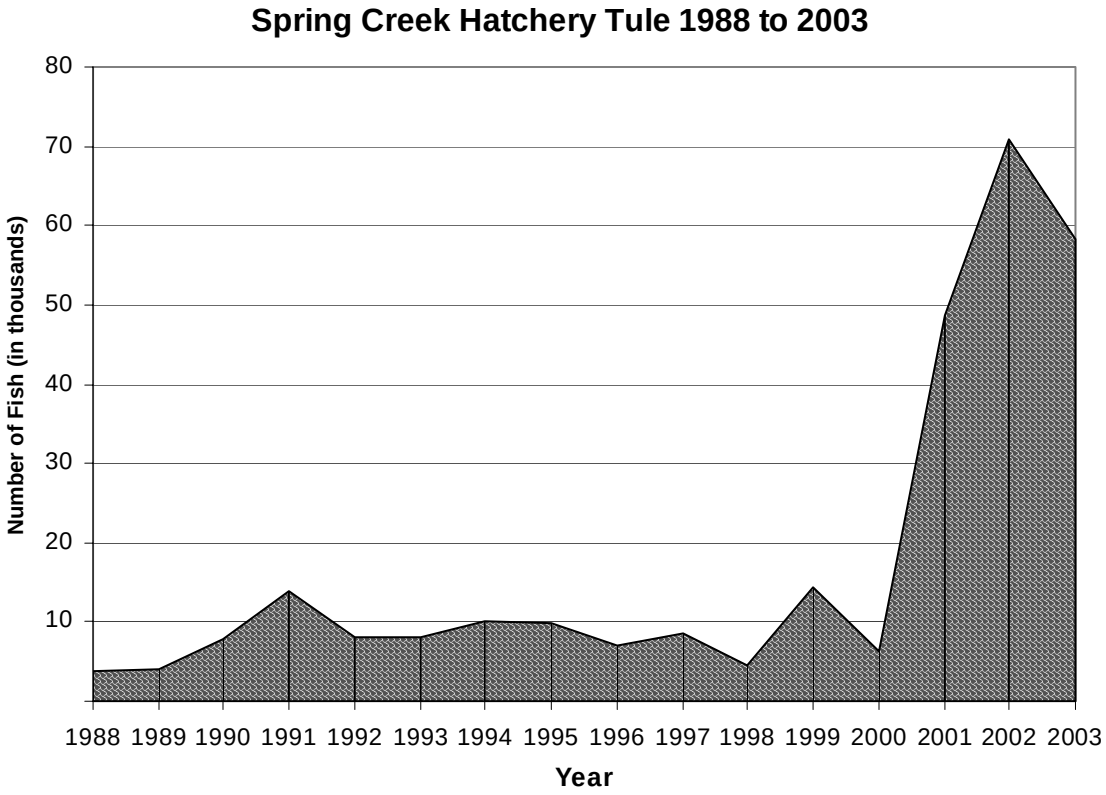

FIGURE 25. Tule Fall Chinook returns to Spring Creek Hatchery, 1988 to 2003.

V. 2003 COLUMBIA RIVER BASIN HATCHERY RELEASES

A. Overview

The Fish Passage Center maintains a hatchery database of anadromous salmon species released from State, Federal, and Tribal hatcheries for archived numbers, from 1979 to the present year, 2003. The database has been upgraded to also facilitate its use for Artificial Production Review and Evaluation (APRE) and Hatchery Genetic Management Plan (HGMP) purposes. Explanation of the new fields/columns can be found in the FPC hatchery meta data section. Hatchery data are normally entered into the database in the following manner. The FPC receives preliminary hatchery release schedules from State, Federal and Tribal agencies (normally the agencies coordinator for their hatchery programs) prior to the juvenile fish migration. These release schedules are then updated on a weekly or monthly basis throughout the year until the release numbers are "finalized" by the State, Federal, and Tribal fish agencies. Most hatchery releases are completed during the spring and summer season. Up-to-date hatchery release schedules allow the Salmon Managers to use hatchery release information to assess migration of hatchery juvenile fish through the hydro system.

The FPC database for hatchery fish released below Bonneville Dam will also be updated through the season; however, hatchery release information is normally gathered after the fish have been released from the hatchery facilities. Hatchery releases **below Bonneville** Dam were incorporated into the FPC database beginning in 1987.

The FPC hatchery release schedules do not include eggs that might be placed in egg boxes or planted in the gravel of Columbia River streams. Fry plants other than fall chinook fry are included in the release schedules and are normally listed as migrating the following year. Also fish that fall in the category of "non anadromous" by the fish managers are not included in the FPC hatchery release schedule (example = subyearling summer chinook released in Lake Chelan; these fish normally do not migrate from the lake).

In 2003, about 87.5 million juvenile salmon were released from Federal, State, Tribal or private hatcheries into the Columbia River Basin above Bonneville Dam. Table 32 gives hatchery release totals by River zone, **Snake River, Mid-Columbia, and Lower Columbia**. The 2003

hatchery release totals were nearly equal to the 87 million released the previous season in the Columbia River basin above Bonneville Dam.

TABLE 32. Summary of Hatchery Releases by Species and Release Area for 2003.

Race/Species	Snake River	Mid-Columbia	Lower Columbia	Total Release
Fall Chinook	4,091,473	12,255,089	25,531,102	41,877,664
Spring Chinook	10,473,825	3,474,730	5,441,505	19,390,060
Summer Chinook	2,332,578	3,001,618		5,334,196
Coho	1,277,246	1,876,158	5,732,260	8,885,664
Sockeye	155,410	208,986		364,396
Summer Steelhead	9,687,941	1,344,613	490,667	11,523,221
Winter Steelhead			94,900	94,900
Total	28,018,473	22,161,194	37,290,434	87,470,101

The 2003 Hatchery Release Schedule (Appendix H) lists the agency, hatchery, release numbers along with other pertinent data such as mark groups, number per pound, date of release, release site, and river zone. The 2004 Release Schedule and prior years can be accessed at the FPC Website Home Page under Hatchery Data, and then Query Current and Historic Hatchery Database (1979-2003). Table 33 to Table 35 list the hatchery release totals from 1980 through 2003 for the Snake, Mid-Columbia, and Lower Columbia rivers.

B. Lower Columbia River

In the FPC database, the Lower Columbia River is designated as the reach from above Bonneville Dam to McNary Dam. This reach accounted for approximately 42.6% of the fish released above Bonneville Dam in 2003, with a grand total of 37.3 million juvenile salmon released from the different hatcheries. Overall, 68.5% or 25.5 million of the 37 million hatchery fish released in this river zone were yearling or subyearling upriver Bright fall or subyearling “tule” chinook stocks (Table 33).

About 18.1 million Tule fall chinook were released from Spring Creek NFH; this total includes unfed fry released in December 2002 from the hatchery. The Tule fall chinook are

present mainly in the Bonneville pool (from Spring Creek Hatchery) and tributaries that flow into the pool. About 7.4 million Bright fall chinook were released in the Klickitat, Little White Salmon, and Umatilla rivers, a small increase above each of the last two years. Yearling fall chinook released in the Umatilla River in March and April comprise a small portion of the total release; most of the Upriver bright fall chinook are subyearlings released during the late spring and early summer time frame. This year's total of 25.5 million fall chinook fell within the normal range of release totals listed in the FPC database since 1980.

The total number of yearling and subyearling spring chinook released from Lower Columbia River hatcheries was 5.44 million, about equal to the previous four-year release totals. (Table 33). The 2003 spring chinook production in this Reach exceeded release of spring chinook in the Mid-Columbia Reach; however, it was about half [52%] of the Snake River release total. Subyearling spring chinook (286,000) were released in the upper Klickitat River in May and August 2003; none were released in the Big White Salmon River. Yearling spring chinook (about 5.2 million) were released from Carson H – Wind R; from Klickitat H – Klickitat R; from Little White Salmon H – Little White Salmon R; Hood R Acclimation Ponds – Hood R; Round Butte and Warm Springs H –Deschutes R; Umatilla R Acclimation Ponds – Umatilla River from late March to early May time frame.

The number of coho salmon released in the lower Columbia Reach during 2003 was about 5.7 million, the lowest total released in this Reach since 1986. This total was approximately one million below normal levels. Based on current schedules, coho salmon will likely stay at this level or be reduced through the next few years. Hatchery reared coho (both Type-S and Type-N) are presently released in the Klickitat, Little White Salmon, and Umatilla rivers with hatcheries located below Bonneville Dam continuing to supply a large portion of the coho planted in the Klickitat and Umatilla rivers.

Both summer and winter race steelhead are released in this Reach, with 15-Mile Creek (just below The Dalles Dam) being the upper boundary for the Winter-run steelhead. The number of steelhead (summer and winter races) released in 2003 was 585,567, and falls within the range recorded in this Reach since 1991 (583k to 689k). Since 1980, steelhead releases have averaged about 630k per year. Winter steelhead releases totaled 94,900 for the year, about 10,000 greater than the previous 4-years. Winter steelhead were released in Hood and Big White Salmon rivers. About 491,000 summer steelhead were stocked in the Klickitat, Hood, Deschutes, and Umatilla

rivers. The John Day River remains a "wild" stream with no steelhead or chinook released in that River basin. No hatchery steelhead have been released in the Wind River since 1998. Hatcheries located below Bonneville Dam, Skamania [WDFW], and Oak Springs [ODFW]) supplied a portion of the Winter and Summer Run steelhead for release in this Reach.

TABLE 33. Lower Columbia Hatchery releases, 1979-2003.

Year	Friday 23-Apr-2004						
	Spring Chinook	Summer Chinook	Fall Chinook	Steelhead	Coho	Sockeye	Totals
1979	3,491,500	110,500	40,975,000	456,500	3,288,000	0	48,321,500
1980	5,806,000	0	31,896,000	819,000	5,495,500	0	44,016,500
1981	6,066,500	0	35,936,500	609,500	4,391,500	0	47,004,000
1982	4,692,500	0	28,093,500	746,000	4,412,500	0	37,944,500
1983	6,003,500	0	34,141,500	631,000	4,912,500	0	45,688,500
1984	6,529,645	0	24,256,048	777,125	4,984,334	0	36,547,152
1985	6,344,905	0	20,804,201	744,290	2,162,846	0	30,056,242
1986	7,234,772	0	19,245,721	588,905	6,736,127	64,384	33,869,909
1987	6,099,130	0	18,149,291	404,000	9,292,000	0	34,002,428
1988	7,628,500	0	20,147,500	447,000	8,690,000	0	36,913,000
1989	8,891,430	0	24,805,762	555,526	8,451,762	0	42,709,616
1990	11,977,052	0	19,347,320	513,171	8,579,511	0	40,417,054
1991	9,046,069	0	27,266,266	583,156	8,467,969	0	45,363,460
1992	8,503,011	0	33,013,100	671,066	6,405,391	0	48,592,568
1993	7,435,146	0	30,927,448	689,196	8,954,465	0	48,006,255
1994	8,204,213	0	27,950,458	652,320	6,299,002	0	43,105,993
1995	6,939,030	0	24,858,274	587,171	6,712,604	0	39,097,079
1996	4,766,136	0	26,442,513	676,167	8,021,423	0	39,906,239
1997	4,093,528	0	23,233,638	688,909	6,763,470	0	34,779,545
1998	8,191,856	0	31,805,034	681,591	7,254,648	0	47,933,129
1999	5,488,404	0	19,322,806	621,079	7,186,404	0	32,618,693
2000	5,320,322	0	28,615,317	635,308	8,021,720	0	42,592,667
2001	5,853,807	0	17,405,628	603,293	6,762,367	0	30,625,095

C. Mid-Columbia River

The Mid-Columbia Reach or Zone encompasses the area from above McNary Dam to Chief Joseph Dam. In 2003, approximately 22.2 million juvenile salmonids were released, slightly above the 2002 season and similar to the 1998 and 2000 totals (Table 34). Hatchery

releases of juvenile chinook, sockeye, coho, and steelhead in this Reach have remained relatively stable since 1994. Release of juvenile coho salmon was the 3rd highest on the FPC database.

Production releases of juvenile fall chinook (up-river Bright stock) totaled 12.3 million, about 1.3 million greater than the 2002 release, and close to the totals reported since 1996. Release of fall chinook from 1996 to 2003 ranged between 10.9 million to 12.4 million per year. Subyearling fall chinook from Ringold Hatchery and Priest Rapids Hatchery totaled 10 million with the remainder released in the Yakima River basin. No yearling fall chinook have been released in this Reach for several years. Hatchery fall chinook comprised about 55.3% of the total fish released in this Zone.

About 3.0 million summer chinook salmon were released from hatcheries, acclimation ponds or into streams and tributaries located above Rock Island Dam. Most summer chinook are reared in the hatchery facilities until yearling age (about 18 months) and released during the spring. The subyearling releases (about 1.1 million) were released in June/July and migrate through the Mid and Lower Columbia rivers in June, July and August. Summer chinook were released in the Wenatchee, Similkameen, and Methow rivers, and the mainstem Columbia River from Wells and Turtle Rock hatcheries. From 1979 through 1994, releases averaged about 2.1-million summer chinook per year. From 1995 to present, releases have increased and now range between 2.8 and 4.3 million per year.

Mid-Columbia hatcheries released about 3.5 million yearling spring chinook, a decrease of about 400,000 from 2002. Hatcheries were not filled to production levels in 2003. Yearling spring chinook were released in the Methow, Entiat, and Wenatchee rivers and tributaries with approximately 369,000 released from Acclimation facilities in the Yakama River basin (Easton Pond, Jack Creek and Clark Flat). Hatchery releases of spring chinook averaged about 4.8 million from 1980 to 2000. Release totals have been reduced since 1993 with only 2 of the 10 years up to the 4.8 million average. Hatchery spring chinook releases should increase slightly over the next few years, but may not maintain the higher levels of previous years. Production of spring chinook at Ringold H was terminated in 2001 and that reduced normal release numbers by about 400,000 per year. Spring chinook production of about 500,000 per year will be restarted at the hatchery by the 2005 release cycle.

Coho salmon production released from acclimation ponds and hatcheries was about 1.9 million (about equal to 2001 and 2002) for the Mid-Columbia Reach with 694,500 released in the

Yakima River Basin and 1.0 million and 0.2 million released in the Wenatchee and Methow rivers, respectively. All coho released in this Reach were transferred from hatcheries below Bonneville Dam or from Willard H (Bonneville Pool) to acclimation pond(s) or hatchery and held until liberated from the facility. Coho releases in the Mid-Columbia are part of the Yakama Tribal Program to reestablish coho runs in the Yakama, Methow and Wenatchee River basins.

About 209,000 yearling sockeye salmon were released from August and late October 2002 from the net pens located in Lake Wenatchee. The majority of these fish resides in the lake through the winter and will migrate during the upcoming spring [2003]. The Wenatchee sockeye were 100% adipose clipped and coded wire tagged. The Osoyoos Program was terminated after release of sockeye in fall 2001.

Since 1992, hatchery production of juvenile steelhead has averaged about 1.4 million per year in this Reach with 2003 releases at 1.35 million. Of this total, about 235,000 juvenile steelhead were released in the Walla Walla River basin with the remainder in the Okanogan, Methow, Wenatchee rivers and tributaries as well as the mainstem release from Ringold Hatchery. As noted in previous years, hatchery steelhead (Wells stock) remain listed as Threatened under the ESA. No hatchery produced steelhead were released in the Yakama River. Hatchery steelhead production has been very stable in this Reach through the past 20 years.

TABLE 34. Mid-Columbia Hatchery releases, 1979-2003.

Year	Friday 23-Apr-2004						
	Spring Chinook	Summer Chinook	Fall Chinook	Steelhead	Coho	Sockeye	Totals
1979	3,509,000	2,501,000	826,500	592,500	640,000	0	8,069,000
1980	4,788,000	2,638,000	3,327,500	873,000	1,206,500	0	12,833,000
1981	5,161,000	2,301,000	5,115,500	985,000	1,089,500	0	14,652,000
1982	5,186,500	2,981,000	6,297,500	1,263,500	482,500	0	16,211,000
1983	4,369,000	1,609,000	10,276,500	1,471,500	536,000	0	18,262,000
1984	6,492,744	1,240,865	15,548,324	1,587,329	517,100	0	25,386,362
1985	4,796,554	1,630,322	10,789,141	1,345,923	389,005	64,031	19,016,813
1986	4,651,848	1,992,057	10,402,956	1,504,450	556,017	64,926	19,259,428
1987	4,585,223	1,413,000	8,606,441	1,748,868	911,500	25,000	17,308,132
1988	6,034,795	2,144,500	9,769,500	2,167,000	1,329,500	47,500	21,492,795
1989	4,565,017	2,597,099	7,571,364	1,810,287	1,084,753	107,299	17,735,819
1990	8,800,002	1,912,708	9,339,478	1,822,491	1,118,138	91,999	23,084,816
1991	6,455,727	2,258,293	7,195,765	1,913,905	1,126,683	616,038	19,566,411
1992	5,250,389	2,551,616	7,216,100	1,382,511	1,246,195	112,205	17,759,016
1993	4,305,286	1,800,199	8,862,582	1,368,682	1,167,694	354,595	17,859,038
1994	3,803,697	2,097,319	14,162,311	1,440,117	857,783	428,200	22,789,427
1995	5,076,896	2,760,748	14,399,490	1,414,719	666,862	40,963	24,359,678
1996	3,243,054	3,889,547	12,422,257	1,411,096	1,680,209	150,000	22,796,163
1997	1,328,576	3,403,136	12,407,097	1,420,394	1,124,821	339,158	20,023,182
1998	3,328,869	3,537,781	11,924,206	1,472,296	1,739,476	365,784	22,368,412
1999	4,956,745	2,977,364	11,870,800	1,726,741	1,486,500	210,591	23,228,741
2000	3,939,920	2,853,950	12,293,934	1,396,898	1,662,994	142,901	22,290,597
2001	3,258,547	4,324,169	11,976,344	1,291,813	2,151,318	241,216	23,243,407
2002	3,915,963	3,520,683	10,913,482	1,312,693	1,911,684	308,042	21,882,547
2003	3,474,730	3,001,618	12,255,089	1,354,983	1,876,158	208,986	22,171,564

D. Snake River

The total release of salmon species in the Snake River basin was 28,018,473 for the 2003 migration season, about 1.5 million greater than the preceding year (Table 35). Most of the hatchery facilities were at production levels throughout the basin and as a result, 2003 ranked 3rd highest in the FPC database. Spring and summer chinook salmon are still rebuilding after the all-time low production in 1996 and 1997, with the fall chinook production levels now exceeding 3-million per year.

The 2003 production of hatchery spring chinook in the Snake River basin totaled about 10.5 million, the highest total on the FPC database since 1990. Yearling spring chinook were released in the Snake (Hells Canyon area) Clearwater, Grande Ronde, Salmon, Tucannon, and Imnaha River basins from hatcheries or acclimation ponds mainly during the spring season with supplemental and acclimation sites releasing about 1.5-million during 2002 fall. Spring/summer chinook were adipose or Ventral fin clipped or else CWTed with no fin clip for the 2003 migration year. A portion of the hatchery production of spring chinook from IDFG, ODFW and WDFW hatcheries remain classified as "listed" under the ESA. Captive brood stock releases of juvenile salmon are now occurring at some of these hatcheries. Production of spring chinook should be near peak levels with more stable hatchery production of these fish maintained in future years rather than the huge peaks and valleys noted during the last 20-years.

About 2.3 million juvenile summer chinook were released from McCall and Pahsimeroi hatcheries in 2003 and ranked 2nd highest in the FPC database. Summer chinook production should begin leveling off in the Snake River as these summer chinook facilities reach capacity. A portion of the hatchery summer chinook from McCall and Pahsimeroi hatcheries is listed as Threatened under the ESA. Yearling-age summer chinook from McCall Hatchery are annually trucked to and released at Knox Bridge located on the S. Fork Salmon River as well as supplemental releases of summer chinook completed in Stolle Meadow Pond and in Johnson Creek.

Hatchery production of Snake River fall chinook was 4.1 million, the 2nd highest total recorded in the FPC database. The upward trend beginning in 1998 continues to be heading in a positive direction. Approximately 1-million yearling chinook were released from Lyons Ferry Hatchery and acclimation facilities at Pittsburg and CPT Johns Landings in the Snake River and Big Canyon Creek in the Clearwater River. The remainder of the fall chinook released in the Snake River was comprised of subyearling fall chinook released from CPT Johns Landing, Big Canyon Creek and Pittsburg Landing acclimation facilities as well as releases into the Snake River near Hells Canyon Dam (Idaho Power program) and the new Nez Perce Tribal facilities in the Clearwater River basin. Yearling releases were completed in April with the subyearling chinook released in late May and June. A portion of the subyearling chinook released from the acclimation sites was unmarked. Distinguishing "Hatchery from Wild" chinook was not possible as juvenile migrants, and will continue to be difficult to ascertain when these fish return as adults in future years.

Production of yearling sockeye totaled 155,410 with releases completed in Red Fish, Alturas, and Pettit lakes and Red Fish Lake Creek for the 2003 migration. Releases occurred during the fall (2002) and a small number in spring 2003. All sockeye were 100% marked with adipose fin clips and a small number of the fish were PIT tagged. Efforts continue to allow adult sockeye to establish a natural spawning base in the Lake system to complement the hatchery-reared fish released as juvenile migrants each year.

About 1.3 million juvenile coho salmon were released in the Clearwater River basin in 2003. This year's release total was the record high total since hatchery production fish were released in 1998. The reintroduction of coho into the Snake River Basin will continue through upcoming years. The majority of production releases have been unmarked, i.e., released without fin clips. Adult coho salmon are now returning to these natal upstream sites and spawning.

Juvenile hatchery steelhead released in the Snake River basin totaled 9.7 million in 2003. From 1981 to present, steelhead production has ranged between 8.1 to 12.1 million with the 2003 release groups residing within this range. About 34.6% of the anadromous salmonids released from Snake River basin hatcheries were steelhead. B-Run steelhead were released in the Clearwater River basin as well as selected areas in the Salmon River Basin. A-Run steelhead were released in the Salmon, Grande Ronde, Imnaha, Snake River (below Hells Canyon) and Tucannon River Basins, and other tributaries of or from Lyons Ferry Hatchery on the Snake River. Most steelhead are released during the spring, late March through late-May and migrate through the River in April and May.

TABLE 35. Snake River Hatchery Releases, 1979-2003.

Year	Friday 23-Apr-2004						
	Spring Chinook	Summer Chinook	Fall Chinook	Steelhead	Coho	Sockeye	Totals
1979	5,641,235	236,500	0	4,064,000	0	0	9,941,735
1980	5,124,000	0	0	6,328,000	0	0	11,452,000
1981	6,757,307	249,500	0	8,409,500	0	0	15,416,307
1982	3,068,233	264,000	0	9,522,500	209,500	0	13,064,233
1983	5,393,623	198,500	79,000	8,279,500	0	0	13,950,623
1984	7,076,708	356,673	427,191	10,802,035	0	0	18,662,607
1985	8,084,943	781,405	1,317,921	9,419,904	0	210,000	19,814,173
1986	6,314,421	982,443	2,271,520	8,085,953	0	0	17,671,075
1987	10,743,364	1,217,000	1,060,500	8,242,200	0	0	21,263,064
1988	11,230,300	1,777,500	4,981,000	11,726,776	0	0	29,715,576
1989	10,446,274	1,991,300	2,153,882	9,146,283	0	0	23,737,739
1990	13,306,749	2,882,400	3,480,110	11,149,502	0	0	30,818,761
1991	8,908,172	936,100	224,660	12,068,104	0	0	22,137,036
1992	8,178,071	1,507,400	689,601	9,510,474	0	0	19,885,546
1993	4,046,446	982,300	966,793	10,302,377	0	0	16,297,916
1994	6,752,805	1,190,673	603,661	9,600,381	0	0	18,147,520
1995	8,557,388	2,095,143	374,882	10,109,372	0	30,973	21,167,758
1996	1,541,127	676,894	630,612	10,461,986	0	157,095	13,467,714
1997	477,929	360,603	1,137,678	9,959,153	0	1,926	11,937,289
1998	3,176,804	577,618	842,007	9,209,992	695,716	263,307	14,765,444
1999	9,310,024	1,574,369	1,834,739	9,840,622	788,358	151,899	23,500,011
2000	5,968,537	1,172,717	3,234,767	9,775,735	797,474	40,419	20,989,649
2001	2,801,460	1,343,943	2,536,218	9,796,039	597,192	86,017	17,160,869
2002	10,206,719	1,676,957	3,665,801	9,509,463	1,089,672	184,507	26,333,119
2003	10,473,825	2,332,578	4,091,473	9,687,941	1,277,246	155,410	28,018,473

APPENDIX A

Memorandums

FISH PASSAGE CENTER

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MEMORANDUM

TO: Rob Lothrop, CRITFC

FROM: Michele DeHart

DATE: December 17, 2003

RE: Summary of Documented Benefits of Spill

In response to your request of December 11, 2003, the Fish Passage Center staff prepared the following summary of information addressing the benefits of spill for fish passage. The benefits of spill for fish passage are well established and accepted throughout the scientific community. There is substantial data and literature documenting the direct and indirect benefits of spill for fish passage. In some river reaches and some time periods, such as the lower Columbia River during the summer migration period, spill for fish passage is the only protection measure that has been provided consistently. For some stocks of salmonids such as Klickitat River, Umatilla River and other lower river tributaries spill is the only passage protection measure provided.

Juvenile Passage; Spill; and Total Dissolved Gas

Background

When fish approach a hydroelectric project they can either enter the powerhouse or continue migrating downstream by passing over the spillway. Upon entering the powerhouse fish either pass through a turbine unit or are mechanically collected and bypassed downstream without passing through the turbines. Employing the use of spill for juvenile migrants has long been used as an effective management tool for improving passage survival of migrating juvenile salmon at mainstem hydroelectric projects. Routing smolts through spillways at hydroelectric projects in the Columbia and Snake rivers is generally considered to be the safest passage strategy, when compared to the passage survival through bypass systems and turbine routes.

Prior to 1993 when the first Biological Opinion was issued, spill was used as mitigation at hydroelectric projects to enhance project survival for juvenile salmonids. Historically, spill occurred operationally, when project capacity or system generation needs were exceeded. As the hydrosystem was developed it became more efficient through such actions as the construction of the DC and AC Intertie transmission lines. As a consequence the occurrence of spill declined, accelerating the disagreements between operators and regulators and the fishery agencies regarding the provision of spill. In December of 1988 a 10-year spill program was developed for implementation of spill at projects that were not equipped with adequate bypass systems to achieve a fish passage efficiency goal. (Fish Spill Memorandum of Agreement).

As fish stocks continued to decline and were listed under the Endangered Species Act, it became clear that the negotiated contracts were not aggressive enough to recover endangered stocks. This lead to the modification of spill programs under the different versions of the Biological Opinion. At the same time that spill was identified as a key element in the recovery of listed stocks, the need to meet the objectives of the Clean Water Act was also identified. Spill causes increased levels of total dissolved gas that could increase mortality and eliminate the benefits associated with the implementation of an aggressive spill program. Therefore, subsequent implementation of a spill program has been within the confines of the "risk" associated with increased levels of total dissolved gas

Decreasing Migration Delays and Predation

Spill and Decreases in Delay associated with Project Passage

Spill is an effective tool in decreasing the amount of delay experienced by fish in forebays and tailraces of dams where predator populations and predation rates are highest. Beamesderfer and Rieman (1991) found that forebay populations of northern pikeminnow (*Ptychocheilus oregonensis*) and smallmouth bass (*Micropterus dolomieui*) were present in substantial numbers in the forebay of John Day Dam. Poe et al. (1991) reported that the diet of northern pikeminnow in the forebay of John Day Dam was 66% salmonid smolts. This suggests that delay of outmigrants in the forebay could reduce survival due to increased predation, and project operations such as daytime spill that decrease forebay residence time could increase survival. In addition, spill was also shown to be an important factor in reducing forebay delay in studies conducted by Snelling and Schreck (1994).

Hansel et al., (1999) showed that in general, yearling chinook salmon and steelhead that arrived in the forebay when no spill occurred tended to delay. Yearling chinook salmon and steelhead that arrived at night, concurrent with spill, passed the dam more readily. Residence times of yearling chinook salmon were markedly reduced with respect to daytime spill, whereas steelhead residence times decreased only slightly in the presence of daytime spill. When daytime spill went from 0 to 30% yearling chinook salmon residence time dropped from 8.5 h to 0.8 h in 1999 and 9.0 h to 2.4 h in 2000, while yearling steelhead residence time decreased from 11.4 to 11.3 h in 1999 and 11.4 to 9.4 h in 2000. Data collected in 1999 and 2000 suggest that hatchery steelhead (>200 mm) may delay in the John Day Dam forebay longer than wild steelhead (<200 mm). (NOAA, 2000)

Dispersal of Predators

Spill establishes a large flow net with increased velocity that disperses predators from the forebay and tailrace areas thus reducing the potential for predator/prey interactions (Faler et al., 1988). The concept of developing spill patterns at FCRPS dams specifically for fish passage was first addressed systematically in the 1960s to facilitate adult salmon passage into the adult fish collection systems. Junge (1967) observed improved adult salmonid passage under intermediate to large spill volumes if four or five gates at each end of the spillway were at low volume settings. At large dams this resulted in a tapered spill pattern near each end and a flat spill pattern across the central portion of the spillway. At smaller dams this produced a “crowned” pattern across the entire spillway tailrace, with the highest discharge in the middle bays. The success of adult salmon passage was evaluated by comparing ladder passage counts associated with various spill patterns. The spill patterns developed that appeared best for adult passage conflict with what is thought today to be best for juvenile passage (high shoreline velocities), since Junge kept near-shore velocities low to facilitate adult migration and passage into fishway entrances located along shorelines (NOAA 2000). Smolt residence time in spillway tailraces is likely influenced by spill volume and pattern. High spill volume and water velocity push water and presumably juvenile salmonids out of the immediate tailrace, and help redistribute piscivorous predators (northern pikeminnow) away from the immediate spillway tailrace, reducing potential predation opportunities (Faler et al. 1988).

Shively et al. (1996) found that ambient river flow velocities of at least 1 m/s were necessary to keep northern pikeminnow from holding in areas near bypass outfalls, and that the degree by which water velocity eliminated northern pikeminnow holding increased as outfall distance from shore and water depth increased. Hansel et al. (1993) found that hydraulic cover such as eddies and backwaters at velocities below this threshold were preferred northern

pikeminnow feeding habitats, particularly when near primary smolt outmigration paths. Spill patterns that facilitate rapid juvenile egress from the spillway stilling basin through the tailrace likely increase juvenile survival. Current spill patterns are developed to increase the survival of juvenile fish through tailraces, by emphasizing minimizing hydraulic cover and maintaining high water velocities near spillway shorelines. To not interfere with daytime adult passage, these juvenile spill patterns are often employed during nighttime hours only (COE, 1999d; NOAA 2000).

Spillway Survival

Whitney et al. (1997) reviewed 13 estimates of spill mortality for salmonids (3 steelhead and 10 salmon) published through 1995 and concluded that 0 to 2% is the most likely mortality range for standard spillbays. They also pointed out that local conditions, such as back eddies or other situations that may favor the presence of predators, may lead to higher spill mortality.

Some point estimates for mortality in spillbays with spill deflectors are higher than estimates for spillbays without deflectors. For example, the highest estimates of survival for yearling chinook salmon and steelhead at Snake River dams were obtained from spillbays without flow deflectors, ranging from 98.4 to 100% (Muir et al. 1995b, 1996, 1998). Although lower survival estimates were obtained from spillbays with flow deflectors (ranging from 92.7 to 100%) (Iwamoto et al. 1994; Muir et al. 1995b, 1998), differences in survival between the two types of spillbays compared pairwise were not significant at Little Goose (steelhead), or Lower Monumental Dams (yearling chinook salmon) (NOAA, 2000).

A number of methodologies have been used to estimate spillway survival at lower Columbia River dams, including identification of test fish by fin clips (Holmes 1952), freeze brands (Johnsen and Dawley 1974, Raymond and Sims 1980), coded-wire tags and freeze brands (Ledgerwood et al. 1990), balloon tags (Normandeau Associates Inc. et al. 1996a, b).

At Bonneville Dam, Holmes (1952) estimated that subyearling chinook salmon survival through the spillway was 96 to 97%, depending on how the data were analyzed. Johnsen and Dawley (1974) compared the survival of subyearling chinook salmon passing through spillbays with and without flow deflectors, and found that relative survival was 87 and 96%, respectively, and that these differences were not statistically different. Ledgerwood et al. (1990) found that survival of subyearling chinook through spillbay 5 was not significantly different than for fish released downstream. Based on the balloon-tag methodology, the calculated survival probabilities for deflector and non-deflector spillways were both 1.0 at Bonneville Dam, however, fish passing through a spillbay without a spill deflector displayed a slightly higher injury rate (Normandeau et al. 1996a; NOAA 2000).

Spill and Total Dissolved Gas

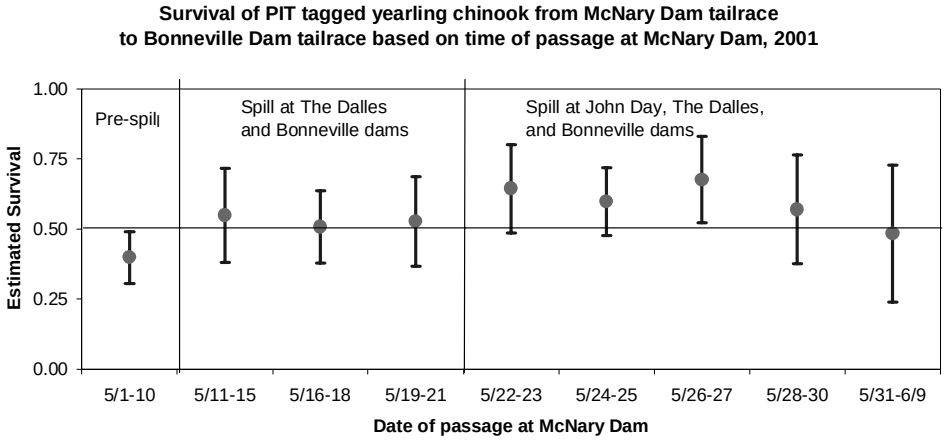
Spilling water can cause high dissolved gas to concentrate by entrainment of air in the form of bubbles as it passes over the spillway and plunges to the tailrace. The air is forced into solution, causing the water to become "supersaturated" at ambient atmospheric pressure with respect to dissolved gas. Water that is supersaturated with respect to dissolved gases may cause gas bubbles to form in the bodies of fish and other aquatic animals under certain conditions that impair their ability to function, or in extreme situations may lead to death. Consequently, spill management must recognize the tradeoff between survival benefits and the detrimental effects of high total dissolved gas levels.

The "Spill and 1995 Risk Management" report was developed by the region's fishery agencies and tribes document and provided part of the biological justification for the implementation of the 1995 Biological Opinion spill program. The document reviewed all available studies and quantified the trade-off between the increase in salmon survival associated with an increase in spill passage, against the potential fish mortality that might be incurred from increased levels of total dissolved gas (TDG). The assessment concluded that the benefits of spill passage outweighed the risk up to TDG levels between 120 to 125%. The annual voluntary spill program has been implemented within these constraints since that time.

In 2000 the NMFS included Appendix E in their Biological Opinion. This appendix was meant to serve as the justification and risk assessment for the spill program included in the 2000 Biological Opinion. The appendix addresses the 120% dissolved gas ceiling and builds on the findings of the 1995 document with information collected subsequently. The NMFS also uses the SIMPAS model as a means of quantifying an amount of system survival attributable to the 120% TDG spill program. The NMFS concludes, "the risk associated with a managed spill program to the 120% total dissolved gas (TDG) level is warranted by the projected 4% to 6% increase in system survival of juvenile salmonids. Recent research and biological monitoring results support the findings of the 1995 report, which predicted that the TDG in the 120% to 125% range, coupled with vertical distribution fish passage information indicating that most fish migrate at depths providing some gas compensation, would not cause juvenile or adult salmon mortalities exceeding the expected benefits of spillway passage. NMFS finds little evidence that this expected survival improvement would be reduced by the mortality related to gas bubble trauma (GBT). NMFS also concludes that physical and biological monitoring of GBT signs can continue to be used to indicate dissolved gas exposure in adult and juvenile salmon migrants."

System-wide Evidence for Spill Survival Benefits

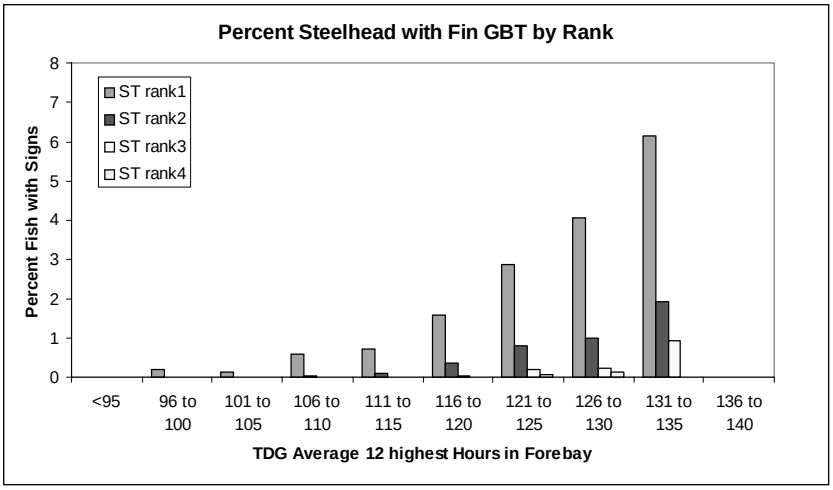
Analysis of smolt survival in the lower Columbia River index reach in 2001 was performed with the year split into periods of passage at McNary Dam (FPC, 2001). The McNary Dam passage distribution of PIT tagged yearling chinook was split into nine multi-day blocks with at least 10,000 PIT tagged smolts per block. A plot of the estimated survival from McNary Dam tailrace to Bonneville Dam tailrace shows evidence of shifts in estimated survival for yearling chinook smolts passing McNary Dam in the May 1-10, May 11-21, and May 22-June 9 periods (Figure 44). One likely explanation of this apparent grouping of the survival data was that spill in the lower Columbia River index reach did not begin at The Dalles and Bonneville dams until May 16 or at John Day Dam until May 25.

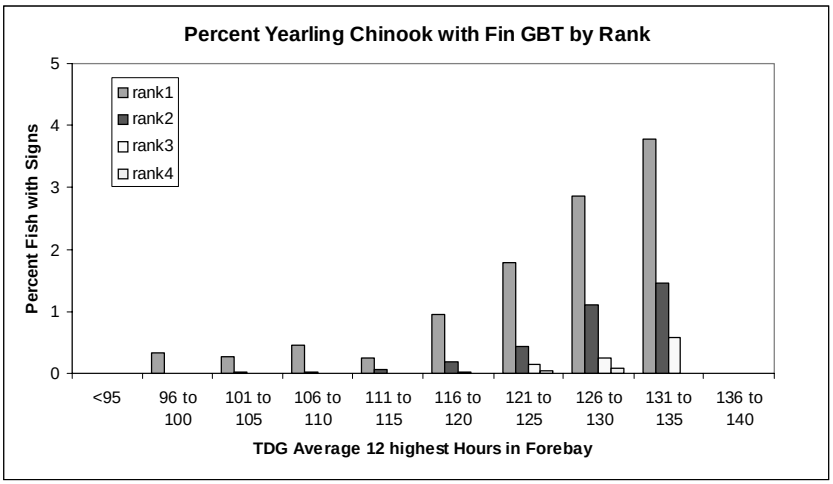


Analyses conducted by Muir et al. (2001) reconfirmed the findings of numerous earlier studies by demonstrating that spillway survival of smolts exceeds that incurred through both turbines and collector/bypass systems at dams on the Snake River.

Evidence for the Appropriateness of the Current Total Dissolved Gas Standards

The effects of elevated dissolved gas on migrating juvenile and adult salmon due to voluntary spill have been monitored each year of spill program implementation. Based on seven years of data from the biological monitoring program, the average incidence of gas bubble disease signs has been low, although the state-allowed maximum TDG due to spill was 120 percent in the tailrace and 115 percent in forebays during periods of voluntary spill. A high percentage of the spill that did occur in some years was involuntary, and often resulted in dissolved gas levels above the 120% waiver. The following graphs depict the incidence and severity of signs of GBT in fish collected for observation over the seven years, grouped in 5 percent TDG levels. Increases in the incidence of signs were observed with increases in the levels of TDG. The severity of signs also increased, but not until dissolved gas levels were above the 120 to 125% level.





These data suggest that total dissolved gas concentrations above 125% may have had a negative impact on survival. These high total dissolved gas measurements are a function of uncontrolled spill that occurred in the hydrosystem because of flow in excess of the hydraulic capacity of the project, or due to spill in excess of generation needs. They are not caused by the implementation of the Biological Opinion Spill Program.

Summary

All of the information collected to-date of survival and the benefits associated with spill indicate that spill provides a significant benefit to juvenile survival at levels up to 125% in the tailrace of the dam.

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MEMORANDUM

TO: Bill Tweit, WDFW

FROM: Michele DeHart

DATE: December 15, 2003

RE: Juvenile Fish Passage in the Lower Columbia River in August – Washington Stocks

In response to your request of December 10, 2003, the Fish Passage Center staff summarized the following population estimates of juvenile salmon passing the lower Columbia River in August. The following juvenile population estimates are computed by dividing the Smolt Monitoring Program passage indices by the fish guidance efficiency at each project. In addition, the December 5, 2003 memorandum provided to Larry Cassidy, NPCC, is attached. We utilized available PIT tag data on fish originating in Washington, plus the smolt trap data from the Klickitat River monitoring by the Yakama Indian Nation. This trap is located near the mouth of the Klickitat River. This trap data shows that Klickitat River fall chinook are passing through Bonneville pool and dam in August. The Klickitat is an example of a stock that is recognized in the NPCC Mainstem Amendments to the Fish and Wildlife Program, "that cannot or are not effectively transported".

- The following summary shows that significant juvenile salmonid passage occurs in August in the lower Columbia River and that a large proportion of the passage is comprised of stocks originating in Washington State tributaries. Reducing the spill for fish passage protection in August will have a significant impact on Washington State stocks, and in particular the Hanford Reach fall chinook. Spill is effective in decreasing the proportion of daily passage that is subjected to direct turbine mortality and indirect mortality in the forebay and tailrace of projects including passage delay.

- In 2003 we estimated over 1 million subyearling chinook passed McNary Dam during August, while we estimated 700,000 and 600,000 subyearling chinook at John Day and Bonneville dams respectively (Tables 1 – 3). Over the past twelve years the estimated population size at McNary Dam in August has been as high as 2.6 million, while the maximum was 3.5 million and 1.75 million subyearlings for John Day and Bonneville dams during the month.

Table 1. Subyearling Population Index* at McNary Dam for August, 1992 – 2003.

Year	8/1 to 8/15	8/16 to 8/31
2003	949,944	139,482
2002	771,437	550,113
2001	788,990	361,316
2000	1,168,668	304,032
1999	744,671	472,097
1998	523,606	172,724
1997	1,980,147	652,587
1996	1,193,721	404,474
1995	195,242	157,361
1994	77,023	43,518
1993	639,800	144,708
1992	138,145	47,032

*Index uses 1:1 spill effectiveness and FGE of 0.62

Table 2. Subyearling Population Index* at John Day Dam for August, 1992 – 2003.

Year	8/1 to 8/15	8/16 to 8/31
2003	610,319	91,859
2002	272,588	292,038
2001	2,527,969	992,422
2000	558,516	100,281
1999	484,269	286,828
1998	428,528	67,978
****1997**	187,731	122,541
1996	368,966	355,009
1995	119,263	76,619
1994	183,653	114,391
1993	403,856	399,813
1992	419,741	121,128

*Index uses 1:1 spill effectiveness and FGE of 0.32
**Last year of airlift sampler, 1998 begins bypass sampler

Table 3. Subyearling Population Index* at Bonneville Dam for August, 1992 – 2003.

Year	8/1 to 8/15	8/16 to 8/31
2003	471,679	142,946
2002	437,257	96,811
2001	1,137,382	603,279
2000	149,564	19,232
1999	514,089	177,589
1998	251,911	80,644
1997	647,556	220,178
1996	170,656	96,144
1995	284,978	123,844
1994	254,867	120,878
1993	423,111	244,289
1992	269,900	539,089

*Index uses 1:1 spill effectiveness and FGE of 0.09 for 1992 to 1999 and 0.28 for 2000 to 2003

- Present tagging programs do not allow a precise breakdown, by stock, of the population of subyearling chinook passing Lower Columbia River dams in August. Our analysis of the presence of various Washington stocks is based on PIT-tag passage data, hatchery release schedules, and tributary trap collections.

- PIT-tagged wild subyearling chinook from the Yakima Basin, Hanford Reach and Tucannon River have been detected at McNary, John Day, and Bonneville dams in August (Tables 4 – 6).

- PIT-tag subyearling chinook releases from Rock Island and Rocky Reach dams are a combination of hatchery and wild origin fish and provide some of the largest numbers of detections at Lower Columbia dams during August (Tables 4 – 6).

- PIT-tag detection data in the Lower River during August, indicate the presence of subyearling chinook released from Wells, Turtle Rock, Priest Rapids, Ringold, and Lyons Ferry hatcheries (Tables 4 – 6). In addition, PIT-tagged hatchery subyearling chinook from the Yakima Basin are also present during August. Of these hatcheries, Wells and Turtle Rock hatcheries tend to have later release schedules and later passage through the lower Columbia River.

Table 4. PIT tagged summer migrants of Washington origin detected at McNary Dam in August, 1997 – 2003.

Group	Release site	Migration Year	First Half of August	Second Half of August	Total
Wild Sub -Yearling Chinook	Chandler Dam & Yakima R	1998	10	1	11
		1999	37	18	55
		2000	9	2	11
	Hanford Reach	1997	26	5	31
		1999	16	2	18
		2000	424	25	449
		2001	231	52	283
		2002	7		7
	Tucannon R	1998	2		2
		2000	9	1	10
		2001	7	6	13
		2002	3	1	4
Mixture of Wild and Hatchery Sub – Yearling Chinook	Rock Island Dam	1997	330	354	684
		1998	367	99	466
		1999	362	166	528
		2000	483	251	734
		2001	225	163	388
		2002	544	336	880
		2003	161	0	161
	Rocky Reach Dam	1998	88	8	96
		1999	59	7	66
		2000	54	2	56
		2001	52	56	108
		2002	131	10	141
Hatchery Sub – Yearling Chinook[1]	Chandler Dam & Yakima R	1999	1	1	2
	Lyons Ferry H	1999	32	18	50
		2000	2		2
		2002	15	3	18
		2003	2		2
	Priest Rapids H	1997	16	1	17
		1999	5	2	7
		2000	14		14
		2001	8	1	9
	Ringold H	1997	6		6
		1998	2		2
		2000	3		3
		2001	4	2	6
	Turtle Rock H	1997	205	75	280
	Wells H	1997	48	6	54
		1998	16	1	17
		1999	56	6	62
		2000	118	6	124
		2001	88	41	129
		2002	56	6	62

[1] Research PIT tagged fish released for dam-specific survival studies are excluded.

Table 5. PIT tagged summer migrants of Washington origin detected at John Day Dam in August, 1997 – 2003.

Group	Release site	Migration Year	First Half of August	Second Half of August	Total
Wild Sub – Yearling Chinook	Chandler Dam & Yakima R	1998	10		10
		1999	16	8	24
		2000	10		10
	Hanford Reach	1998	4		4
		1999	24	11	35
		2000	196	7	203
		2001	388	173	561
		2002	2	1	3
	Tucannon River	1998	4		4
		2000	4		4
		2001	4	13	17
Mixture of Wild and Hatchery Sub – Yearling Chinook	Chandler Dam & Yakima R	2001	8	2	10
	Rock Island Dam	1997	1	5	6
		1998	142	27	169
		1999	97	65	162
		2000	100	41	141
		2001	85	188	273
		2002	88	123	211
		2003	35	0	35
	Rocky Reach Dam	1998	19	7	26
		1999	4	1	5
		2000	18	0	18
		2001	14	42	56
		2002	33	5	38
Hatchery Sub – Yearling Chinook[1]	Chandler Dam & Yakima R	1999	3		3
		2001	8	7	15
	Lyons Ferry Hatchery	1999	9	6	15
		2000	1		1
		2002	8	2	10
		2003	1		1
	Priest Rapid Hatchery	1998	2		2
		1999	4	3	7
		2000	17		17
		2001	137	39	176
	Ringold Hatchery	1998	12		12
		1999	5	1	6
		2000	2		2
		2001	146	30	176
	Wells Hatchery	1998	6		6
		1999	25	2	27
		2000	44	3	47
		2001	55	68	123
		2002	9	2	11

[1] Research PIT tagged fish released for dam-specific survival studies are excluded.

Table 6. PIT tagged summer migrants of Washington origin detected at Bonneville Dam in August, 1997 - 2003.

Group	Release site	Migration Year	First Half of August	Second Half of August	Total
Wild Sub – Yearling Chinook	Chandler Dam & Yakima R	1998	2	1	3
		1999	2	2	4
	Hanford Reach	1997	4	4	8
		1998	1		1
		1999	3	2	5
		2000	21	2	23
		2001	47	33	80
	Tucannon R	2001		3	3
		2002	1		1
Mixture of Wild and Hatchery Sub – Yearling Chinook	Chandler Dam & Yakima R	2001	2	2	4
	Rock Island Dam	1997	23	19	42
		1998	24	4	28
		1999	30	11	41
		2000	8	3	11
		2001	5	19	24
		2002	8	13	21
		2003	5	0	5
	Rocky Reach Dam	1999	1	0	1
		2000	3	0	3
		2001	1	4	5
		2002	2	3	5
Hatchery Sub – Yearling Chinook[1]	Big White Salmon H [2]	2001		121	121
	Chandler Dam	2001	1	2	3
	Lyons Ferry H	1999	6	1	7
		2002	3		3
	Priest Rapids H	1997	1	1	2
		2000	1		1
		2001	20	4	24
	Ringold H	1998	1	1	2
		1999	1		1
		2001	22	2	24
	Turtle Rock H	1997	14	4	18
	Wells H	1997	2	1	3
		1998	2		2
		1999	12	1	13
		2000	5	1	6
		2001	8	13	21

[1] Research PIT tagged fish released for dam-specific survival studies are excluded.
[2] Big White Salmon H release is thinning release of Carson spring chinook stock on May 2, 2001, at 100 fish per pound.

- Washington Department of Fish and Wildlife estimated Hanford Reach fry production between 13 and 23 million for the years 1999 to 2003. This is larger than the combined hatchery releases of subyearling chinook from all Washington hatcheries above McNary Dam in the Mid-Columbia (Table 7). Because Hanford Reach PIT-tagging is limited to large-early migrant fish, we would expect a greater presence of Hanford Reach fish in the Lower Columbia in August than PIT-tag detections indicate.

Table 7. Estimated Hanford Reach subyearling chinook fry production compared to hatchery releases in the Hanford Reach and Yakima River (in millions).

Emergence Year					
	2003	**2002**	**2001**	**2000**	**1999**
Hanford Fry	23.5	16.5	19.6	13.8	13.4
Hatchery Releases	10.6	8.4	10.8	10.7	7.6

- In 2001, due to low flows, which slowed the migration, we saw greater numbers of detections of yearling chinook, steelhead, coho, and sockeye in August than any other year (Tables 8 – 10).

Table 8. PIT tagged spring migrants of Washington origin detected at McNary Dam in August , 1997 - 2003.

Group	Release site	Migration Year	First Half of August	Second Half of August	Total
Yearling Hatchery Chinook[1]	Leavenworth H	2003	1		1
Coho	Leavenworth H	2000	4	1	5
		2001	1	1	2
	Winthrop H	2000	4	1	5
		2001	5		5

[1] Research PIT tagged fish released for dam-specific survival studies are excluded.

Table 9. PIT tagged spring migrants of Washington origin detected at John Day Dam in August, 1997 – 2003.

Group	Release site	Migration Year	First Half of August	Second Half of August	Total
Wild Yearling Chinook	Yakima R	2001		1	1
Hatchery Yearling Chinook[1]	Easton AP (Yakima)	2001		1	1
	Leavenworth H	2001	1		1
Coho	Leavenworth H	2001	74	34	108
		2003	1		1
	Winthrop H	2000	3	1	4
		2001	17	7	24
	Yakima R	2000	1		1
	Natches R (Yakima)	2001	43	10	53
	Chandler Dam & Yakima R	2001	12	3	15
Sockeye	Rocky Reach Dam	1998		1	1
		2001	1	1	2
Steelhead	Rock Island Dam	2001	2	2	4
	Rocky Reach Dam	2001		1	1
	Wells H	2003	1		1

[1] Research PIT tagged fish released for dam-specific survival studies are excluded.

Table 10. PIT tagged spring migrants of Washington origin detected at Bonneville Dam in August, 1997 – 2003.

Group	Release site	Migration Year	First Half of August	Second Half of August	Total
Hatchery Yearling Chinook[1]	Carson H	2001		1	1
	Rapid River H	1997	1		1
		1999	1		1
Coho	Leavenworth H	2001	6	3	9
	Natches R & Yakima R	2001	6	3	9

[1] Research PIT tagged fish released for dam-specific survival studies are excluded.

- Based on Klickitat River Trap collections from June 1 to September 15, more than 10% of the subyearling chinook trap collections occurred between July 20 and August 20 (Table 11). Fish passing between those dates would likely be passing Bonneville Dam during the month of August. Hatchery releases in the Klickitat Basin exceeded 4 million fish in 2003, so that Klickitat River releases likely make up a sizeable portion of the run passing Bonneville Dam in August.

Table 11. Collection of fall chinook or unknown race chinook from the Klickitat River Trap (river mile 6) comparing collection from July 20 to August 20 to total collection from June 1 to September 15.

Migration Year	Collection June 1 to September 15	Collection July 20 to August 20
2000	17,270	5,625
1999	61,961	6,461
1998	32,428	4,307
1997	14,118	442
1996	14,107	1,507

- Median Travel Time of subyearling chinook from McNary Dam to Bonneville Dam was estimated to average 8.0 days during August for the years 1997 to 2003 (Table 12). These travel times would likely be longer without spill at John Day and The Dalles and Bonneville dams.

Table 12. Travel Times for subyearling chinook detected at McNary Dam in August, 1997 – 2003.

Migration Year	N	Median Travel Time (in days)
2003	7	7.4
2002	62	9.6
2001	49	13.2
2000	9	9.4
1999	40	5.0
1998	84	6.4
1997	40	5.0

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MEMORANDUM

TO: Larry Cassidy, NWPCC

FROM: Michele DeHart, FPC

DATE: December 5, 2003

RE: Historical Fish Passage Data

In response to your request the Fish Passage Center staff summarized the following juvenile fish passage data in the Lower Columbia River for August. This historical passage data was presented to the Regional Forum Implementation Team in October 2003. The following historical data includes several caveats and limitations.

- The following PIT tag mark group data presents a conservative representation of fish presence in the lower Columbia River because the majority of the available PIT tag mark groups are not designed to represent the entire passage distribution of the marked population with the exception of the Smolt Monitoring Program group marked at Rock Island Dam. Nor do the mark groups represent a specific proportion of the population so they can not be used as an indicator of the magnitude of the population passing a particular project.
- The Smolt Monitoring Program historical passage index data is a conservative representation of the migrating population. The passage index is not expanded to a population estimate to account for fish guidance efficiency.
- The presence of fish in the Lower Columbia River is greatly affected by passage conditions and operations at upstream sites. Specifically, the transportation of juvenile fall chinook at the Snake River projects affects the number of fish observed downriver.
- Transportation of fall chinook juveniles is being evaluated. Evaluation of fall chinook transportation is an identified Action (46 page 9-78) in the present Biological Opinion. The effectiveness of transportation of fall chinook will determine how many juveniles are present in the Lower Columbia River. If a spread the risk policy is implemented as the result of the transportation evaluation, the number of fall chinook in the lower Snake and Columbia rivers will greatly increase.

- There is a flow and juvenile survival relationship for fall chinook in the Lower Columbia River and there is a flow/travel time relationship for juvenile fall chinook in the lower Columbia River. This results in a broad range of percent of the population present in August, depending on the flow passage conditions. In higher flows fish move faster through the lower Columbia.
- There are only two mitigation operations provided for summer migrants in the lower Columbia River, flow targets and spill at John Day and The Dalles Dams. The August flow target has only been met in two out of the past 12 years. Spill for fish passage has been provided in eleven of the past twelve years. Spill is the only mitigation measure consistently provided in August for in river migrants in the lower Columbia and lower Snake Rivers.

Percentage of Annual PIT tag detections occurring in August at McNary Dam for subyearling chinook originating in the Snake River and the Mid Columbia River Basins

Table 1

Year	**Snake River Basin**			**Mid-Columbia River Basin**			
	Clearwater River Basin (%)	Snake River (%)	Tucannon River (%)	Yakima River (%)	Hanford** Reach (%)	Rock* Island Dam (%)	Wells Hatchery (%)
1998	28.6	18.7	1.2	3.3	0.0	53.1	1.8
1999	(0 tags)	42.3	No tags	30.7	2.4	64.9	14.1
2000	(0 tags)	8.8	6.9	2.9	16.3	64.0	20.3
2001	(0 tags)	33.4	33.3	0.0	17.2	71.7	37.7
2002	(0 tags)	12.7	2.0	No tags	No tags	57.2	5.1
2003	3 tags	12.5	No tags	0.0	0.0	28.6	1.0

*** Of the PIT tag mark groups included in this table only the Rock Island group is designed to cover the entire passage distribution. None of these mark groups is designed to mark a specific proportion of the specific population.**

**** This mark group only represents the early portion of the migration. There is no tag data for the middle and late portion of this population**

Percentage of annual PIT tag detections occurring during the first and last two weeks of August at McNary Dam for subyearling chinook originating in the Snake River and Mid-Columbia River basins.

Table 2

Year	August Period	Snake River Basin			Mid-Columbia River Basin			
		Clearwater River (%)	Mainstem Snake R. (%)	Tucannon River (%)	Yakima River (%)	Hanford Reach (%)**	Rock Island Dam (%) *	Wells Hatchery (%)
1998	8/1-15	14.3	15.2	1.2	3.0	0.0	41.9	1.7
	8/16-31	14.3	3.5	0.0	0.3	0.0	11.2	0.1
1999	8/1-15	(0 fish)	32.2	No tags	21.1	2.2	45.4	12.8
	8/16-31		10.1		9.6	0.2	19.5	1.3
2000	8/1-15	(0 fish)	5.6	6.2	2.4	15.3	41.8	19.3
	8/16-31		3.2	0.7	0.5	1.0	22.2	1.0
2001	8/1-15	(0 fish)	27.8	17.9	0.0	14.1	41.8	25.7
	8/16-31		5.6	15.4	0.0	3.1	29.9	12.0
2002	8/1-15	(0 fish)	11.4	1.5	No tags	No tags	35.1	4.6
	8/16-31		1.3	0.5			22.1	0.5
2003	8/1-15	(3 fish)	8.0	No tags	No tags	0.0	28.6	1.0
	8/16-31		4.5			0.0	0.0	0.0

Of the PIT tag mark groups included in this table only the Rock Island group is designed to cover the entire passage distribution. None of these mark groups is designed to mark a specific proportion of the specific population.
**** This mark group only represents the early portion of the migration. There is no tag data for the middle and late portion of this population**

Percentage of Subyearling Wild Chinook Migrants at John Day Dam During August

Table 3

Year	Yakima River (%)	Hanford Reach (%)
1998	19.6	2.3
1999	20.0	9.2
2000	20.8	44.7
2001	4.5	66.7

Passage Index for sub-yearling fall chinook at McNary and John Day Dams in the first and last two weeks of August, 1992-2003**

Table 4

MCN and JDA Passage Index for Fall Chinook for the month of August 1992 to 2003

Year	Dates	MCN Passage Index	JDA Passage Index
1992	08/01 - 08/15	85,650	134,317
	08/16 - 08/31	29,160	38,761
1993	08/01 - 08/15	396,676	129,234
	08/16 - 08/31	89,719	127,940
1994	08/01 - 08/15	47,754	58,769
	08/16 - 08/31	26,981	36,605
1995	08/01 - 08/15	121,050	38,164
	08/16 - 08/31	97,564	24,518
1996	08/01 - 08/15	740,107	118,069
	08/16 - 08/31	250,774	113,603
1997*	08/01 - 08/15	1,227,691	60,074
	08/16 - 08/31	404,604	39,213
1998	08/01 - 08/15	324,636	137,129
	08/16 - 08/31	107,089	21,753
1999	08/01 - 08/15	461,696	154,966
	08/16 - 08/31	292,700	91,785
2000	08/01 - 08/15	724,574	178,725
	08/16 - 08/31	188,500	32,090
2001	08/01 - 08/15	489,174	808,950
	08/16 - 08/31	224,016	317,575
2002	08/01 - 08/15	478,291	87,228
	08/16 - 08/31	341,070	93,452
2003	08/01 - 08/15	588,965	195,302
	08/16 - 08/31	86,479	29,395

***Through 1997 sampling at John Day utilized an airlift collector in unit 3. Beginning in 1998 the bypass sampler at John Day was operational**

**** The passage index is a <u>conservative</u> index of passage, it does not account for fish guidance efficiency (FGE) the efficiency of the screen guidance systems. FGE for fall chinook is estimated at approximately 32%. The actual population passing the project is larger than the passage index.**

Expected impact of eliminating spill for fish passage in August

Several research projects are being conducted on the passage and migration characteristics of fall chinook. The research questions being pursued include the effectiveness of the present smolt transportation program for fall chinook. Research to date shows that there is a significant flow and juvenile survival and flow travel time relationship for fall chinook in the lower Columbia River. Available data indicate that there will be direct and indirect impacts of eliminating summer spill. The direct impact is that a large proportion (over 40%) of fish approaching each project will pass through turbine units increasing the project mortality. FGE estimates vary by project, the NMFS BIOP lists estimates at McNary of .62, John Day .32, and Bonneville .28. Recent turbine survival estimates for McNary and Ice Harbor Dam are .77 and .90 respectively.

Potential Indirect impacts of decreasing spill include, increase migration delay in the forebay, which increases stress, exposure to high water temperatures, and exposure to predators. Tailrace mortality may increase in reduced spill conditions and bypass outfall mortality may increase as predators are not dispersed by spill. Research conducted in the Snake River indicates that in low summer flow conditions such as occurs in August, considerable forebay delay can occur. Elimination of spill for fish passage in the Columbia and Snake River can reasonably be expected to exacerbate forebay delay of migrating fall chinook. Water temperature standards are often violated in the month of August. Prolonged exposure to higher water temperatures can increase the incidence of disease.

Conclusions – Passage Data

- **The historic passage data indicates that significant proportion of the summer migration is present in the lower Columbia River in August.**
- **The same data shows that the proportion of passage present in August varies from year to year.**
- **The data indicates that mid-Columbia stocks in particular Hanford Reach fall chinook will be impacted by decrease in summer spill. The average 95% passage date at McNary Dam (1997-2003) of unclipped sub yearling fall chinook marked at Rock Island Dam is September 16 (at McNary). Travel time through the John Day pool at low flows places these fish in the lower Columbia through September. The present August 31 end date of summer spill does not provide protection to 95% of the mid-Columbia fall chinook passage distribution. This shows a substantial portion of the migration is present in the lower Columbia River in August.**
- **The expected fish benefits of the Mid-Columbia HCP will probably be decreased if Lower Columbia River spill for fish passage in August is decreased or eliminated.**
- **The smolt transportation program upstream largely affects the presence of juvenile fall chinook in the lower Columbia and lower Snake Rivers. The effectiveness of transportation of fall chinook juveniles is presently being evaluated. If a "spread-the-risk" policy for transportation of fall chinook is implemented in the future, the proportion of fall chinook present in the lower Columbia River and the lower Snake River will increase.**
- **Any consideration of modification of spill for fish passage for summer migrants is premature prior to the actual determination of the benefits of the fall chinook transportation program.**

Conclusions-Offsets

- **The question of offsets to mitigate for the adverse impact on fall chinook survival of the Bonneville Power Administration proposal to reduce or eliminate spill in August is problematic. All viable offsets have already been included in the Biological Opinion. The Opinion was defined as the "aggressive non-breech " approach. The data indicates that migration time decreases in years of higher flow resulting in smaller proportions of the migration present in the lower Columbia in August. Higher water flows and higher water velocities would be an effective offset, which is not already included in the Biological Opinion.**

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MEMORANDUM

TO: Jim Ruff, NOAA Fisheries

FROM: Michele DeHart

DATE: November 7, 2003

RE: Lower Monumental Historic Passage Distribution

In response to your request at the November 6, 2003 meeting of the Implementation Team, the FPC staff summarized the historical passage distribution at Lower Monumental. The first of the two attached plots shows run-at-large timing and the second plot shows timing of the fall chinook PIT tags from the USFWS Snake River study (William Connor). These plots illustrate the same points made in the larger historical review presented at the Implementation Team on October 23, 2003.

- There are fewer years of historical data at Lower Monumental Dam. The new bypass facility at Lower Monumental Dam became operational May 3, 1993 and PIT tag detection capabilities became operational in 1994, so there are fewer years of PIT Tag recaptures at Lower Monumental.

- Lyons Ferry Hatchery is approximately 17 miles upstream of Lower Monumental Dam. The attached plot of the run-at-large at Lower Monumental Dam illustrates the effect of hatchery releases, particularly those just upstream of the sampling site, on the run-at-large passage distribution. The on-site hatchery release dates are annotated on the run-at-large passage distribution.

- On-site releases of approximately 200,000 subyearling chinook have occurred from Lyons Ferry Hatchery on 6/24/93, 5/26/00, 6/24/02, and 6/6/03. Of the four years with the earliest 95% passage dates, three of those years had on-site hatchery releases.

- The average travel time over the years of historic data is five days between Lower Monumental and Ice Harbor projects.

- In three of the seven years without an on-site release of subyearling fall chinook from Lyons Ferry Hatchery, the date of 95% passage at Lower Monumental Dam of the run-at-large subyearling chinook (measured by the cumulative passage index) occurred after the August 31 end of spill at Ice Harbor Dam.

- In these same three years (1994, 1995, and 1997), the date of 95% passage at Lower Monumental Dam for subyearling chinook PIT tagged in the Snake River by USFWS also occurred after the August 31 end of spill at Ice Harbor Dam

- In a total of four of the ten years of PIT tag detection capability at Lower Monumental Dam, the date of 95% passage of for subyearling chinook PIT tagged in the Snake River by USFWS exceeded the August 31 end of spill at Ice Harbor Dam.

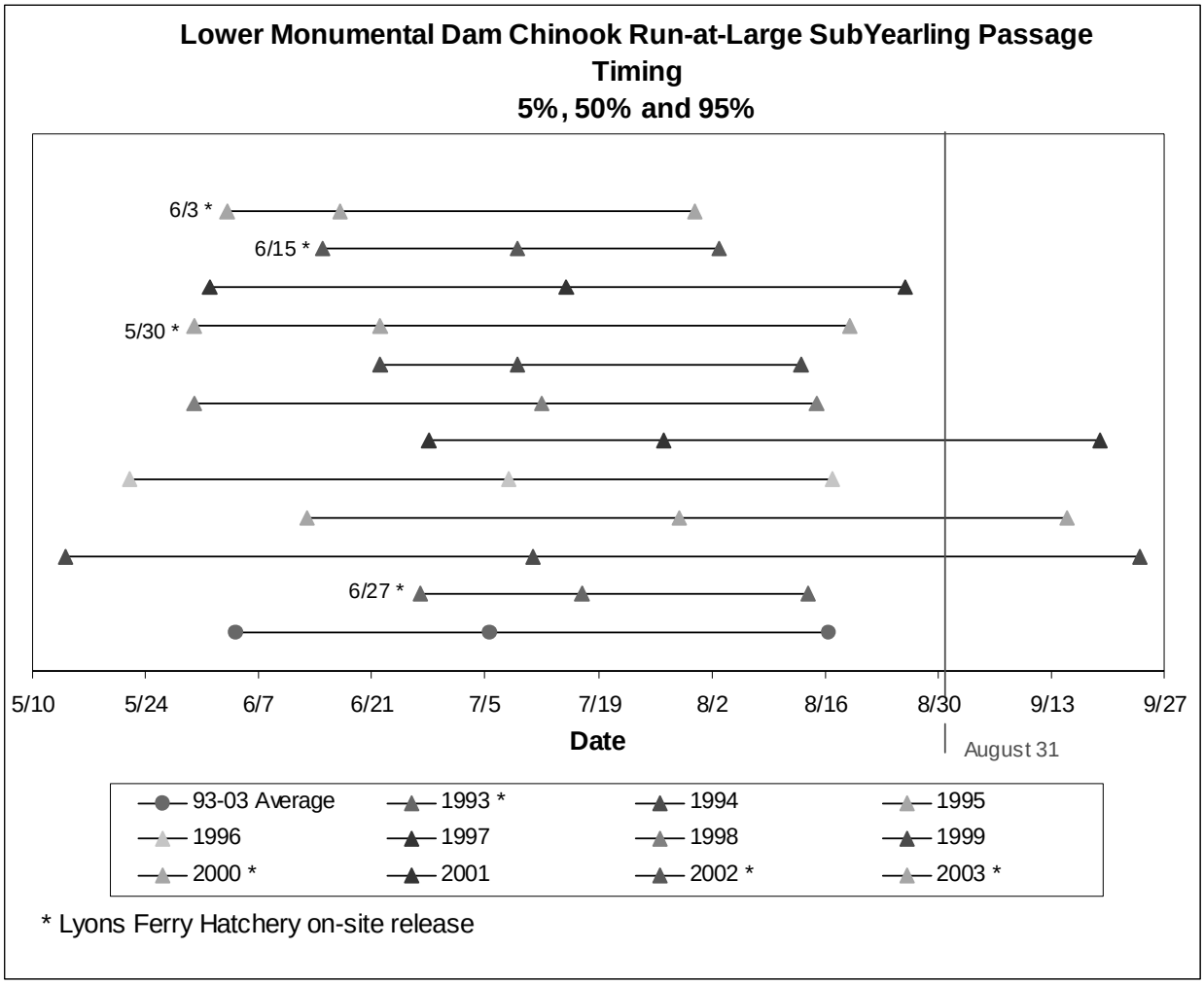
- Three of these four years have occurred before 1998 when Lyons Ferry began its program of production releases of unclipped hatchery supplementation fish from acclimation ponds in the Snake River above locations where USFWS researchers are targeting wild subyearling chinook for PIT tagging.

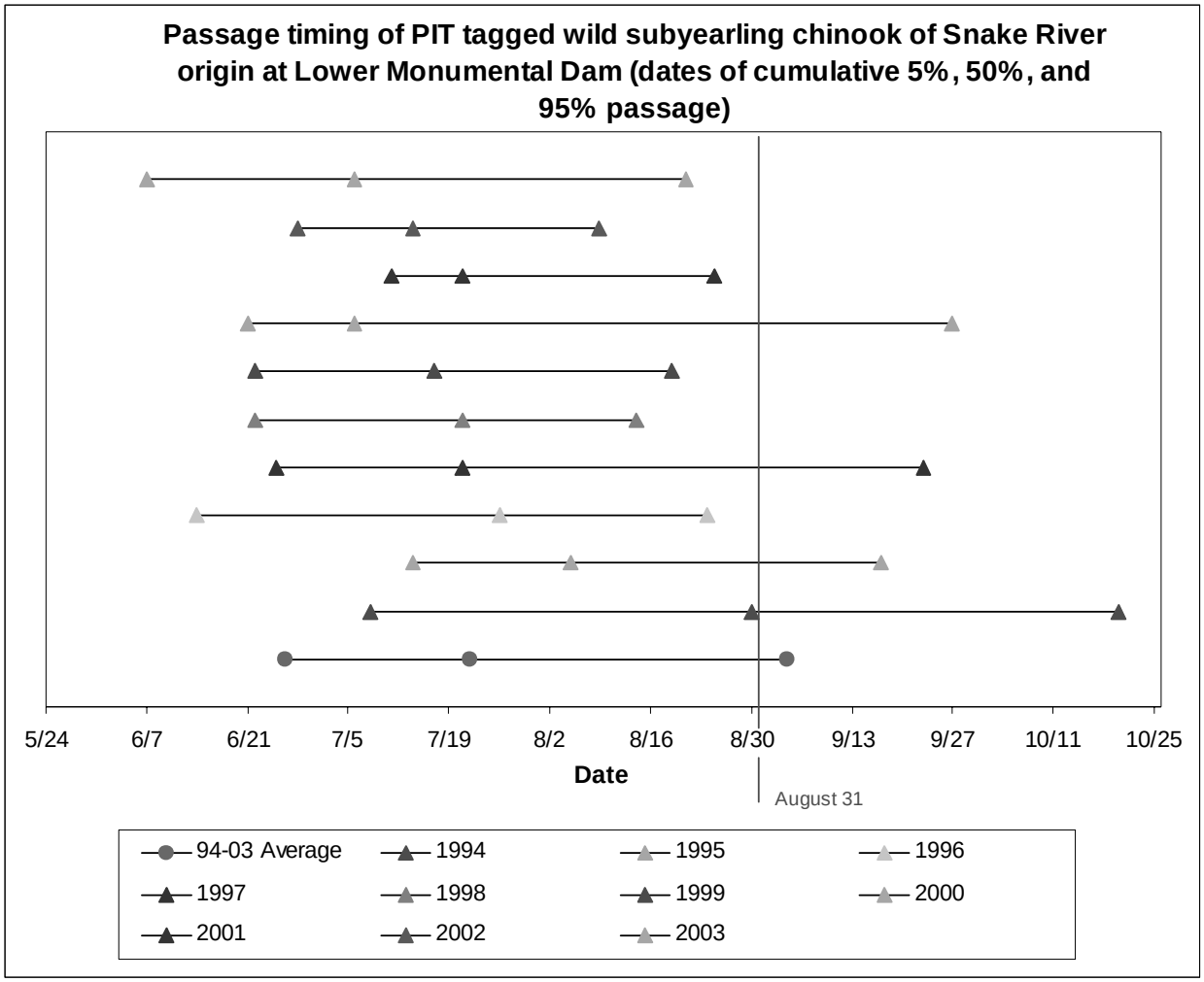
- Unclipped supplementation fish may be inadvertently PIT tagged along with the targeted wild subyearling chinook in 1998 and later years. Since supplementation fish released in the Snake River tend to have earlier passage timing, any inclusion of these fish with wild subyearling chinook in the PIT tagging sample could bias the projected date of 95% passage at Lower Monumental Dam earlier than actually occurs for the wild stocks.

- The following tables are the historic percent passage dates at Lower Monumental run-at-large fall chinook and PIT tagged wild Snake River fall chinook at Lower Monumental and Ice Harbor based on an average travel time of five days.

	Lower Monumental fall chinook run-at-large			Ice Harbor
	5 %	**50%**	**95%**	**95 %**
1993-2003	6/4	7/5	8/16	8/21
1993	6/27	7/17	8/14	8/19
1994	5/14	7/11	9/24	9/29
1995	6/13	7/29	9/15	9/20
1996	5/22	7/8	8/17	8/22
1997	6/28	7/27	9/19	9/24
1998	5/30	7/12	8/15	8/20
1999	6/22	7/9	8/13	8/18
2000	5/30	6/22	8/19	8/24
2001	6/1	7/15	8/26	8/30
2002	6/15	7/9	8/3	8/8
2003	6/3	6/17	7/31	8/5

	Lower Monumental Snake River wild fall chinook pit tags			Ice Harbor
	5 %	**50%**	**95%**	**95 %**
1993-2003	6/26	7/22	9/4	9/9
1994	7/8	8/30	10/20	10/25
1995	7/14	8/5	9/17	9/24
1996	6/14	7/26	8/24	8/29
1997	6/25	7/21	9/23	9/28
1998	6/22	7/21	8/14	8/19
1999	6/22	7/17	8/19	8/24
2000	6/21	7/6	9/27	10/2
2001	7/11	7/21	8/25	8/30
2002	6/28	7/14	8/9	8/14
2003	6/7	7/6	8/21	8/26


Lower Monumental Dam Chinook Run-at-Large SubYearling Passage Timing
5%, 50% and 95%
6/3 *
6/15 *
5/30 *
6/27 *
5/10
5/24
6/7
6/21
7/5
7/19
8/2
8/16
8/30
9/13
9/27
Date
August 31
93-03 Average
1993 *
1994
1995
1996
1997
1998
1999
2000 *
2001
2002 *
2003 *
* Lyons Ferry Hatchery on-site release


Passage timing of PIT tagged wild subyearling chinook of Snake River origin at Lower Monumental Dam (dates of cumulative 5%, 50%, and 95% passage)
5/24
6/7
6/21
7/5
7/19
8/2
8/16
8/30
9/13
9/27
10/11
10/25
Date
August 31
94-03 Average
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003

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MEMORANDUM

TO: Jim Ruff, NOAA Fisheries

FROM: Michele DeHart, FPC

DATE: October 23, 2003

RE: Historical Review of Fish Passage Data

In response to your request, as chairperson of the Implementation Team, the Fish Passage Center staff prepared a summary of fish passage data for presentation to the Implementation Team. The power point presentation slides are attached. The presentation was prepared and presented to assist the Implementation Team in their consideration of two different approaches to management of spill for fish passage. At the present time, the spill for fish passage, as defined in the NMFS 2000 Biological Opinion, is managed according to pre-set planning dates. The issue of using a different management approach was elevated last summer through the Regional Forum process from the Technical Management Team to the Implementation Team, and then to the Executive Committee, by Bonneville Power Administration (BPA) representatives. This issue was raised by BPA as a result of the early migration timing in the summer of 2003, which prompted BPA to pursue an earlier end of spill than the BiOp's August 31 planning date. The request by the Bonneville Power Administration to end spill prior to the BIOP planning date was considered through the regional process. The Technical Management Team, the Implementation Team and the Executive Committee considered the BPA proposal. Due to the lack of regional consensus spill for fish passage was implemented according to the Biological Opinion planning dates. The Executive Committee then sent the attached memorandum to the Implementation Team. As a result, the Implementation Team then began their review of management options for spill for fish passage by requesting the data review.

The FPC staff collected and summarized the Smolt Monitoring Program juvenile fish passage data for 1985 through 2003. In addition, the FPC staff collected and summarized PIT-tag mark data that provided additional insight into passage timing of specific stocks. These efforts resulted in the data summary plots included in the attached power point presentation. As the passage data was summarized, several issues became obvious regarding the two management approaches being considered by the Implementation Team. These issues are included in the power point slides and explained in additional detail in the following discussion.

Advantages and Disadvantages

The different approaches to spill management have both advantages and disadvantages. The significant advantage of utilizing planning dates is the certainty factor for planning hydrosystem operations and power marketing. In addition, when the completed data summaries clearly showed that, particularly for the summer migration, in most years the August 31 planning date results in curtailing spill for fish passage earlier than what would occur utilizing a 95% cumulative passage date. The most significant disadvantage of using the percent passage date approach, other than the uncertainty in planning, is the additional investment required to increase the smolt marking and sampling program at a time when funding is critically limited. From a fish protection standpoint for run-at-large summer migrants, on average, the BiOp's planning date for the end of spill (August 31) is reasonably close to the 95% passage date at Lower Granite Dam (September 3). However, specific stocks may receive less protection. In addition, the August 31 end of spill date does not incorporate adequate travel time of summer migrants to Ice Harbor Dam where summer spill actually takes place. With an average travel time of 15 days from Lower Granite to Ice Harbor Dam, only the passage distribution through August 15 at Lower Granite Dam is afforded spill protection at Ice Harbor Dam. The percent passage dates at Lower Monumental plus travel time to Ice Harbor were also considered relative to spill management at Ice Harbor. Pit tag detection at Lower Monumental Dam was not in place until 1994, resulting in fewer years of historical data. However, for wild fall chinook PIT tags the results were similar when considering Lower Monumental plus an average travel time of five days to Ice Harbor Dam. In four of the ten years the 95% passage date occurred after August 31.

Changing Management Approaches

Managing spill for a specific fish passage percentage relative to planning dates will require an increase in specific index group marking or sampling. If the decision is made to change to a percent passage date approach, significant work needs to be done in design of an adequate smolt sampling program and additional index group marking. This will require regional consultation, peer review of an expanded smolt monitoring program, and additional funding. Based upon our knowledge and experience in developing regional consensus on fish marking and monitoring programs, and then implementing those programs, i.e., funding and marking, we do not believe it is practically feasible to attempt to implement a new spill management approach for the 2004 passage season.

Attachment:
August 26, 2003

Statement of Corps of Engineers, Bonneville Power Administration, NOAA Fisheries
Re: Continuation of Summer Spill for Fish Passage in the Columbia and Snake Rivers

The regional heads of the Corps of Engineers (General William Grisoli), Bonneville Power Administration (Steve Wright) and NOAA Fisheries (Bob Lohn) said today that spill at Federal Columbia Basin dams to aid juvenile salmon migrants will continue until Aug. 31 consistent with the planning date identified in the 2000 NOAA Fisheries Biological Opinion on operation of the Federal Columbia River Power System. But the agency heads said they believe changes must be implemented before next summer to more clearly allow alternative measures that could accomplish the biological benefit associated with spill at a reduced cost.

Currently the river system is operated consistent with a 2000 biological opinion that provides recommendations for operating the system to improve survival of salmon and steelhead listed as threatened or endangered. The opinion sets a planning date for terminating the summer spill program on August 31, although the exact date is subject to in-season management by the Technical Management Team. However, the biological opinion provides little guidance for determining when to end spill in a particular year.

The federal agency heads noted that the summer spill program, based on available evidence, appears to be excessively costly relative to the biological benefit provided. An analysis performed by the Northwest Power and Conservation Council concludes that summer spill in August is likely to result in an increase in the number of 5 adult listed Snake River fall chinook, while non-listed adult upper Columbia River fall chinook are expected to increase by approximately 2400. Estimates by some of the region's Tribes indicate potentially higher numbers of survival as a result of the spill program. Spill this year is reducing revenues for the Bonneville Power Administration by approximately $1 million a day in August. The federal agency heads are concerned that under any of the survival estimates the costs appear exceedingly high relative to the biological benefit.

The federal agencies attempted to work with States and Tribes to identify alternative measures that would achieve similar or greater biological benefits. However, regional consensus could not be reached. Following considerable review, the federal agencies concluded there was an inadequate basis to cease spill this year at a time other than the August 31 planning date. The federal agencies determined to continue spill through August 31.

The agency heads stated their goal is to have a method in place by next year to help ensure that biological benefits are met in the most cost effective manner available. The agency heads concluded that they have a responsibility to the region to devise an approach that is less costly while maintaining the ability to achieve the biological objectives for salmon and steelhead, and will work with all interested parties in the region to accomplish this objective.

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MEMORANDUM

TO: FPAC

FROM: Michele DeHart

DATE: August 18, 2003

RE: Methods for estimating 95%

The FPC staff received the proposed methodology for estimating 95% passage from NOAA fisheries this afternoon. We reviewed and discussed the methodology within the context of the proposed management application. The implementation of a passage percentage approach to spill management has implications for the future that should be considered prior to adoption. The management of hydrosystem protection measures on the basis of percentage passage conflicts with the fundamental objective of other aspects of fish management such as management of fisheries. Management of sport, commercial and tribal fisheries is based upon protection of weakest stocks. Unless the percent passage concept is expanded to include percentage of weaker stocks it will weight protection towards strongest stocks and conflict with the basis of weak stock management. We offer the following comments for your consideration and discussion.

The passage percentage criteria should be carefully considered establishing a precedent for management. We reviewed the protocol and the baseline data. The year at each monitored dam with the lowest daily passage index proportion on the 95% passage date is used as a baseline from which to make a prediction of 95% passage dates for other years. However, even within the year that was used as the baseline, in 4 of 5 monitored dams the date of actual 95% passage and predicted 95% passage differed by a week or more (in two years it was earlier and in the other two years it was later, not unlike tossing a coin).

The proposal represents a modification or divergence from the management approach in the NOAA Biological Opinion. The planning date concept of management, which was incorporated into the Biological Opinion, represents a compromise. In past years spill has been shut off on August 31. This "planning date" management concept did not consider the travel time for fish between Lower Granite and Ice Harbor or the lower Columbia River. The memorandum from FPC dated August 18, shows that in most recent years the 95% passage date for the run-at-large extends into September and October, well beyond the planning date. The planning date management concept precluded the extension of spill to protect these migrants. If the 95% passage date management approach is implemented instead of the "planning date" concept then most of the time spill should be extended into September and October and fish travel time to the lower Snake River and Columbia River projects should be included in the determination of spill dates. In other words the effect of a change from planning date would be to increase the period of spill. It would appear inconsistent and illogical to only implement the 95% passage criteria to shorten the spill period when applicable.

The 95% passage management criteria are not adequately defined in terms of management objectives. Sport and commercial fisheries are managed in terms of stock specific stock status. Fisheries are managed on the basis of protection of weakest stocks. Sport, tribal and commercial fisheries are regulated on the basis of weakest stock protection. Managing fish passage mitigation on the basis of strongest stock is inconsistent. The question is 95% of what. If 95% of passage-at-large is the objective; passage protection will be weighted toward the large hatchery and supplementation production, which are unlisted stocks. Smaller populations, which offer genetic diversity and often comprise the tails of the passage distribution, will not be protected. 95% passage based solely on the passage index will weight protection to the large hatchery releases.

95% passage based upon the passage index alone without consideration of weaker stocks will create an illogical management scenario. Weighting towards large hatchery releases could create a situation in which the 95% passage point is reached at downstream sites prior to upstream sites because of hatchery release schedules and timing. This could result in 95% passage being reached at downstream sites prior to upstream sites creating a situation in which less protection is provided to upstream originating stocks. As an example Wells or Lower Granite stocks could reach 95% on later dates than Bonneville and McNary, and so not have passage protection at lower river sites.

The 95% passage criteria should also include a not less than X% of specific stocks to avoid weighting towards large hatchery releases at the expense of wild stocks and wild production. One of the primary criticisms of the water budget volume management concept was that protection was weighted towards large hatchery releases. The tails of the passage distribution were not provided with protection. The state of Idaho, NOAA and the Tribes have supported the shift of fish flow augmentation into September to provide protection to late migrating fish from the Clearwater River. Eliminating spill prior to the planning date conflicts with this plan. Extending spill to correlate with the provision of flows should be discussed.

If this type of criteria is established, the Smolt Monitoring Program and tributary programs will have to be modified to include population marking on each stock. At the present time there are inadequate stock specific mark groups to allow spill passage management on the basis of 95% of anything. Some research mark groups are available but they are limited in their use because they may not represent the entire population distribution. If the goal is to protect the late listed wild sub-yearling chinook runs originating above Lower Granite Dam then the basis for any passage distribution must be made on these wild listed fish. In order to obtain a more complete picture of the out-migration timing of these wild listed stocks, there will need to be a greater effort made to PIT tag representative fish from these stocks and track their out-migration progress.

The 95% point of passage occurs earliest in years when the flows are low and the passage distribution is truncated. Eliminating spill protection early in these circumstances would exacerbate a poor passage situation. Spill for fish passage in the summer period is a high priority for testing in the Snake River. Spill may be extremely important to summer migrants in lower than target flow conditions. Establishing a protocol for the purpose of truncating spill is premature.

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MEMORANDUM

TO: FPAC

FROM: Michele DeHart

DATE: August 18, 2003

RE: Update status of sub-yearling chinook passage and the determination of a 95% passage date.

We are providing the following brief points updating subyearling chinook downstream passage on the basis of monitoring information and a discussion of the probability of accurately predicting a 95% passage date.

- The concept of protecting 95% of the juvenile fish run is difficult to quantify. Fish pass through the hydrosystem year round, however, passage increases during the time noted as "in-season". Any 95% passage date based on migration in-season already excludes those fish that don't pass during "prime-time" passage.

- In the 1980's and early 1990's mitigation for the hydrosystem development was often based on protecting the middle 80% of the run. This middle 80% was dominated by large numbers of fish released from hatcheries that all migrated around the same time period causing a peaked or "bell" shaped curve. Fish managers argued that managing in this fashion afforded little, or no, protection to the tails of the migration (either early or late). Individual stocks of wild fish could display either an early or late migration that occurred completely outside of the middle 80% passage dates and consequently not be afforded any protection measures.

- To address this issue the region began looking at the migration in more detail to include migrating fish in the tails under the umbrella of protection. Reference and planning based on the 95% date of passage became more common. While it seems intuitive that 95% dates would include the tails of the run, the actual management based on available data may in fact mislead managers into thinking a majority of fish are being protected. For example, the Mid Columbia projects are operating on the basis of spilling until the 95% passage date. Based on an in-season methodology for predicting the 95% passage date, the 2003 spill program has ended at Rocky Reach, Rock Island and Wanapum dams and will end soon at Priest Rapids Dam. However, spill is scheduled to continue at Wells Dam until August 26 based on the historic passage 95% date (21 years of hydroacoustic data). Since this project is above all the other projects it is apparent that 95% passage of the upper Mid Columbia stocks will not be protected by spill at the lower Mid Columbia projects. The point here is that the intent of the 95% passage date was to protect the genetic integrity of the tails of the migration. However, by managing on a project-by-project basis and using the 95% passage of the run-at-large we may be managing against the part of the population that initially caused managers to extend protection to the 95% passage date.

Snake River

- The dates in the Biological Opinion were not based on an actual 95% passage date, but were negotiated based on the impact to the hydropower system. Historic data shows the actual 95% passage dates extend into the fall. By choosing August 31 as the end of protection a factor of compromise is already incorporated into the protection period.

- Present in-season passage distributions of subyearling migrants at Lower Granite Dam are difficult to interpret. Predictions based on the run-at-large have been heavily influenced by the addition of hatchery supplementation fish. These fish are relatively large at time of release and pass through the river relatively quickly. The numbers (over a million in past years) dwarf the wild population, which numbers in the thousands. The faster and therefore earlier migration of the supplementation fish causes the passage distribution to skew earlier and is likely completed earlier than the wild fish migration.

- In addition, the run-at-large 95% passage date appears to be getting earlier as the years progress. This is an artifact of the large numbers of supplementation fish that are being added to the system. (Passage indices at Lower Granite Dam ranged from a low of 18,500 in 1996 to over 1.1 million predicted for 2003). These supplementation fish are migrating earlier and in large numbers, which skews the distribution to look like it is now occurring earlier.

Table 1. The 95% passage date at Lower Granite Dam for the run at large (hatchery and wild combined) and the wild PIT tagged fish.

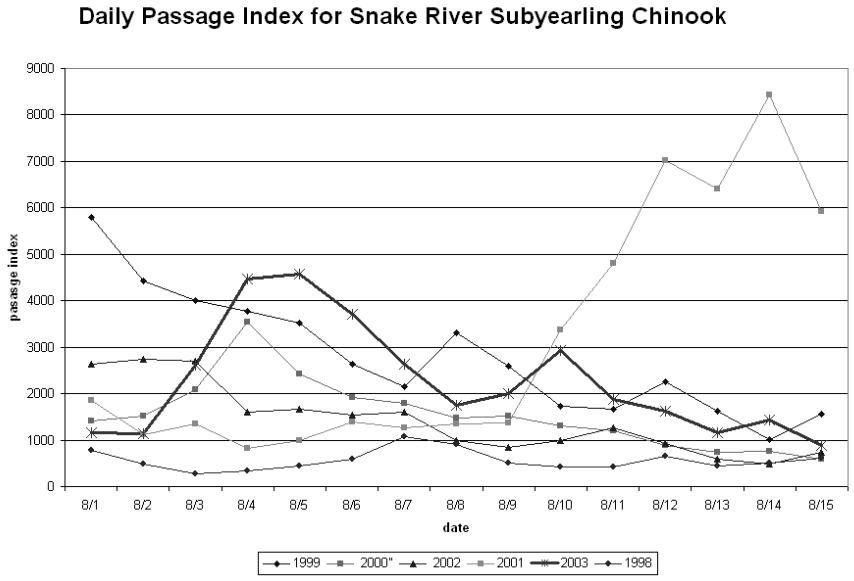
YEAR	95% Passage Date Run at Large	95% Passage Date Wild PIT Tagged Fish
1995	Oct 11	Sept 14*
1996	Sept 20	Aug 27
1997	Sept 23	Sept 14
1998	Sept 26	Aug 15
1999	Sept 22	Aug 15
2000	Sept 08	Sept 14*
2001	Aug 16	Aug 18
2002	Aug 31	July 28

*Last date category actual date may be later

- Reliance on passage timing as determined on the basis of wild PIT tag recoveries also has limitations. Marking of these designated wild fall chinook is limited by two factors, the first is size at time of marking and the second is availability of fish to mark. As fish grow and mature they move from near shore areas and decrease in availability to beach seining techniques used for collection. Consequently, it is difficult to determine the portion of the run that is represented by the wild PIT tagged fall chinook. Likely, because of the accessibility of early fish the PIT tagged distribution is skewed early. This is consistent with what is observed when the PIT tagged subpopulation is compared to the run-at-large timing at Lower Granite Dam (Table 1). (Also, this discrepancy is recognized and documented on the DART in season forecast metadata. Historical data shows that on average the 95% point of passage for the run-at-large is on average 27 days later than the wild Snake River PIT tagged group.)

- The sub-yearling chinook passage index at Lower Granite Dam is averaging 2,261 fish per day, for the past 15 days. For the past three days the passage index at Lower Granite has maintained near 2,000 fish per day. This is a substantial number of migrants and represents about 2.5% of the migration to-date. With an average estimated travel time of 17 days (based on the wild subyearling travel time estimates observed thus far in 2003) the fish have begun arriving and will continue to pass Ice Harbor Dam throughout the next several weeks.

- The 2003 migration appeared to initially migrate earlier than it has in the last several years. However, the environmental conditions in 2003 (flow that are, and have been, much below the Biological Opinion flow targets) have likely caused the migration to tail for a longer period of time. The daily passage index at Lower Granite Dam for subyearling chinook is not any different than observed in past years' for passage during this time period.



- Based upon historical travel time data, at the present flows in the Snake River, wild fall chinook passing Lower Granite Dam are expected to have a 19-day travel time to McNary Dam and an additional 5-day travel time to below Bonneville.

- Small numbers of PIT tagged wild and hatchery chinook continue to be detected at Lower Granite Dam, from the Nez Perce hatchery, Pittsburgh Landing, and release groups from Lyons Ferry.

- Based on PIT-tags of wild subyearlings in the Clearwater River, a large portion of that population is still rearing above Lower Granite Dam. A total of 663 subyearling chinook were marked in the Clearwater River in 2003. Of those fish only 15 have been detected at Lower Granite or Little Goose dams.

- Much effort has been made this year to protect small numbers of late migrating fall chinook from the Clearwater drainage. Flow augmentation protection for fall chinook migrants passing during the month of August was decreased in order to protect these fish. It is inconsistent to hold water in reserve for these fish in September, while at the same time terminating spill mitigation in the lower Snake River.

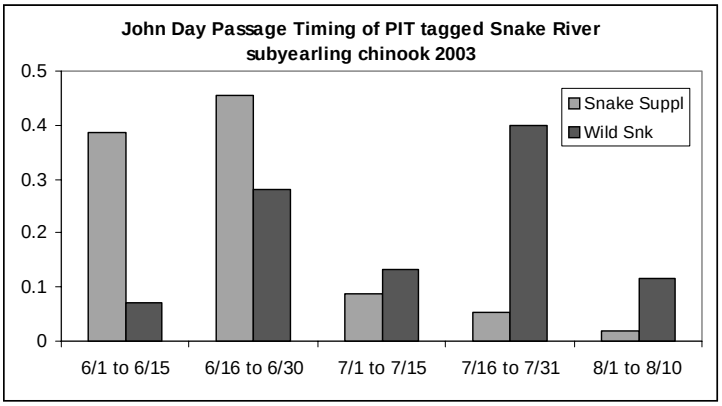
Lower Columbia River

- The daily passage index at McNary Dam during the first two weeks of August has averaged approximately 41,000 subyearling chinook smolts per day. With no spill and assuming around 50% FGE at this time of the season, the population of smolts (PIT tagged and non-tagged) is projected to be approximately 82,000 wild and hatchery smolts per day. The estimated number of hatchery subyearling chinook arriving at McNary Dam during this time period (also assuming a 50% FGE) is projected to be approximately 1,713 smolts per day (based on expanding production fish PIT tag detections at McNary Dam by the proportion of PIT tags released with production). During the first two weeks of August the hatchery subyearling chinook appear to be accounting for only 2% of the subyearling chinook arriving at McNary Dam, leaving approximately 98% of the subyearling chinook smolts arriving at McNary Dam after August 1 to be of wild origin.

- The wild subyearling chinook arriving at McNary Dam in August are most likely of Hanford reach origin. Of the 2,975 Hanford reach wild chinook PIT tagged on May 27, 2003, a total of 525 have been detected at McNary Dam with 99% detected by mid-July, and none detected in August. However, given such limited PIT tagging in 2003 on a single day, it may be premature to assume that the entire Hanford reach population arrived at McNary Dam before August this year. PIT tag data in prior years had shown Hanford reach subyearling chinook continuing to migrate past McNary Dam in August. The 90% passage date at McNary Dam for PIT tagged wild Hanford reach fall chinook was at the end of the first week of August in 1991, within the third week of July in 1992, and near the end of July in 1993 (Figure 7 in the 1993 McNary Dam and Lower Monumental Dam Smolt Monitoring Program annual report by Paul Wagner, WDFW, prepared for BPA Project No. 87-127). In two of these three years, at least 10% of the PIT tagged smolts from the Hanford reach run were arriving McNary Dam after August 1st.

- The breakdown of the daily rate of arrival of hatchery subyearling chinook at McNary Dam during the first two weeks of August is as follows (assuming a 50% FGE): approximately 609/d Big Canyon Creek AP (Clearwater R); 403/d Pittsburg Landing AP (Snake R); 355/d Nez Perce Tribal Hatchery (Clearwater R); 158/d Wells Hatchery (mid-Columbia R); 89/d Lapwai AP (Clearwater R); 52/d Captain Johns Rapids AP (Snake R); 38/d Lyons Ferry Hatchery (Snake R); and 9/d Oxbow Hatchery's Hells Canyon release (Snake R). No additional smolts from Priest Rapids Hatchery (mid-Columbia R) and Prosser AP (Yakima R) appear to be passing McNary Dam in August, although it is unknown if any subyearling chinook from mid-Columbia River releases at Turtle Rock, Ringold Hatchery, or the Little White Salmon River Hatchery release at Prosser AP in 2003 because no PIT tags were released with these production releases.

- The Plot below shows passage timing at John Day Dam, of Snake River wild subyearling chinook along with timing for pit-tagged supplementation fish. The data confirms that a significant portion of the wild run is still in-migration, since 11% of the run-to-date is passing in August. Also, it shows the earlier timing of the supplementation fish.



- Most subyearlings passing through the lower river are of mid-Columbia origin. Historical travel time data indicates that at the present flows these fall chinook can be expected to travel quite slowly through the reach from McNary to John Day Dam. Our analysis shows that median travel time from McNary to John Day was 21.3 days for Hanford Reach subyearling chinook when flows were between 100 and 130 Kcfs.
- Based upon historical travel time data, at the present flows in the Snake River, wild fall chinook are expected to have an additional 5 day travel time to below Bonneville.

Summary

- Managing subyearling migrants for a 95% passage date is misleading for management purposes. There is a high risk of making a mistake based on a per project prediction of a 95% passage date.

- Management actions must be consistent. If modifications have been made to the Biological Opinion to provide protection to late migrating Clearwater fall chinook then it is not appropriate to terminate spill protection early.

- From all the information reviewed to-date for the 2003 migration, it appears that the planning dates contained in the 2000 Biological Opinion are conservative and should be used when managing for the end of spill this year.

- Managing spill and flow on the basis of 95% passage is a departure from the management contemplated in the Biological Opinion. Historical data shows that the 95% passage often occurs after the August 31 planning date. The management precedent being considered establishes the possibility that in some circumstances spill will continue beyond the August 31 planning date.

- Managing to the 95% passage date requires adequate tagging of specific groups of fish. Modifications to the smolt monitoring program may be necessary to meet the spill management requirements.

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MEMORANDUM

TO: Tom Lorz, CRITFC

FROM: FPC Staff

DATE: August 12, 2003

RE: Update status of sub-yearling chinook passage

In response to your request we are providing the following brief points updating sub-yearling chinook downstream passage on the basis of monitoring information.

- Subyearling chinook continue to pass in relatively large daily numbers in the Lower Columbia River. McNary passage indices have averaged 44,000 fish per day over the past two weeks. Over the past four days the indices have increased to an average of 50,000 per day.
- The sub-yearling passage index at Lower Granite Dam is averaging 2,247 fish per day, for the past 15 days. For the past three days the passage index at Lower Granite has maintained near 2,000 fish per day.
- Small numbers of PIT tagged wild and hatchery chinook continue to be detected at Lower Granite Dam, from the Nez Perce hatchery, Pittsburgh Landing, and release groups from Lyons Ferry.
- Most subyearlings passing through the lower river are of mid-Columbia origin. Historical travel time data indicates that at the present flows these fall chinook can be expected to travel quite slowly through the reach from McNary to John Day Dam. At present flows our analysis shows travel times up to 20 days for these fish from McNary to John Day.
- Based upon historical travel time data, at the present flows in the Snake River, wild fall chinook passing Lower Granite Dam are expected to have a 19 day travel time to McNary Dam and an additional 5 day travel time to below Bonneville.

- Wild PIT tag passage timing for the later half of the distributions have varied greatly from the run-at-large passage distribution. Historical data shows that on average the 95% point of passage for the run-at-large is 27 days later than the wild Snake River PIT tagged group. This results from size and temperature conditions on tagging.
- Based on PIT-tags of wild subyearlings in the Clearwater River, a large portion of that population is still rearing above Lower Granite Dam. A total of 663 subyearling chinook were marked in the Clearwater River in 2003. Of those fish only 15 have been detected at Lower Granite or Little Goose dams.
- Wild sub yearling chinook passage at Lower Granite Dam is likely later than either the run-at-large or the wild marked fish from the Lower Snake River (i.e. WPC 15W marks used by DART). The passage index for subyearling chinook at Lower Granite Dam recently increased from 800 fish per day on July 30 to 4,500 fish per day on August 5. While the 95% passage date for run-at-large is likely past, wild subyearling fish, as measured by run timing prior to supplementation, reach that point in mid-September. Very few Clearwater PIT–tagged fish have reached Lower Granite Dam (12 of 750 tags have been detected).

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MEMORANDUM

TO: FPAC

FROM: FPC Staff

DATE: August 11, 2003

RE: Timing of the 2003 Migration

The purpose of the Biological Opinion Spill Program is to protect juvenile listed fall chinook from the Snake River migrating through the hydrosystem to below Bonneville Dam. In addition, the spill program gives protection to subyearling fall chinook migrating from the Mid Columbia above McNary Dam, and stocks migrating from tributaries below McNary Dam.

The Biological Opinion refers to protecting 95% of the wild fall chinook run. The questions remains as to how the 95% passage is assessed. Prior to the 1995 Biological Opinion the information regarding how the fall chinook migrated was difficult to ascertain. In earlier years sampling programs ended when transportation ended in early July. Subsequent to ESA listing sampling continued into October and the passage distribution was observed. The fall chinook migration timing is extremely variable and is a product of the environmental conditions experienced by these fish.

Passage timing distributions are presently considered in two ways 1) by considering specific PIT tagged mark groups or 2) by looking at the passage at large at a specific site. Passage timing in the Snake River considers the passage at Lower Granite Dam of wild fall chinook marked by USFWS as part of an on-going study. Marking of these designated wild fall chinook is limited by two factors, the first is size at time of marking and the second is availability of fish to mark. As fish grow and mature they move from near shore areas and decrease in availability to beach seining techniques used for collection. Consequently, it is difficult to determine the portion of the run that is represented by the wild PIT tagged fall chinook. Likely, because of the accessibility to fish the PIT tagged distribution is skewed early. This is consistent with what is observed when the PIT tagged subpopulation is compared to the run at large timing at Lower Granite Dam (Table 1).

Table 1. The 95% passage date at Lower Granite Dam for the run at large (hatchery and wild combined) and the wild PIT tagged fish.

YEAR	95% Passage Date Run at Large	95% Passage Date wild PIT Tagged Fish
1995	Oct 11	Sept 14*
1996	Sept 20	Aug 27
1997	Sept 23	Sept 14
1998	Sept 26	Aug 15
1999	Sept 22	Aug 15
2000	Sept 08	Sept 14*
2001	Aug 16	Aug 18
2002	Aug 31	July 28

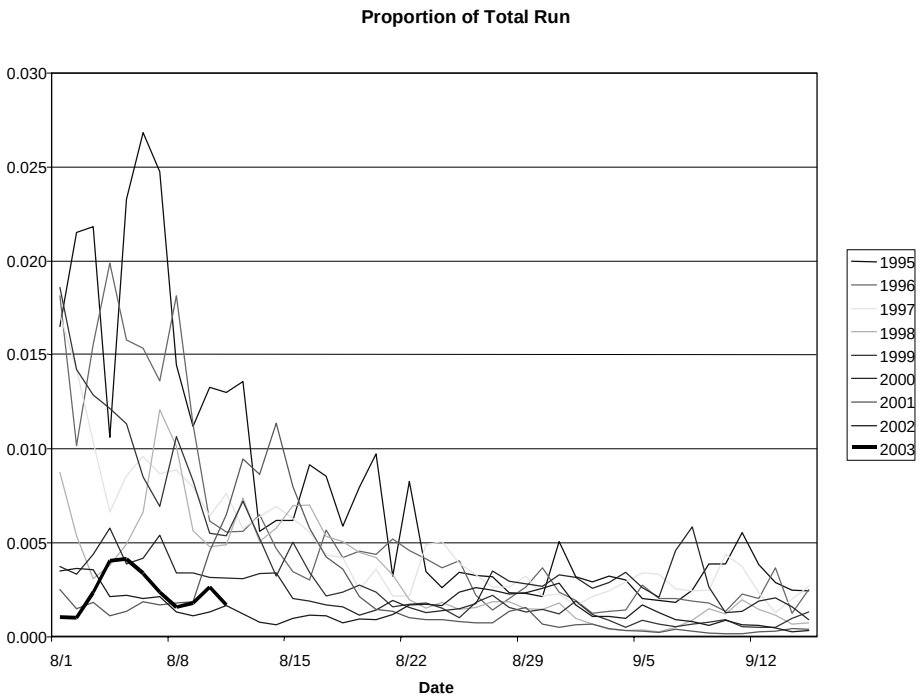
*Last date category actual date may be later

In addition, the run at large 95% passage date appears to be getting earlier as the years progress. This is an artifact of the large numbers of supplementation fish that are being added to the system (passage indices at Lower Granite Dam ranged from a low of 18,500 in 1996 to over 1.1 million predicted for 2003). These supplementation fish are migrating earlier and in large numbers, which skews the distribution to look like it is now occurring earlier.

2003 Migration

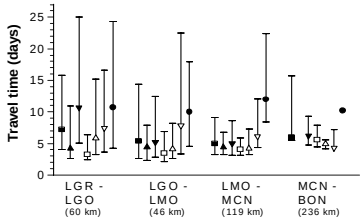
The 2003 migration appeared to initially migrate earlier than it has in the last several years. However, the environmental conditions in 2003 (flow that are, and have been much below the Biological Opinion flow targets) have likely caused the migration to tail for a longer period of time. The following graph (Figure 1) depicts the proportion of the total run observed each day during August and compares it to the total passage index for that year. As you can see in the earlier years the proportion of the run in August comprised a greater amount of the total. However, in the more recent years the proportion of fish that migrates in August is diminished because of the observations of supplementation fish. This does not mean that the wild fall chinook timing has changed from what was observed historically, with a greater proportion of these fish migrating in August. In fact the 2003 data (dark heavy line) seems to be right where you would expect the proportion to be at this time of the year, given the impact of the supplementation fish.

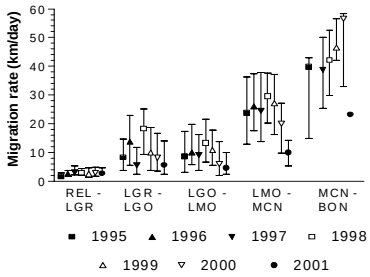
In summary, it is difficult to predict in-season where a run is relative to the percent of passage. According to the data presented over six years (1993-1998) the predicted 95% date of passage based on the wild PIT tagged fall chinook is significantly earlier than the 95% date for the passage at large in 5 of the six years, and nearly the same in the sixth year. It is of concern, however, that on average the actual 95% passage date of the run at larger during this time period was 27 days LATER than predicted based on the wild PIT tags, reinforcing the concept that this statistic only represents the early portion of the run.



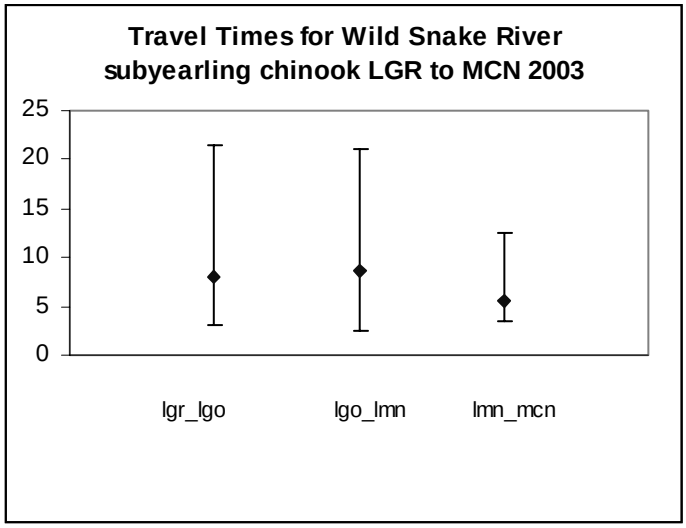
Travel Time

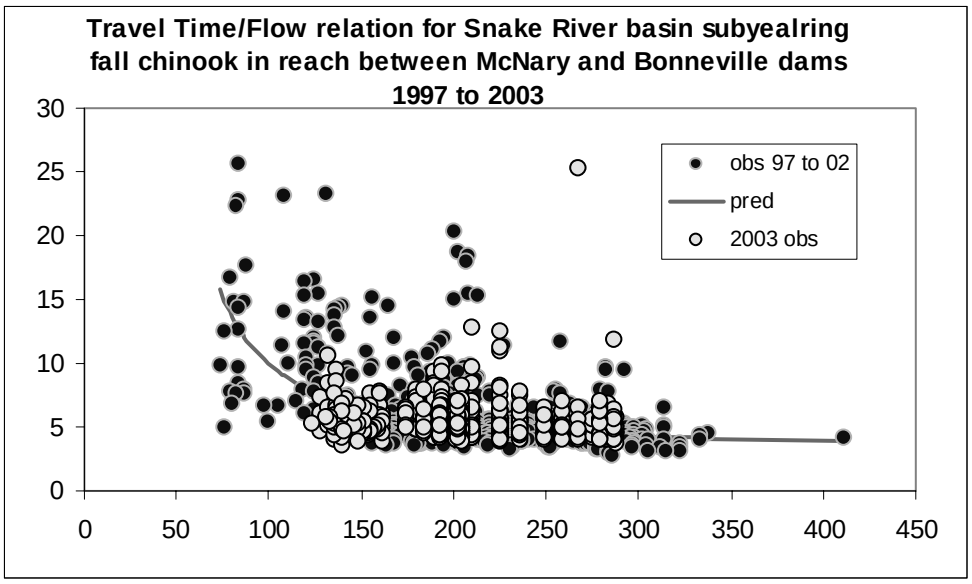
Once fish pass Lower Granite Dam it takes several days to pass through the hydrosystem. The concept of establishing a 95% date of August 31 at Lower Granite Dam is flawed in the 2000 Biological Opinion, since it does not take migration time into consideration. The following graphs were developed by NOAA Fisheries and presented to the ISAB on December 17, 2002. The graphs show the travel time of marked subyearling fall chinook from Lower Granite to Bonneville dams from 1995 to 2001. On average it takes fish between 24 and 30 days to migrate from Lower Granite Dam to below Bonneville Dam. A majority of that time is spent in the Snake River.





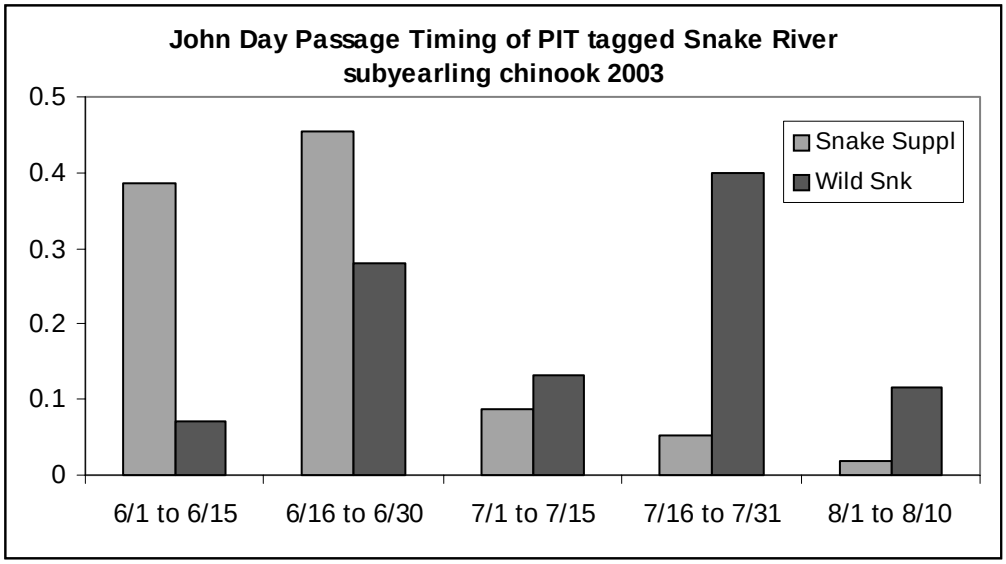
Travel time for subyearling chinook shows a similar trend to the NMFS data. The first figure below shows timing for wild subyearling chinook in the Snake River 2003, while the second depicts 2003 travel times for all supplementation and wild subyearlings from the Snake River, in the Lower Columbia plotted against average flows at McNary Dam as well as historic travel time data. As can be seen from these graphs, the travel time from Lower Granite to McNary for wild subyearling chinook appears to be slower than in recent years. While the McNary to Bonneville travel time of all Snake River Subyearling chinook appears to be similar to past years.





Any passage date at Lower Granite should include at least twenty days for fish to get out of the Snake River and one month to pass through the hydrosystem. Nearly 29,000 juvenile fall chinook have passed Lower Granite Dam since the first of the month. A sufficient travel time estimate should be added to these passage dates to assure that these fish pass through the system.

The Plot below shows passage timing at John Day Dam, of Snake River wild subyearling chinook along with timing for pit-tagged supplementation fish. The data confirms that a significant portion of the wild run is still in-migration, since 11% of the run-to-date is passing in August. Also, it shows the earlier timing of the supplementation fish.



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MEMORANDUM

TO: Rod Sando, CBFWA

FROM: Michele DeHart, FPC

DATE: June 30, 2003

RE: Review of Issue Brief No. 2, "The Variable Impact of Dams on Columbia and Snake River Salmon Populations" by Jay O'Laughlin and the supporting paper by Levin & Tolimieri.

In response to your request a group of agencies technical staff with technical expertise in these analysis reviewed these documents. As a result of that review, we conclude that O'Laughlins' Issue Paper 2 is inaccurate and misleading and has no application to present fish passage management questions. The supporting paper by Levin & Tolimieri has technical and analytical weaknesses that raise questions about the management application of their conclusions.

Comments on Issue paper:
The variable impacts of dams on Columbia and Snake River Salmon Populations
by Jay O'Laughlin, Professor and Director
College of Natural Resources Policy Analysis Group
University of Idaho

Comments by C. Petrosky, H. Schaller and S. Haeseker

O'Laughlin claims that 'the clear logic of breaching proposition is perhaps too simple, however, as there are other factors affecting salmon populations, including not only habitat, harvest, hatcheries, and ocean conditions, but also the variable impact of dam design and operations on salmon.' The author did not acknowledge that a past study, PATH (Plan for Analyzing and Testing Hypotheses), performed comprehensive decision analyses of various management options (including breaching of the 4 lower Snake River dams), which

- considered all of the factors listed above and assumptions about the effectiveness of dam operation and design on salmon survival rates. The PATH analysis found that breaching the 4 lower Snake River dams, plus actions in harvest, habitat and hatchery reform was the most likely option to recover Snake River salmon. Therefore, the logic used for justifying breaching was by no measure simple, but rather comprehensive. This work has been published in peer-reviewed journals (Deriso et al. 2001, Peters and Marmorek 2001, Peters et al. 2001, Budy et al. 2002, Petrosky et al. 2001, and Schaller et al 1999).

- In addition, recent analysis by Wilson (2003) using an analytical framework employed by Karieva et al. (2000) (and by NMFS in the 2000 Biological Opinion for the Columbia River hydrosystem) came to similar conclusions as PATH on the issue of breaching the 4 lower Snake River dams. This is a recent study, which employs sound ecological data, is based on well-constructed analyses, and was published in a well-respected international scientific journal.

- The analyses that O'Laughlin refers to (Levin and Tolimieri 2001), reanalyzes previous published data (Schaller et al. 1999, and Deriso et al. 2001) using techniques that are questionable (see comments below on Levin and Tolimieri).

- O'Laughlin claims the authors unequivocally conclude that the 4 lower Snake River dams are not preventing the recovery of salmon in Idaho. However, the authors qualify their conclusion, and the logic they present is equivocal. Levin and Tolimieri found significant declines in spawner numbers from the before to after period (pre and post lower Snake dam development) in the Snake and Upper Columbia Rivers, but not in the Middle Columbia River. The authors claim that this suggests hydropower strongly impacted both Upper Columbia and Snake River populations. Based on this finding, and their qualification that results from Ricker residuals should be interpreted cautiously, it is difficult to follow the logic how the authors concluded that dams on the lower Snake are not a potential force preventing recovery of endangered salmon.

- O'Laughlin claims that he can draw clear inferences about breaching of the four lower Snake River dams from the Levin and Tolimieri study. His hypothesis is that efforts have been taken to bypass juvenile salmon migrants around the four lower Snake River dams, and the dams are not preventing the recovery of Snake River chinook salmon populations. However, breaching was not investigated in the Levin and Tolimieri study. The results in the study were equivocal when contrasting findings from spawners, recruits/spawner, and Ricker residuals. Also, unlike the work in PATH, this study did not evaluate the operational changes in the hydrosystem versus dam breaching.

Comments on Levin & Tolimieri (2001)

Our comments are primarily focused on the ill-founded construction of Levin and Tolimieri's analyses, for these following reasons:

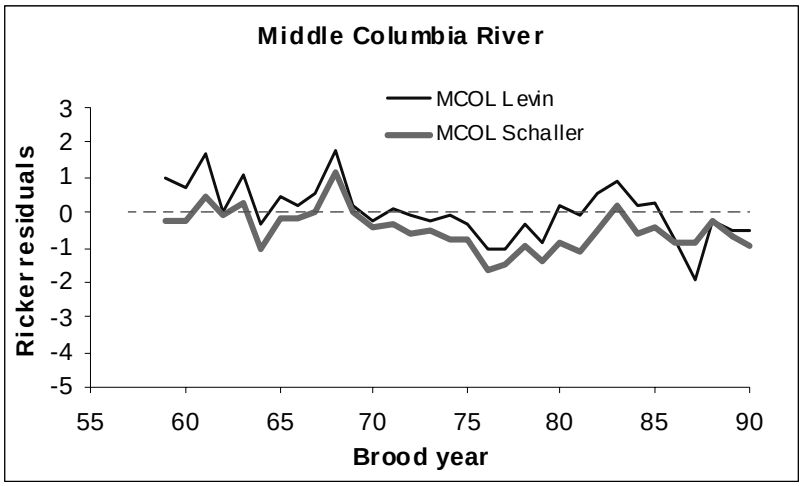
- The authors ignored the fact that the ESUs used for evaluation are composed of a number of independent populations (with varying productivities, capacities, and hydrosystem impacts). Even though the data they relied on are segregated by independent populations, the authors aggregated the information for their analyses. This approach has the potential to dampen the populations' response to perturbations, minimizing the individual response of the independent populations that compose the aggregate ESU. The approach of managing for these independent viable salmonid populations has been documented by NMFS in McElhany et al. (2000).

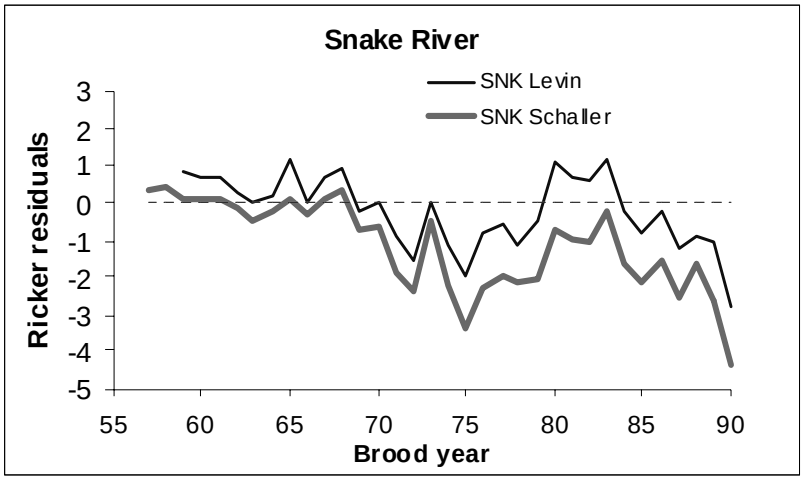
- The authors fit a parent/progeny function (Ricker function) to the entire time series of data (which includes pre and post lower Snake River dam construction). Due to major changes in the physical environment (the migration habitat impacted by four lower Snake River dams), fitting a Ricker function to all years of record would be expected to poorly describe the population dynamics for the aggregate ESU population (Walters 1987, Hilborn and Walters 1992). Analyses that have accounted for these changes in the migration habitat have been performed on these data sets (Schaller et al. 1999; Deriso et al. 2001).

- Levin and Tolimieri do not provide adequate description in the methods section to allow us to precisely duplicate their Ricker residuals presented in their figure 6 (nor do they present any results on the actual models fitted). However, it is apparent that their residual pattern grossly underestimates the actual magnitude of decline in productivity that occurred in Snake River and Upper Columbia stream-type chinook stocks coincident with hydrosystem construction and operation (Schaller et al. 1999; Deriso et al. 2001). Levin and Tolimieri residuals showed less decrease over time, particularly in the Snake River region (Fig. 1), apparently a result of their poor fitting Ricker model(s).

- Levin and Tolimieri acknowledge (p. 294) that their Ricker residuals were autocorrelated, and that "(t)herefore, significant results from analyses of Ricker residuals should be interpreted cautiously." While they caution here against type 1 error, they explicitly accept substantial type 2 error, stating (p. 294) "…absence of differences among regions that vary in dam number would be strongly suggestive that passage through the hydrosystem is not the leading determinant of population size or dynamics." If the fitted Ricker functions do not adequately describe the population dynamics, one would not expect the residuals from a poorly fit model to accurately reflect the productivity changes over time, nor would the resulting non-significant statistical results strongly suggest minimal impact from dams.

- Contrasting results between regions from other studies, the average Snake River stock productivity decreased 64%-71% compared to the Middle Columbia from the pre-dam period to the post-dam period (Schaller et al. 1999, Deriso et al. 2001). Using the Levin and Tolimieri (interpolated) residuals, ln(R/S) decreased only by 0.03, or recruits/spawner decreased by a mere 3% compared to the Middle Columbia. As discussed above, a major factor in this discrepancy appears to be due to Levin and Tolimieri's poor fitting Ricker functions.
- We analyzed the Levin and Tolimieri residuals and contrasted those to analysis of residuals from Schaller et al. (1999). Using Levin and Tolimieri's period designation (1959-65 period 1, 1980-1990 period 2) for the residuals from Schaller et al. (1999), the residuals from period 2 exhibited a significant drop from period 1 ($P<0.001$). In addition, using the period designation (1959-69 period 1, 1975-1990 period 2) from Schaller et al. (1999) for the residuals from Levin and Tolimieri (2001), the residuals from period 2 exhibited a significant drop from period 1 ($P<0.006$). It is apparent from these analyses that Levin and Tolimieri's results are highly influenced by selection of time period, their method for fitting the Ricker function, and aggregation of independent populations. Therefore, we conclude that Levin and Tolimieri's results from the Ricker residuals are questionable and their conclusion (which primarily relies on analysis of residuals) that 'dams on the lower Snake are not a potential force preventing recovery of endangered salmon' is highly equivocal.





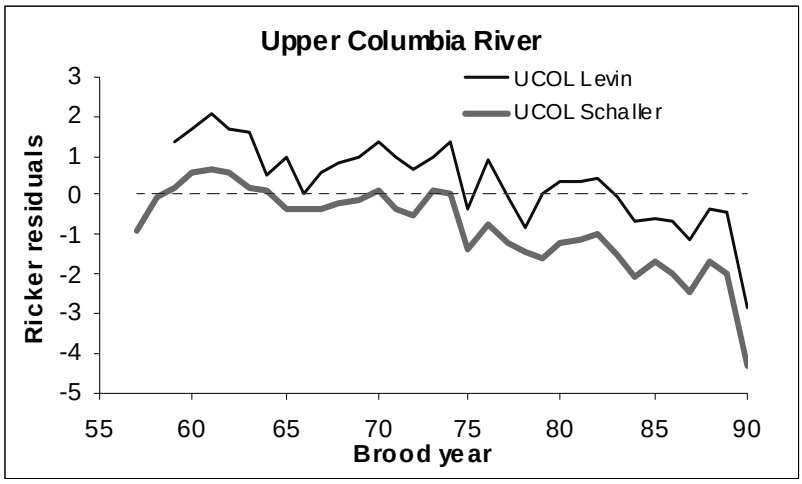


Figure 1. Residuals from Ricker functions for three interior Columbia regions, from Levin and Tolimieri (2001) and Schaller et al. (1999), 1957-1990.

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FISH PASSAGE CENTER

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MEMORANDUM

TO: Rod Sando, CBFWA

FROM: FPC Staff

DATE: April 17, 2003

RE: 1995-2002 Biological Opinion Operations

At your request the Fish Passage Center has compiled information regarding the fulfillment of Biological Opinion measures between the years of 1995 and 2002. In our analysis we have compiled information on spill for fish passage, spring and summer flow objectives, and summer draft limits. The following points outline the findings of our analyses:

SPILL

- Spill has mostly been provided in accordance with the prevailing spill program in any specific year; however, there has been a considerable variation in spill among years for a variety of reasons (excess generation spill, excess hydraulic capacity spill, maintenance issues, test schedules).

FLOW

- Fulfillment of the Biological Opinion flow objective has varied from year to year:

  - 1995: 3 of 4 Flow Objectives Met = 75%
  - 1996: 3 of 4 Flow Objectives Met = 75%
  - 1997: 4 of 4 Flow Objectives Met = 100%
  - 1998: 3 of 4 Flow Objectives Met = 75%
  - 1999: 5 of 5 Flow Objectives Met = 100%
  - 2000: 1of 5 Flow Objectives Met = 20%
  - 2001: 0 of 5 Flow Objectives Met = 0%
  - 2002: 2 of 5 Flow Objectives Met = 40%

- Since 1995 flow objectives have been met 58% of the time; over the last three years, flow objectives have only been met 20% of the time.

SUMMER DRAFT LIMITS

- **Grand Coulee:** Were within ½-foot of the August 31st draft limit in six of the last eight years.

- **Hungry Horse:** Were within ½-foot of the August 31st draft limit in three of the last eight years.

- **Libby:** Were within ½-foot of the draft limit in zero of the last eight years (two years were drafted over four below the limit), mostly due to agreements with BC Hydro.

- **Dworshak:** Were within ½-foot of the draft limit in three of the last eight years

Spill for Fish Passage

Prior to 1993 when the first Biological Opinion was issued, spill was considered mitigation at hydroelectric projects to enhance project survival for juvenile salmonids. Historically, spill occurred operationally, when project capacity or system generation needs were exceeded. As the hydrosystem was developed it became more efficient through such actions as the construction of the DC and AC Intertie transmission lines. As a consequence, the occurrence of spill declined, accelerating the disagreements between operators and regulators and the fishery agencies regarding the provision of spill. In December of 1988, a 10-year spill program was developed for implementation of spill at projects that were not equipped with adequate bypass systems to achieve a fish passage efficiency goal. (Fish Spill Memorandum of Agreement).

As fish stocks continued to decline and were listed under the Endangered Species Act, it became clear that the negotiated contracts were not aggressive enough to recover endangered stocks. This led to the modification of spill programs under the different versions of the Biological Opinion. At the same time that spill was identified as a key element in the recovery of listed stocks, the need to meet the objectives of the Clean Water Act was also identified. Spill causes high levels of total dissolved gas that could increase mortality and eliminate the benefits associated with the implementation of an aggressive spill program. Therefore, subsequent implementation of a spill program has been within the confines of the “risk” associated with increased levels of total dissolved gas. Consequently, spill is limited by the “gas cap” approved by the State water quality agencies as a way of managing risk. The following is a yearly account of the program in place and the spill that occurred in the federal Hydrosystem.

1993 – The NMFS Biological Opinion was issued on May 26, 1993. Prior to that date spill was in accordance with the COE Annual Fish Passage Plan, which prohibited spill at the collector projects and only called for spill at the non-collector projects to achieve a 70/50 fish passage efficiency (fish passage efficiency (FPE) is a measurement of the proportion of fish that pass a project via a non turbine route). The Fish Passage Plan criteria applied to Ice Harbor and Bonneville dams. Spill according to the 1989 Fish Spill MOA was implemented at The Dalles and John Day dams. The 1993 Opinion superceded the earlier implementation scheme and prohibited planned spill at the collector projects, limited spill at Ice Harbor Dam, called for the removal of fish screens at Ice Harbor and Bonneville dams during the summer migration and implemented spill according to the 1989 MOA at John Day and The Dalles dams. The 1989 Spill MOA called for spill at John Day during the spring for 10 hours a day at a level equal to 20% of instantaneous flow, and spill at The Dalles Dam at a level equal to 10% of the daily average flow during the spring and 5% of daily average flow during the summer.

No planned spill occurred at the Snake River collector projects, but some excess generation spill did occur during the spring season. The spill MOA was implemented at John Day and The Dalles dams. During the period of peak runoff spill exceeded the levels of the MOA, but whenever possible they were managed down to those levels.

1994 – Spill was initially provided according to the 1994 –1998 BIOP, which required 70% spring and 50% summer FPE at non-collector projects. Operations changes on May 11 and implementation was requested to the 80% FPE. Spill was adjusted and varied up to the TDG waivers until May 27, when NMFS requested a one-third reduction in spill levels. Summer spill was limited at John Day and The Dalles Dams.

1995 – Spill was provided according the 1995 Biological Opinion. This included spring spill at the Snake and Lower River projects and summer spill at Ice Harbor, John Day, The Dalles and Bonneville dams. Spill was up to the 80% FPE objective, or as limited by the gas cap. Ice Harbor Dam's hydraulic capacity was limited to 66 Kcfs; consequently, significant excess hydraulic capacity spill occurred at this project. John Day Dam did not have spillway deflectors installed and spill was limited

1996 – Spill was provided according to the 1995 Biological Opinion. Extremely high natural runoff conditions resulted in spill levels in excess of those that would have occurred under a spill program managed for total dissolved gas levels.

1997 - Spill was provided according to the 1995 Biological Opinion. Extremely high natural runoff conditions again this year resulted in spill levels in excess of those that would have occurred under a spill program managed for total dissolved gas levels. Full use of the John Day Dam spillway was delayed until after May 5 because of delays in spillway deflector installation due to contested contracts. The Ice Harbor project operated with spillway deflectors. The addition of spillway deflectors at both Ice Harbor and John Day resulted in lower levels of total dissolved gas compared to the previous high flow year values.

1998 – The 1998 Supplemental BIOP called for additional spill to the gas caps on a system-wide basis, even if the project met the 80% FPE at lower spill amounts. The Supplemental BIOP also modified the planning dates for spill allowing earlier initiation of the program and keying the duration to fish passage movement.

1999 – Spill was provided according to the 1998 Supplemental BIOP and was primarily involuntary, resulting from flows in excess of hydraulic capacity and power needs. Spill at most projects met or exceeded the 80% fish passage efficiency objective. The notable exception was The Dalles Dam, where the conduct of a spill test, where spill alternated between 64% of average daily flow and 30% of average daily flow, resulted in less spill than called for in the BIOP.

2000 – In April of 2000 NMFS released a Spill Plan agreement that modified the 1998 Supplemental BIOP spill levels, and was to be the basis for the 2000 BIOP spill program. Spill at Lower Monumental Dam was increased from a 12-hour to a 24-hour period. At The Dalles Dam, spill was reduced from the 64% of daily average flow, to 40% of daily average flow. In addition, while spill remained the same at John Day and Bonneville dams, spill tests were called for at both the projects. In general, the BIOP was implemented up to the spill gas caps.

2001 – The low flows and the declaration of a power system emergency resulted in no spill occurring in the Snake River during either the spring or the summer migration. A limited spill program equal to 600 MW months of energy was implemented after mid-May at Bonneville and The Dalles dams, and on May 25th at McNary and John Day dams that extended to June 15th. A limited summer spill program was implemented beginning in mid July at The Dalles and Bonneville dams.

2002 – Spring and summer spill were provided according to the NMFS 2000 BIOP, as constrained by the total dissolved gas caps. The only exception occurred at Lower Monumental Dam where spill was not implemented because of repairs work that was being conducted in the stilling basin.

While spill has mostly been provided in accordance with the prevailing spill program in any specific year, there has been a considerable variation in spill among years for a variety of reasons (excess generation spill, excess hydraulic capacity spill, maintenance issues, test schedules). To capture this variation the following tables summarize the amount of spill that occurred in two different ways. The daily average spill (in Kcfs) that occurred is summed over the spring and summer period to give an estimate of the magnitude of water spilled. For comparison sake all periods were standardized to the present planning dates for spill, that is to say, the spring period extends from April 3 to June 20 in the Snake River and April 10 to June 30 in the lower Columbia River, while the summer period extends from June 21 to August 31 in the Snake and July 1 through August 31 in the lower Columbia. The second summary statistic averages the daily proportion of water spilled (relative to total flow) over the same time periods. Spill over the ten-year period has ranged from the lows observed during the power emergency in 2001 to the highs observed during the high flow years of 1996 and 1997.

YEAR	Lower Granite				Little Goose				Lower Monumental				Ice Harbor			
	Spring		Summer		Spring		Summer		Spring		Summer		Spring		Summer	
	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %
1993	848	0.07	0	0.00	1748	0.17	0	0.00	1382	0.12	0	0.00	2548	0.29	931	0.29
1994	736	0.15	13	0.01	1069	0.20	0	0.00	424	0.09	14	0.01	1611	0.34	342	0.13
1995	824	0.09	33	0.00	1491	0.19	96	0.01	1176	0.14	87	0.01	2787	0.33	1817	0.49
1996	4203	0.39	332	0.05	4015	0.38	407	0.07	3892	0.34	465	0.08	4506	0.41	1825	0.52
1997	4304	0.32	268	0.04	4453	0.36	186	0.02	4652	0.36	278	0.03	6924	0.53	2830	0.59
1998	2647	0.28	106	0.02	2813	0.32	14	0.00	2501	0.26	8	0.00	5151	0.58	2998	0.72
1999	3328	0.37	359	0.04	2136	0.25	84	0.01	1848	0.20	88	0.01	5567	0.62	3178	0.76
2000	1880	0.29	15	0.00	1606	0.22	29	0.01	2310	0.33	6	0.00	4855	0.70	2205	0.79
2001	0	0.00	15	0.01	0	0.00	1	0.00	0	0.00	9	0.01	10	0.00	0	0.00
2002	2432	0.37	383	0.08	2142	0.35	271	0.07	70	0.01	0	0.00	4463	0.65	2397	0.76

	McNary				John Day				The Dalles				Bonneville			
	Spring		Summer		Spring		Summer		Spring		Summer		Spring		Summer	
	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %	Total	Avg %
1993	4574	0.18	0.38	0.00	2645	0.11	609	0.07	4450	0.02	408	0.05	8289	0.43	3783	0.41
1994	1494	0.09	159	0.02	558	0.03	418	0.06	3341	0.21	397	0.05	6410	0.40	2781	0.35
1995	7611	0.36	429	0.03	693	0.03	318	0.03	10189	0.47	6138	0.59	6888	0.33	5403	0.51
1996	11650	0.56	4094	0.28	6758	0.22	2231	0.18	16859	0.57	7253	0.57	14296	0.47	5482	0.42
1997	21698	0.59	4829	0.31	11630	0.29	2840	0.19	21923	0.58	9102	0.64	18751	0.49	6220	0.43
1998	9289	0.38	1186	0.09	7116	0.28	2939	0.28	10342	0.42	4856	0.46	8373	0.34	5456	0.51
1999	10960	0.44	4867	0.33	6403	0.25	3938	0.28	10599	0.42	7871	0.57	8274	0.32	5350	0.38
2000	7760	0.38	365	0.03	6274	0.31	3311	0.35	7627	0.38	3688	0.39	7306	0.35	5653	0.57
2001	163	0.01	0	0.00	400	0.04	0	0.00	1263	0.11	1163	0.20	1482	0.12	1281	0.20
2002	9560	0.42	2015	0.13	6952	0.30	3426	0.29	8107	0.37	4507	0.39	9919	0.44	6724	0.58

Spring and Summer Flow Objectives

The following table summarizes the Spring and summer Biological Opinion flow objectives and actual flows for the years 1995 to 2002 at Lower Granite, Priest Rapids, and McNary. For each year, bold font would indicate that the spring or summer actual average flow was equal to or greater than the flow objective.

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Lower Granite								
Spring Objective	**95.0**	**100.0**	**100**	**90.0**	**100.0**	96.3	85.0	97.0
Spring Average	**101.1**	**138.3**	**162.5**	**115.6**	**117.0**	85.1	47.5	83.4
Summer Objective	**52.0**	53.5	**55.0**	**50.6**	**54.0**	51.3	50.0	51.0
Summer Average	**55.3**	52.7	**66.3**	**53.2**	**56.0**	39.6	25.4	41.2
Priest Rapids								
Spring Objective	*Na*	*Na*	*Na*	*Na*	**135.0**	**135.0**	135.0	**135.0**
Spring Average	*Na*	*Na*	*Na*	*Na*	**169.6**	**158.1**	76.7	**180.6**
McNary								
Spring Objective	**249.0**	**260**	**260.0**	**228.0**	**260.0**	260.0	220.0	**246.0**
Spring Average	**253.0**	**357.1**	**463.5**	**287.8**	**303.6**	243.4	123.9	**269.3**
Summer Objective	200.0	**200.0**	**200.0**	200.0	**200.0**	200.0	200.0	200.0
Summer Average	164.7	**214.5**	**236.6**	169.7	**228.2**	153.6	90.9	190.9

Fulfillment of the Biological Opinion flow objective has varied from year to year:

- 1995: 3 of 4 Flow Objectives Met = 75%
- 1996: 3 of 4 Flow Objectives Met = 75%
- 1997: 4 of 4 Flow Objectives Met = 100%
- 1998: 3 of 4 Flow Objectives Met = 75%
- 1999: 5 of 5 Flow Objectives Met = 100%
- 2000: 1of 5 Flow Objectives Met = 20%
- 2001: 0 of 5 Flow Objectives Met = 0%
- 2002: 2 of 5 Flow Objectives Met = 40%

Overall, taking into account all of the projects with BiOp flow objectives (all blocks in the above table), since 1995 flow objectives have been met 58% of the time. Within the last three years, flow objectives have only been met 20% of the time.

Summer Draft Limits

The following table summarizes the actual end of August elevations of Grand Coulee, Hungry Horse, Libby, and Dworshak along with the BiOp draft limit. The end of August draft limits are fixed at Hungry Horse (3540 feet), Libby (2439 feet), and Dworshak (1520 feet); however, the draft limit ranges between 1278-1280 at Grand Coulee depending on the July final April-to-August runoff volume forecast at The Dalles Dam (for each year the draft limit is in parenthesis).

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Grand Coulee	1280.4 (1280.0)	1280.3 (1280.0)	1279.8 (1280.0)	1279.0 (1280.0)	1286.4 (1280.0)	1280.4 (1280.0)	1278.3 (1278.0)	1279.5 (1280.0)
Hungry Horse (3540)	3552.8	3543.2	3546.2	3540.0	3554.3	3539.8	3539.4	3544.9
Libby (2439)	2454.2	2452.3	2450.1	2443.9	2455.63	2434.9	2434.9	2442.2
Dworshak (1520)	1530.9	1535.6	1500.5	1520.3	1526.6	1520.1	1520.5	1534.0

Meeting the BiOp summer draft limits varies depending on the project. Since1995:

- **Grand Coulee:** Six of the last eight years were within ½-foot of the draft limit
- **Hungry Horse:** Three of the last eight years were within ½-foot of the draft limit
- **Libby:** Zero of the last eight years were within ½-foot of the draft limit (Two years were drafted over four below the limit)
- **Dworshak:** Three of the last eight years were within ½-foot of the draft limit

(One year was drafted below the limit)

The following paragraphs provide a year-by-year summary of why projects did not draft to their respective BiOp summer limits.

1995: None of the projects were drafted to the elevations specified in the BiOp by the end of August. Two agreements left water in Libby 1) BC Hydro drafted 385 Kaf out of Arrow in lieu of Libby and 2) The State of Montana left 290 Kaf in Libby. Outflows at Hungry Horse were limited by switching yard work, implementing selective withdrawal construction, and by an agreement between the federal parties and the State of Montana. Outflows at Dworshak were limited by dissolved gas.

1996: Neither the Hungry Horse or Libby reservoirs were drafted to their respective Biological Opinion levels of 3540 and 2439 feet by August 31st. The Hungry Horse reservoir drafted to an elevation of 3543 feet, three feet above the BiOp level, due to construction works at the powerhouse. The Libby reservoir drafted to an elevation of 2452, approximately 13 feet above the BiOp draft limit, due to an agreement with BC Hydro that provided a volume of 10 feet of water from Arrow reservoir instead of drafting Libby.

1997: Neither the Hungry Horse or Libby reservoirs were drafted to their respective Biological Opinion levels of 3540 and 2439 feet by August 31st. The Hungry Horse reservoir drafted to an elevation of 3546 feet, six feet above the BiOp level. The Libby reservoir drafted to an elevation of 2450, approximately 11 feet above the BiOp draft limit, due to an agreement with BC Hydro (Libby/Arrow Swap) that provided a volume of 10 feet of water from Arrow reservoir instead of drafting Libby. Dworshak was drafted to 1500 feet because of grouting work during the fall of 1997.

1998: The Hungry Horse reservoir was drafted to its Biological Opinion limit of 3540 feet by August 31st. The Libby reservoir was drafted to 2444 feet by August 31st, five feet above the BiOp level of 2439 feet, as a result of an agreement with BC Hydro (Libby/Arrow Swap) that provided a 210 Kaf of water from Arrow reservoir instead of drafting Libby.

1999: Neither the Hungry Horse or Libby reservoirs were drafted to their respective Biological Opinion levels of 3540 and 2439 feet by August 31st. The Hungry Horse reservoir drafted to an elevation of 3554 feet, 14 feet above the BiOp level, and the Libby reservoir drafted to an elevation of 2456, approximately 17 feet above the BiOp draft limit. High inflows from the Canadian portion of the Upper Columbia eliminated the necessity to draft the Libby and Hungry Horse reservoirs to the BiOp recommended levels.

2000: The Hungry Horse reservoir was drafted to its Biological Opinion limit of 3540 feet by August 31st. The Libby reservoir was drafted to 2435 feet by August 31st, four feet below the BiOp level of 2439 feet, as a result of early season drafts (including those for Bull Trout) and a lower than expected runoff volume.

2001: The Hungry Horse reservoir was drafted to 3439 feet by August 31st, just slightly below its Biological Opinion limit of 3540 feet. The Libby reservoir was drafted to 2435 feet by August 31st, four feet below the BiOp level of 2439 feet, as a result of an extremely low runoff volume.

2002: Neither the Hungry Horse or Libby reservoirs were drafted to their respective Biological Opinion levels of 3540 and 2439 feet by August 31st. The Hungry Horse reservoir drafted to an elevation of 3545 feet, five feet above the BiOp level, and the Libby reservoir drafted to an elevation of 2442, approximately three feet above the BiOp draft limit. The extra five feet of water left in Hungry Horse was released in September of 2002, and the draft limit was not reached at Libby because of a Libby/Canadian Swap. By August 31st 2002, Dworshak drafted to an elevation of 1534.0 feet, 14 feet above the BiOp draft limit. An agreement was made to release the remaining 14 feet of water in Dworshak during the month of September.

APPENDIX B

Total Dissolved Gas Saturation Plots

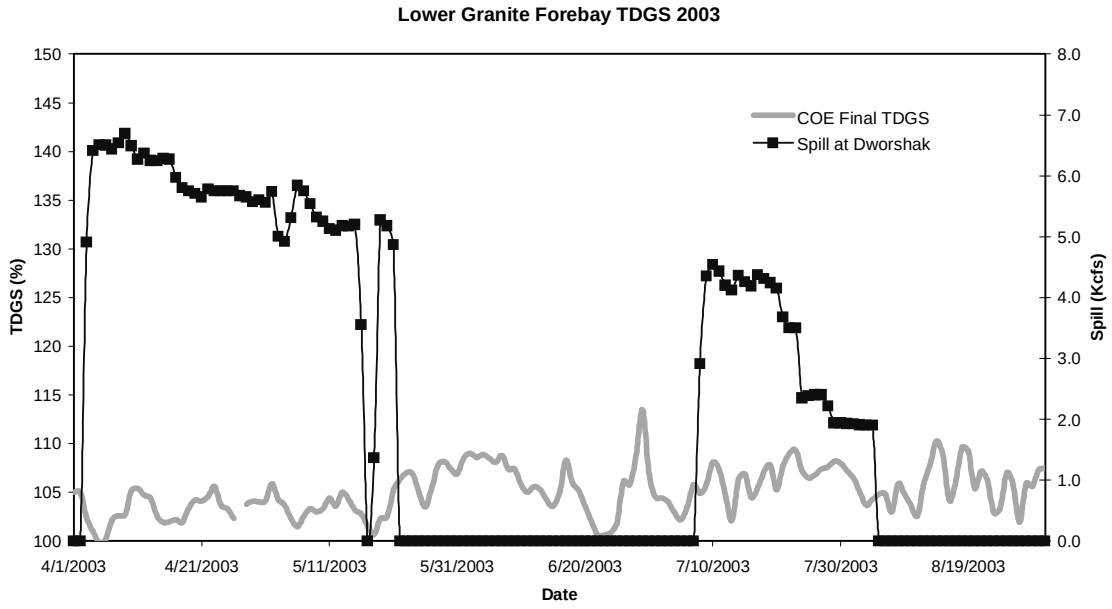


FIGURE B-1. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the Lower Granite Forebay and daily average spill at Dworshak.

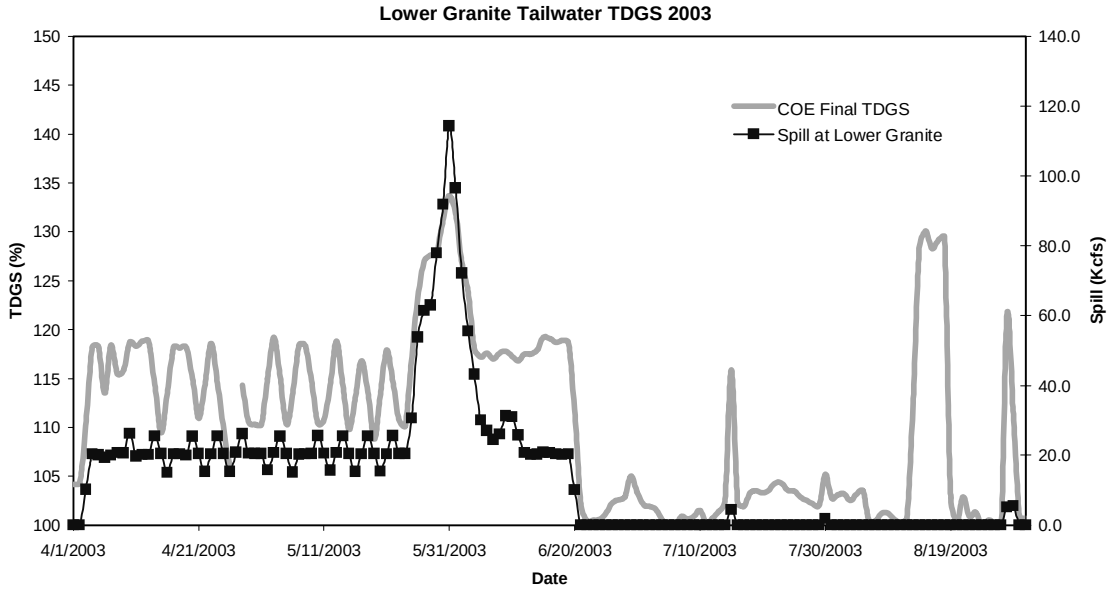


FIGURE B-2. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the Lower Granite tailwater and daily average spill at Lower Granite.

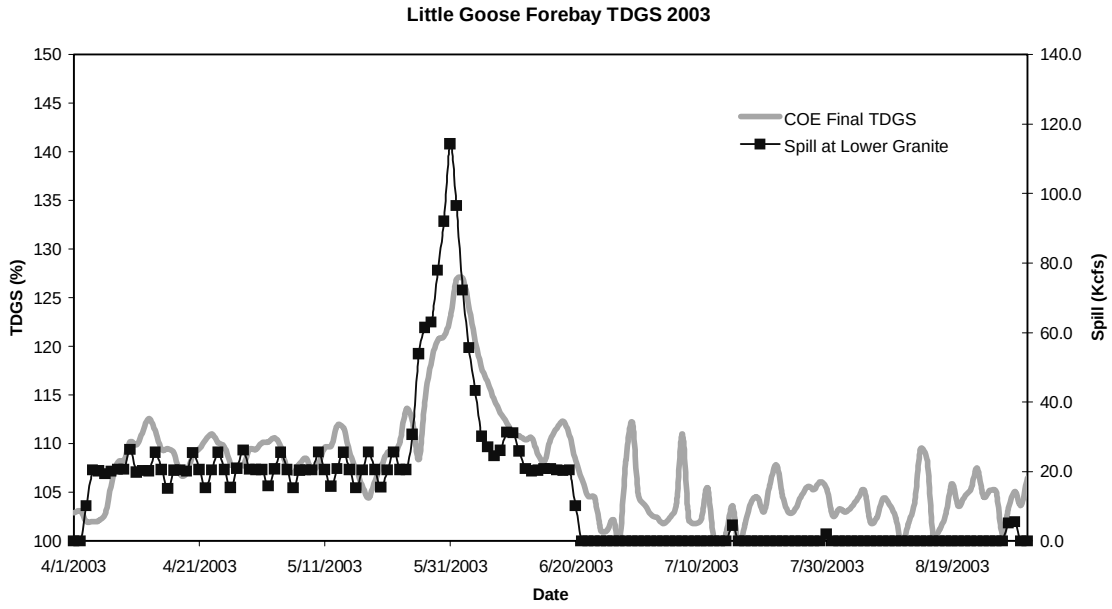


FIGURE B-3. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the Little Goose Forebay and daily average spill at Lower Granite.

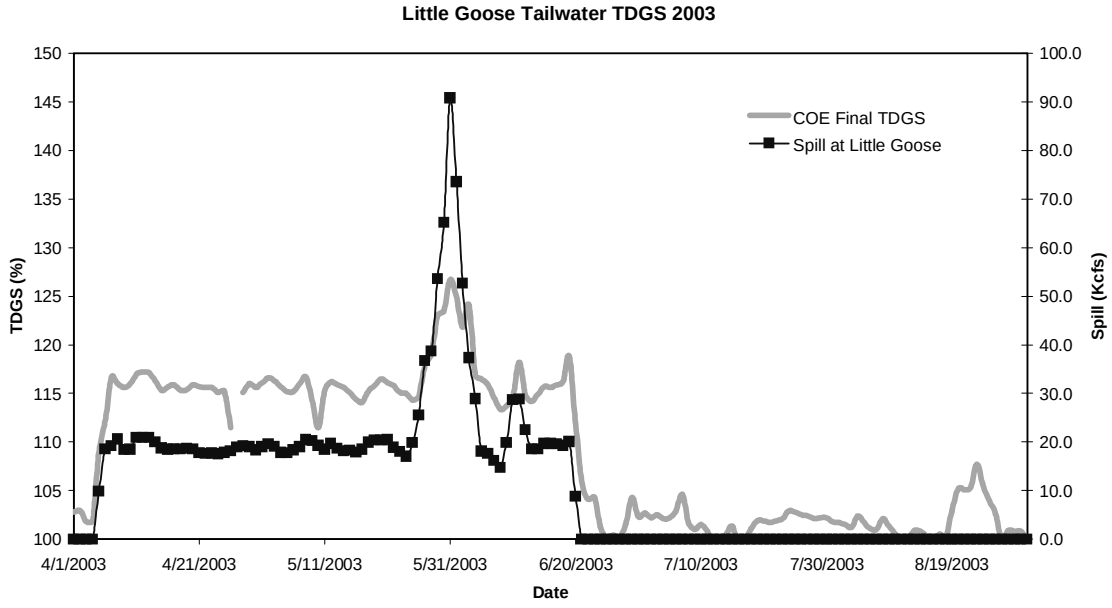


FIGURE B-4. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the Little Goose Tailwater and daily average spill at Little Goose.

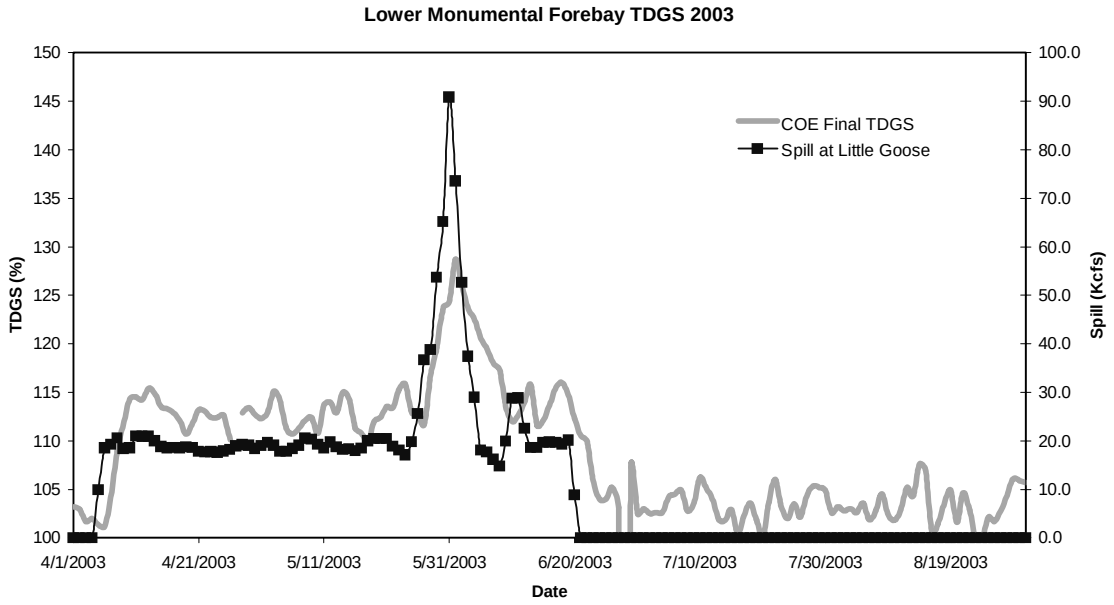


FIGURE B-5. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the Lower Monumental Forebay and daily average spill at Little Goose.

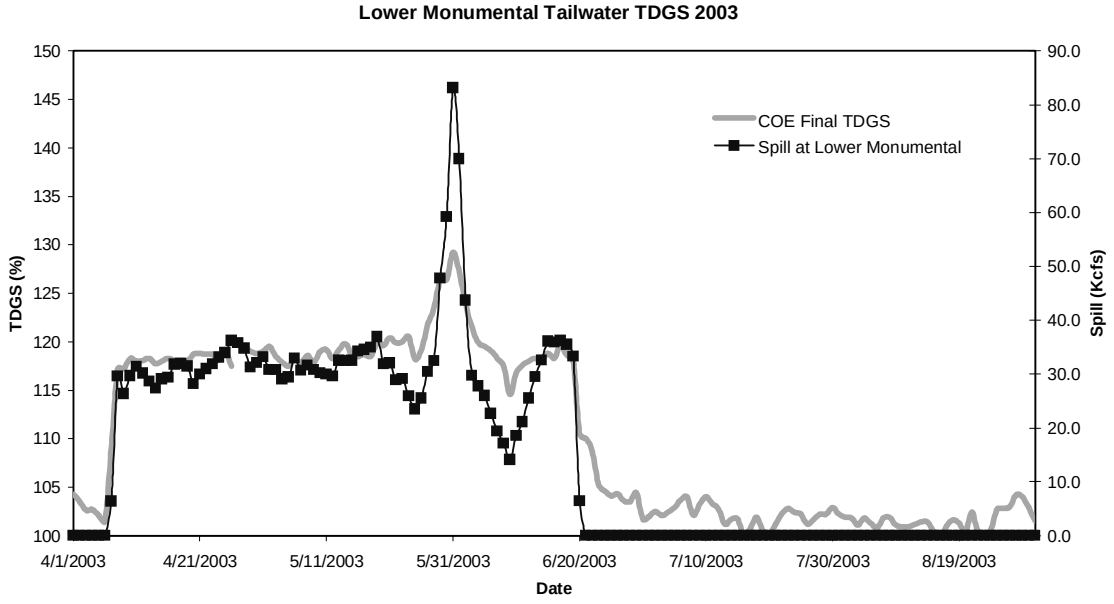


FIGURE B-6. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the Lower Monumental Tailwater and daily average spill at Lower Monumental.

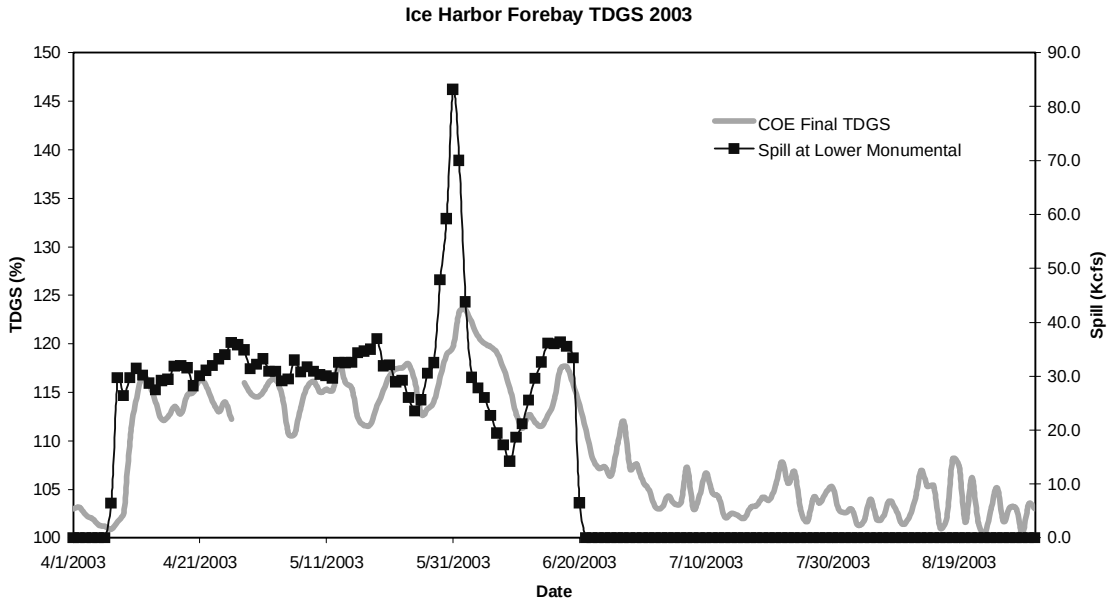


FIGURE B-7. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the Ice Harbor Forebay and daily average spill at Lower Monumental.

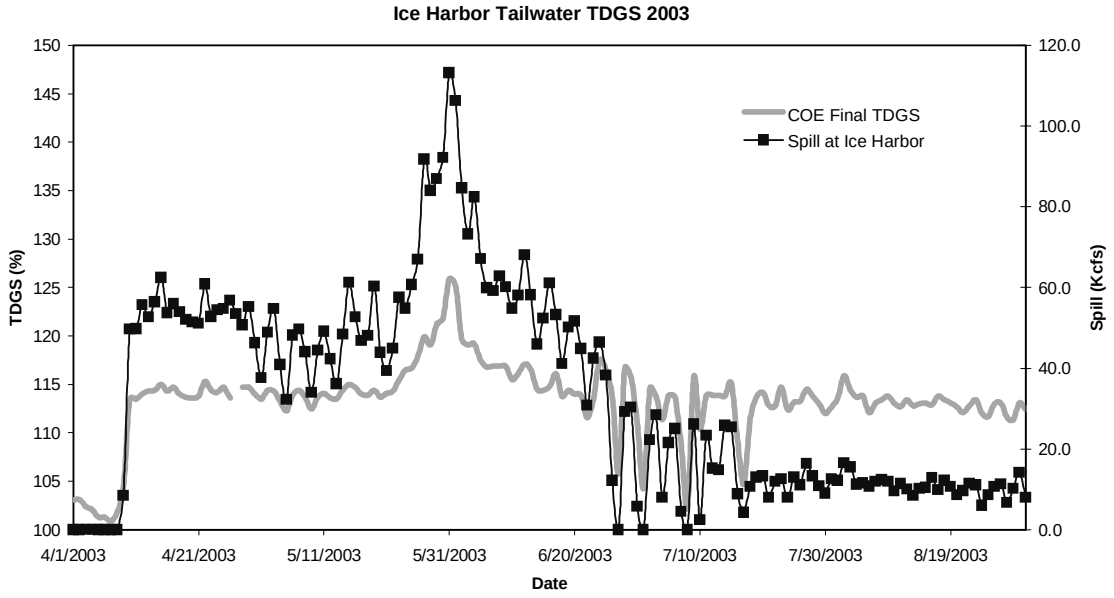


FIGURE B-8. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the Ice Harbor Tailwater and daily average spill at Ice Harbor.

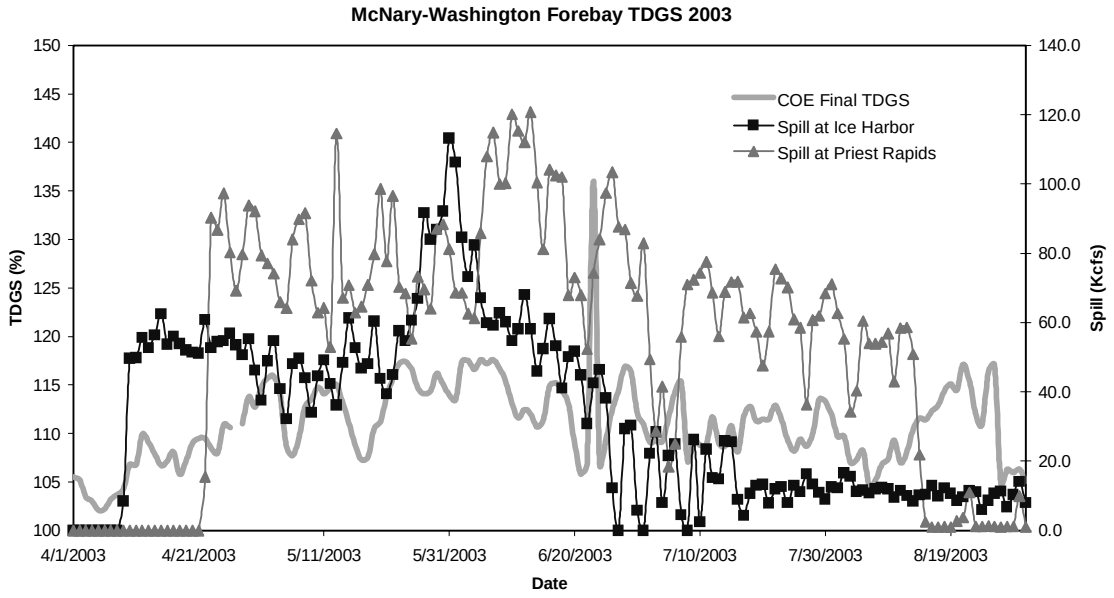


FIGURE B-9. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the McNary-Washington Forebay and daily average spill at Ice Harbor and Priest Rapids.

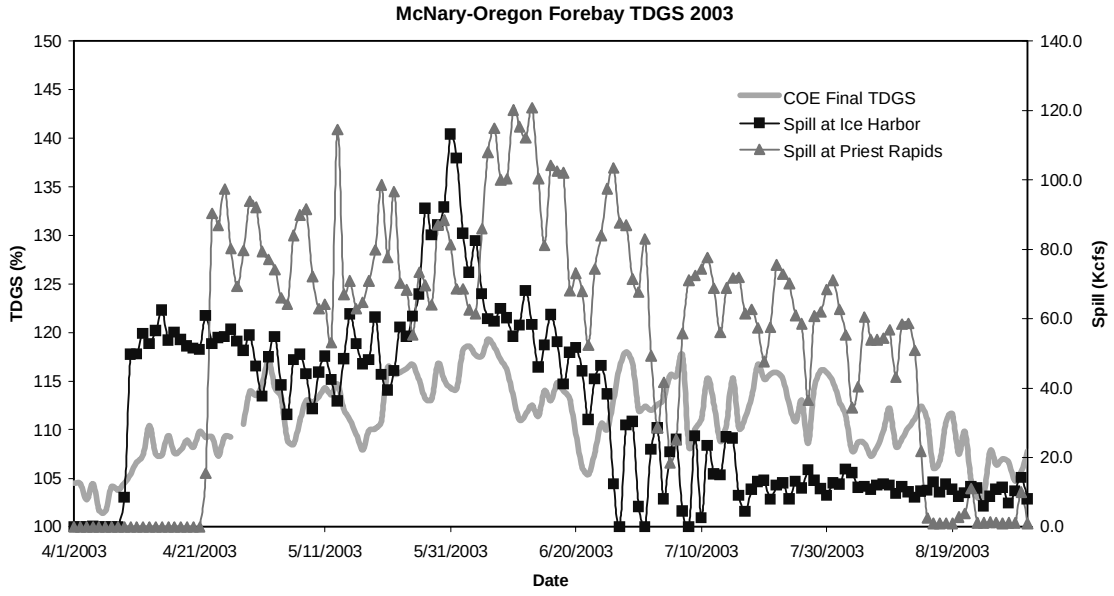


FIGURE B-10. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the McNary-Oregon Forebay and daily average spill at Ice Harbor and Priest Rapids.

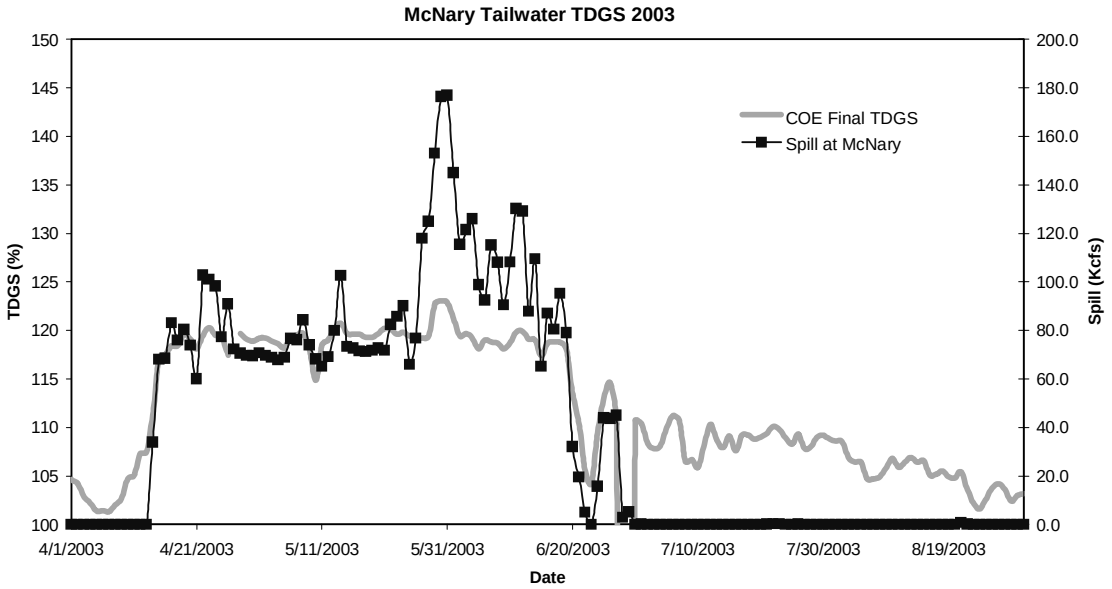


FIGURE B-11. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the McNary Tailwater and daily average spill at McNary.

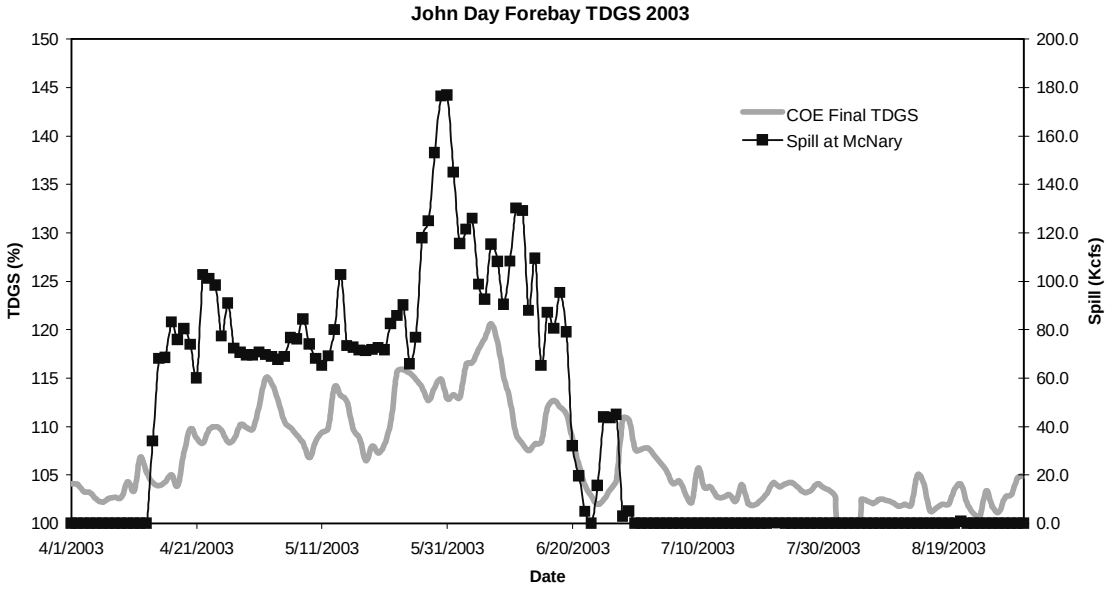


FIGURE B-12. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the John Day Forebay and daily average spill at McNary.

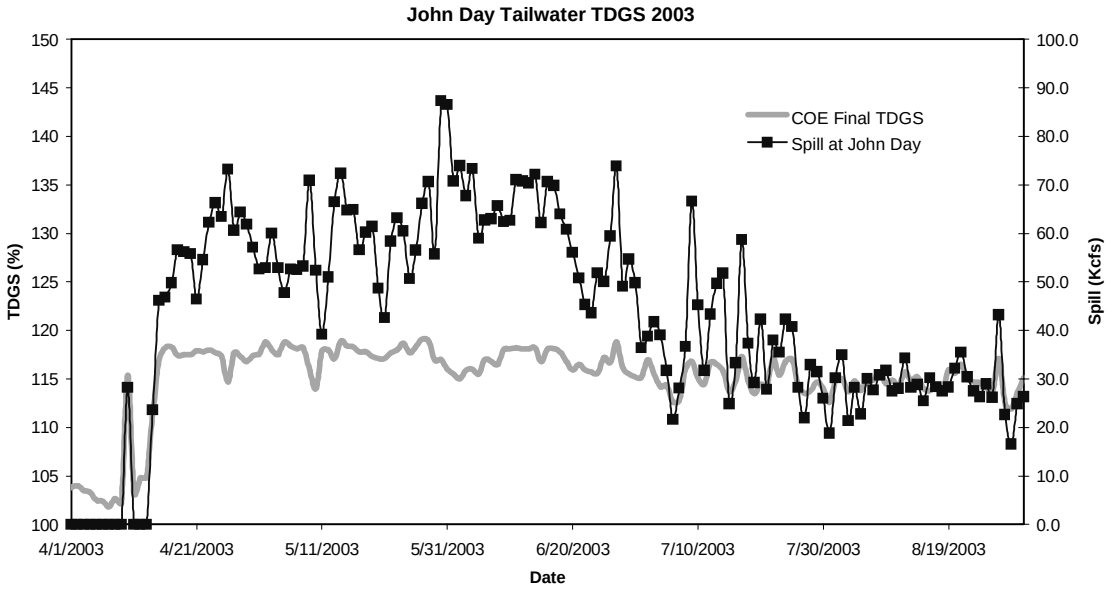


FIGURE B-13. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the John Day Tailwater and daily average spill at John Day.

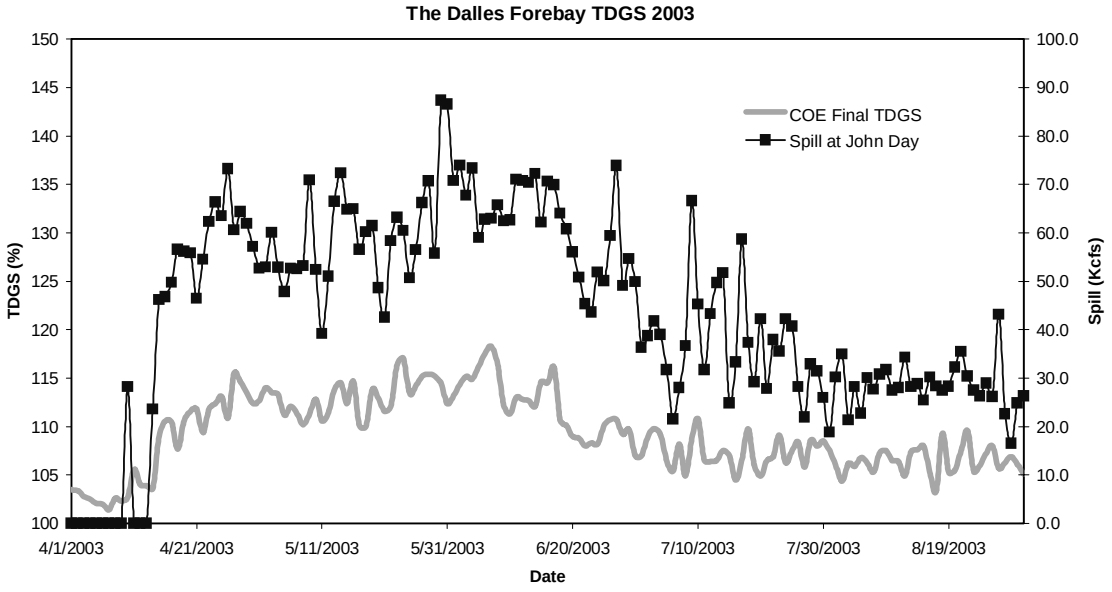


FIGURE B-14. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in The Dalles Forebay and daily average spill at John Day.

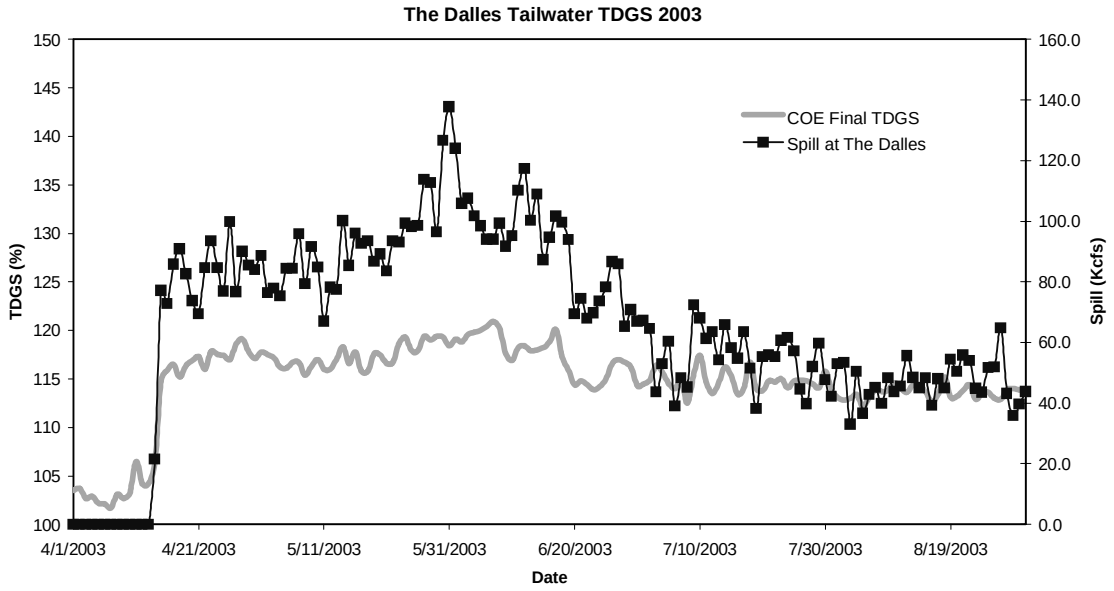


FIGURE B-15. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in The Dalles Tailwater and daily average spill at The Dalles.

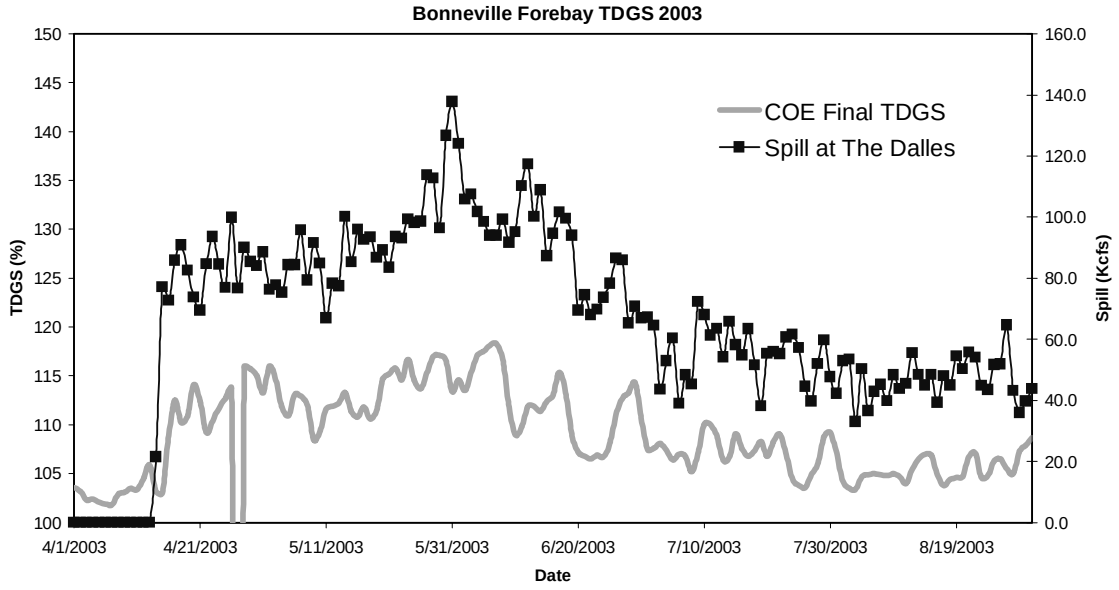


FIGURE B-16. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) in the Bonneville Dam Forebay and daily average spill at The Dalles.

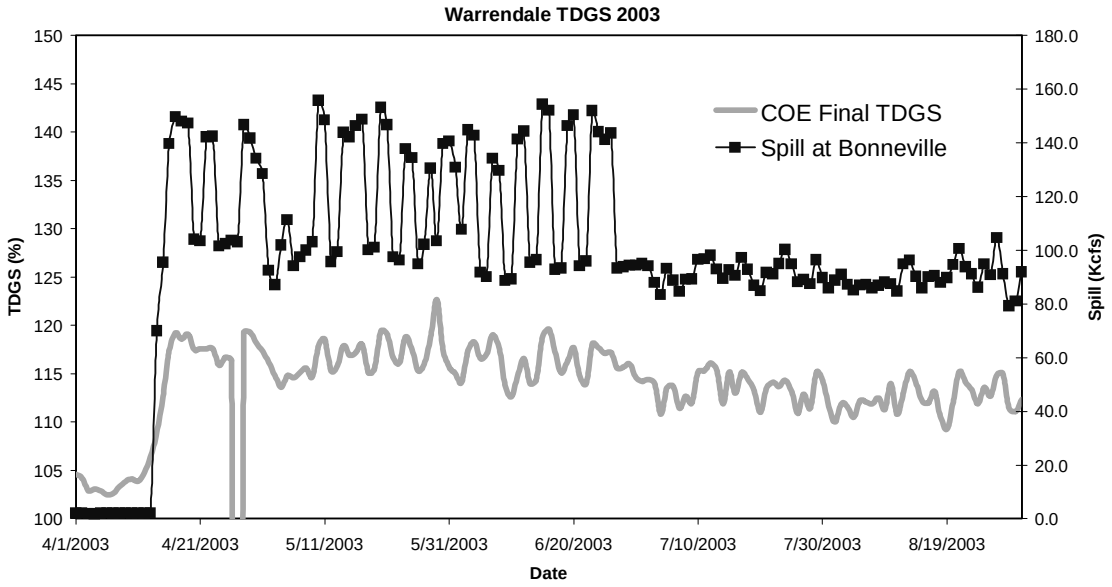


FIGURE B-17. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) at Warrendale and daily average spill at Bonneville Dam.

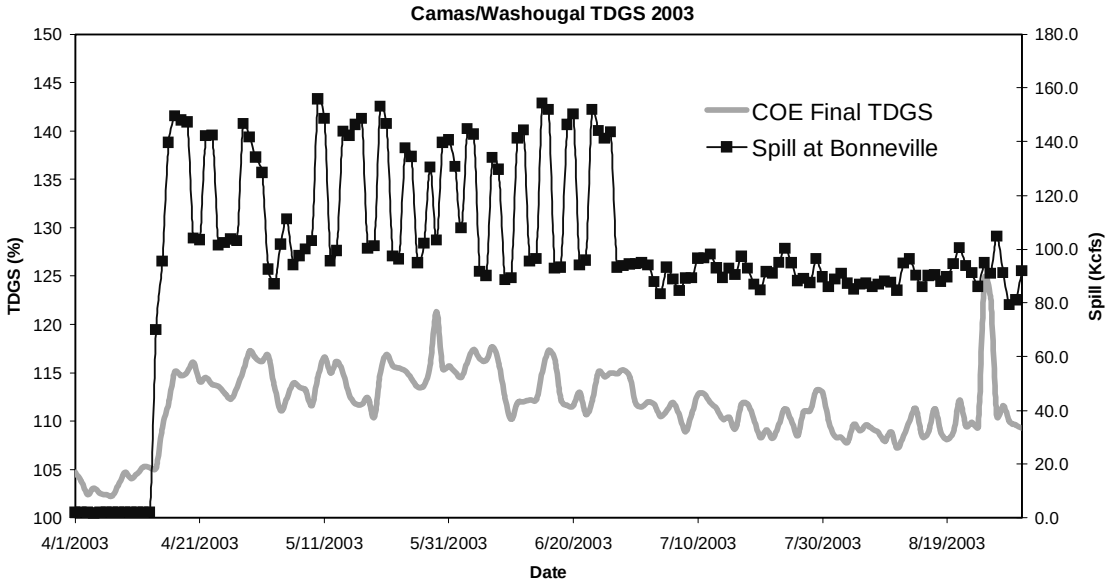


FIGURE B-18. Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) at Camas/Washougal and daily average spill at Bonneville Dam.

APPENDIX C

Gas Bubble Trauma and

Total Dissolved Gas Saturation

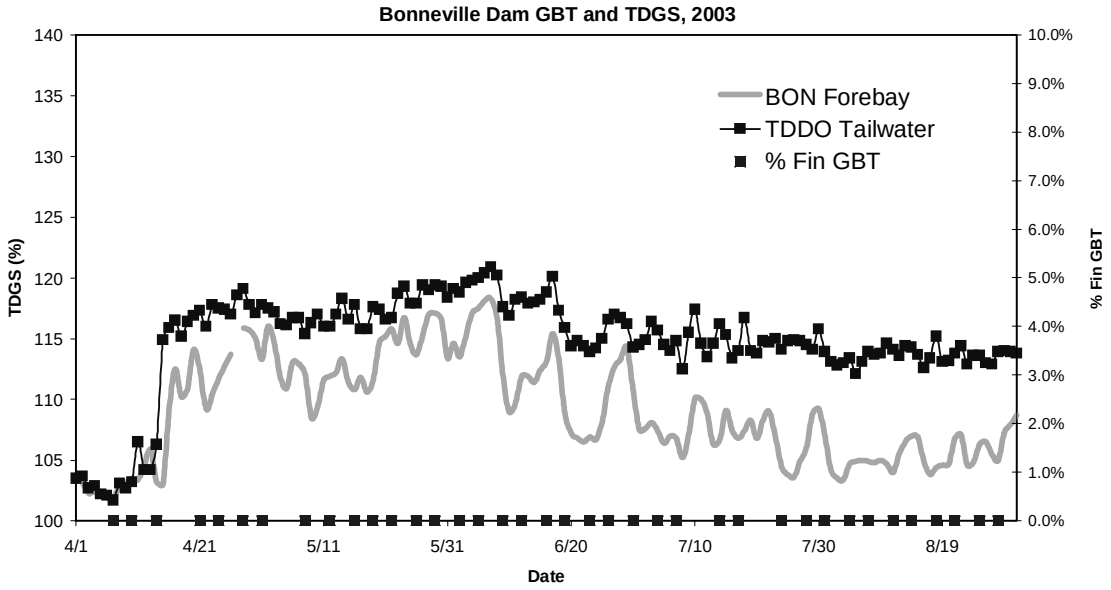


FIGURE C-1. Percent of fish examined at Bonneville Dam showing signs of GBT with associated dissolved gas saturation levels in the Bonneville Dam forebay and The Dalles Dam tailwater.

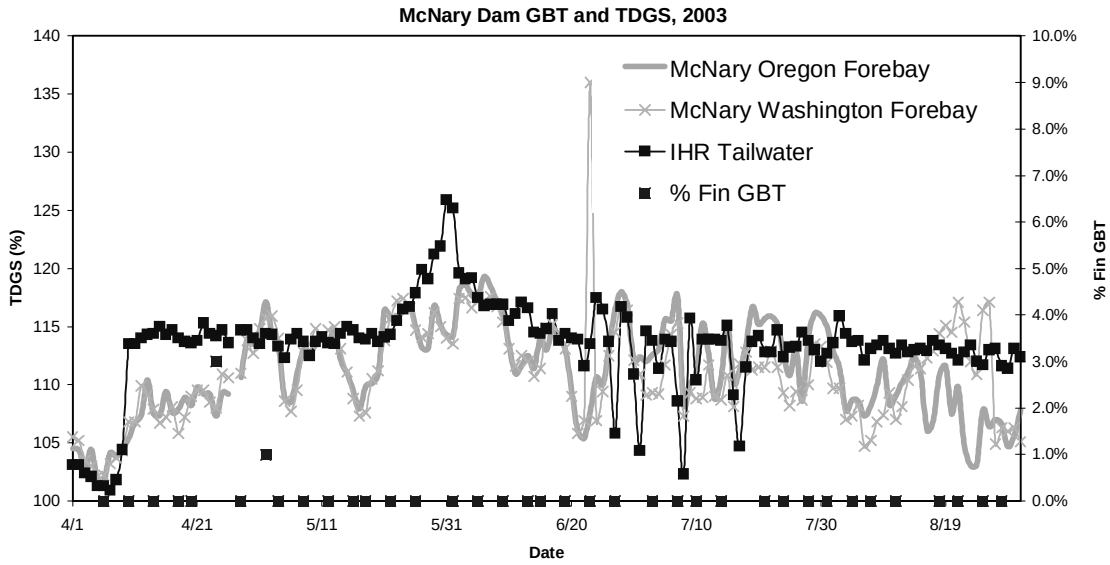


FIGURE C-2. Percent of fish examined at McNary Dam showing signs of GBT with associated dissolved gas saturation levels in the McNary Dam forebay (both Oregon and Washington sides) and the Ice Harbor Dam tailwater.

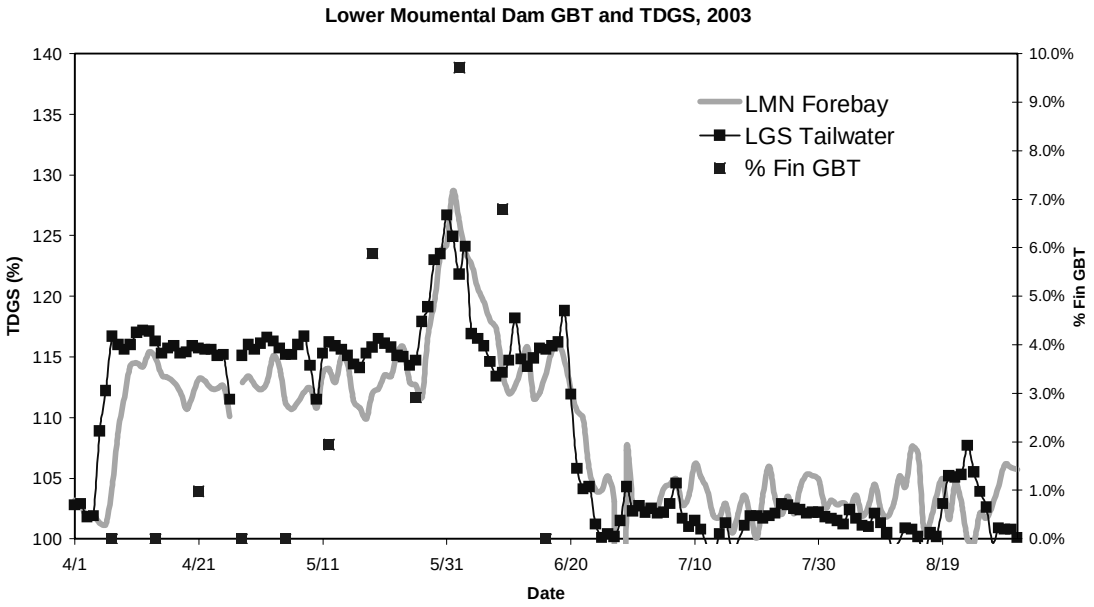


FIGURE C-3. Percent of fish examined at Lower Monumental Dam showing signs of GBT with associated dissolved gas saturation levels in the Lower Monumental Dam forebay and the Little Goose Dam tailwater.

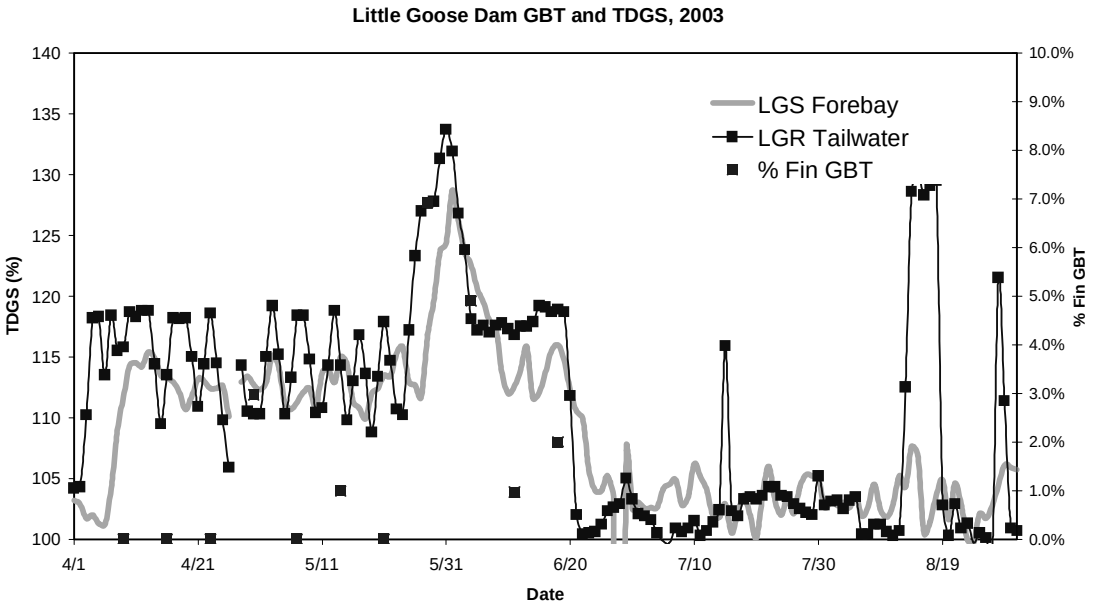


FIGURE C-4. Percent of fish examined at Little Goose Dam showing signs of GBT with associated dissolved gas saturation levels in the Little Goose Dam forebay and the Lower Granite Dam tailwater.

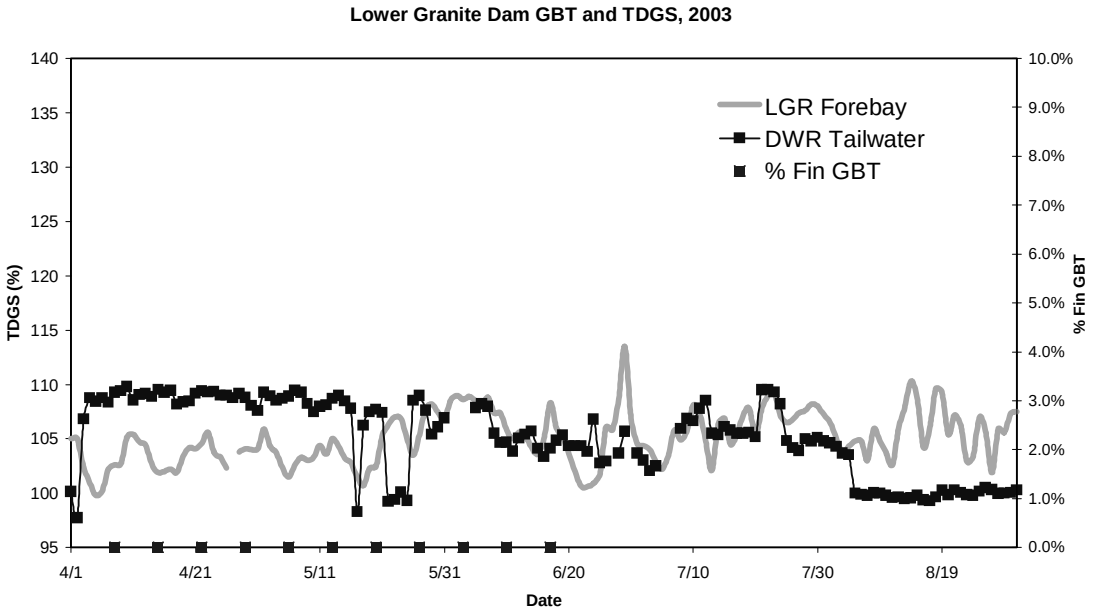


FIGURE C-5. Percent of fish examined at Lower Granite Dam showing signs of GBT with associated dissolved gas saturation levels in the Lower Granite Dam forebay and the Dworshak Dam tailwater.

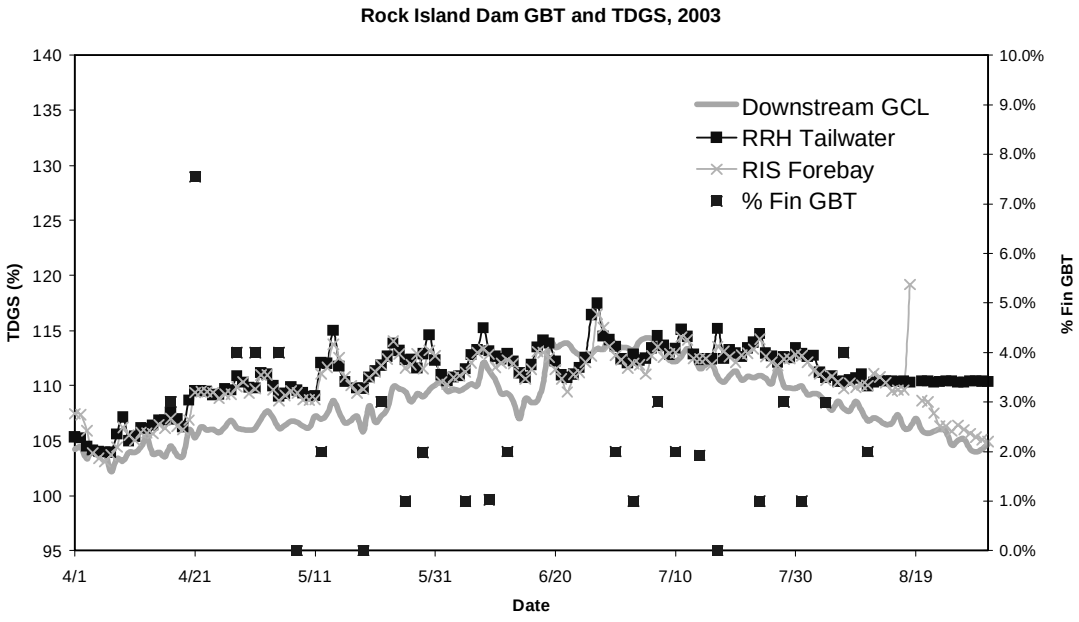


FIGURE C-6. Percent of fish examined at Rock Island Dam showing signs of GBT with associated dissolved gas saturation levels in the Rock Island forebay and Rocky Reach Dam and Grand Coulee Dam tailwaters.

APPENDIX D

Migration Timing Plots

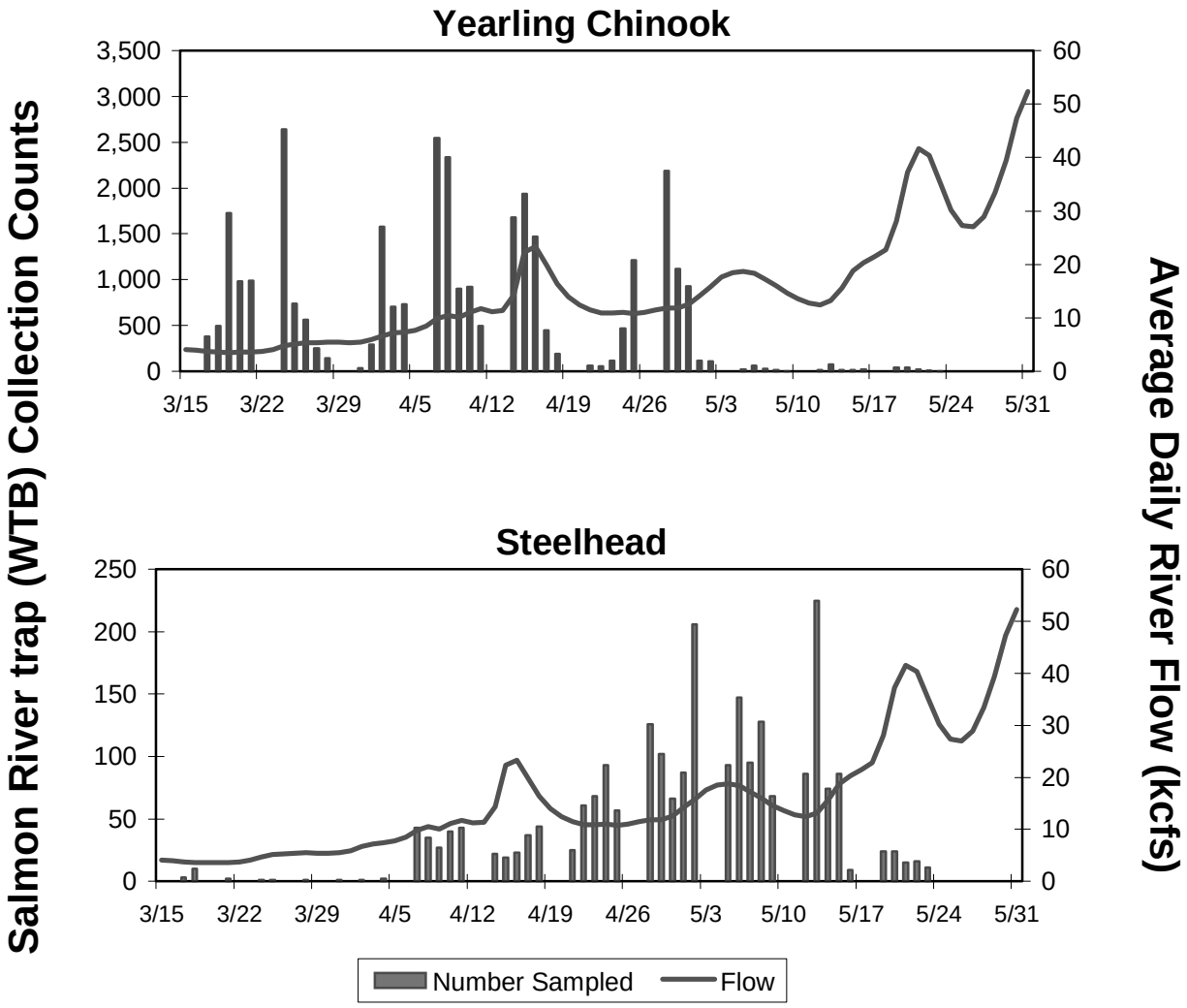


FIGURE D-1. Smolt migration timing at Salmon River Trap (WTB) with associated flow, 2003.

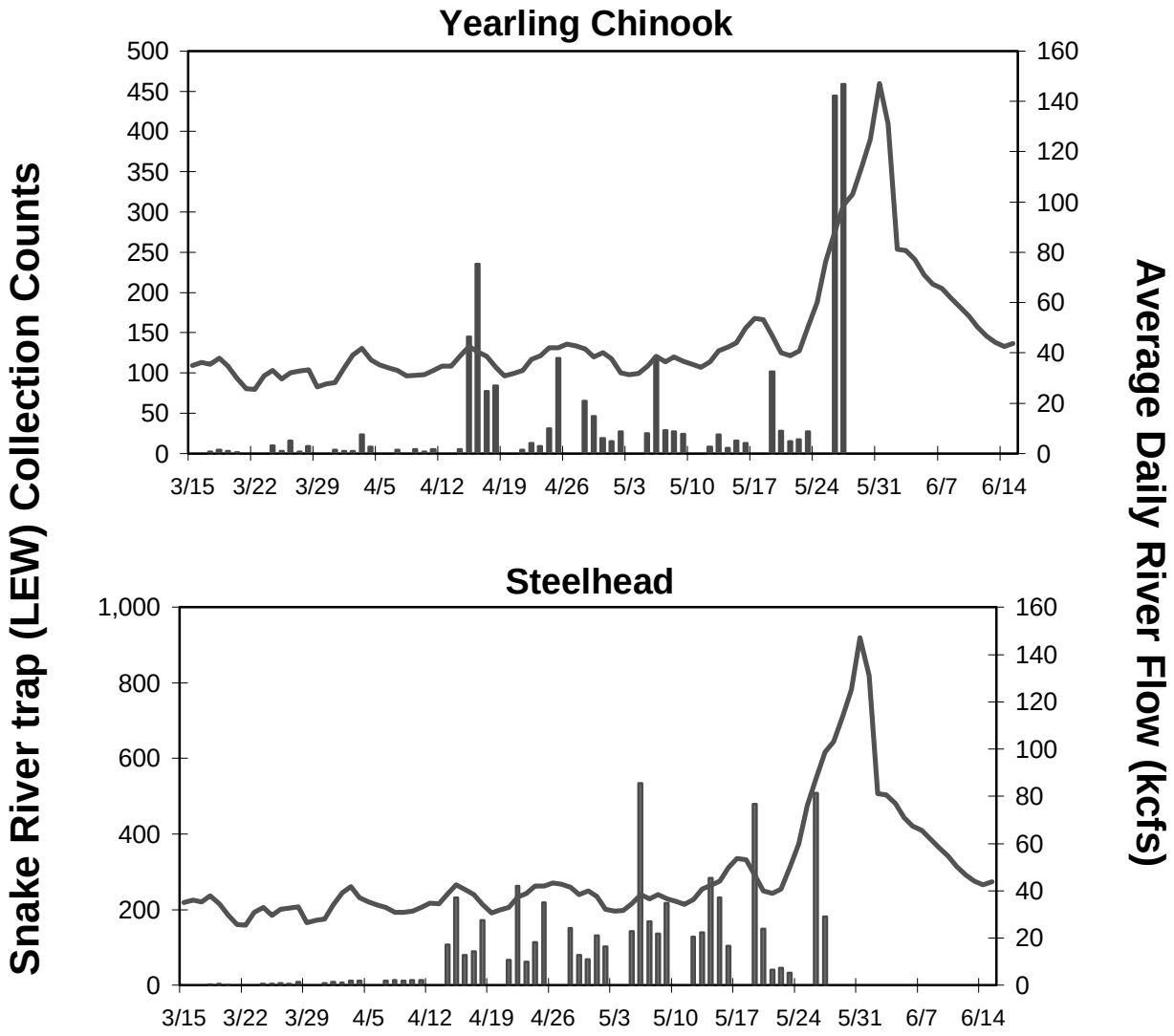


FIGURE D-2. Smolt migration timing at Snake River Trap (LEW) and associated flow, 2003.

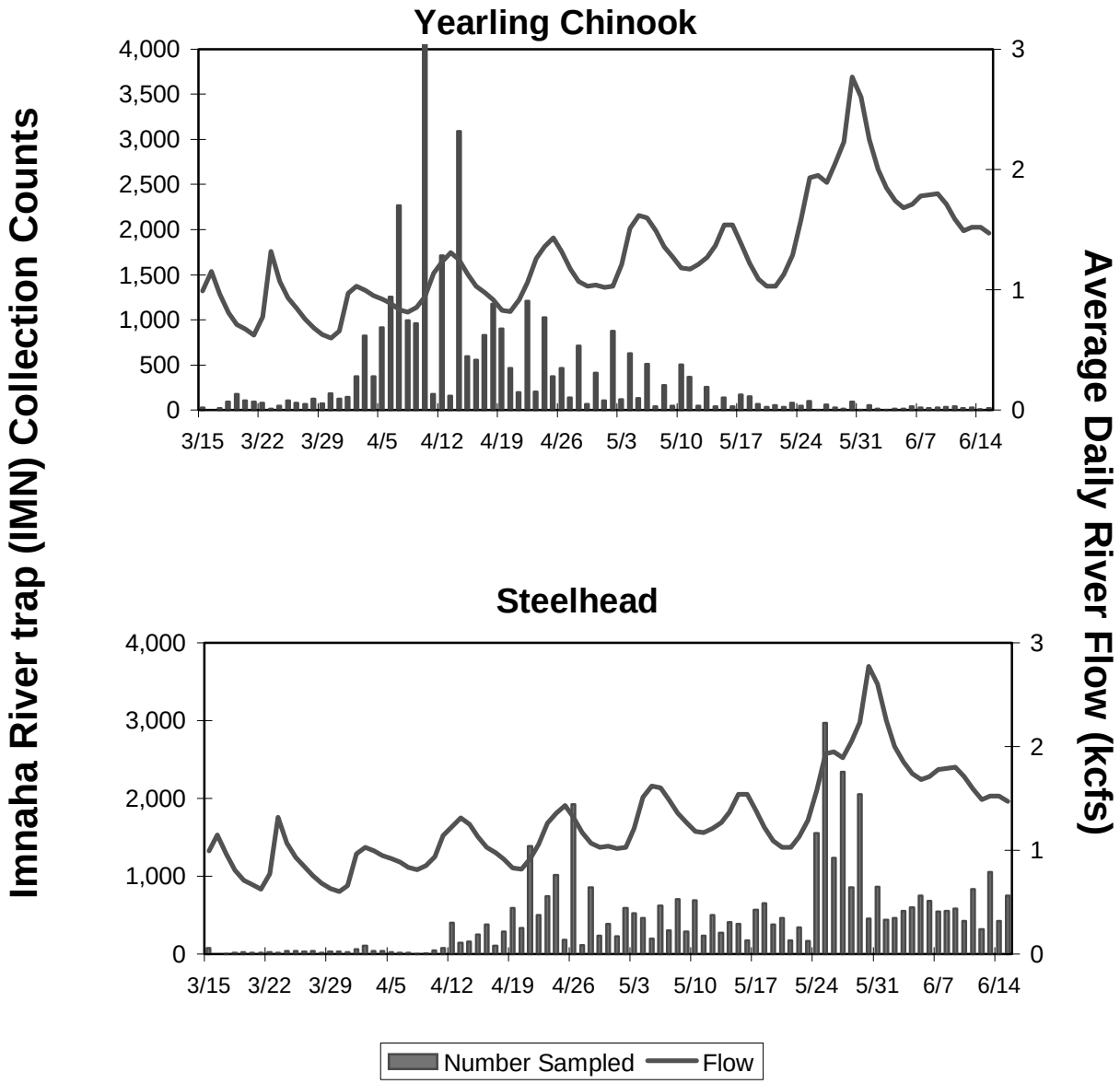


FIGURE D-3. Smolt migration timing at Imnaha River Trap with associated flows, 2003.

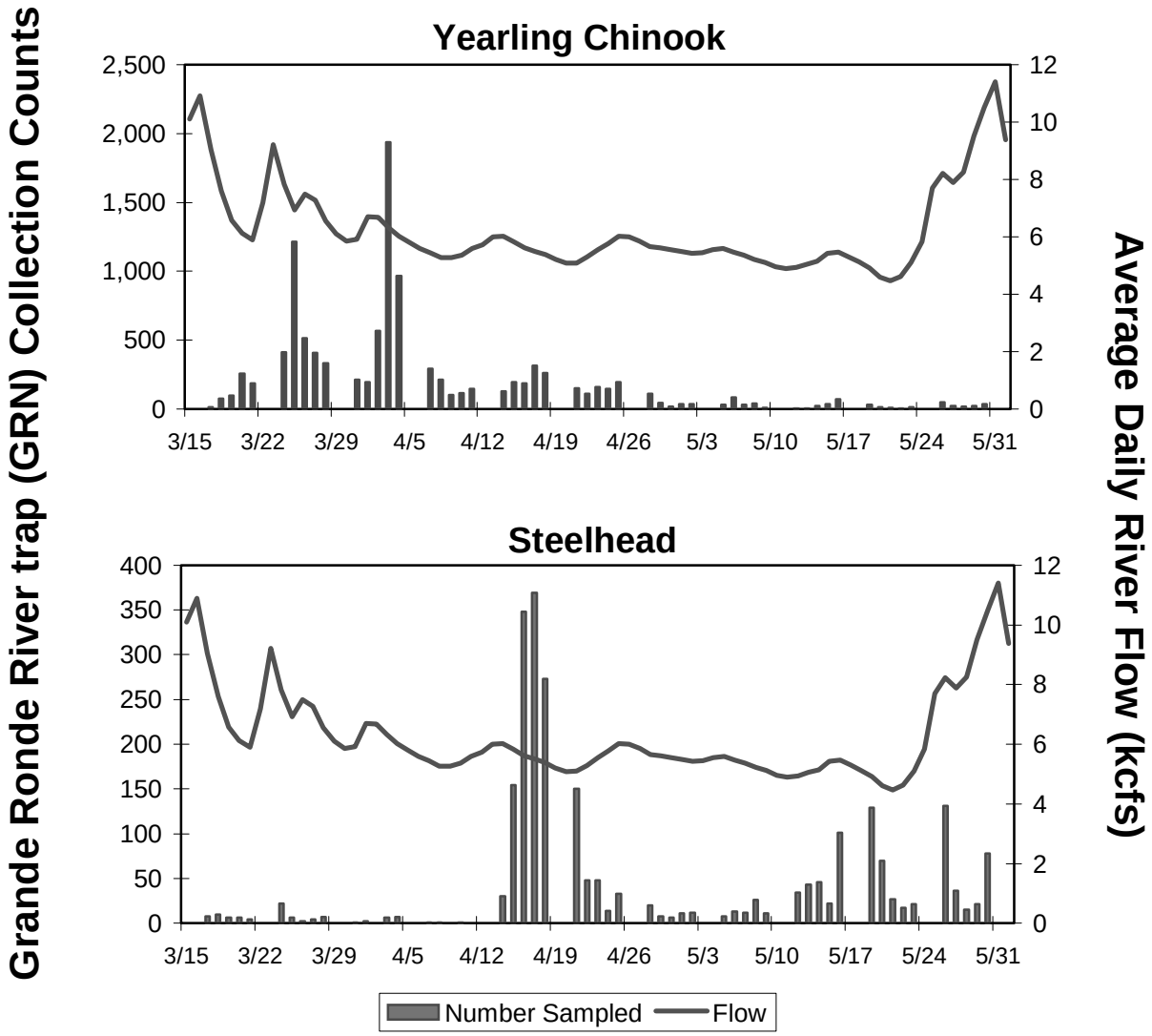


FIGURE D-4. Smolt migration timing at Grande Ronde River Trap with associated flows, 2003.

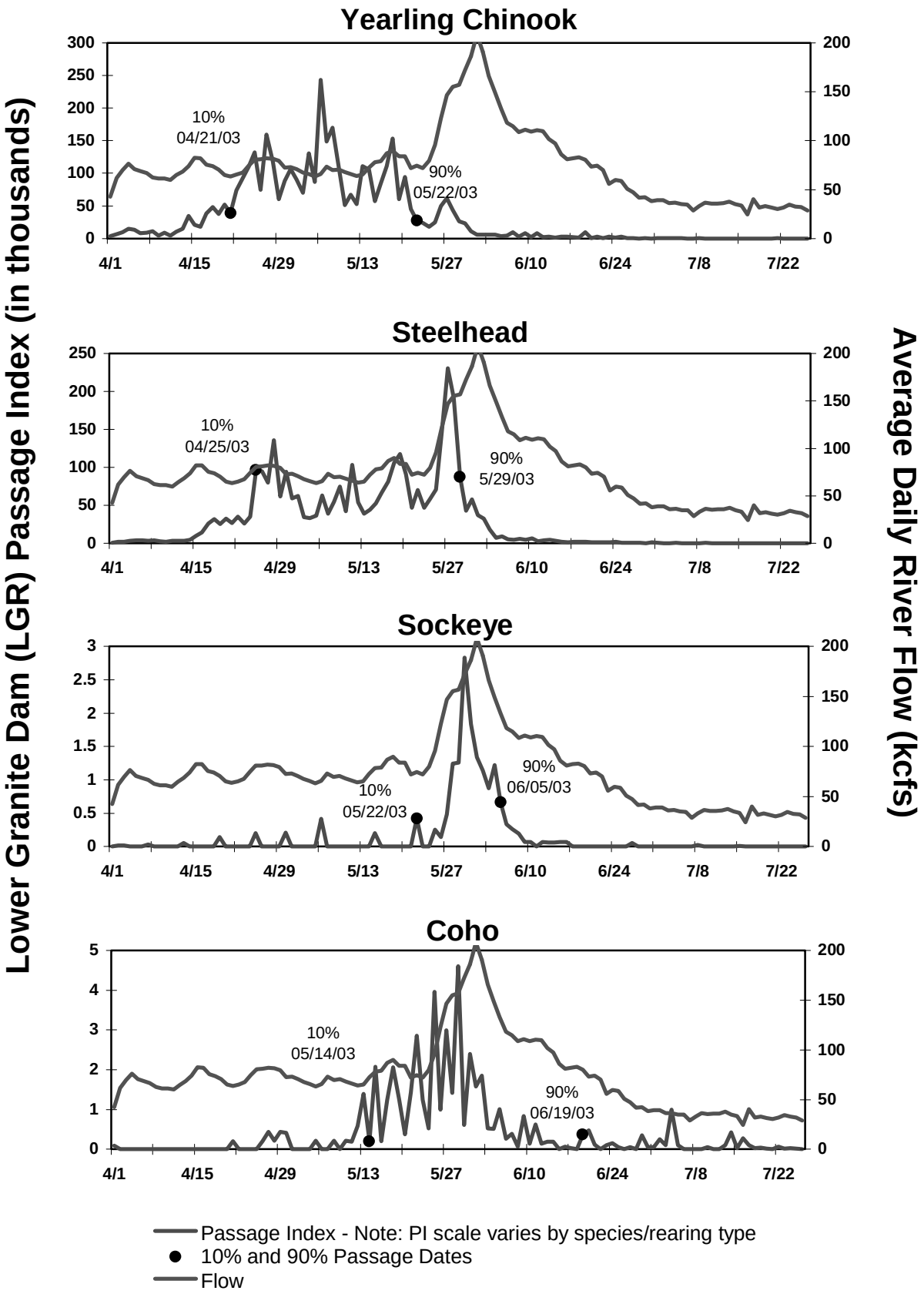


FIGURE D-5. Smolt migration timing at Lower Granite Dam with associated flow, 2003.

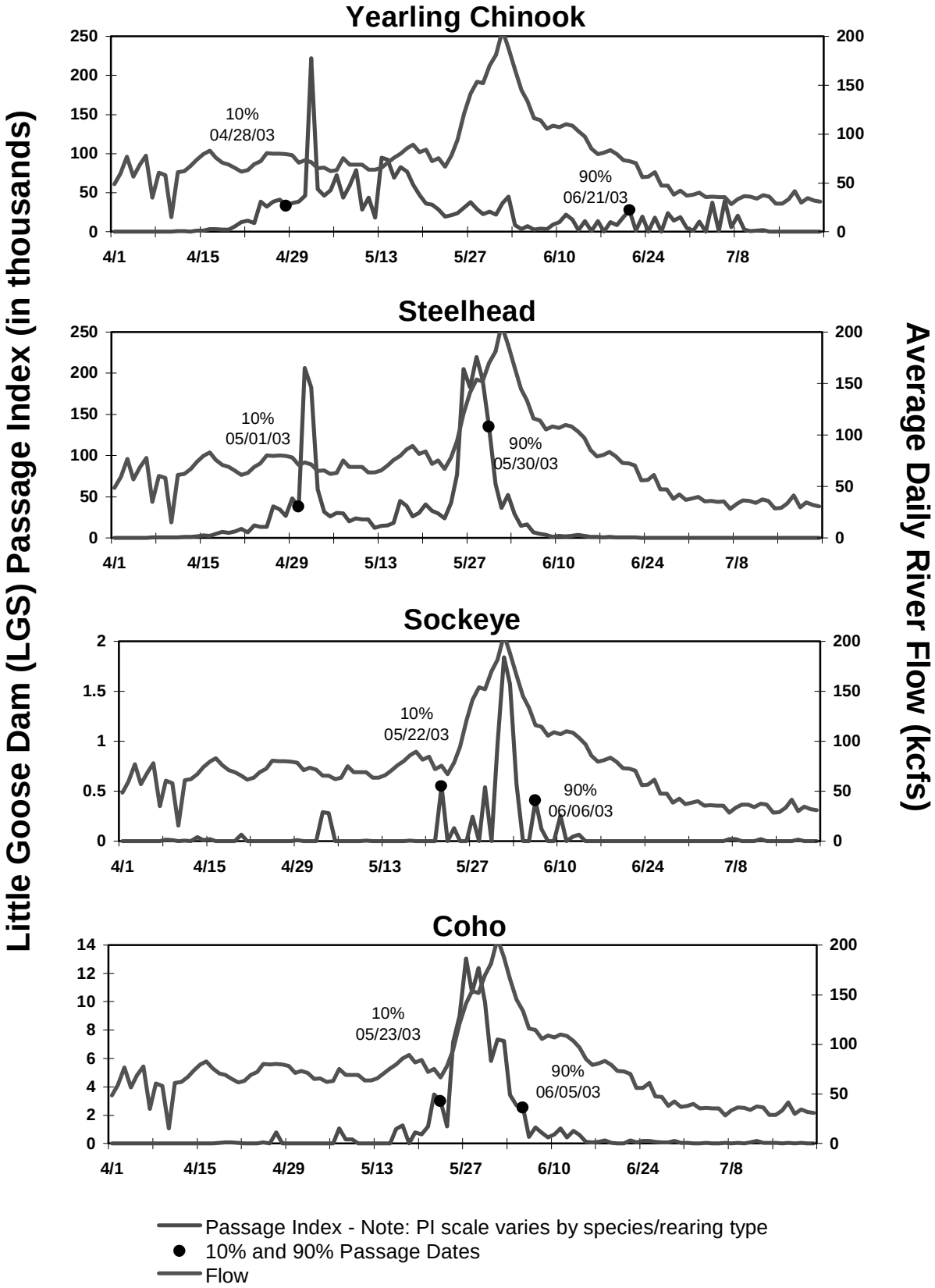


FIGURE D-6. Smolt migration timing at Little Goose Dam with associated flows, 2003.

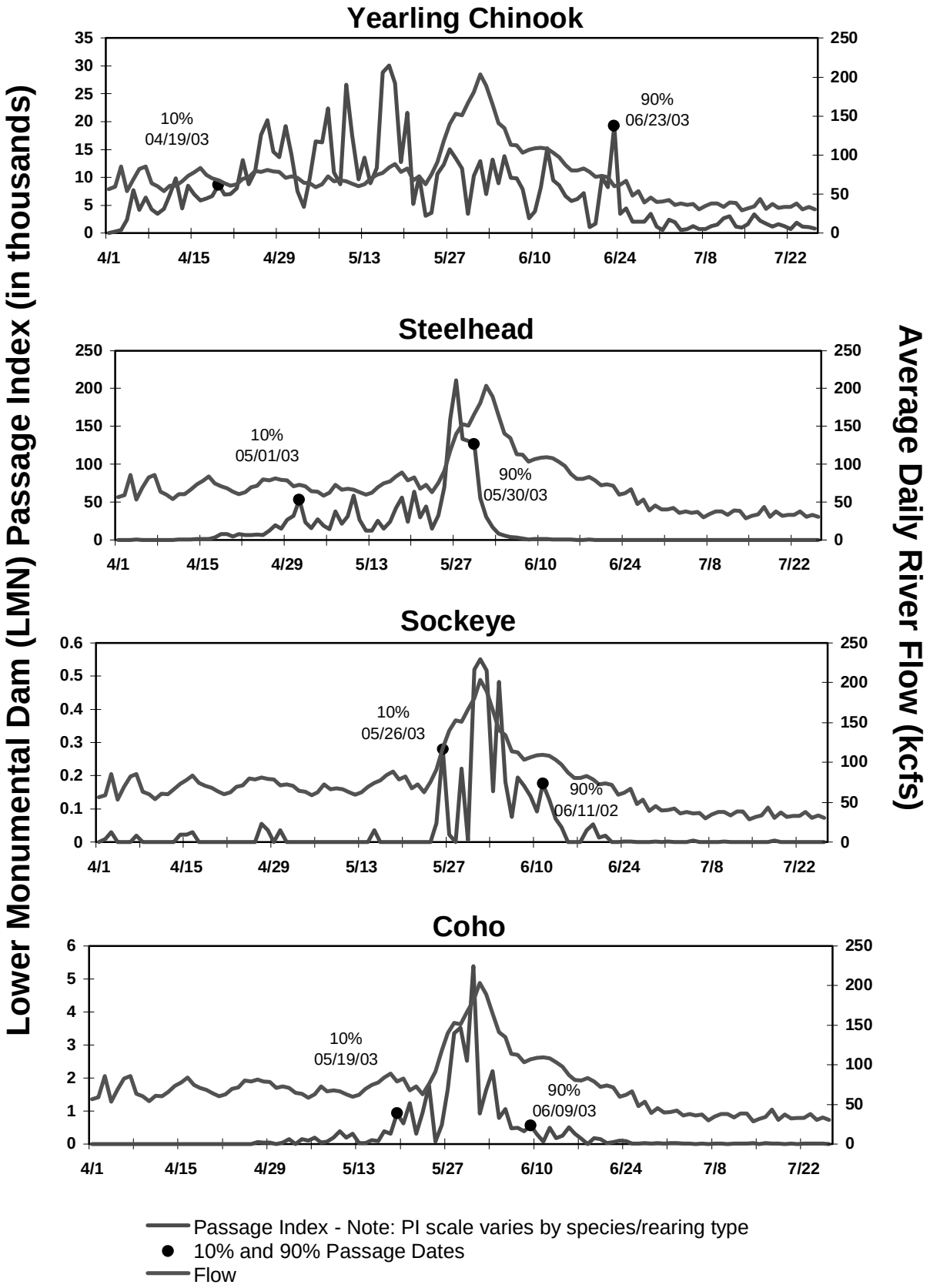


FIGURE D-7. Smolt Migration timing at Lower Monumental Dam with associated flow, 2003.

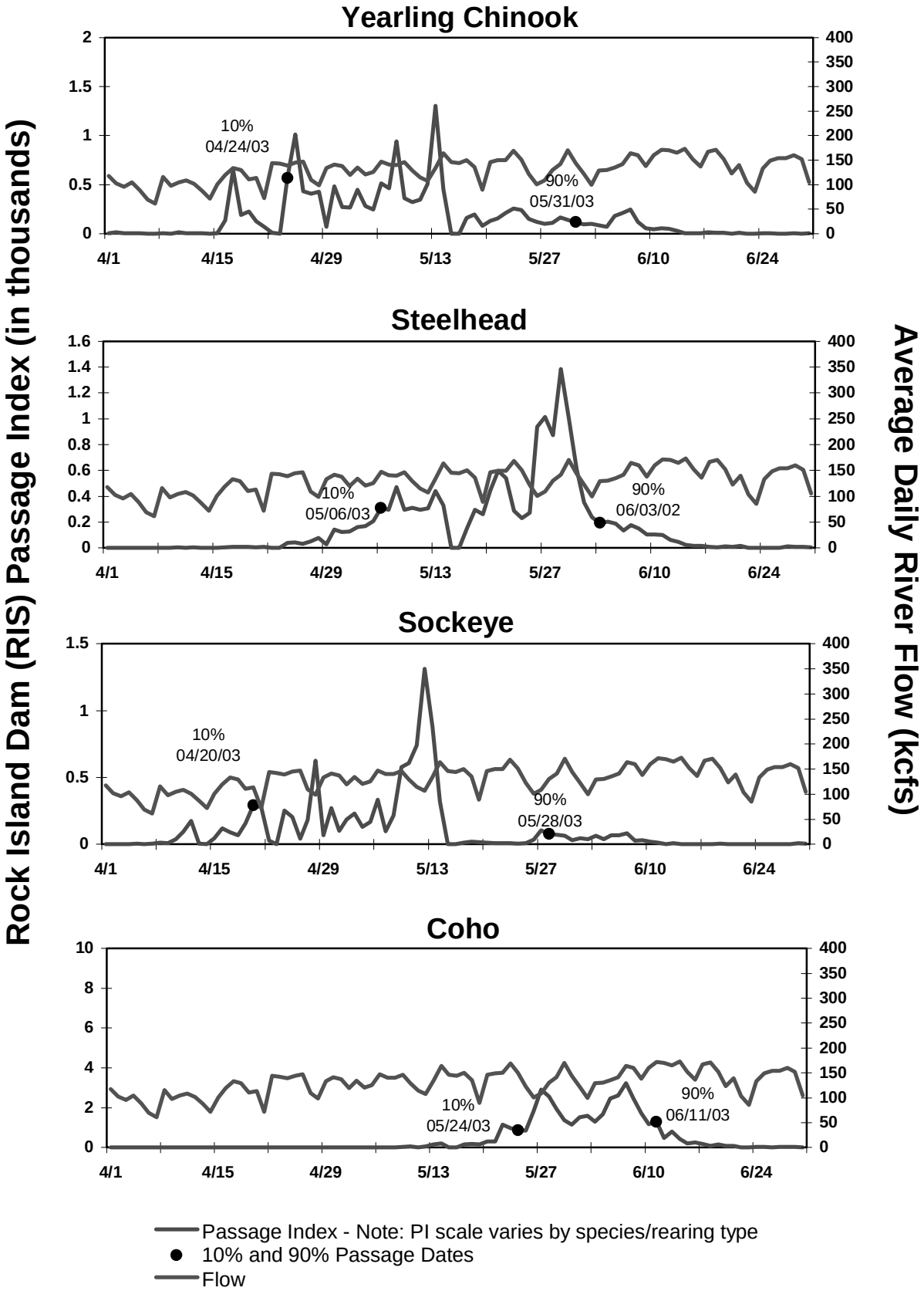


FIGURE D-8. Smolt migration timing at Rock Island Dam with associated flow, 2003.

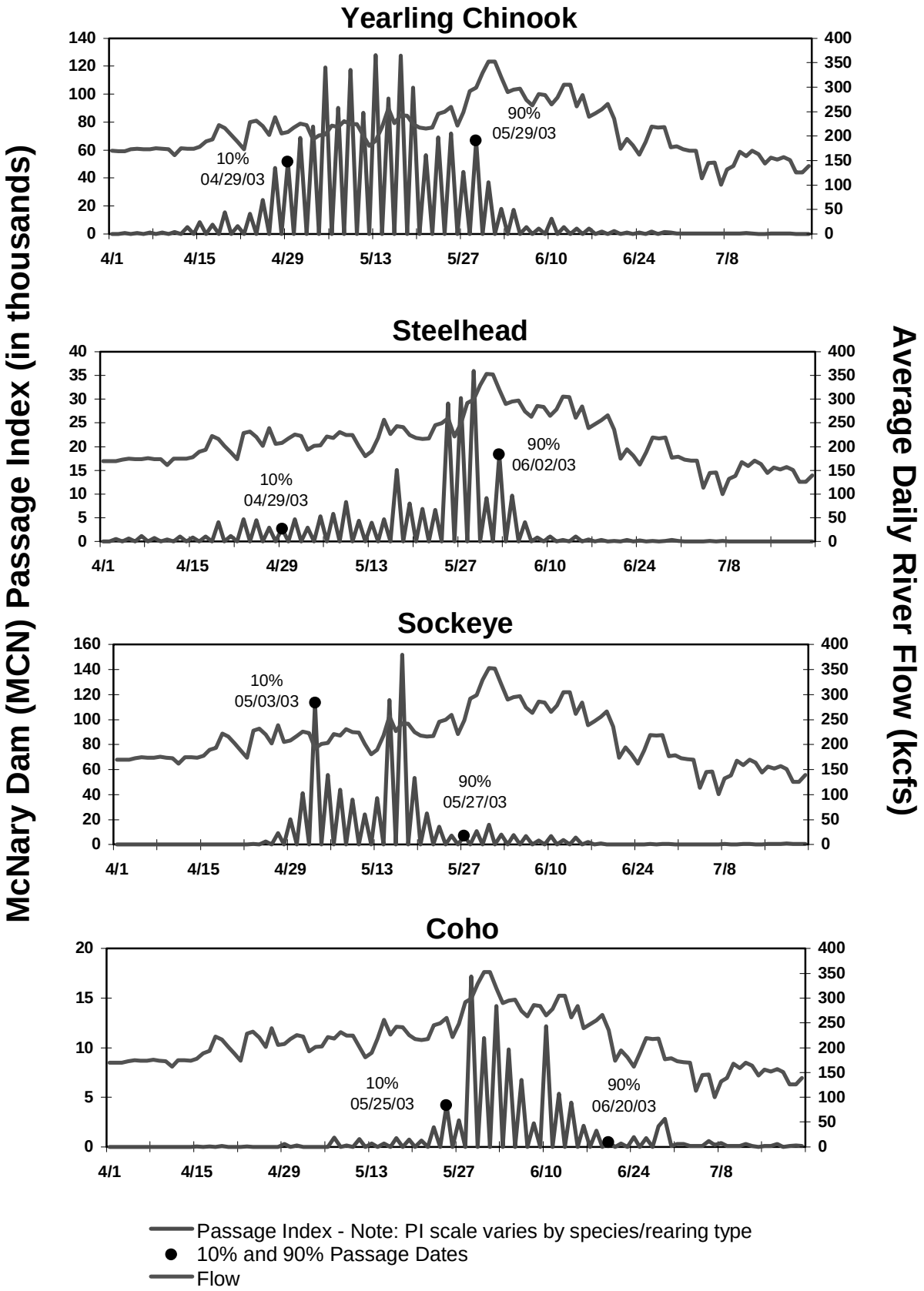


FIGURE D-9. Smolt migration timing at McNary Dam with associated flow, 2003.

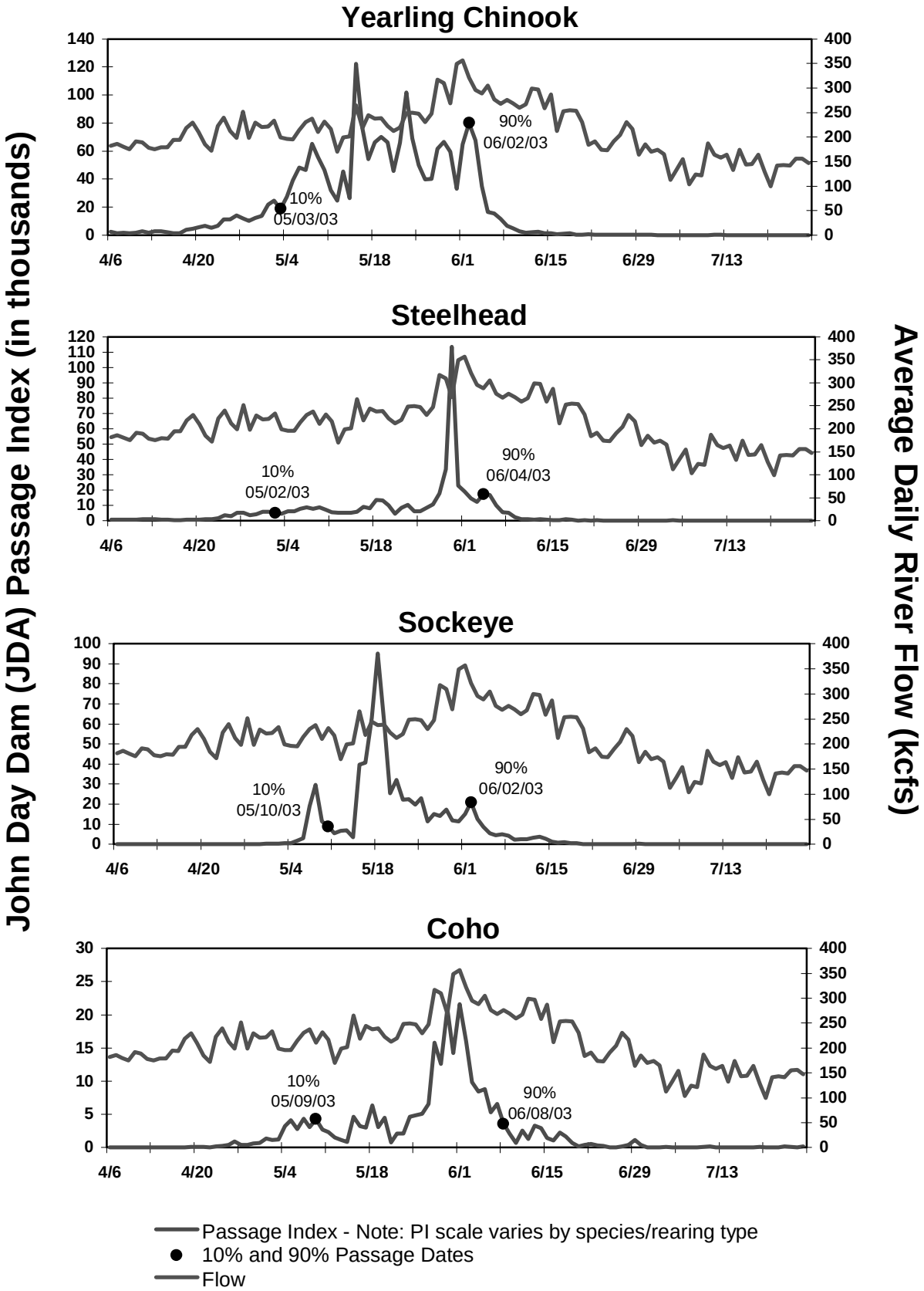


FIGURE D-10. Smolt migration timing at John Day Dam with associated flow, 2003.

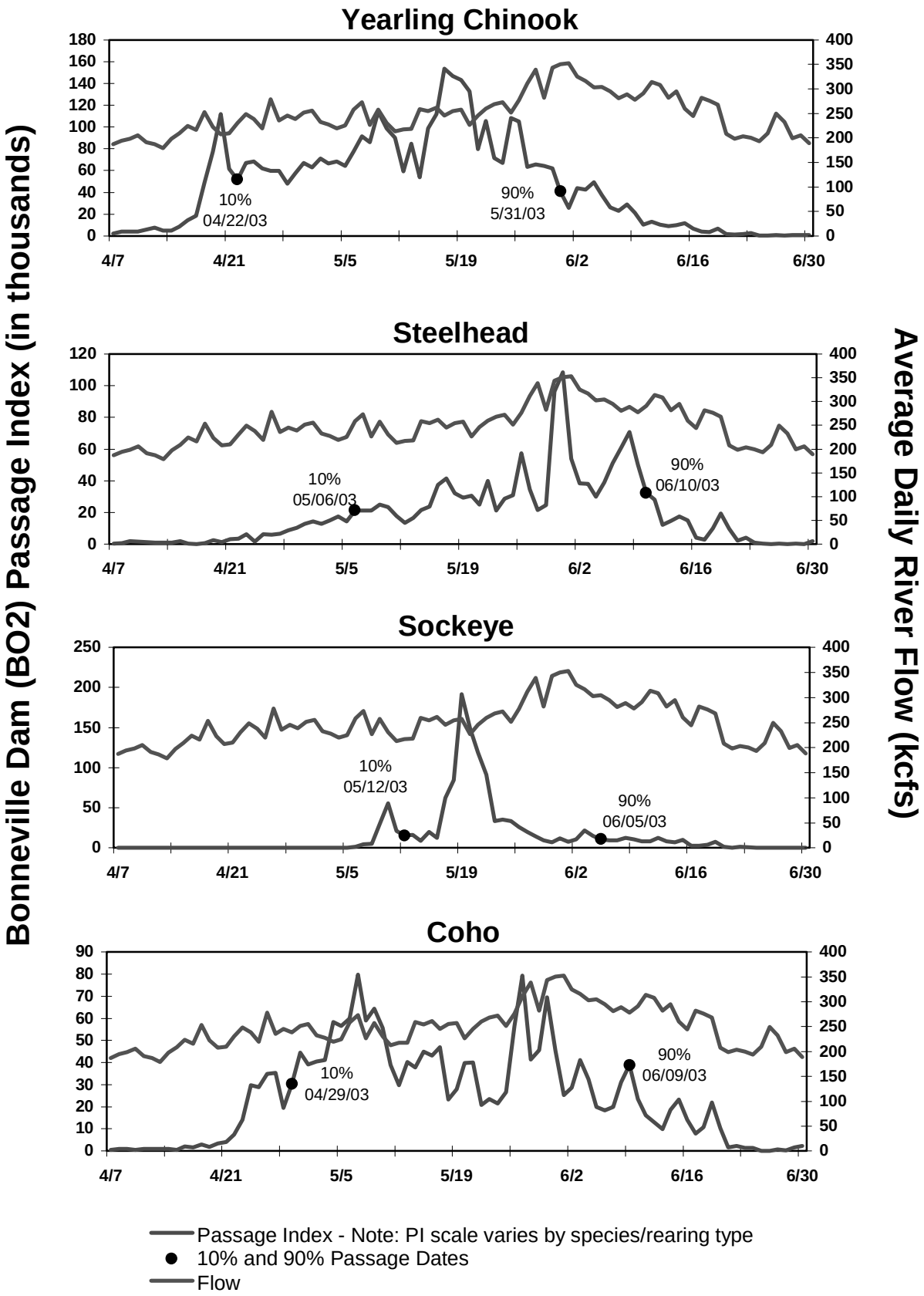


FIGURE D-11. Smolt migration timing at Bonneville Powerhouse II (BO2) with associated flow, 2003.

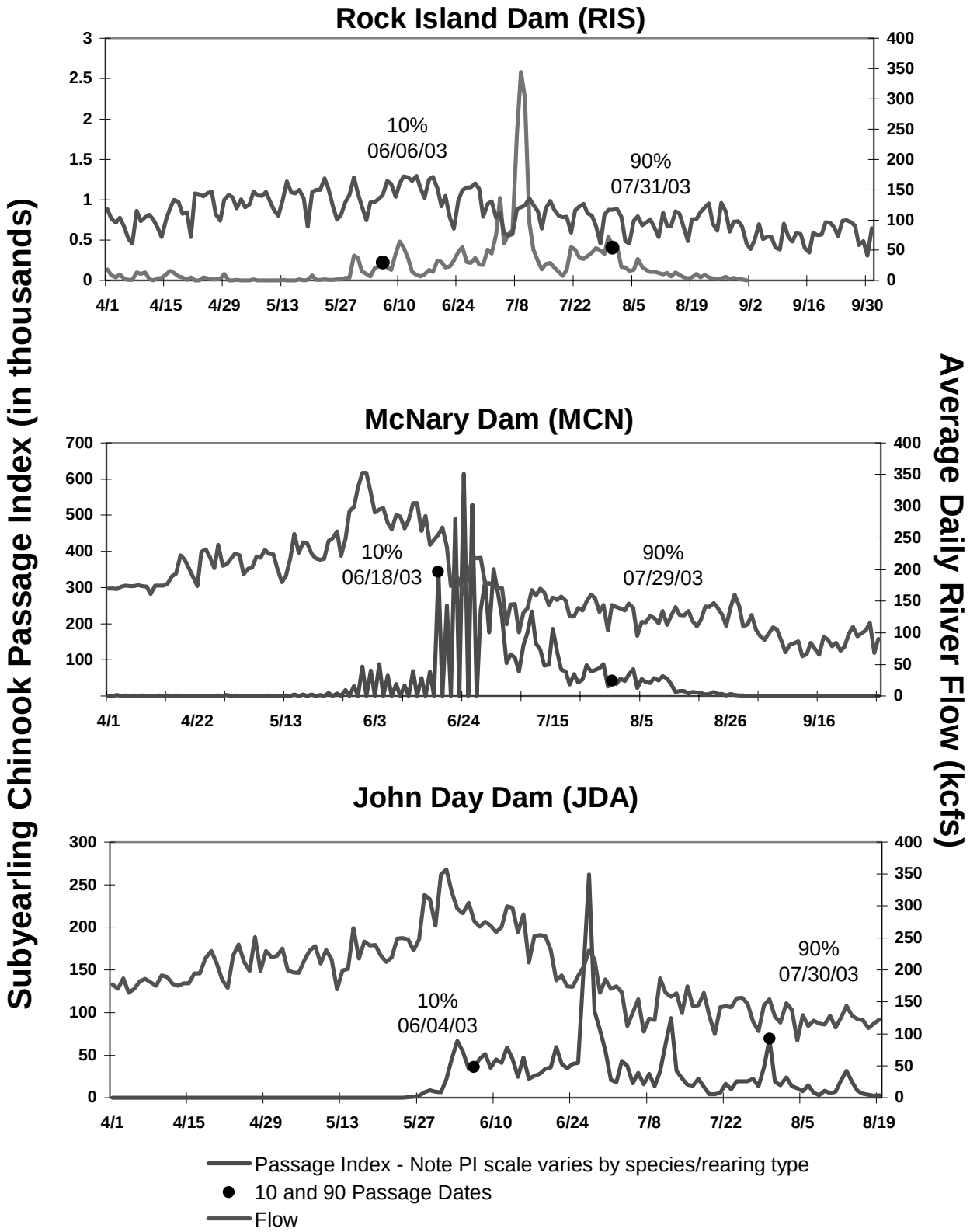


FIGURE D-12. Subyearling chinook smolt migration timing at Snake River sites with associated flow, 2003.

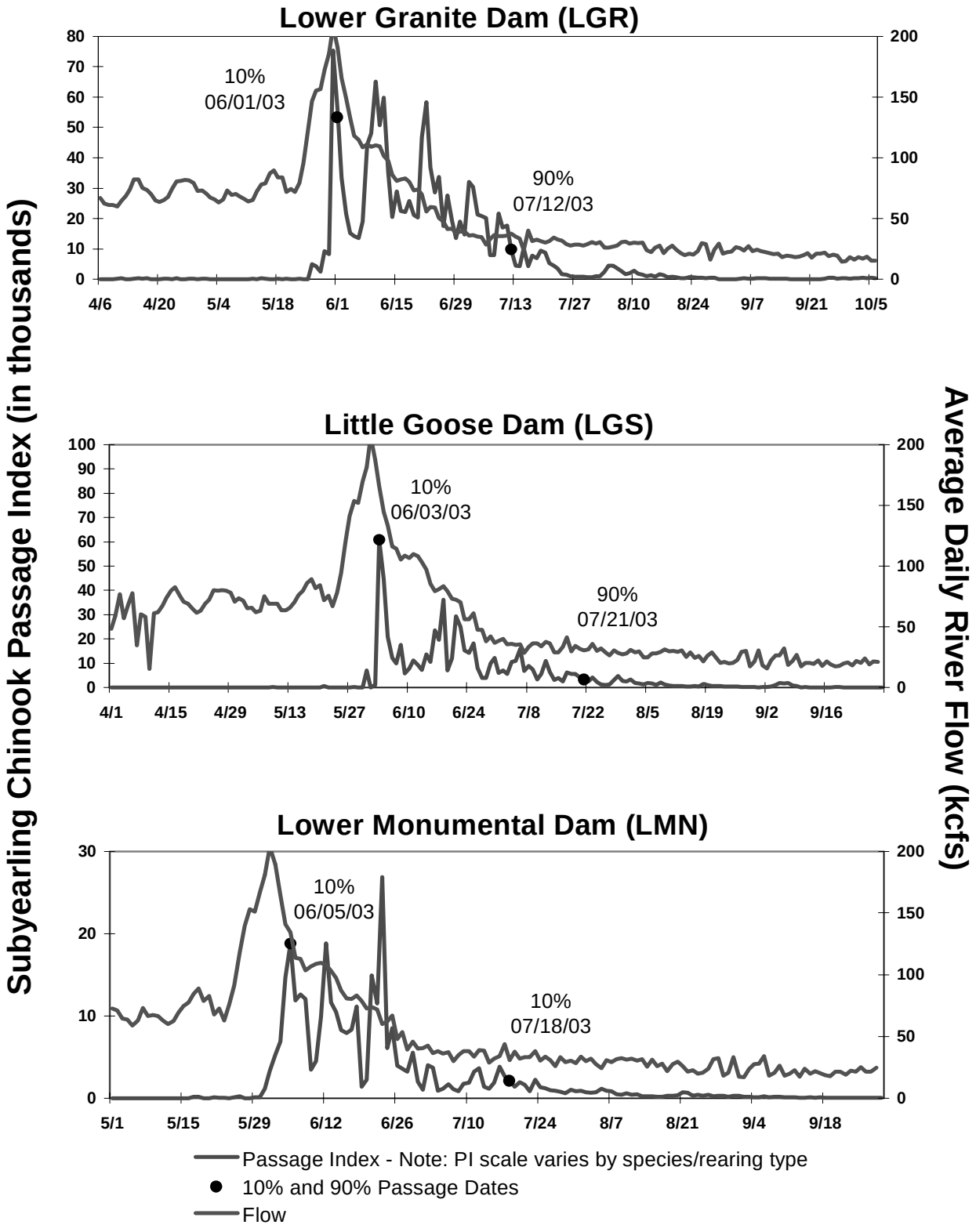
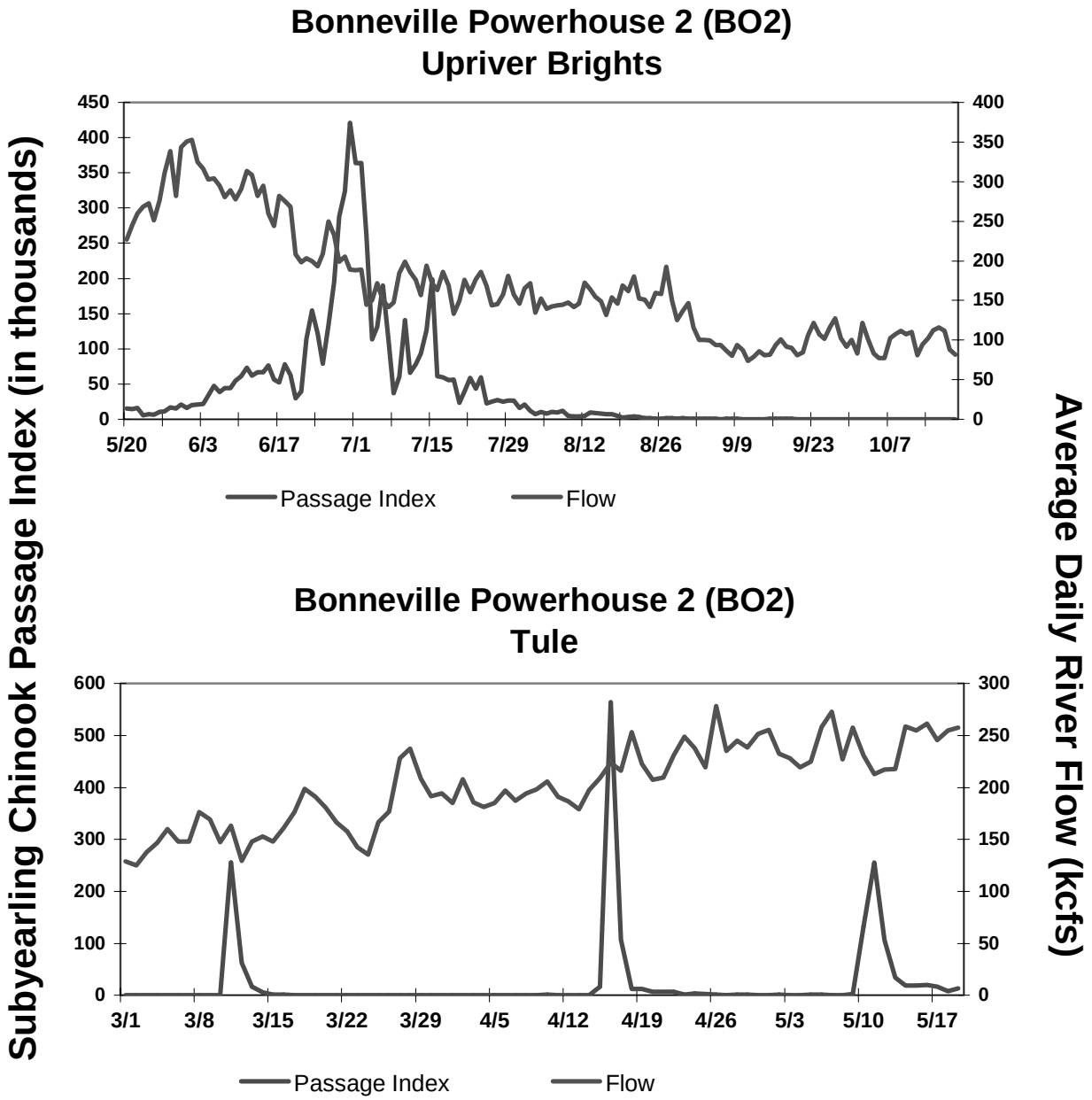


FIGURE D-13. Subyearling chinook smolt migration timing at Snake River sites with associated flow, 2003.



Spring Creek Hatchery Chinook (Tule) released on:

Date	Number Released
03/08/03	7,638,672
04/14/03	4,070,365
05/08/03	3,370,867

FIGURE D-14. Subyearling chinook smolt migration timing at Columbia River sites with associated flow, 2003.

APPENDIX E

Travel Time Tables

DISTANCES OVER WHICH TRAVEL TIME IS MEASURED:

Snake River Basin Hatcheries		**Distance to Lower Granite Dam**	
Drainage	**Hatchery/Release Site**	**Kilometers**	**Miles**
S.F. Salmon River	McCall H/Knox Bridge	457	284
Salmon River	Rapid River H	283	176
Salmon River	Imnaha A P	209	130
Grand Ronde River		238	148
Clearwater River	Dworshak H	116	72

Snake River Basin Traps		**Distance to Lower Granite Dam**	
Drainage	**Trap Location**	**Kilometers**	**Miles**
Salmon River	km 103	233	145
Imnaha River	km 7	142	88
Grande Ronde River	km 5	103	64
Snake River	km 225	52	32

Mid-Columbia River Basin		**Distance to McNary Dam**	
Drainage	**Hatchery**	**Kilometers**	**Miles**
Methow River	Winthrop H	454	282
Wenatchee River	Leavenworth H	330	205
Mainstem Columbia River	Wells H	360	224
Mainstem Columbia River	Priest Rapids H	169	105
Mainstem Columbia River	Ringold H	97	60

Key Index Reaches	**Reach Distance**	
Reach Location	**Kilometers**	**Miles**
Lower Granite Dam to McNary Dam	225	140
Rock Island Dam to McNary Dam	260	161
McNary Dam to Bonneville Dam	236	147

Distance Source: Kilometers of sites obtained from 1998 PIT Tag Specification Document, [editor] Carter Stein, Pacific States Marine Fisheries Commission, March 17, 1998. Miles computed using conversion 0.621 miles per kilometer.

Computation of average flow and average temperature: Flow and temperature data are averaged over the period of days equal to the estimated median travel time commencing on the date of

release (or date of passage at upstream dam for the Snake River and lower Columbia River index reaches). The flows and temperatures are indexed at Lower Granite Dam for the release to Lower Granite Dam travel time data. They are indexed at Ice Harbor Dam for the Lower Granite Dam to McNary Dam index reach and at The Dalles Dam for McNary Dam to Bonneville Dam index reach. For the release to McNary Dam travel time data of mid-Columbia River basin released fish, the flows and temperatures are indexed at Priest Rapids Dam.

TABLE E-1. 2003 travel time of PIT- tagged wild yearling chinook released from the Salmon River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/14	15.2	31.2	60	25.9	36.5	28	58.6
3/15	16.4	29.7	65.2	26.3	34.9	73	58.5
3/16	16.1	29.5	71.4	28	33.9	116	59.3
3/17	15	30.1	62.3	27.9	32	132	59.8
3/18	11.4	29.1	60.4	27.2	30.9	161	59.9
3/19	12.4	31	63	29.8	33.1	212	60.9
3/20	11.4	34	60	30.2	35.6	90	61.8
3/21	11.6	30.8	68	27.9	33.2	58	61.7
3/22	11.5	26.4	57.5	22.1	31.9	25	61.9
3/23	9	30	55.3	26.9	31.2	59	63.4
3/24	8.9	29.8	65.6	28.6	30.8	153	64.2
3/25	8.7	27.8	56.4	23.6	30.7	60	64
3/26	16.7	26.3	53.9	23.5	30.4	29	64.4
3/27	10	24.8	53.3	21.2	32.9	24	64.7
3/28	18.9	26	35.8	23.5	33	14	65.3
3/29	14.7	20.6	42.9	14.7	42.9	7	65.5
3/30	14.1	24	56.1	-	-	6	66.7
3/31	14.4	16.1	55.4	-	-	5	67.6
4/1	9.8	21	54.4	15.3	25.2	26	68.7
4/2	10.1	21.2	49.1	20	24.2	73	69.3
4/3	10.4	20.3	46	19	22.8	60	69.3
4/4	8.6	19.4	52.7	18.9	20.4	100	68.9
4/5	8.4	18.9	52.5	17.9	20	129	69.4
4/6	7.8	18.6	47.6	17.3	20.1	117	70
4/7	9.2	19.9	50.4	17.2	21.9	71	71.3
4/8	7.7	15.2	46.7	12.4	18	41	69.3
4/9	7.1	14.9	37.9	11.2	18	22	70.6
4/10	11.5	14.1	37.3	11.7	18	11	71.2
4/11	7.2	14.1	26.1	7.4	22	11	72.6
4/12	6.1	11.4	43.4	11	15	23	71.9
4/13	4.9	13.2	42.7	11.7	14	159	74.1
4/14	6.4	12	37.7	11	12.9	77	74.1
4/15	6.2	12.5	45.4	11.4	15	195	74.4
4/16	7	19.4	42.9	17.5	20.1	131	71.9
4/17	6.2	13.5	39.2	10.8	17.8	65	73.4
4/18	6.9	14	39	12.1	17.8	30	73
4/19	5.6	14.9	43.3	12.6	16.3	33	72.1
4/20	6.3	12.6	29.8	6.3	29.8	7	73.2
4/21	6	11.9	16.3	9.4	15	9	74
4/22	8.5	13.6	34.7	-	-	6	73.2
4/23	6.9	14	36.5	12	29.6	17	73.4
4/24	5.9	12.1	32.6	11	13.1	40	73.6
4/25	6	11.3	30.9	10.6	12.2	92	73
4/26	6.3	11.9	31	10.2	15.3	48	71.9
4/27	8.1	10.3	29.8	9.2	14.7	20	71.1
4/28	6.4	14.8	31.6	11.8	18	101	69.2
4/29	7.9	19.6	29.1	17	21	40	72.8
4/30	8.9	19.1	30.5	17.5	24.6	43	72.9
5/7	7.8	10.9	18.5	8.3	16.7	10	74.5

TABLE E-2. 2003 travel time of PIT-tagged hatchery yearling chinook released from the Salmon River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/18	14.5	26.4	48.3	22	39.2	12	57.6
3/19	16.3	37.4	59.1	35.2	38.5	59	62.6
3/20	29	37.5	48.2	33.8	44.1	19	63.8
3/21	8.4	34.2	57.2	31.9	41.9	21	62.7
3/24	23.1	33.8	53.8	31.4	38.7	36	66.1
3/25	17.1	33.2	82.4	29.6	36.8	30	66.4
3/26	23	38.7	53.1	32	41.8	33	67.5
3/27	25.1	36	55.4	33.4	46.1	35	67.9
3/28	23.6	35	51.3	30.2	50.3	17	68.1
4/1	17.9	29.5	45	26	34.2	43	71.2
4/2	22.2	33.2	54	27.2	41	24	70.8
4/3	14.1	32.6	48.5	27.8	36.1	32	70.9
4/4	16.4	31.1	43.6	23.1	38.3	24	70.7
4/7	13.8	28.5	42.9	21.9	33.7	29	71
4/8	10.3	28.9	48.6	20	38.1	21	71.2
4/9	8.3	28.2	41.3	22.1	36.1	34	71.5
4/10	11.2	25.2	35.5	18.5	27.3	29	71.9
4/11	7.1	19.5	36.1	15.9	23.4	35	73.7
4/14	10.7	22.9	34	20.6	25.3	31	72.8
4/15	8.2	27.2	36.5	21	30.6	27	71.3
4/16	9.5	25.4	39.9	21.3	30.2	30	71.2
4/17	9.1	23	39.5	20.3	26.2	31	71.3
4/18	10.9	19	31.4	15.7	25.1	15	71.6
4/19	15.6	19.8	26	16.6	25.4	10	71.5
4/23	11	20.1	28.3	18.1	23.1	19	71.8
4/24	6.1	18.2	32.5	14.2	19.2	78	71.6
4/25	4.6	13.2	23.5	12.7	19.2	33	72.6
4/28	8	14	26.7	12.5	15.8	35	69
4/29	6.2	14.8	25.9	11.7	17.1	30	69.1
4/30	10.8	16	23.1	13.5	18.5	32	70.6
5/1	9.2	16.4	25.5	15	19.2	24	71.6
5/2	6.1	15.2	24.4	12.9	17.4	25	71.6
5/3	9	12.2	21.5	10.3	13.2	19	69.3
5/4	8.9	12.6	17.1	12	13.5	12	72.3
5/6	7.1	11.4	19.6	10.2	12.5	18	73.6
5/13	3.5	5.7	9.6	4.9	6.7	26	82

TABLE E-3. 2003 travel time of PIT-tagged wild steelhead released from the Salmon River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/15	38.4	38.4	38.4	-	-	1	61
3/16	24.5	24.5	24.5	-	-	1	56.4
3/17	30.3	30.3	30.3	-	-	1	59.8
3/18	18.3	28.5	31.8	-	-	5	59.9
3/21	9.9	9.9	9.9	-	-	1	48.1
4/12	4.1	4.1	4.1	-	-	1	76.5
4/13	3.9	5.1	17.4	-	-	5	76.3
4/14	3.9	7.3	13.4	-	-	4	72.2
4/16	5.5	5.9	15.5	-	-	3	68.7
4/17	4	5.9	7.7	-	-	5	68.6
4/18	4.6	9.7	12.2	-	-	5	73.7
4/21	3.7	6.6	9.4	-	-	2	76.4
4/22	4.1	4.9	5.7	-	-	2	77.8
4/23	4.2	4.4	4.5	-	-	2	79.9
4/24	3.1	4.9	7.5	-	-	4	79.5
4/25	4.3	4.4	5.3	-	-	4	79.3
4/26	15.2	18.9	22.6	-	-	2	71.4
4/28	3.5	5.4	7.1	-	-	4	71.5
4/29	5.4	7.4	10.9	-	-	4	69
4/30	4.9	4.9	4.9	-	-	1	67.7
5/2	4.7	4.7	4.7	-	-	1	67.6
5/3	4.3	4.6	4.8	-	-	2	68
5/5	3.7	3.7	3.7	-	-	1	69.4
5/6	7.1	7.4	7.6	-	-	2	68.6
5/7	4.1	4.8	5.5	-	-	2	67.3
5/8	4.5	5.5	7	-	-	5	69.2
5/9	4	4.8	5	-	-	4	69
5/10	5.3	5.3	5.3	-	-	1	70.9
5/11	5.5	5.5	5.5	-	-	1	76.5
5/12	4.6	6.3	8	-	-	2	79.4
5/13	3.5	4.2	6.2	3.7	4.8	9	81.3
5/14	7.7	7.7	7.7	-	-	1	80
5/15	2.8	4.2	5.5	-	-	2	84.7
5/16	2.8	2.8	2.8	-	-	1	86.1
5/17	2.8	3	3.1	-	-	2	82.4
5/19	3.5	3.8	4	-	-	2	76.4
5/20	4.6	4.6	4.7	-	-	2	86.1
5/21	3.6	4	4.5	-	-	2	88.9
5/22	3.7	3.7	3.7	-	-	1	103.4
5/23	2.6	2.6	2.6	-	-	1	111.2

TABLE E-4. 2003 travel time of PIT-tagged hatchery steelhead released from the Salmon River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/7	5.8	9.8	24.6	7	12.9	12	69.6
4/8	6.8	11	16.7	-	-	6	69.9
4/9	4.8	9	22.5	4.8	22.5	8	71.2
4/10	4.4	7.6	21.1	6.8	10.7	18	72.4
4/11	3.4	4.9	11.1	3.7	8	9	74.5
4/12	3.6	6.5	30.1	5.5	10.4	22	74
4/13	4	6	27.2	4.6	7.9	10	74.7
4/14	7.4	19	30.7	-	-	2	73.7
4/15	6.6	6.6	6.6	-	-	1	70.4
4/16	4.7	4.7	4.7	-	-	1	68.9
4/17	6.5	16.6	26.6	-	-	2	72.1
4/18	3.8	5.8	37.7	4.4	9.3	17	69.5
4/19	4.9	6.7	29.8	5.7	8.8	12	72.4
4/21	3.7	6.6	11.7	4.6	10.2	9	76.4
4/22	3.5	4.8	23.9	3.9	6.9	23	77.8
4/23	3.5	4.6	23	3.7	6.7	17	79.8
4/24	3.5	4.9	23.8	4.4	5.9	23	79.5
4/25	3.5	5.6	12	3.5	12	8	77.2
4/26	3.7	4.3	5.5	-	-	3	77.7
4/27	3.9	4.8	5.7	-	-	2	74.1
4/28	3.5	6.4	21.3	3.8	16	21	70.4
4/29	3.9	5.4	19.6	4.5	15.6	10	68.9
4/30	4.5	5.9	10.8	4.5	10.8	7	68.5
5/1	3.7	4.6	8.6	4	6.5	15	67.7
5/2	3.5	6.5	24.5	4.8	9	41	68
5/3	2.8	5.4	23.5	3.7	10.6	17	68
5/5	4.2	7.6	21.6	4.7	13.6	17	68.3
5/6	4.7	6.4	20.5	4.8	7.9	24	68.1
5/7	4.7	5.8	20.1	5.1	9.2	15	68
5/8	2.8	5.7	16.6	4.8	7.6	30	69.2
5/9	3.8	6.2	10.7	4.2	8.5	10	70.4
5/10	4.5	6.1	16.6	5.1	8.2	23	73.2
5/11	3.5	5	15.8	4.6	5.7	20	74.3
5/12	2.9	4	15.7	3.8	4.8	25	76.4
5/13	2.7	4.5	14.8	3.9	4.7	54	81.7
5/14	2.6	3.8	12.2	3.5	4.7	19	83.6
5/15	2.5	3.7	12	3.5	4.8	16	84.7
5/16	4.6	4.6	4.6	-	-	1	81.8
5/19	2.6	4.3	5.6	-	-	4	76.4
5/20	3.6	5.2	6.5	-	-	4	86.1
5/21	3.6	3.6	4.6	-	-	3	88.9
5/22	2.7	3.8	4.7	-	-	6	103.4
5/23	2.6	3	6.3	-	-	5	111.2

TABLE E-5. 2003 travel time of PIT-tagged wild yearling chinook released from the Snake River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/15	2.3	5.2	12.3	3.2	8.2	17	71.7
4/16	3.6	7	43.7	5.8	7.7	38	69.4
4/17	4	6.8	11.1	4	11.1	8	70.1
4/18	3.8	5.2	12.8	4.9	7.5	15	67.7
4/19	3.8	5	7.3	3.8	7.3	8	69.4
4/20	4.4	5	5.6	-	-	2	72.1
4/21	5.9	5.9	5.9	-	-	1	76
4/22	4.5	4.5	4.5	-	-	1	77.8
4/23	3.2	3.2	3.2	-	-	1	79.5
4/24	3	6.5	6.9	-	-	3	77.6
4/25	3.8	5	11.9	-	-	4	78.2
4/26	4.3	4.6	4.8	-	-	2	76.5
4/27	4	5.7	6.1	-	-	3	72.9
4/29	5.9	7.1	13.9	6.5	9.9	10	69
5/3	2.6	3.3	4	-	-	2	67
5/6	4.3	5.2	6.1	-	-	2	68.6
5/7	4.7	5.3	5.9	-	-	2	67.3
5/8	3.5	4	4.6	-	-	2	66.8
5/9	3.7	3.7	3.7	-	-	1	67.2
5/11	3.1	3.1	3.1	-	-	1	70
5/12	4	4	4	-	-	1	76.4
5/13	19.6	19.6	19.6	-	-	1	117.7
5/14	3.8	3.8	3.8	-	-	1	83.6
5/16	2.5	19.2	35.8	-	-	2	126.2
5/17	2.1	2.1	2.1	-	-	1	85.8
5/18	3	5.3	33.6	-	-	4	77.6
5/19	3.7	5	6.2	-	-	2	79.6
5/20	3.9	5.1	5.6	-	-	4	86.1
5/22	3.5	3.5	3.5	-	-	1	103.4
5/23	2.5	4	5.6	-	-	2	120
5/25	1.1	3.4	25.8	3.2	3.7	171	145.3
5/26	1.8	4	26.4	3.4	4.7	33	163.4
5/27	1.2	4.5	55.8	3.2	7	29	178.2

TABLE E-6. 2003 travel time of PIT-tagged hatchery yearling chinook released from the Snake River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/15	2.9	8.4	23.5	7.3	9.6	48	70.8
4/16	3.7	7.9	21.1	7.2	8.8	52	70.7
4/17	4	7.3	45.2	4.9	16.5	17	70.1
4/18	3.4	6.4	19	5.7	9.1	15	69.5
4/19	6.2	6.6	7	-	-	2	72.4
4/20	3.1	4.1	10.1	-	-	3	70.3
4/21	3.2	3.2	3.2	-	-	1	72
4/22	4	5.1	10.2	-	-	4	77.8
4/23	3.1	4.6	7.8	-	-	4	79.8
4/24	3.1	4.1	6	3.1	6	8	80.9
4/25	3.5	6.5	19.6	5.5	7.8	29	76
4/26	3.6	4.5	8.1	3.6	8.1	7	76.5
4/27	4.1	7	10.3	4.8	8.7	16	71.7
4/28	2.9	5.8	13.9	4.8	7	16	70.4
4/29	5.5	6.7	8.4	5.6	8.1	11	69
4/30	4.5	7	10.2	-	-	5	68.7
5/1	4.5	6	11.1	-	-	4	68
5/2	3	3.7	7.9	3.6	5.4	11	67.1
5/3	2.6	5	22.1	4	7.1	27	68
5/4	3	4	11.5	-	-	4	68.5
5/5	3.4	5.1	7.3	3.4	7.3	7	68.9
5/6	2.8	6.1	11.6	5.8	6.8	28	68.1
5/7	3.7	5.3	6.3	-	-	3	67.3
5/8	5	5.1	7.1	5	7.1	7	67.7
5/9	3.2	4.1	8.5	3.2	8.5	7	67.2
5/10	3.2	3.4	3.7	-	-	2	66.9
5/11	3.1	3.1	3.1	-	-	1	70
5/12	2.8	4.3	4.3	-	-	3	76.4
5/13	3	3.2	4	3	4	8	79.2
5/14	2	3.1	3.4	-	-	4	83.5
5/15	1.4	2	2.2	-	-	4	85.3
5/16	2.5	2.5	2.5	-	-	1	86.1
5/17	1.9	2.2	3.2	-	-	4	85.8
5/18	2.1	7.6	20.9	2.3	14.4	10	92.3
5/19	3.1	11.7	29.9	5.5	16.7	18	125.1
5/20	3.5	9.6	12.5	-	-	6	121.2
5/21	3.7	6.1	10.5	-	-	4	106.6
5/22	3.1	6.3	9.5	-	-	2	118.4
5/23	2.3	3.6	14.4	2.5	6.7	10	120
5/24	1.7	3	15.5	-	-	4	130.1
5/25	1.3	9.6	25.9	6.8	13.4	39	162.4
5/26	1.4	9.6	39	6.1	14.5	37	162
5/27	1.5	5.2	28.3	3.8	8.3	56	178.2

TABLE E-7. 2003 travel time of PIT-tagged wild steelhead released from the Snake River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/18	2.6	3.6	4.9	3.1	4.2	12	66.4
4/19	2.6	3.1	7.1	-	-	5	65.3
4/20	3.5	3.5	3.5	-	-	1	70.3
4/21	2.2	2.6	3.3	-	-	4	72
4/22	2	2.5	4.5	2.4	3.7	9	75.9
4/23	1.8	3	4.3	-	-	2	79.5
4/24	4.6	4.6	4.6	-	-	1	79.5
4/25	1.9	2.4	9.6	2.2	3.5	9	81.5
4/26	2.5	2.7	8.6	2.6	3.5	9	78.8
4/27	2.3	2.5	6	2.4	2.7	13	76.6
4/28	1.6	2.6	2.9	-	-	3	74
4/29	2.7	3	4.5	-	-	3	71
4/30	3	3.5	3.8	-	-	5	68.1
5/1	2.3	3.4	4.5	-	-	5	66.9
5/2	2.5	2.7	2.9	-	-	2	65.6
5/3	2.5	2.7	6	2.5	5.4	10	67
5/4	1.9	2.8	4.2	-	-	5	68
5/5	2.4	2.8	3.9	-	-	6	69.8
5/6	2.4	3.4	4.6	2.8	4.4	18	70.4
5/7	2.4	3.1	3.7	-	-	5	68.6
5/8	2.3	2.5	2.7	-	-	5	67.2
5/9	2.6	2.6	2.7	-	-	3	65.9
5/10	2.4	3.5	4.2	-	-	5	69.2
5/11	2.4	2.6	3.7	-	-	3	70
5/12	2.7	3	3.3	-	-	2	73.7
5/13	2	2.2	2.5	-	-	2	76.6
5/14	1.5	2.1	3.6	1.5	3.6	8	81.5
5/15	1.4	1.7	4.5	-	-	4	85.3
5/16	1.7	1.9	2.5	-	-	5	86.8
5/17	1.4	1.6	1.9	1.5	1.8	9	85.8
5/18	1.5	2.4	5.6	2.4	2.7	32	79.9
5/19	2.3	2.6	4.9	2.5	2.7	20	75.6
5/20	2.5	2.6	2.6	-	-	2	74.6
5/21	1.6	2.9	5.5	2.5	4.9	9	80.5
5/22	2.7	2.7	2.7	-	-	1	92.5
5/24	1.3	1.6	3.5	-	-	5	121.7
5/25	1.1	1.4	3	1.3	1.5	76	134.7
5/26	1.2	1.4	4.1	1.3	1.8	20	150.9
5/27	1	1.4	1.8	1	1.8	8	156

TABLE E-8. 2003 travel time of PIT-tagged hatchery steelhead released from the Snake River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/13	1.5	1.8	2.6	1.5	2.4	10	79.5
4/14	1.6	2.4	12.8	2.1	2.8	48	80
4/15	1.8	2.8	18.7	2.6	3.2	72	75.5
4/16	2.3	3	9.7	2.6	4.6	19	71.2
4/17	1.6	2	3.1	1.8	2.7	15	69.7
4/18	1.9	3	9.5	2.7	3.4	36	66
4/19	2.4	2.7	38.3	2.6	3.8	19	65.3
4/20	1.8	2.5	41.2	2.2	15.7	11	67.7
4/21	1.8	3.4	14.5	2.4	4.5	17	72
4/22	1.6	2.5	31.9	2.5	2.7	75	75.9
4/23	1.7	1.8	31.3	1.7	2.1	15	78.7
4/24	1.5	2.4	23.4	1.8	2.7	49	81.3
4/25	1.5	2.1	10.1	1.7	2.6	27	81.5
4/27	2.3	2.6	13.1	2.5	2.7	42	76.6
4/28	1.6	2.4	14.4	1.8	2.7	28	75
4/29	1.7	2.8	4.7	1.8	3.1	13	71
4/30	1.5	2.6	3.5	1.7	3.5	10	69.3
5/1	2.5	3.5	14	2.5	5.5	11	66.6
5/2	2.5	2.6	3.7	2.5	2.7	16	65.6
5/3	1.8	2.7	5.1	2.5	3.4	21	67
5/4	1.4	2.4	9.3	1.7	2.6	21	67.5
5/5	2	2.8	6.2	2.6	3.6	35	69.8
5/6	2	3.5	10.4	2.9	3.7	53	69.5
5/7	1.7	3	20.8	2.4	3.4	30	68.6
5/8	2.1	2.6	3.5	2.5	2.7	15	67.2
5/9	1.5	1.9	14.4	1.8	3.4	15	66.1
5/11	1.9	3.1	14	2.5	4.5	17	70
5/12	1.7	2.7	3.9	2.5	2.8	28	73.7
5/13	1.5	1.8	12.1	1.8	3	24	76.6
5/14	1.4	1.7	7.5	1.6	2	41	81.5
5/15	1.6	2	11.3	1.8	2.7	29	85.3
5/16	1.5	1.7	5	1.7	1.8	21	86.8
5/17	1.4	1.8	2.8	1.4	2.5	14	85.8
5/18	1.5	2.5	9.8	2.1	2.7	33	78.5
5/19	2.5	2.8	4.3	2.6	3.6	21	75.6
5/20	1.6	2.7	5.6	2.1	2.9	27	74.6
5/21	1.5	2.6	2.7	-	-	4	80.5
5/22	1.6	2	2.7	1.6	2.6	11	82.5
5/23	1.6	1.8	4.5	1.6	2.7	12	99.4
5/24	1.4	1.6	5.5	1.5	1.7	63	121.7
5/25	1.3	1.6	4.8	1.5	1.7	53	141.5
5/26	1.2	1.4	4.6	1.3	1.4	67	150.9
5/27	1.1	1.3	6.6	1.3	1.5	52	156

TABLE E-9. 2003 travel time of PIT-tagged wild yearling chinook released from the Imnaha River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/15	13.1	42.8	70.3	40	53.6	56	63.1
3/17	17	28.0	39	-	-	5	58.4
3/18	15.4	28.4	38.7	22.3	33.3	22	59.3
3/19	12.4	31.3	49.6	28.5	35.4	55	60.9
3/20	11.1	26.8	65.8	25.2	31.1	38	60.1
3/22	15.4	28.9	53.9	21.6	34.7	20	62.3
3/23	30.7	31.4	32.1	-	-	2	63.7
3/24	10.1	29.8	52.9	23.8	43	16	64.2
3/25	9	25.6	43.1	20.1	28.9	32	63.9
3/26	14.8	27.7	47.5	21.5	35.7	21	64.8
3/27	14.1	26.6	43.4	17.1	33.7	17	65.2
3/28	15	27.9	55.7	24.7	29.8	40	66.4
3/29	14.5	26.0	53	17.1	27.9	23	66.4
3/30	11.7	23.8	46.9	21.7	25.3	58	66.7
3/31	10.8	22.2	42.4	18.9	24.1	42	67.6
4/1	10.6	22.1	44.9	19.9	24.7	52	69
4/2	8.6	20.7	52	19.6	21.6	97	69.3
4/3	8.1	23.4	46.7	21	24.3	84	70.8
4/4	10.2	21.2	43	20	22.1	121	70
4/5	8.3	19.0	50	17.7	20.6	71	69.4
4/6	9.6	19.8	48.7	18	23	52	70.6
4/7	5.2	17.2	48.1	14.6	19.7	28	69.6
4/8	9.5	19.1	35.3	13.6	34.4	9	71.7
4/9	8.5	13.8	31.6	8.5	31.6	7	69.9
4/10	7.5	11.8	24.3	7.5	24.3	7	70.2
4/11	4.8	14.2	29.2	8	19	12	72.6
4/12	8.3	13.4	43.5	9	22.1	9	73.1
4/13	8.1	15.6	25.5	10.7	22.1	18	74.8
4/14	9.5	11.8	21	10	15.3	16	74.1
4/15	8.8	12.8	25.3	11.4	20.4	15	74.4
4/16	8	13.2	28.9	10.8	21.3	21	73.7
4/17	5.8	13.1	26	6.9	19.9	11	73.6
4/18	6	13.1	34.2	8.7	18.3	16	73.4
4/19	6.8	16.5	29.8	9	25	17	71.8
4/20	6	13.1	25	11.1	15	40	73.2
4/21	4.9	9.8	24.1	8.4	14.2	23	75.3
4/22	5.5	12.1	25	8.9	14.1	31	73.8
4/23	7	12.2	31.3	11.1	17.1	37	73.7
4/24	5.3	12.0	27.2	6.2	19.2	13	73.6
4/25	5.5	11.1	29.2	10.1	12.4	16	73
4/26	8	13.9	23	8	23	7	71.3
4/27	8.2	11.8	19.4	10.6	16.1	18	70.8
4/28	6.8	13.3	28.8	7.9	21	16	69.3
4/29	6.3	8.9	25.7	6.7	18.9	13	69.2
4/30	5.1	15.3	25	6	16.5	18	69.5

TABLE E-9. 2003 travel time of PIT-tagged wild yearling chinook released from the Imnaha River trap to Lower Granite Dam.
(continued)

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
5/3	6.7	10.3	12.8	8.5	12	12	67.6
5/4	7.3	9.0	14	8	12.7	15	67.8
5/5	7.5	11.3	20	-	-	6	71.6
5/6	6.9	8.0	11	-	-	5	69.7
5/7	6.3	7.4	10	-	-	5	69.3
5/9	4.9	7.1	15.4	6.4	7.8	30	72.5
5/10	5	6.4	18.1	5.5	8.2	22	73.2
5/11	5.3	8.9	19.1	6.1	14	15	77.5
5/12	3	7.4	15.3	5.9	9.9	36	79.9
5/14	2.7	5.8	12	5	9.1	26	82
5/15	3.8	7.0	15.7	5.8	10.1	15	80.3
5/16	5.7	8.3	14	6.3	10.2	17	82
5/17	7.4	9.0	13	-	-	6	92.1
5/18	4.8	6.9	11.9	4.8	11.9	8	85.5
5/19	6	6.0	8.4	6	6.9	9	85.8
5/20	6	6.1	6.2	-	-	2	94.8
5/21	4	5.8	9.3	4.1	8.2	12	106.6
5/22	3.2	3.9	8.7	3.6	7	11	103.4
5/23	2.9	4.0	7	3.1	5.9	11	120

TABLE E-10. 2003 travel of PIT-tagged wild steelhead released from the Imnaha River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/13	22.8	53	73.7	40.6	56.8	10	64.2
3/14	11.8	36	53.7	-	-	6	60.6
3/15	17.5	52.4	71.5	44.5	54.7	31	64.3
3/17	41	47	52.9	-	-	2	64.3
3/18	8.1	17.1	32.2	-	-	3	53.8
3/19	36.7	50	63.4	-	-	4	65
3/20	33.4	44.5	55.6	-	-	2	64.8
3/21	36.2	48.7	58.6	-	-	3	65.6
3/22	10.2	11	33.5	-	-	6	51.9
3/23	32.4	35	37.6	-	-	2	65.7
3/24	5.9	33	47.9	8.6	45.6	12	65.7
3/25	8.1	26.7	45.7	8.1	45.7	7	63.9
3/26	6.5	24.8	43	7.2	34.6	12	64.4
3/27	8.1	13.8	31.5	10.7	29.9	10	59.9
3/28	5.7	9.8	50	-	-	6	59.5
3/29	5.2	34.8	57	20.5	51.7	12	68.5
3/30	6.8	30.8	56.5	-	-	6	69.3
3/31	3.9	5	6.2	-	-	4	65
4/1	7.5	8.3	38.7	-	-	5	66.6
4/2	4.3	25.6	44.5	9.2	33.5	21	71.4
4/3	4.8	17.7	44.7	6.5	35.6	13	69.1
4/4	5.2	10.1	34.6	5.7	23.1	12	67.3
4/5	6.1	21.4	36.1	6.1	36.1	7	70.5
4/6	8.1	18	18.9	-	-	3	69.4
4/7	7.6	23.7	32.5	-	-	6	71.7
4/8	10.5	20.8	31	-	-	2	72.1
4/9	5.5	18.8	33.9	-	-	3	72.6
4/10	6.1	14.7	37.1	6.1	37.1	7	71.8
4/11	4.6	22.2	45.7	7.2	36.4	10	73.1
4/12	3.8	15	26.5	4.2	25.5	9	74.2
4/13	4.1	10.6	43.5	5.2	16.5	19	72.9
4/14	4	10.6	42.3	4.9	12.5	13	73.5
4/15	4.1	7.7	28.1	5.9	13.9	15	70.8
4/16	5.5	6.6	39.6	-	-	4	69.4
4/17	4.3	7.3	21	5.1	9	16	70.1
4/18	4.8	7.4	9.9	-	-	3	71
4/19	4.1	5.6	11.5	4.7	10.6	14	71.1
4/20	4	6.7	36.4	5	18.3	15	74.5

TABLE E-10. 2003 travel of PIT-tagged wild steelhead released from the Imnaha River trap to Lower Granite Dam.
(continued)

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/21	3	4.6	21.8	3.6	5.6	18	75.2
4/22	3.3	4.6	31.6	4.1	5.6	34	77.8
4/23	2.9	4.6	32.9	4.1	4.9	51	79.8
4/24	3	5.4	32.5	4.7	5.8	64	79.5
4/25	3.4	4.9	15.5	4.6	5.6	70	78.2
4/26	3.6	7.4	16.1	6	9.7	38	74.1
4/27	3.6	7.6	28.9	6.5	11	30	71.1
4/28	3.6	6.2	11.6	4.7	8	24	70.4
4/29	4.1	5.8	7.5	4.1	7.5	8	68.4
4/30	4.5	6.8	26.9	5.6	8.6	31	68.7
5/1	4.5	5.5	7.5	-	-	5	68
5/3	2.8	4.6	23.3	3.9	5.6	26	68
5/4	3.4	4.8	23.1	4.6	4.9	73	68.4
5/5	3.5	5.7	21.6	5.3	6.4	98	68.2
5/6	3	6	20.3	5.4	7.4	38	68.1
5/7	3.7	6.7	21	5.7	8.6	47	69.3
5/8	4.1	7.6	18.9	4.3	13.9	10	72.3
5/9	3	6	10.8	4.7	6.7	29	70.4
5/10	2.8	5.7	15.6	4.9	6.3	57	73.2
5/11	3.1	5.1	14.6	4.1	5.7	39	74.3
5/12	2.9	4.3	11.8	4	4.8	75	76.4
5/13	2.8	3.9	13.9	3.8	4	126	81.3
5/14	2.5	3.6	15	3.5	3.7	130	83.6
5/15	2.5	3.5	16.1	3.4	3.9	118	84.7
5/16	2.1	4.2	11.1	3.8	4.6	147	83.3
5/22	2.7	3.7	6.1	3.6	3.7	100	103.4
5/23	2.7	3	6.6	2.7	3.7	16	111.2

TABLE E-11. 2003 travel time of PIT-tagged hatchery steelhead released from Imnaha River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/11	3.9	17.4	44.6	4.1	39.9	14	74
4/12	2.6	19.7	45.9	13.9	26.9	39	73.8
4/13	3.2	17.2	42.5	13.2	23.7	36	74.7
4/14	3.7	13.9	40.1	8.4	23.4	27	75
4/15	3.4	17.4	44.9	12.1	21.9	42	73.7
4/16	2.8	8.2	40.7	6.1	12.2	91	70.7
4/17	2.7	7.8	31	5.2	9.9	47	71.3
4/19	3.4	4.2	11.9	3.9	10	10	67.1
4/20	2.8	6.8	37.5	5.6	8.9	72	74.5
4/21	3	6.3	35	4.7	8.9	53	76
4/22	2.8	4.3	34.6	3.9	5.2	68	77.1
4/23	2.3	5.4	27.7	4	6.1	57	79.8
4/24	4.3	4.3	4.3	-	-	1	80.9
4/27	3.6	10.8	33.8	9.2	12.2	90	71.1
4/28	3.7	8.7	28.7	6.7	11.1	37	70.1
4/29	2.7	7.9	27.7	4.7	15.7	19	69.1
4/30	4.7	8.6	21.9	5	14	22	68.8
5/8	2.9	11.1	24.4	9.9	14.1	107	75.7
5/9	2.9	9.9	24.6	8.6	13.8	139	76.1
5/10	3.1	6.2	18.3	3.1	18.3	7	73.2
5/11	3.1	4.6	16.4	4	5.4	36	74.3
5/12	2.3	5	16.8	4.2	6.3	59	78.6
5/13	2	4	20.2	3.5	4.2	63	81.3
5/14	1.7	3.7	14.6	3.2	3.9	69	83.6
5/15	2.7	3.8	16.3	3.1	5	48	84.7

TABLE E-12. 2003 travel time of PIT-tagged wild yearling chinook released from the Grand Ronde River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/18	13.4	25.9	36.1	16	34.7	13	57.6
3/19	13.8	25.7	41.4	17.7	28.7	22	58.5
3/20	8.7	23.6	35.3	16.4	28.9	22	57.7
3/21	12.7	27.7	52.8	14.9	45.6	11	61.4
3/22	7.4	23.2	44.4	14.8	25.6	33	60
3/23	12.1	18.1	26.8	-	-	6	58.5
3/24	7.6	21.3	42.5	18.5	29.3	29	61.5
3/25	6.7	21.8	42.2	18.3	23.6	44	63.1
3/26	8.8	18.9	29.1	11.2	23.7	12	62.1
3/27	8.7	20.8	42.7	18.3	28.2	21	64.5
3/28	16.5	21	37.1	17.5	26.2	15	64.9
3/29	8.8	18.9	39.1	17	22	29	65.2
3/30	12.7	18.1	28.1	15.1	21.2	11	66.4
3/31	11.1	16.8	36.2	13	23.8	16	67.9
4/1	12.5	14	22.7	12.5	22.7	8	68.7
4/2	10.6	17.8	25.8	13.2	21	26	69.3
4/3	7.7	17.2	34.5	15.1	21.2	30	69.3
4/4	8.2	18.5	48.5	13	22.9	24	68.6
4/5	9.4	17.2	32.6	13.9	19.2	24	68.5
4/6	8.8	18.4	30.9	16.7	21.1	9	69.4
4/7	9.3	16.4	25.5	9.3	25.5	8	68.9
4/8	8.1	15.3	19	8.9	18	11	69.3
4/9	17	17	17	-	-	1	71.8
4/10	10.1	12.9	16.9	-	-	5	70.5
4/11	5.8	12.7	26	5.8	26	8	72
4/12	4.1	13.2	14.2	-	-	6	73.1
4/13	4.5	10.6	57.2	9.3	11.4	24	72.9
4/14	5	9.2	16.1	7.5	12.9	19	72
4/15	5.4	8.8	11.9	8.1	10.9	19	71.8
4/16	5.8	8.3	20.4	6.9	10.2	13	70.7
4/17	6.3	9.6	12.4	6.3	12.4	8	73.2
4/18	7.2	8.1	12.4	-	-	3	72.2
4/19	6.4	7.9	18.1	6.8	16.4	9	73.4
4/20	6	7.2	16.9	6	16.9	8	74.5

TABLE E-12. 2003 travel time of PIT-tagged wild yearling chinook released from the Grand Ronde River trap to Lower Granite Dam.
(continued)

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/21	14.3	14.9	15.5	-	-	2	72.7
4/22	4	5	10.9	-	-	5	77.8
4/23	3.3	8.8	12.6	3.3	12.6	8	76.3
4/24	5.2	7.5	19.8	-	-	6	76.5
4/25	4.4	8.4	14.7	-	-	6	74.8
4/26	4.4	8.7	17.7	6.3	9.7	18	72.2
4/27	3.9	9.2	15.4	8.1	10	28	71.3
4/28	7	7.7	12.4	7.3	10	11	70.2
4/29	5.9	9.1	13.4	-	-	5	69.2
4/30	5.5	8.8	12	-	-	6	68.8
5/1	4.6	6.8	13	-	-	6	68.3
5/3	2.5	4.4	10.7	-	-	6	67.6
5/5	3.9	5.6	9	-	-	5	68.2
5/6	5.3	7	10.5	6.1	10.4	9	68.6
5/7	5.2	6.8	50.8	-	-	5	69.3
5/8	3.7	6.2	8	-	-	6	69.2
5/9	7.8	7.8	7.8	-	-	1	74.4
5/11	4.5	4.8	5	-	-	2	74.3
5/12	7.5	7.5	7.5	-	-	1	79
5/14	3.5	4.2	4.9	-	-	4	83.6
5/15	2.8	4.6	5.5	-	-	6	82.6
5/16	2.3	3.4	64.7	3	5.2	16	86.1
5/17	4.1	4.8	9.7	4.2	8.6	9	79.3
5/18	4.7	6.4	7.5	4.7	7.5	7	80.2
5/19	3.6	4.6	6.4	3.6	6.4	8	79.6
5/20	4.6	5	5.5	-	-	2	86.1
5/21	4	4.5	28.8	-	-	3	98.5
5/22	3.5	28.7	53.9	-	-	2	119.2
5/23	9.5	20.6	26.5	-	-	3	133.8
5/24	2.2	2.4	2.5	-	-	3	121.7
5/25	1.6	5.3	41.5	2	31.5	9	156.6
5/26	2.5	4.6	6.1	3.5	5.5	9	170.9
5/27	2.7	5.1	9.6	-	-	4	178.2
5/28	2.3	3.5	9.5	-	-	5	182.8
5/29	1.5	2.5	22.6	1.5	22.6	7	189.3
5/30	2.5	2.9	6.5	-	-	5	187.8
5/31	1.7	2.4	3.2	-	-	2	188.3
6/1	3.2	4.2	6.4	-	-	4	151.4
6/2	4.5	5	8.5	4.5	8.5	7	131.6
6/3	2.7	8.6	14.5	-	-	4	116.6
6/4	2	10.4	22.8	2	22.8	7	109.1
6/5	5.6	9.9	33.2	6	17.7	9	104.3
6/6	2.5	13.6	25.6	-	-	6	94.8
6/7	3	12	24.6	3	24.6	8	94.9
6/8	4.5	10.2	16.6	6.8	12.7	10	95.6

TABLE E-13. 2003 travel time of PIT-tagged hatchery yearling chinook released from the Grande Ronde River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/20	6.4	31.2	47.9	22.7	34.7	47	61.1
3/21	4.4	28.8	46.9	12.5	32	36	61.5
3/22	4.6	14	45.4	11.9	20.6	98	55.9
3/24	4.3	22	51.4	18.6	24.8	78	62.4
3/25	9.5	29.5	45.3	28	31.5	80	64.9
3/31	6.1	23.9	44.4	21.6	26.2	39	68.4
4/1	13.1	28.8	43.8	19.9	34.6	13	71.2

TABLE E-14. 2003 travel time of PIT-tagged wild steelhead released from the Grande Ronde River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/20	12.7	47.4	50.5	-	-	3	65
3/21	36.2	36.2	36.2	-	-	1	63.8
3/23	8.8	29.6	36.6	-	-	4	63.4
3/25	7.4	7.6	14.2	-	-	3	53
3/26	4.5	4.5	4.5	-	-	1	49.1
3/27	10	10	10	-	-	1	59.4
3/28	6.3	12.5	19.2	-	-	4	59.8
4/14	3.6	3.6	3.6	-	-	1	76.8
4/15	6.2	6.2	6.2	-	-	1	70.8
4/16	2.7	5.7	6.6	-	-	3	68.7
4/17	3.5	4.4	4.4	-	-	3	67.6
4/18	5.6	5.6	5.6	-	-	1	69.5
4/22	3.5	5	6.5	-	-	2	77.8
4/24	3.4	3.4	3.4	-	-	1	81.3
4/25	2.5	4	5.5	-	-	2	79.3
4/26	2.8	3.5	3.6	-	-	4	77.7
4/27	3.5	3.6	6.8	-	-	3	75.4
4/28	4	4	4	-	-	1	72.7
5/3	2.7	3	3.4	-	-	2	67
5/4	3	3	3	-	-	1	68
5/5	2.7	2.7	2.7	-	-	1	69.8
5/6	4.7	4.7	4.7	-	-	1	68.6
5/8	2.8	3.1	3.4	-	-	2	67.2
5/10	2.7	2.7	2.7	-	-	1	66.9
5/11	2.7	2.7	2.7	-	-	1	70
5/12	9.7	9.7	9.7	-	-	1	78
5/13	3.4	3.5	3.6	-	-	2	81.3
5/14	2.4	3.4	12.7	2.4	12.7	8	83.5
5/15	2.8	3.5	4.7	-	-	3	84.7
5/16	2.7	4	10.8	2.7	10.8	7	83.3
5/17	1.5	3	4.5	-	-	6	82.4
5/18	3.2	3.7	5.5	-	-	3	77.2
5/19	3.4	3.6	7.6	-	-	5	76.4
5/20	2.5	2.7	5.5	-	-	5	74.6
5/21	2.6	3.3	5.6	-	-	6	80.5
5/22	2.8	2.8	2.8	-	-	1	92.5
5/23	2.3	2.5	3.5	-	-	4	111.2
5/25	1.4	1.7	6.9	1.5	1.8	36	141.5
5/26	1.4	1.6	2.6	1.5	1.7	22	152.9
5/27	1.7	2.5	2.7	-	-	5	167.6
5/28	1.3	1.5	2.1	-	-	5	171.7
5/29	1.2	1.8	7.2	1.2	7.2	8	188.8
5/30	1.5	1.7	7.4	1.6	2.1	14	195
5/31	1.2	2.1	7.4	1.4	4	10	188.3
6/1	1.2	1.8	3.7	1.5	2.1	12	168.6
6/2	1.3	2	3.2	-	-	4	149.3
6/4	1.6	2.2	2.9	-	-	2	122

TABLE E-15. 2003 travel time of PIT-tagged hatchery steelhead released from the Grande Ronde River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/15	2.6	3.6	38.8	3.2	4.5	47	73.4
4/16	2.4	4.2	39.7	3.5	4.7	83	69.6
4/17	2.6	4.6	52.9	3.5	13.6	27	67.6
4/19	2.5	4.6	42.8	3.5	6.2	37	69.4
4/20	2.4	3.4	36.5	2.7	5.1	23	67.7
4/21	2.5	3.6	36.9	3.5	5.6	49	73.8
4/22	2.4	2.8	35.2	2.5	4.7	14	75.9
4/23	2.4	2.8	16.5	2.4	4.4	9	79.5
4/24	2.7	3.3	3.9	-	-	2	81.3
4/25	2.4	2.7	24.8	-	-	5	80.9
4/26	2.5	3.8	13.6	2.9	8.1	15	77.7
4/27	2.6	3	28.5	2.6	28.5	8	76.6
4/28	2.7	2.7	2.7	-	-	1	74
4/29	3	3	3	-	-	1	71
4/30	2.7	2.7	2.7	-	-	1	69.3
5/3	2.6	2.6	2.6	-	-	1	67
5/4	2.7	2.7	2.7	-	-	1	68
5/6	2.7	2.8	6.7	-	-	3	70.4
5/7	2.9	2.9	2.9	-	-	1	68.6
5/8	2.4	2.9	3.8	-	-	5	67.2
5/9	2.6	2.8	3.7	-	-	3	65.9
5/10	3.8	3.8	3.8	-	-	1	69.2
5/11	2.8	3.1	3.7	-	-	3	70
5/12	2.6	2.8	14	2.7	3.9	12	73.7
5/13	2.6	2.9	9.6	-	-	5	79.2
5/14	1.7	2.6	9.6	1.7	4.4	10	83.5
5/15	1.7	1.9	2.1	-	-	2	85.3
5/16	1.4	1.9	3	1.6	2.7	14	86.8
5/17	1.5	2.8	15	1.7	8.8	12	82.4
5/18	3.5	3.6	4.9	-	-	4	77.2
5/19	2.7	5.1	9.1	3.7	7.5	14	79.6
5/20	2.6	2.7	3.6	2.7	3	15	74.6
5/21	2.6	3.2	3.4	-	-	5	80.5
5/22	2.5	2.6	6	2.5	6	7	92.5
5/23	2.5	3.1	3.7	-	-	4	111.2
5/24	1.7	1.9	2.5	1.7	2.5	8	121.7
5/25	1.4	1.6	2.9	1.6	1.8	57	141.5
5/26	1.4	1.6	7.5	1.5	1.8	39	152.9
5/27	1.5	3.2	10.2	-	-	4	167.6
5/28	1.5	1.5	1.5	-	-	1	171.7
5/29	1.5	1.6	1.8	-	-	3	188.8
5/30	1.2	1.4	9.7	1.3	3.5	13	197.2
5/31	0.9	1.6	9	1.4	2	54	188.3
6/1	1	1.8	17.5	1.5	2.8	26	168.6
6/2	1.4	1.8	6.5	-	-	5	149.3

TABLE E-16. 2003 travel time of PIT-tagged subyearling chinook released from the Rock Island Dam to McNary Dam.

	Travel Time			Confidence Limits			River Zone
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
6/30	9.2	10	22.6	9.2	22.6	8	109.8
7/1	7.8	12.9	31.9	9.9	14.4	32	111.8
7/2	7	10	34.9	8	13.4	15	109.2
7/3	6.7	11.7	30.7	10	12.7	53	110.9
7/4	6.3	10.4	37.4	9.8	11	58	111
7/5	6.1	12	28.4	9.9	16.7	42	113.6
7/6	6.8	9.4	30	8.7	11.8	30	117.9
7/7	5.8	10.4	28.8	8	13.1	28	121.1
7/8	5	11.5	28	7.2	17.4	27	116.9
7/9	8.4	15	27.4	11.2	17.3	16	118
7/10	10	20.4	26.3	13.4	22.9	17	113.2
7/11	8	19.8	26.4	12.1	24.3	16	113
7/13	9	13.2	24.4	9.1	20.7	10	113.2
7/14	10.4	15.8	21.8	10.8	21	11	111.3
7/15	6.4	14.2	20.9	10.7	18.4	14	110
7/16	7.4	12.1	18.5	8.8	18.2	10	108.8
7/17	8.1	10.5	18.4	8.5	14.9	13	107.3
7/18	8.3	10	16.1	-	-	4	107.1
7/20	8.5	12.2	17.8	8.9	15.4	10	110.1
7/21	8.4	11.4	17	9.3	15.4	9	112.3
7/22	6.6	9.5	15.8	8.4	10.4	25	113.1
7/23	5.5	8	15.1	7.3	9.4	28	110.7
7/24	6.3	8.3	11.9	6.8	10.6	15	108.8
7/27	5.4	8.2	11	6.2	8.6	16	96.9
7/28	4.1	7.5	10	6.9	9.1	31	101.6
7/29	5.7	6	6.9	-	-	5	99.9
7/30	5.4	7.8	8.1	5.8	8.1	10	98.7
8/3	6.2	10.7	81.2	7.8	12.2	15	92.7
8/4	5.6	8.8	10.9	6.9	10.8	9	94.6
8/5	5.3	8	20.9	6.2	11.7	13	97.1
8/6	4.9	10.1	24.7	7.8	13.1	27	98.3
8/7	6.1	9.7	83.9	7.8	12.3	13	96

TABLE E-17. 2003 travel time of PIT-tagged yearling chinook released in the Snake River basin between Lower Granite and McNary Dam (grouped by observation date at Lower Granite Dam).

Lower Granite	Travel Time			Confidence Limits		Ice Harbor Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
04/02	13.1	21.8	58.8	17.4	24.7	26	71.5
04/03	12.4	22.6	48.1	19.4	24.4	28	72
04/04	10.6	22.7	41.3	19.2	26.1	29	73.5
04/05	10.8	21.4	35.4	17.1	29.7	13	73.5
04/06	11.9	18.9	34.7	15.6	24.8	18	72.4
04/07	12.6	16.7	36.6	15.3	23.6	9	71.4
04/08	17.3	20.4	49.9	-	-	6	74
04/09	12.5	17	47	13.4	27.4	11	73.9
04/10	11.7	15.3	31.8	11.7	31.8	7	74.8
04/11	9.9	15.6	35.1	12.2	18.5	14	76.4
04/12	9.9	14	32.2	12.8	16.5	25	76.8
04/13	9.4	14.4	40	13.6	16	51	77.5
04/14	9	15	53.5	13.8	15.9	60	77.6
04/15	10.3	13.3	38.1	11.8	14.2	39	77.5
04/16	9.8	13.3	39.3	12.8	14	85	76.6
04/17	8.8	13	33.9	12.3	14.1	89	76.5
04/18	8.5	12	29.1	11.6	12.6	88	76.5
04/19	7.9	11.2	33.4	10.9	12	134	76.8
04/20	7.8	11.1	35.9	10.8	11.5	113	77.3
04/21	6.6	11.1	29.7	10.5	11.7	152	77.4
04/22	6.9	11.2	52.1	10.9	11.7	321	77.5
04/23	6.6	10.6	28.1	10.2	10.9	342	76.7
04/24	5.9	10.9	37.1	10.6	11.1	508	76
04/25	7	11.3	37	10.5	11.6	313	75.5
04/26	6.8	11	38.4	10.7	11.4	470	74.7
04/27	7.1	10.6	35.5	10.2	10.9	301	73.8
04/28	7.1	10.6	24.7	10.2	10.8	169	72.6
04/29	8	10.5	20.9	10.2	10.8	152	71.5
04/30	6.6	9.7	22.8	9.5	10	215	71.2
05/01	6.8	9.9	20.6	9.5	10.3	126	70.3
05/02	6.9	9.3	19.5	9	9.8	123	69.7
05/03	5.9	9.7	45.3	9.3	10.2	124	70.1
05/04	6.6	10.3	27.2	9.7	10.7	120	71.2
05/05	6.6	9.6	18.6	9.4	9.9	253	72.7
05/06	6.1	9.8	49	9.7	9.9	429	74.8
05/07	6.1	9.4	29.6	9.3	9.6	353	74.4
05/08	5.7	9.5	19.4	9.1	9.6	234	77.3
05/09	6.6	9	21.5	8.7	9.4	130	77.6
05/10	6.6	8.6	16.7	8.4	9	84	79.4

TABLE E-17. 2003 travel time of PIT-tagged yearling chinook released in the Snake River basin between Lower Granite and McNary Dam (grouped by observation date at Lower Granite Dam).
(continued)

Lower Granite	Travel Time			Confidence Limits		Ice Harbor Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
05/11	6	8.5	20.4	8.1	8.8	77	80.2
05/12	5.5	8.7	15.7	8.3	8.8	199	81.3
05/13	5.4	8.1	14.6	7.8	8.2	201	82.9
05/14	5	8.2	16.6	8	8.5	134	82.6
05/15	5.8	8.1	14.6	7.9	8.5	208	82.8
05/16	5.1	7.8	28.1	7.6	7.9	376	84.4
05/17	5.2	7.9	19.9	7.7	8	507	88.1
05/18	5.7	8.2	36.9	7.9	8.5	216	93.5
05/19	6.3	8	12.5	7.8	8.1	146	101.8
05/20	5.6	7.6	11.3	7.3	7.8	102	109.1
05/21	5.9	7.3	15.6	6.9	7.7	55	113.3
05/22	5.5	6.7	9.1	6.6	7.4	42	124.7
05/23	4.7	6.3	12.8	5.8	7.3	22	132.5
05/24	4.4	6.3	8.2	5.7	6.6	32	146.9
05/25	4	5.7	10.7	5.5	6.1	91	161.9
05/26	4.2	5.6	50.8	5.2	6.3	60	172.2
05/27	4.4	6.2	8.2	5.5	6.7	50	176.1
05/28	4	6.4	8.4	5.5	6.7	42	174.3

TABLE E-18. 2003 travel time of PIT-tagged steelhead released in the Snake River Basin between Lower Granite and McNary Dam (grouped by observation date at Lower Granite Dam).

Lower Granite	Travel Time			Confidence Limits			Ice Harbor Dam
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
04/21	6.8	9.9	37	8.2	24.9	13	78.4
04/22	7.4	15.1	18.3	7.4	18.3	7	75.8
04/23	9	10.3	19.4	-	-	6	77.6
04/24	6.8	12.1	35.1	9.6	21.2	17	76.2
04/25	8	26.6	33.7	9.6	29.9	16	76.5
04/26	7.1	14.6	30.2	8.2	22.9	22	73.5
04/27	7.3	10.1	32.1	8.3	25.9	15	73.8
04/28	8.8	11.1	27.7	10	17.9	15	72.6
04/29	9	15.2	29.8	10	25	19	71.6
04/30	8.4	11.7	26.9	9.2	19.7	13	70.6
05/01	8.3	10	26.1	-	-	6	70.3
05/02	7.7	14.3	24.2	7.7	24.2	8	72.6
05/03	14.1	17.2	23.4	-	-	4	75.8
05/04	8.2	12.3	21.3	8.2	21.3	7	73.5
05/05	7.6	15.8	20.5	11.8	19.8	9	77
05/06	7.6	10.6	19.1	8.5	18.4	11	76.4
05/07	7.8	15.1	21.9	8	19.7	9	77.2
05/08	8.6	10.3	20.6	9	16.1	16	77.3
05/09	7.2	10	19.2	8	15.8	18	78.6
05/10	7.2	14.4	18.2	7.7	18.2	10	79.9
05/11	7.3	12.7	19.5	11.8	15	16	80.7
05/12	6.2	12.7	16	11.2	15	16	84.6
05/13	6.6	10.8	13.8	9.8	13	9	83
05/14	7.1	11.1	17.1	8.9	13.2	13	87
05/15	7.3	10.2	18.5	9	10.8	36	87.7
05/16	7	8.9	13.7	8.2	10	62	88.2
05/17	6.1	9.5	14.8	8.2	10	73	99.5
05/18	6	8.9	16.1	8.2	9.2	59	100
05/19	7	8.4	10.9	7.5	9.1	22	101.8
05/20	7.5	8.1	9.1	7.7	8.7	16	109.1
05/21	6.1	7	9.7	6.3	8.1	14	113.3
05/22	4.9	6.9	11	5.9	7.4	17	124.7
05/23	5	6.2	8.9	-	-	5	132.5
05/24	5	7.1	20.8	5	20.8	8	153.8
05/25	5	6.2	7.9	-	-	6	161.9
05/26	4.2	6.1	12.4	5.2	7.1	21	172.2
05/27	4.3	5.4	10	5	6	42	177.2
05/28	3.7	4.9	12.4	4.1	6.1	15	178.9
05/29	3.2	5.8	11.2	3.6	10.8	11	172.2
05/30	4	5.3	9.3	-	-	6	172.6
05/31	4.9	6.1	7.7	5.7	7.1	10	155.9
06/01	4.8	5.8	7.3	5	7.2	10	142.4

TABLE E-19. 2003travel time of PIT-tagged subyearling chinook released in the Snake River basin between Lower Granite and McNary Dam (grouped by observation date at Lower Granite Dam).

Lower Granite	Travel Time			Confidence Limits			Ice Harbor Dam
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
06/08	5.1	10.4	83	9.6	11	237	97.9
06/09	5.8	10.8	58	10.2	11.8	231	93.1
06/10	6	11.1	63.5	10.8	11.6	237	89.9
06/11	5.2	10.7	79.6	10.3	11.1	277	85.8
06/12	5.7	10.7	55.4	10.3	11.2	215	81.9
06/13	5	9.9	66.1	9.4	10.6	159	79.6
06/14	5.5	10.6	83.8	10.2	11.1	169	74.3
06/15	5.8	10.2	58.3	9.6	11	127	72.7
06/16	6.6	10.2	64.7	9.3	13.5	128	69.7
06/17	6.4	12.5	48	9.4	13.3	125	60.3
06/18	5.7	13	44.5	12	14.9	118	56.9
06/19	6.7	13.8	57.3	11.9	16.2	78	52.4
06/20	7.3	13.2	51.4	11.2	14	148	50.7
06/21	7.1	15.3	65.3	13.5	17.2	229	46.1
06/22	7.7	18.3	48.9	15.3	22.2	137	42.1
06/23	6.8	20.8	51.7	16.7	23.5	80	39.9
06/24	8.6	21.5	52.8	18	24.5	69	38.7
06/25	7.8	24.8	66.8	19.8	27.6	66	36.5
06/26	8.3	23.4	69.4	18.8	26.7	41	36.2
06/27	8.4	19.2	67.6	17.2	23.6	39	36.2
06/28	12.3	21.4	33.9	14.7	28.3	17	35.4
06/29	11.4	24.2	41.2	15.2	28.3	21	34.6
06/30	9.3	16.7	45.8	14	25.3	23	35.1
07/01	10.7	20.6	44.2	16	24.6	34	34.4

TABLE E-20. 2003 travel time of PIT-tagged yearling chinook released in any basin above McNary Dam between McNary Dam and Bonneville Dam (grouped by observation date at McNary Dam).

McNary Dam	Travel Time			Confidence Limits			The Dalles Dam
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
04/13	7.1	12.1	24.2	7.8	21	11	202.7
04/14	6.7	8.6	12.6	7	9.6	10	204.8
04/15	6.6	9.4	22.3	7.5	10.4	12	207.7
04/16	7.9	9.9	11.7	7.9	11.7	8	211.8
04/17	7.3	10.2	20.4	9.3	12.3	20	212.1
04/18	6.1	10	19.2	8.8	11.3	21	213.2
04/19	5.2	9	12.8	7.3	10.3	24	211.4
04/20	5	7.9	13.5	7	10.2	17	211.6
04/21	5.2	8.5	16.8	6.2	12.4	17	215.9
04/22	6.2	8.3	11.6	7.2	9.8	20	220.2
04/23	5.3	8.8	19.3	8.4	9.4	69	218.9
04/24	5.3	8.3	18.5	8	9.2	51	216.6
04/25	5.5	8.5	17.3	8.2	9.5	120	212.9
04/26	5	8.4	27.4	8	8.9	162	214.8
04/27	5	8.4	64.4	8.2	8.6	264	211
04/28	5.1	7.8	18.8	7.5	8.1	221	214.1
04/29	4.3	7.4	18.8	7.3	7.5	386	212.1
04/30	5	6.8	32.1	6.5	7.1	324	215.8
05/01	4.5	7	28.1	6.8	7.1	548	212.7
05/02	4.4	6.7	23.5	6.5	6.8	365	213.3
05/03	3.8	6.3	26.4	6.2	6.4	607	216.3
05/04	4.1	6.5	23.9	6.3	6.8	328	212.8
05/05	3.9	7.4	34.7	7.3	7.5	662	213.7
05/06	4.5	6.8	29.7	6.5	7	289	210.7
05/07	3.6	7.3	27.4	7.2	7.4	627	215.5
05/08	3.7	7	19.9	6.8	7.1	388	212
05/09	4.3	6.5	24.4	6.4	6.6	743	217.6
05/10	4.2	6.2	22.7	6.1	6.3	417	215
05/11	4.1	6	25.5	5.8	6.2	475	217.5
05/12	3.6	5.6	30.6	5.5	5.7	335	227.2
05/13	3.7	5.5	27.5	5.4	5.7	571	230.2
05/14	3.8	5.4	17.6	5.2	5.5	317	235.9
05/15	3.7	5.7	19.9	5.6	5.9	636	227
05/16	4.1	5.8	29	5.7	5.8	620	231.1
05/17	3.7	6.2	12.8	6.1	6.3	916	231.7
05/18	4.4	6.2	16.7	6.1	6.3	470	234
05/19	3.8	5.8	24.1	5.6	5.9	659	233.3

TABLE E-20. 2003 travel time of PIT-tagged yearling chinook released in any basin above McNary Dam between McNary Dam and Bonneville Dam (grouped by observation date at McNary Dam).
(continued)

McNary Dam	Travel Time			Confidence Limits			The Dalles Dam
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
05/20	3.8	5.4	10.3	5.3	5.5	310	235.4
05/21	3.4	5.1	16.3	5	5.2	478	240
05/22	3.7	5.2	19.6	5.1	5.3	412	254.8
05/23	3.2	5.2	18.4	5.1	5.3	699	267.4
05/24	3.4	4.8	12.1	4.7	4.9	443	271.3
05/25	3.1	4.4	9.4	4.3	4.5	465	275.3
05/26	2.9	4.3	10.8	4.2	4.4	208	297.5
05/27	3.2	4.4	15.2	4.3	4.5	356	320.2
05/28	3	4.4	13.6	4.3	4.6	304	322.2
05/29	3	4.3	12.7	4.3	4.4	659	317.3
05/30	2.9	4.2	13.1	4.1	4.3	261	321.5
05/31	2.6	4.4	30.3	4.3	4.4	390	310.2
06/01	3	4.4	20	4.2	4.5	200	295.7
06/02	3.1	4.4	25.7	4.4	4.5	274	285.9
06/03	3.5	4.5	8.4	4.4	4.6	197	279.8
06/04	3	4.3	8.1	4.3	4.4	375	277.5
06/05	2.9	4.3	46.6	4.3	4.4	266	272
06/06	2.8	4.2	15.9	4.2	4.3	290	269.4
06/07	2.8	4.2	48.1	4.1	4.3	126	274.2
06/08	2.7	4.1	13.5	4	4.2	177	280.7
06/09	2.9	4.2	8.9	4.1	4.3	195	276.5
06/10	2.7	4.1	18.9	4.1	4.2	255	281.4

TABLE E-21. 2003 travel time of PIT-tagged steelhead released in any basin above McNary Dam between McNary Dam and Bonneville Dam (grouped by observation date at McNary Dam).

McNary Dam	Travel Time			Confidence Limits			The Dalles Dam
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
04/21	5	6.5	10.3	5.9	7.4	19	215
04/22	4.8	6.3	14.8	5.6	7.9	34	220.4
04/23	5	7	42.1	6.4	7.5	110	220.7
04/24	5.1	8.3	40.3	6.7	10.3	61	216.6
04/25	4.5	8.5	45.3	7.5	10	92	212.9
04/26	4.8	6.3	39.9	5.8	9.8	25	220.2
04/27	4.6	8.4	37.5	7.4	9.1	63	211
04/28	4.7	5.8	17.8	5.1	8	13	212.2
04/29	4.9	8.8	24	5.9	9.2	26	214
04/30	4.8	6.7	16.7	5.8	7.7	32	215.8
05/01	4.4	6.4	29.5	5.6	7.5	50	214.9
05/02	4.8	6.5	11.8	-	-	6	213.3
05/03	4.9	7.4	17.4	5	12	18	216.5
05/04	4	6.8	19.7	4.6	10.9	14	212.8
05/05	4.2	6.5	16.4	5.2	9.1	21	213.7
05/06	5.6	9.4	10.8	6.7	9.8	10	216.5
05/07	4.5	6.6	26.2	6.2	7.6	56	215.5
05/08	4.8	7.7	13.1	6.7	8	16	215.3
05/09	4.9	6.4	22	6	7	78	214.1
05/10	4.8	6.4	34.7	5.9	6.8	66	215
05/11	4.5	6	14.8	5.5	6.4	54	217.5
05/12	4.3	6.3	13.9	4.6	9.8	14	227.2
05/13	4	5.5	17.3	5	6.7	35	230.2
05/14	4.2	5.1	11.7	4.8	6.8	21	235.9
05/15	3.9	5.5	12.1	5	6	71	227
05/16	3.8	5.7	13.7	5.3	5.9	57	231.1
05/17	4	6.1	13.8	5.9	6.5	168	231.7
05/18	3.8	6.5	27	5.8	6.9	87	233.7
05/19	3.5	5.6	21.1	5.3	5.8	241	233.3
05/20	4.2	5.7	29	5.6	5.9	102	236.1
05/21	3.9	5	16.5	4.8	5.2	100	240
05/22	3.9	5	10.7	4.7	5.8	49	254.8
05/23	3.4	5.5	16.1	5.2	5.7	157	267.8
05/24	3.5	5	15.5	4.9	5.3	133	271.3

TABLE E-21. 2003 travel time of PIT-tagged steelhead released in any basin above McNary Dam between McNary Dam and Bonneville Dam (grouped by observation date at McNary Dam).
(continued)

McNary Dam	Travel Time			Confidence Limits			The Dalles Dam
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
05/25	3.1	4.3	9	4.2	4.4	285	275.3
05/26	3	4.2	13.7	4	4.4	182	297.5
05/27	3.2	4.4	18.1	4.1	4.6	181	320.2
05/28	3	4.7	21.8	4.3	4.8	135	318.2
05/29	2.8	4.9	18.7	4.6	5.5	177	312.9
05/30	3.6	5.2	16	4.2	6.7	44	315.7
05/31	3.1	5.3	12.5	5.1	6	75	305.4
06/01	3.4	4.9	9	4.7	5	112	291.8
06/02	3.2	4.8	15.6	4.7	4.9	412	282.6
06/03	3.3	4.8	16.8	4.8	4.9	175	279.8
06/04	3.2	4.8	14.5	4.7	4.9	277	274.4
06/05	3.1	4.8	16.8	4.7	5	126	271.4
06/06	3.8	5	22.4	4.6	5.5	80	273.8
06/07	4.1	5.7	11.4	4.6	6.5	20	275.7
06/08	3.2	5.4	12.6	4.7	6	44	277.4
06/09	3.2	5.2	10.2	4.7	6.3	30	277.6
06/10	3.1	4.4	8.7	4.1	4.6	48	281.4
06/11	3.6	6.1	8.7	4	6.7	21	265.6
06/12	3.6	5.6	6.8	4.8	5.9	25	259.9
06/13	3.7	4.9	17.7	4.7	5.6	25	253.4
06/14	3.9	4.4	13.2	4.1	4.6	16	252

TABLE E-22. 2003travel time of PIT-tagged subyearling chinook released in any basin above McNary Dam between McNary Dam and Bonneville Dam (grouped by observation date at McNary Dam).

McNary Dam	Travel Time			Confidence Limits			The Dalles Dam
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
06/21	4.2	5.6	20.9	5.5	5.8	185	195.2
06/22	4.2	5.5	23.2	5.4	5.6	183	191.8
06/23	3.7	5.5	19.1	5.3	5.7	145	193.6
06/24	3.1	5.3	28.6	5.2	5.5	289	196.6
06/25	3.3	5.5	17.1	5.3	5.7	256	190.2
06/26	3.7	5.4	10.1	5.4	5.5	337	188.5
06/27	3.9	5.7	19.8	5.6	5.8	298	168.9
06/28	3.8	6.5	18.9	6.4	6.7	479	156.2
06/29	4.6	6.4	23.5	6.3	6.5	396	155
06/30	4.2	6	20.4	5.9	6.1	451	143.9
07/01	3.7	7.2	21.2	6.9	8	269	135.2
07/02	4.1	7.4	18.7	7.2	7.5	267	136.7
07/03	4.7	6.8	14.4	6.7	7	195	137.5
07/04	5	6.4	15.9	6.1	6.8	170	141.6
07/05	4.6	6.4	13	6.3	6.6	217	144.6
07/06	4.5	5.8	21.3	5.6	6	162	145.6
07/07	4.3	6.2	16.9	6	6.6	195	149.6
07/08	3.8	6.3	16.7	6.2	6.6	171	155.1
07/09	3.9	5.7	16.5	5.6	5.9	203	159.7
07/10	3.6	5.5	10.5	5.3	5.6	173	153.7
07/11	4.3	5.8	15.1	5.6	6	157	152.9
07/12	3.8	5.8	12	5.5	6	112	150
07/13	4.2	5.5	12.2	5.4	5.8	81	141.2

APPENDIX F

Reach Survival Tables

Description of Reach Survival Tables:

Table F-1 presents 2003 survival estimates for PIT tagged yearling chinook and steelhead released from traps on the lower Salmon (103 km above mouth at Twin Bridges), lower Imnaha (6.8 km above mouth), lower Grande Ronde (5 km above mouth), and mainstem Snake (225 km above mouth at Lewiston) rivers through a series of three reservoirs and dams to the tailrace of Lower Monumental Dam. The Seber (1965) and Jolly (1965) methodology and computer program Mark (Burnham *et al.* 1987) were used to obtain point estimates of survival for the series of reaches, along with corresponding standard errors of the estimates and the correlation between estimates from adjacent reaches. The three reaches were: trap location to Lower Granite Dam tailrace (denoted **lgr**); Lower Granite Dam tailrace to Little Goose Dam tailrace (denoted **lgs**); and Little Goose Dam tailrace to Lower Monumental Dam tailrace (denoted **lmn**). The product of these three reach estimates produced the entire 3-dam reach survival estimate from the trap's location to Lower Monumental Dam tailrace (denoted **surv_reach**). The associated standard errors (denoted **se_lgr**, **se_lgs**, and **se_lmn** for the respective reach estimates) and covariances derived from the correlation estimates (denoted **corr_lgrlgs** and **corr_lgslmn**) went into computing the variance for the overall reach estimate (denoted **var_reach**) using Meyer's (1975) formulas for propagation of error (*i.e.*, variance of the product of three random variables whose error may be correlated). Normally distributed 95% confidence intervals were computed for the overall reach survival point estimates, and are denoted **ul_reach** for the upper limit and **ll_reach** for the lower limit. Plots of the reach survival estimates with associated 95% confidence intervals are presented in Table F-1 for PIT tag releases from the traps on the Salmon, Snake, Imnaha, and Grande Ronde rivers.

Table F-2 presents 2003 survival estimates for PIT tagged yearling chinook from selected hatcheries in the Snake River basin through a series of reservoirs and dams to John Day Dam tailrace. Survival estimates through the 3-dam reach as described in the preceding paragraph are extended further downstream to encompass the Lower Monumental Dam tailrace to McNary Dam tailrace reach (denoted **mcn**), and McNary Dam tailrace to John Day Dam tailrace reach (denoted **jda**). The product of the five reach estimates produced the entire 5-reach survival estimate from trap's release location to the tailrace of John Day Dam (again denoted **surv_reach**). Along with the additional standard errors (**se_mcn**, and **se_jda**) and correlations (**corr_lmnmcn**, and **corr_mcnjda**), the variance for the entire 5-reach survival estimate was computed using Meyer's

(1975) formulas.

Table F-3 presents 2003 survival estimates for PIT tagged yearling and subyearling chinook, steelhead, and sockeye from several release sites in the Mid-Columbia River basin through one reach consisting of multiple reservoirs and dams. Winthrop Hatchery yearling chinook passed six dams, Wells Hatchery subyearling chinook passed five dams, Leavenworth Hatchery yearling chinook passed four dams, Rock Island Dam releases passed three dams, and Priest Rapids Hatchery and Ringold Hatchery passed one dam. The tables present survival estimates (denoted **mcn**) and confidence intervals from release site to tailrace of McNary Dam.

Sources:

Burnham, K.P., D.R. Anderson, G.C. White, C. Bronwnie, and K.H. Pollock, 1987, *Design and analysis methods for fish survival experiments based on release-recapture*, American Fisheries Society Monograph 5, 437 pp.

Jolly, G.M., 1965, Explicit estimates from capture-recapture data with both death and immigration – stochastic model, *Biometrika*, 52: 225-247.

Meyer, S.L., 1975, *Data analysis for scientists and engineers*, John Wiley and sons, N.Y., 513 pp.

Seber, G.A.F., 1965, A note on the multiple-recapture census, *Biometrika*, 52: 249-259.

TABLE F- 1. 2003 survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn), and within the entire reach (surv-reach).

Site	Snake River Trap			
species/reartype	Hatchery Chinook			Wild Chinook
dates	4/15 to 4/25	4/26 to 5/06	5/19 to 5/27	4/12 to 4/18
lgr	1.0751	0.9363	0.9690	1.0204
se_lgr	0.0687	0.0632	0.0440	0.0503
lgs	0.8230	1.0249	0.8197	0.8439
se_lgs	0.0920	0.1268	0.0458	0.0527
lmn	1.0583	0.8175	0.9909	1.0299
se_lmn	0.2976	0.1908	0.0582	0.0527
corr_lgrlgs	-0.6071	-0.5317	-0.8080	-0.8817
corr_lgslmn	-0.2425	-0.3773	-0.2292	-0.2556
N	482	504	779	890
ul_reach	1.4279	1.1059	0.8719	0.9623
ll_reach	0.4448	0.4632	0.7021	0.8114
surv_reach	0.9364	0.7846	0.7870	0.8868
var_reach	0.0629	0.0269	0.0019	0.0015

Site	Snake River Trap							
species/reartype	Hatchery Steelhead					Wild Steelhead		
dates	4/12 to 4/18	4/19 to 4/25	4/27 to 5/03	5/04 to 5/12	5/13 to 5/20	4/18 to 5/02	5/03 to 5/17	5/18 to 5/27
lgr	0.9777	0.9331	0.9398	0.9615	0.9701	0.8748	0.8332	0.9901
se_lgr	0.0509	0.0507	0.0659	0.0490	0.0372	0.0747	0.0593	0.0317
lgs	0.9892	0.8611	0.9925	0.8506	0.9115	0.9846	1.0505	0.8913
se_lgs	0.0999	0.0819	0.1129	0.0616	0.0494	0.1481	0.1281	0.0413
lmn	0.9043	1.1418	1.0268	1.0019	1.0440	0.9916	0.8314	0.9087
se_lmn	0.1597	0.1915	0.1746	0.1005	0.0946	0.3333	0.1625	0.0829
corr_lgrlgs	-0.5168	-0.5608	-0.6077	-0.6936	-0.6921	-0.5328	-0.5166	-0.6788
corr_lgslmn	-0.4197	-0.3655	-0.4170	-0.3419	-0.2764	-0.3127	-0.4425	-0.2015
N	753	648	664	893	732	299	335	431
ul_reach	1.1385	1.1882	1.2293	0.9613	1.0748	1.3771	0.9667	0.9405
ll_reach	0.6107	0.6467	0.6861	0.6774	0.7715	0.3312	0.4886	0.6631
surv_reach	0.8746	0.9174	0.9577	0.8194	0.9231	0.8541	0.7276	0.8018
var_reach	0.0181	0.0191	0.0192	0.0052	0.0060	0.0712	0.0149	0.0050

TABLE F- 1. 2003 survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn), and within the entire reach (surv-reach).
(Continued)

Site	Salmon River Trap							
species/reartype	Wild Yearling Chinook							
dates	3/14 to 3/18	3/19 to 3/23	3/24 to 3/30	3/31 to 4/6	4/7 to 4/13	4/14 to 4/20	4/21 to 4/27	4/28 to 5/7
lgr	0.8548	0.7761	0.7143	0.8680	0.8423	0.8063	0.7811	0.7632
se_lgr	0.0311	0.0270	0.0277	0.0287	0.0366	0.0274	0.0353	0.0386
lgs	0.8198	0.9573	0.9610	0.8408	0.8098	0.9311	0.9963	0.8204
se_lgs	0.0501	0.0635	0.0632	0.0501	0.0623	0.0612	0.0934	0.0647
lmn	0.8713	0.8648	0.8707	0.9500	1.0549	0.8173	0.9895	0.9365
se_lmn	0.0892	0.1174	0.1212	0.1371	0.1756	0.0867	0.1603	0.0991
corr_lgrlgs	-0.6849	-0.5527	-0.5477	-0.6180	-0.6536	-0.5733	-0.4888	-0.6722
corr_lgslmn	-0.3055	-0.3507	-0.3134	-0.2488	-0.2458	-0.4253	-0.4489	-0.3314
N	1536	1348	924	1358	927	1621	688	703
ul_reach	0.7220	0.7976	0.7490	0.8795	0.9419	0.7228	0.9797	0.6959
ll_reach	0.4992	0.4873	0.4465	0.5072	0.4973	0.5045	0.5604	0.4768
surv_reach	0.6106	0.6425	0.5978	0.6934	0.7196	0.6136	0.7700	0.5864
var_reach	0.0032	0.0063	0.0060	0.0090	0.0129	0.0031	0.0114	0.0031

Site	Salmon River Trap					
species/reartype	Hatchery Yearling Chinook					
dates	3/14 to 3/16	3/18 to 3/22	3/25 to 3/29	3/30 to 4/5	4/8 to 4/12	4/15 to 4/19
lgr	0.7102	0.6657	0.7663	0.7190	0.7144	0.7736
se_lgr	0.0513	0.0397	0.0596	0.0440	0.0405	0.0425
lgs	0.9006	0.9740	0.8618	0.8953	0.7929	0.8328
se_lgs	0.1059	0.1006	0.1084	0.0905	0.0677	0.0626
lmn	0.7619	0.8659	0.9934	0.7902	1.6181	1.0215
se_lmn	0.1761	0.1861	0.2627	0.1414	0.4191	0.1485
corr_lgrlgs	-0.5547	-0.4652	-0.5679	-0.5040	-0.5658	-0.6111
corr_lgslmn	-0.3256	-0.3471	-0.2972	-0.3775	-0.1868	-0.2477
N	699	683	593	604	808	589
ul_reach	0.6907	0.7795	0.9735	0.6696	1.3704	0.8374
ll_reach	0.2838	0.3434	0.3386	0.3476	0.4627	0.4787
surv_reach	0.4873	0.5614	0.6561	0.5086	0.9165	0.6580
var_reach	0.0108	0.0124	0.0262	0.0067	0.0536	0.0084

TABLE F- 1. 2003 survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn), and within the entire reach (surv-reach).
(continued)

Site	Salmon River Trap			
species/reartype	Hatchery Steelhead			
dates	4/07 to 04/16	4/17 to 04/27	4/28 to 05/05	5/06 to 05/12
lgr	0.9519	0.8610	0.8837	0.8607
se_lgr	0.0850	0.0649	0.0615	0.0511
lgs	1.3672	1.2664	0.9289	0.9266
se_lgs	0.3028	0.2200	0.0926	0.0833
lmn	0.5717	0.8250	0.9145	0.8764
se_lmn	0.1922	0.2213	0.1173	0.1083
corr_lgrlgs	-0.3989	-0.4068	-0.6757	-0.6149
corr_lgslmn	-0.5678	-0.5452	-0.4000	-0.4229
N	291	415	682	615
ul_reach	1.1290	1.2792	0.9094	0.8422
ll_reach	0.3589	0.5199	0.5920	0.5558
surv_reach	0.7439	0.8995	0.7507	0.6990
var_reach	0.0386	0.0375	0.0066	0.0053

Site	Grande Ronde Trap				
species/reartype	Hatchery Yearling Chinook		Wild Chinook		
dates	3/17 to 3/22	3/24 to 4/01	3/17 to 3/25	3/27 to 4/04	4/05 to 4/15
lgr	0.8706	0.8569	0.9032	0.9816	0.8602
se_lgr	0.0567	0.0510	0.0535	0.0692	0.0557
lgs	0.8010	0.9137	0.8791	0.8351	0.8081
se_lgs	0.0963	0.1006	0.0799	0.1051	0.0978
lmn	1.1070	0.7885	1.0719	1.2595	0.9180
se_lmn	0.2688	0.1352	0.2393	0.3905	0.2250
corr_lgrlgs	-0.5285	-0.5194	-0.7451	-0.6931	-0.5898
corr_lgslmn	-0.3346	-0.4527	-0.1856	-0.2280	-0.2888
N	594	798	666	553	282
ul_reach	1.1098	0.7934	1.2090	1.6289	0.9248
ll_reach	0.4342	0.4413	0.4931	0.4362	0.3515
surv_reach	0.7720	0.6173	0.8510	1.0326	0.6381
var_reach	0.0297	0.0081	0.0334	0.0926	0.0214

TABLE F- 1. 2003 survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn), and within the entire reach (surv-reach).
(continued)

Site	Grande Ronde Trap				
species/reartype	Hatchery Steelhead				Wild Steelhead
dates	4/14 to 4/19	4/20 to 4/29	5/16 to 5/25	5/26 to 6/04	5/24 to 6/02
lgr	0.8844	0.9126	0.9498	0.8926	0.8734
se_lgr	0.0478	0.0730	0.0402	0.0343	0.0379
lgs	0.9989	0.8949	1.0365	0.9407	0.9437
se_lgs	0.0966	0.1251	0.0686	0.0564	0.0624
lmn	1.0718	0.9240	0.7394	0.8621	0.7942
se_lmn	0.1677	0.1975	0.0776	0.1059	0.1063
corr_lgrlgs	-1.0927	-0.5656	-0.6027	-0.4964	-0.4780
corr_lgslmn	-0.5774	-0.4280	-0.3990	-0.3028	-0.3099
N	721	459	469	334	270
ul_reach	1.1115	1.0250	0.8578	0.8882	0.8166
ll_reach	0.7823	0.4843	0.5982	0.5596	0.4927
surv_reach	0.9469	0.7547	0.7280	0.7239	0.6546
var_reach	0.0071	0.0190	0.0044	0.0070	0.0068

Site	Imnaha River Trap						
species/reartype	Wild Yearling Chinook						
dates	10/01 to 10/31	11/01 to 11/21	3/15 to 3/22	3/23 to 3/30	3/31 to 4/06	4/07 to 4/16	4/17 to 4/26
lgr	0.2645	0.3330	0.7719	0.7897	0.8309	0.7953	0.7356
se_lgr	0.0165	0.0191	0.0385	0.0340	0.0213	0.0437	0.0337
lgs	0.9189	1.1145	0.8893	0.9406	0.9404	0.9395	0.9226
se_lgs	0.1022	0.1308	0.0703	0.0634	0.0407	0.0869	0.0641
lmn	1.0444	0.6447	0.9260	0.9083	0.8637	0.8622	0.9866
se_lmn	0.2615	0.1158	0.1428	0.1283	0.0737	0.1683	0.1211
corr_lgrlgs	-0.5928	-0.5298	-0.5290	-0.5153	-0.4674	-0.4839	-0.5288
corr_lgslmn	-0.3078	-0.5193	-0.3190	-0.3089	-0.3499	-0.3263	-0.3504
N	3511	3672	666	698	1390	432	818
ul_reach	0.3691	0.3061	0.8143	0.8495	0.7790	0.8734	0.8172
ll_reach	0.1387	0.1724	0.4570	0.4998	0.5707	0.4150	0.5219
surv_reach	0.2539	0.2392	0.6356	0.6747	0.6749	0.6442	0.6696
var_reach	0.0035	0.0012	0.0083	0.0080	0.0028	0.0137	0.0057

TABLE F- 1. 2003 survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn), and within the entire reach (surv-reach).
(continued)

Site	Imnaha River Trap									
species/ reartype	Hatchery Steelhead					Wild Steelhead				
dates	4/12 to 4/18	4/19 to 4/25	4/27 to 4/30	5/06 to 5/12	5/14 to 5/22	4/21 to 4/26	4/27 to 5/04	5/05 to 5/09	5/10 to 5/15	5/16 to 5/23
lgr	0.9482	0.8921	0.8694	0.8627	0.9884	0.8522	0.8286	0.9116	0.8601	0.8006
se_lgr	0.0437	0.0424	0.0526	0.0236	0.0611	0.0416	0.0517	0.0467	0.0220	0.0239
lgs	0.9859	1.0238	1.0353	1.0422	0.8256	0.9603	0.8555	0.9038	0.9181	0.9757
se_lgs	0.0750	0.0892	0.0980	0.0419	0.0717	0.0879	0.0868	0.0743	0.0360	0.0396
lmn	0.8863	0.9647	0.8996	0.9063	1.0261	0.8428	0.9202	0.9033	1.0782	0.7815
se_lmn	0.0895	0.1181	0.1082	0.0573	0.1155	0.1334	0.1557	0.1083	0.0694	0.0479
corr_lgrlgs	-0.6020	-0.5208	-0.6129	-0.5730	-0.7060	-0.4926	-0.5789	-0.5993	-0.5636	-0.4543
corr_lgslmn	-0.4752	-0.5128	-0.4851	-0.4052	-0.3371	-0.4235	-0.3696	-0.4165	-0.3629	-0.4244
N	1164	1023	957	1331	435	909	774	823	1730	718
ul_reach	0.9603	1.0502	0.9604	0.9029	1.0004	0.8767	0.8453	0.8937	0.9483	0.6769
ll_reach	0.6967	0.7122	0.6590	0.7268	0.6743	0.5028	0.4592	0.5947	0.7544	0.5440
surv_reach	0.8285	0.8812	0.8097	0.8149	0.8373	0.6898	0.6522	0.7442	0.8513	0.6105
var_reach	0.0045	0.0074	0.0059	0.0020	0.0069	0.0091	0.0097	0.0058	0.0024	0.0011

TABLE F- 2. 2003 survival estimates for Snake River basin fish from release site to John Day Dam tailrace (jda).

Hatchery & species	McCall Chinook	Dworshak Chinook	Rapid R Chinook	Imnaha R Chinook	Catherine Ck Chinook
lgr	0.5704	0.6886	0.6742	0.7146	0.3480
se_lgr	0.0269	0.0329	0.0198	0.0228	0.0132
lgs	0.9305	0.9073	0.9122	0.8969	0.9558
se_lgs	0.0791	0.0722	0.0560	0.0523	0.0681
lmn	0.8802	0.8920	0.9221	0.9156	0.8722
se_lmn	0.1279	0.1092	0.0968	0.1036	0.1058
mcn	1.0338	0.9851	0.9157	0.8899	1.1468
se_mcn	0.1536	0.1238	0.0894	0.1038	0.1511
jda	0.9824	0.9167	1.0242	1.1307	0.7537
se_jda	0.1739	0.1459	0.1010	0.1501	0.1257
corr_lgrlgs	-0.6206	-0.6836	-0.6555	-0.6442	-0.5662
corr_lgslmn	-0.3801	-0.3749	-0.4086	-0.3300	-0.4134
corr_lmnmcn	-0.7484	-0.7278	-0.7733	-0.8043	-0.6904
corr_mcnjda	-0.2009	-0.1973	-0.1371	-0.1632	-0.2682
N	51524	51476	178931	20904	17987
c-hat	18.12	18.24	11.82	3.59	2.35
surv_reach	0.4744	0.5032	0.5318	0.5905	0.2507
se_reach	0.0189	0.0164	0.0099	0.0169	0.0042
Ul_reach	0.7439	0.7541	0.7266	0.8453	0.3773
Ll_reach	0.2049	0.2523	0.3371	0.3357	0.1241

TABLE F- 3. 2003 survival estimates for Mid-Columbia River basin fish from release site to McNary Dam tailrace (mcn).

Site	Leavenworth Hatchery	Winthrop Hatchery
species/age	Chinook 1's	Chinook 1's
dates	04/21/03	4/14/03
rel to mcn	0.6619	0.5503
se	0.0038	0.0138
N	240558	19962
ll_reach	0.6545	0.5232
ul_reach	0.6693	0.5773

Source: NOAA Fisheries transportation study releases

TABLE F- 3. 2003 survival estimates for Mid-Columbia River basin fish from release site to McNary Dam tailrace (mcn).
(continued)

Site	Wells Hatchery	Priest Rapids H
species/age	Chinook 0's	Chinook 0's
dates	6/17	6/11-6/19
rel to mcn	0.4559	0.6334
se	0.0256	0.0220
N	5996	2984
ll_reach	0.4058	0.5902
ul_reach	0.5061	0.6766

Site	Rock Island Dam			
species/age	Chinook 0's	Chinook 0's	Chinook 0's	Chinook 0's
dates	6/28 to 7/4	7/05 to 7/13	7/13 to 7/21	7/22 to 7/28
mcn	0.7195	0.4635	0.2785	0.3046
se_mcn	0.1010	0.0560	0.0648	0.0880
N	517	742	602	795
ll_reach	0.5214	0.3537	0.1514	0.1321
ul_reach	0.9175	0.5732	0.4056	0.4772

APPENDIX G

Multi-Year Analysis Survival Estimates

Multi-year Analysis Survival Estimates

TABLE G1. Rock Island Dam to McNary Dam Reach Survival Estimates and Related Parameters used in Multi-Year Analysis.

Species	Migration Year	Release Dates	Release number	Survival	Travel Time	Water Transit Time	Avg Spill Percentage	Avg Reach Temperate (?C)
CH1HW	1998	4/21	1	0.59	12.4	5.7	43	12.5
CH1HW	1998	5/5	2	0.93	5.7	5.1	42	11.2
CH1HW	1999	4/21	1	0.74	14.0	5.5	47	9.5
CH1HW	1999	5/5	2	0.74	6.4	5.6	46	10.6
CH1HW	1999	5/19	3	0.79	7.4	5.1	49	12.4
CH1HW	2000	4/21	1	0.78	17.6	5.3	46	12.6
CH1HW	2000	5/5	2	0.79	5.8	5.5	45	12.9
CH1HW	2001	4/21	1	0.53	29.4	11.0	36	12.0
CH1HW	2001	5/5	2	0.68	17.5	12.0	36	13.0
CH1HW	2001	5/19	3	0.59	17.5	10.2	36	14.4
CH1HW	2002	4/21	1	0.65	12.5	6.4	38	10.0
CH1HW	2002	5/5	2	0.68	7.7	6.3	39	10.9
CH1HW	2002	5/19	3	0.59	6.9	5.2	48	12.3
STHW	1998	4/21	1	0.59	7.9	6.0	42	12.5
STHW	1998	5/5	2	0.60	5.7	5.1	42	11.2
STHW	1998	5/19	3	0.45	7.7	4.7	47	12.8
STHW	1999	4/21	1	0.67	6.2	5.3	48	9.2
STHW	1999	5/5	2	0.61	6.4	5.6	46	10.6
STHW	1999	5/19	3	0.68	7.4	5.1	49	12.4
STHW	2000	4/21	1	0.91	6.0	5.0	46	11.1
STHW	2000	5/5	2	0.66	5.8	5.5	45	12.9
STHW	2000	5/19	3	0.41	7.7	6.6	43	13.3
STHW	2001	4/21	1	0.25	19.0	11.3	34	11.2
STHW	2001	5/5	2	0.23	17.5	11.8	36	13.0
STHW	2001	5/19	3	0.18	17.5	10.2	36	14.4
STHW	2002	4/21	1	0.76	6.7	6.4	40	10.0
STHW	2002	5/5	2	0.68	7.7	6.3	39	10.9
STHW	2002	5/19	3	0.63	6.9	5.1	48	12.3

TABLE G2. Lower Granite to McNary Dam Reach Survival Estimates and Related Parameters used in Multi-Year Analysis.

Species	Migration Year	Release Dates	Release number	Survival	Travel Time	Water Transit Time	Avg Spill Percentage	Avg Reach Temperate (?C)
CH1W	1995	4/15	3	0.83	14.1	11.9	29	10.5
CH1W	1995	4/22	4	0.67	11.5	10.3	29	10.9
CH1W	1995	4/29	5	0.80	9.4	8.7	32	11.1
CH1W	1995	5/6	6	0.76	8.9	8.9	33	11.9
CH1W	1996	4/15	3	0.74	9.8	7.0	39	10.5
CH1W	1996	4/22	4	0.48	9.4	8.2	34	10.7
CH1W	1996	4/29	5	0.56	14.5	8.2	37	11.0
CH1W	1998	4/1	1	0.76	22.7	11.1	40	10.9
CH1W	1998	4/8	2	0.74	18.2	10.8	39	11.2
CH1W	1998	4/15	3	0.80	13.8	10.0	38	11.7
CH1W	1998	4/22	4	0.79	11.3	8.2	38	12.4
CH1W	1998	4/29	5	0.80	10.9	7.2	37	12.9
CH1W	1998	5/6	6	0.82	10.6	7.4	36	12.5
CH1W	1998	5/20	8	0.60	7.6	5.1	51	12.5
CH1W	1999	4/1	1	0.78	19.3	9.1	39	9.4
CH1W	1999	4/8	2	0.81	13.9	8.6	37	9.7
CH1W	1999	4/15	3	0.79	10.6	7.8	34	10.2
CH1W	1999	4/22	4	0.79	9.8	8.3	35	10.4
CH1W	1999	4/29	5	0.81	9.9	9.2	39	10.3
CH1W	1999	5/6	6	0.69	9.5	10.0	40	11.1
CH1W	1999	5/13	7	0.76	8.5	8.5	38	12.3
CH1W	1999	5/20	8	0.90	6.4	6.0	40	13.2
CH1W	2000	4/8	2	0.73	11.7	8.2	44	10.3
CH1W	2000	4/15	3	0.82	11.8	8.5	42	10.8
CH1W	2000	4/22	4	0.75	10.6	9.1	38	11.2
CH1W	2000	4/29	5	0.73	9.4	9.9	44	11.8
CH1W	2000	5/6	6	0.73	9.9	11.7	51	12.2
CH1W	2000	5/13	7	0.73	10.5	10.1	42	14.1
CH1W	2000	5/20	8	0.86	7.5	10.1	41	14.3
CH1W	2001	4/8	2	0.65	26.3	18.4	0	11.1
CH1W	2001	4/15	3	0.61	21.5	18.1	0	11.6
CH1W	2001	4/22	4	0.59	21.1	16.1	0	12.3
CH1W	2001	4/29	5	0.52	19.5	14.6	0	12.4
CH1W	2001	5/6	6	0.51	16.4	13.2	1	13.4
CH1W	2001	5/13	7	0.46	15.1	14.1	1	13.6
CH1W	2001	5/20	8	0.26	15.8	16.4	1	15.0
CH1W	2002	4/22	4	0.73	13.8	12.1	36	10.3
CH1W	2002	4/29	5	0.66	11.2	12.9	35	10.8
CH1W	2002	5/6	6	0.66	11.4	12.1	37	11.3
CH1W	2002	5/13	7	0.64	8.2	9.7	34	11.8
CH1W	2002	5/20	8	0.77	8.1	8.3	33	12.0

TABLE G2. Lower Granite to McNary Dam Reach Survival Estimates and Related Parameters used in Multi-Year Analysis.
(continued)

Species	Migration Year	Release Dates	Release number	Survival	Travel Time	Water Transit Time	Avg Spill Percentage	Avg Reach Temperate (?C)
CH1W	2003	4/1	1	0.70	22.0	11.8	45	9.5
CH1W	2003	4/8	2	0.65	15.2	11.9	46	9.7
CH1W	2003	4/15	3	0.72	14.9	11.6	42	10.0
CH1W	2003	4/22	4	0.73	8.2	11.8	42	10.4
CH1W	2003	4/29	5	0.64	10.0	12.6	43	10.5
CH1W	2003	5/6	6	0.70	8.0	11.4	41	11.1
CH1W	2003	5/13	7	0.76	9.1	10.3	39	11.9
CH1W	2003	5/20	8	0.85	6.3	6.5	36	12.6
CH1H	1995	4/15	3	0.73	16.5	10.9	29	10.7
CH1H	1995	4/22	4	0.67	12.8	9.9	30	11.0
CH1H	1995	4/29	5	0.78	10.6	8.7	32	11.1
CH1H	1996	4/15	3	0.59	11.4	7.1	38	10.5
CH1H	1996	4/22	4	0.68	13.4	9.1	32	10.9
CH1H	1996	4/29	5	0.65	13.7	8.2	36	10.9
CH1H	1996	5/6	6	0.69	9.7	6.4	43	11.3
CH1H	1996	5/13	7	0.78	8.5	6.1	48	10.7
CH1H	1997	4/29	5	0.44	9.5	5.8	43	11.1
CH1H	1998	4/1	1	0.81	22.3	11.4	41	10.9
CH1H	1998	4/8	2	0.74	17.2	11.3	40	11.0
CH1H	1998	4/15	3	0.74	13.1	10.4	38	11.5
CH1H	1998	4/22	4	0.81	11.5	8.1	38	12.5
CH1H	1998	4/29	5	0.79	10.4	7.2	37	12.9
CH1H	1998	5/6	6	0.81	10.4	7.4	36	12.4
CH1H	1998	5/13	7	0.86	9.7	6.3	43	12.9
CH1H	1999	4/1	1	0.83	13.2	11.0	39	8.6
CH1H	1999	4/8	2	0.75	12.3	8.8	37	9.6
CH1H	1999	4/15	3	0.72	11.5	7.8	35	10.2
CH1H	1999	4/22	4	0.81	10.8	8.4	36	10.4
CH1H	1999	4/29	5	0.81	10.7	9.3	39	10.4
CH1H	1999	5/6	6	0.80	10.2	10.1	41	11.2
CH1H	1999	5/13	7	0.80	8.4	8.3	38	12.2
CH1H	1999	5/20	8	0.72	6.1	6.1	40	13.2
CH1H	2000	4/15	3	0.94	12.7	8.7	42	10.9
CH1H	2000	4/22	4	0.76	11.6	9.2	39	11.4
CH1H	2000	4/29	5	0.72	10.1	10.1	44	11.7
CH1H	2000	5/6	6	0.75	10.9	11.7	52	12.4
CH1H	2000	5/20	8	0.73	7.3	10.0	41	14.3

TABLE G2. Lower Granite to McNary Dam Reach Survival Estimates and Related Parameters used in Multi-Year Analysis.
(continued)

Species	Migration Year	Release Dates	Release number	Survival	Travel Time	Water Transit Time	Avg Spill Percentage	Avg Reach Temperate (?C)
CH1H	2001	4/8	2	0.57	28.7	18.4	0	11.5
CH1H	2001	4/15	3	0.61	21.7	18.0	0	11.6
CH1H	2001	4/22	4	0.59	20.2	16.5	0	12.3
CH1H	2001	4/29	5	0.58	20.2	14.1	1	12.7
CH1H	2001	5/6	6	0.55	16.6	13.4	1	13.5
CH1H	2001	5/13	7	0.47	14.3	14.1	1	13.7
CH1H	2001	5/20	8	0.28	17.2	16.7	1	15.2
CH1H	2002	4/22	4	0.59	14.0	12.3	36	10.4
CH1H	2002	4/29	5	0.73	11.8	13.3	36	10.9
CH1H	2002	5/6	6	0.64	12.2	11.4	36	11.4
CH1H	2002	5/13	7	0.73	8.5	9.5	34	11.9
CH1H	2002	5/20	8	0.75	9.1	8.0	33	12.2
CH1H	2003	4/15	3	0.75	12.0	11.5	41	9.9
CH1H	2003	4/22	4	0.73	10.8	12.3	43	10.4
CH1H	2003	4/29	5	0.82	9.9	12.6	43	10.5
CH1H	2003	5/6	6	0.72	9.4	11.3	40	11.2
CH1H	2003	5/13	7	0.75	7.9	10.7	40	11.8
CH1H	2003	5/20	8	0.86	7.0	6.6	36	12.6
STHW	1996	4/24	2	0.79	7.9	8.4	33	10.7
STHW	1996	5/1	3	0.79	10.5	9.1	36	10.8
STHW	1996	5/15	5	0.66	5.4	5.8	48	10.8
STHW	1997	4/17	1	0.90	7.0	5.4	47	9.5
STHW	1997	4/24	2	0.61	6.6	5.6	47	10.0
STHW	1997	5/1	3	0.80	7.5	5.9	42	11.1
STHW	1998	4/17	1	0.62	12.6	9.8	39	11.8
STHW	1998	4/24	2	0.75	9.1	8.3	38	12.4
STHW	1998	5/1	3	0.68	9.3	7.2	37	12.8
STHW	1998	5/8	4	0.69	9.0	7.4	36	12.4
STHW	1998	5/15	5	0.75	7.7	6.1	44	12.9
STHW	1998	5/22	6	0.63	4.9	5.2	51	12.5
STHW	1999	4/17	1	0.75	10.3	7.8	35	10.3
STHW	1999	4/24	2	0.72	8.4	8.4	36	10.3
STHW	1999	5/1	3	0.71	9.0	9.4	39	10.4
STHW	1999	5/8	4	0.63	11.3	9.8	40	11.5
STHW	1999	5/15	5	0.74	7.8	7.6	38	12.6
STHW	1999	5/22	6	0.84	5.7	5.8	42	13.1

TABLE G2. Lower Granite to McNary Dam Reach Survival Estimates and Related Parameters used in Multi-Year Analysis.
(continued)

Species	Migration Year	Release Dates	Release number	Survival	Travel Time	Transit Time	Avg Spill Percentage	Temperate (?C)
STHW	2000	4/17	1	0.72	8.3	8.4	43	10.7
STHW	2000	4/24	2	0.59	9.4	9.2	39	11.3
STHW	2000	5/1	3	0.55	10.1	10.5	46	11.8
STHW	2000	5/8	4	0.56	13.8	10.7	45	13.5
STHW	2001	4/24	2	0.16	19.9	16.2	0	12.3
STHW	2001	5/1	3	0.18	17.3	14.5	0	12.4
STHW	2001	5/8	4	0.19	13.8	13.1	1	13.4
STHW	2001	5/15	5	0.14	15.3	14.2	1	13.7
STHW	2001	5/22	6	0.08	23.3	18.2	0	15.5
STHW	2002	4/24	2	0.46	10.9	12.3	36	10.3
STHW	2002	5/1	3	0.47	12.1	13.4	37	11.1
STHW	2002	5/8	4	0.39	11.1	10.6	36	11.5
STHW	2002	5/15	5	0.52	8.0	9.2	33	12.1
STHW	2002	5/22	6	0.72	9.6	7.4	36	12.6
STHW	2003	4/8	2	0.73	12.2	10.2	47	9.5
STHW	2003	4/15	3	0.74	11.7	10.0	43	9.8
STHW	2003	5/6	6	0.59	11.2	9.9	40	11.2
STHW	2003	5/13	7	0.62	9.9	10.3	39	12.0
STHW	2003	5/20	8	0.63	6.5	8.0	37	12.6

TABLE G3. McNary Dam to Bonneville Dam Reach Survival Estimates and Related Parameters used in Multi-Year Analysis.

pecies	Migration Year	Release Dates	Release number	Survival	Travel Time	Transit Time	Avg Spill Percentage	Temperate (?C)
H1HW	1999	4/25	1	0.67	6.2	5.7	37	10.8
H1HW	1999	5/9	2	0.76	5.5	6.1	36	12.3
H1HW	1999	5/23	3	0.66	4.0	4.6	37	14.3
H1HW	2000	4/25	1	0.66	6.9	5.9	33	11.8
H1HW	2000	5/9	2	0.67	11.0	6.5	36	14.0
H1HW	2001	4/25	1	0.45	13.6	13.2	7	13.2
H1HW	2001	5/9	2	0.52	10.9	11.8	23	15.3
H1HW	2001	5/23	3	0.59	6.6	11.6	26	16.4
H1HW	2002	4/25	1	0.69	6.2	7.6	40	10.6
H1HW	2002	5/9	2	0.82	4.9	7.1	38	12.6
H1HW	2002	5/23	3	0.67	4.5	5.2	41	14.3
H1HW	2003	4/25	1	0.74	7.7	7.5	38	11.7
H1HW	2003	5/9	2	0.80	4.5	7.0	38	12.5
THW	1999	5/11	1	0.70	5.1	5.1	37	13.5
THW	2000	5/11	1	0.50	5.5	7.0	37	14.5
THW	2001	5/11	1	0.22	10.4	11.9	24	16.0
THW	2002	5/11	1	0.52	4.9	5.8	39	13.7
THW	2003	5/11	1	0.64	4.8	6.6	35	14.1

APPENDIX H

Hatchery Release Schedule

Colville Tribe

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Leavenworth NFH	CH1-SP	04/05/2003	04/15/2003	95,000	20	Bonaparte Acclimation Pond	Okanogan River	2001	100% LV clip.
Leavenworth NFH Total				**95,000**					
Winthrop NFH	CH1-SP	04/10/2003	04/15/2003	35,000	23	Omak Creek	Okanogan River	2001	100% RV clip.
Winthrop NFH Total				**35,000**					
Colville Tribe Total				**130,000**					

Idaho Dept. of Fish and Game

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Clearwater Hatchery	CH1-SP	07/27/2002	07/29/2002	299,787	65	Colt Killed Creek	Lochsa River	2001	100% RV clip; .7k PIT tag.
Clearwater Hatchery	CH1-SP	08/04/2002	08/04/2002	14,067	29	Squaw Creek	Salmon River (ID)	2001	100% CWT; No fin clips; .7k PIT tag.
Clearwater Hatchery	CH1-SP	08/04/2002	08/04/2002	13,948	33	Pete King Creek	Lochsa River	2001	100% CWT - No fin clips; 1k PIT tag.
Clearwater Hatchery	CH1-SP	09/23/2002	09/27/2002	169,768	14	Crooked R Acclim Pond	S Fk Clearwater River	2001	100% RV clip; .5k PIT tag.
Clearwater Hatchery	CH1-SP	09/25/2002	09/27/2002	526,733	13	Powell Acclim Pond	Lochsa River	2001	100% ad clip; .7k PIT tag.
Clearwater Hatchery	CH1-SP	09/27/2002	09/27/2002	85,064	17	Red River Acclim Pond	S Fk Clearwater River	2001	100% LV clip; .5k PIT tag.
Clearwater Hatchery	CH1-SP	09/30/2002	09/30/2002	123,677	48	Redhouse (SFk ClearH20 R)	S Fk Clearwater River	2001	100% ad clip.
Clearwater Hatchery	CH1-SP	04/01/2003	04/01/2003	350,665	17	Powell Acclim Pond	Lochsa River	2001	100% ad clip; .3k PIT tag.
Clearwater Hatchery	CH1-SP	04/02/2003	04/02/2003	629,687	18	Crooked R Acclim Pond	S Fk Clearwater River	2001	100% ad clip; .3k PIT tag; H2O inlet problem/early rel.
Clearwater Hatchery	CH1-SP	04/02/2003	04/02/2003	351,066	18	Red River Acclim Pond	S Fk Clearwater River	2001	100% ad clip; .3k PIT tag.
	CH1-SP Total			**2,564,462**					
Clearwater Hatchery	ST-SU	09/30/2002	09/30/2002	63,952	36	N Fk Clearwater River	Clearwater River M F	2002	100% ad clip.
Clearwater Hatchery	ST-SU	04/17/2003	04/17/2003	249,987	6	Red River Acclim Pond	S Fk Clearwater River	2002	100k ad clip; 149.5k unclipped; .5k PIT tag.
Clearwater Hatchery	ST-SU	04/18/2003	04/18/2003	149,664	6	Redhouse (SFk ClearH20 R)	S Fk Clearwater River	2002	100% ad clip; 65k adLV+CWT; .9k PIT tag.
Clearwater Hatchery	ST-SU	04/19/2003	04/19/2003	264,558	6	Crooked R Acclim Pond	S Fk Clearwater River	2002	97.6k ad clip; 78.8k non clip; 64.7k adLV+CWT; 22k CWT only; 2.7k PIT tag.
Clearwater Hatchery	ST-SU	04/21/2003	04/21/2003	108,052	7	Clear Creek	Clearwater River M F	2002	100% ad clip.
	ST-SU Total			**836,213**					
Clearwater Hatchery Total				**3,400,675**					
Magic Valley Hatchery	ST-SU	04/07/2003	04/07/2003	32,560	4	Lemhi River	Salmon River (ID)	2002	100% adLV+CWT; .3k PIT tag.
Magic Valley Hatchery	ST-SU	04/07/2003	04/07/2003	83,157	5	Lemhi River	Salmon River (ID)	2002	No fin clips; 300 PIT tag.
Magic Valley Hatchery	ST-SU	04/09/2003	04/09/2003	121,070	4	Squaw Cr Acclim Pond	Salmon River (ID)	2002	100% adLV+CWT.
Magic Valley Hatchery	ST-SU	04/14/2003	04/14/2003	183,634	5	Hammer Creek	Salmon River (ID)	2002	100% ad clip; .3k PIT tag.
Magic Valley Hatchery	ST-SU	04/15/2003	04/15/2003	128,035	5	Salmon River (ID)	Salmon River (ID)	2002	Rel = Section 16; 100% ad clip; 33.4k adLV+CWT .3k PIT tag.
Magic Valley Hatchery	ST-SU	04/16/2003	04/17/2003	265,730	5	Salmon River (ID)	Salmon River (ID)	2002	Rel = Sec. 17; includes Pah trap, Colston Corner; Lemhi Hole; 100% ad clip; 66k adLV+CWT; .3k PIT tag.
Magic Valley Hatchery	ST-SU	04/18/2003	04/21/2003	169,747	5	McNabb/Salmon River	Salmon River (ID)	2002	100% ad clip; .3k PIT tag; Rel = Sec 18; & Tunnel Rock.
Magic Valley Hatchery	ST-SU	04/23/2003	04/23/2003	202,079	5	Squaw Creek	Salmon River (ID)	2002	Rel=Below Acclim. Pd; 100% ad clip; 72k adLV+CWT; .3k PIT tag.
Magic Valley Hatchery	ST-SU	04/23/2003	04/25/2003	215,666	5	East Fk Salmon River	Salmon River (ID)	2002	100% ad clip.
Magic Valley Hatchery	ST-SU	04/24/2003	04/24/2003	27,707	4	East Fk Salmon River	Salmon River (ID)	2002	No Clips.
Magic Valley Hatchery	ST-SU	04/25/2003	04/25/2003	32,665	4	Valley Creek	Salmon River (ID)	2002	no fin clips; Rel = Sec 18; .3k PIT tag.
Magic Valley Hatchery	ST-SU	04/28/2003	04/29/2003	166,791	4	Yankee Fk (Salmon R)	Salmon River (ID)	2002	100% ad clip; 34k adLV+CWT; .3k PIT tag.
Magic Valley Hatchery	ST-SU	04/29/2003	05/01/2003	336,983	5	Little Salmon River	Salmon River (ID)	2002	Rel=Stinky Springs; 100% ad; 67.5k adLV+CWT; .3k PIT tag.
Magic Valley Hatchery Total				**1,965,824**					

McCall Hatchery	CH1-SU	03/31/2003	04/03/2003	1,053,660	21	Knox Bridge	Salmon River (ID)	2001	100% ad clip; 346k ad+CWT; 74.6k PIT tag.
McCall Hatchery Total				**1,053,660**					
Niagara Springs	ST-SU	03/24/2003	04/04/2003	525,884	5	Hells Canyon Dam	Snake River	2002	100% ad clip; 31k adLV+CWT; .3k PIT tag.
Niagara Springs	ST-SU	04/08/2003	04/10/2003	302,314	5	Little Salmon River	Salmon River (ID)	2002	100% ad clip; 32k adLV+CWT; .3k PIT tag..
Niagara Springs	ST-SU	04/12/2003	05/01/2003	843,257	4	Pahsimeroi Hatchery	Pahsimeroi River	2002	100% ad clip; 61k adLV+CWT; .3k PIT tag.
Niagara Springs	ST-SU	05/02/2003	05/06/2003	185,231	4	Little Salmon River	Salmon River (ID)	2002	100% ad clip; 33k adLV+CWT; .3k PIT tag.
Niagara Springs Total				**1,856,686**					
Oxbow-Idaho	CH0-FA	05/22/2003	05/22/2003	209,261	47	Hells Canyon Dam	Snake River	2002	100% ad clip; 9.9k PIT tag.
Oxbow-Idaho Total				**209,261**					
Pahsimeroi Hatchery	CH1-SU	03/29/2003	04/06/2003	295,992	15	Pahsimeroi Hatchery	Pahsimeroi River	2001	No Clips; 100% CWT; .5k PIT tag; Supplement. Group.
Pahsimeroi Hatchery	CH1-SU	03/29/2003	04/06/2003	909,926	15	Pahsimeroi Hatchery	Pahsimeroi River	2001	100% ad clip; .5k PIT tag.
Pahsimeroi Hatchery Total				**1,205,918**					
Rapid River Hatchery	CH1-SP	03/17/2003	04/28/2003	2,330,557	19	Rapid River Hatchery	Little Salmon River	2001	100% ad clip; 348.6k ad+CWT; 184k PIT tag.
Rapid River Hatchery	CH1-SP	03/18/2003	03/18/2003	199,900	20	Hazard Creek/Little Salmon R	Little Salmon River	2001	100% ad clip.
Rapid River Hatchery	CH1-SP	03/19/2003	03/20/2003	299,854	20	Hells Canyon Dam	Snake River	2001	100% ad clip.
Rapid River Hatchery Total				**2,830,311**					
Sawtooth Hatchery	CH1-SP	04/07/2003	04/18/2003	960,193	20	Sawtooth Hatchery	Salmon River (ID)	2001	100% ad clip; HxH cross; 200k Hi-Bkd group.
Sawtooth Hatchery	CH1-SP	04/07/2003	04/18/2003	144,976	20	Sawtooth Hatchery	Salmon River (ID)	2001	100% CWT; No clips; 1k PIT tag; ISS group.
	CH1-SP Total			**1,105,169**					
Sawtooth Hatchery	SO-UN	10/07/2002	10/07/2002	45,001	30	Redfish Lake	Salmon River (ID)	2001	100% ad clip; 1k PIT.
Sawtooth Hatchery	SO-UN	10/08/2002	10/08/2002	19,981	31	Pettit Lake	Salmon River (ID)	2001	100% ad clip; 10k ad+CWT; 2k PIT tag.
Sawtooth Hatchery	SO-UN	10/06/2003	10/08/2003	15,000	30	Pettit Lake	Salmon River (ID)	2002	100% ad clip; 2k PIT tag.
	SO-UN Total			**79,982**					
Sawtooth Hatchery Total				**1,185,151**					
Idaho Dept. of Fish and Game Total				**13,707,486**					

Nez Perce Tribe

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Cherry Lane Hatchery	CH0-FA	05/27/2003	05/30/2003	191,382	61	Lapwai Creek	Clearwater River MF	2002	169k CWT 61-26-48, 49, 52, 57; 3k PIT tag; No fin clips.
Cherry Lane Hatchery	CH0-FA	06/03/2003	06/05/2003	199,632	38	Cherry Lane Hatchery	Clearwater River MF	2002	100% CWT 61-1-7; 3k PIT tag; No fin clips.
Cherry Lane Hatchery	CH0-FA	06/19/2003	06/21/2003	114,897	81	Cherry Lane Hatchery	Clearwater River MF	2002	98k CWT; 2.4k PIT tag; unclipped.
	CH0-FA Total			**505,911**					
Cherry Lane Hatchery	CO-UN	03/25/2003	03/25/2003	29,030	1100	Orofino Creek	Clearwater River MF	2002	Unmarked/unclipped fry rel; Actual rearing = Potlatch.
	CO-UN Total			**29,030**					
Cherry Lane Hatchery Total				**534,941**					
Clearwater Hatchery	CH0-SP	08/05/2002	08/08/2002	403,261	50	Meadow Creek - SELW	Selway River	2001	100% CWT 61; No fin clip.
Clearwater Hatchery	CH0-SP	08/21/2002	08/21/2002	12,870	50	Mill Cr Bridge	S Fk Clearwater River	2001	100% CWT 61-1-3.
	CH0-SP Total			**416,131**					
Clearwater Hatchery	CH1-SP	03/14/2003	03/14/2003	43,621	23	Mill Cr Bridge	S Fk Clearwater River	2001	100% CWT 61-26-26; Non clipped rel.
Clearwater Hatchery	CH1-SP	03/17/2003	03/18/2003	287,175	26	Meadow Creek - SELW	Selway River	2001	1k PIT tag; 100% ad clip.
Clearwater Hatchery	CH1-SP	03/19/2003	03/19/2003	147,488	22	Lolo Creek	Clearwater River MF	2001	100% CWT 61-1-12, 13; 1k PIT tag; Non clipped rel.
Clearwater Hatchery	CH1-SP	03/20/2003	03/20/2003	101,513	25	Boulder Creek	Lochsa River	2001	100% CWT 61-26-27, 31; Non clipped rel.
Clearwater Hatchery	CH1-SP	03/21/2003	03/21/2003	74,066	27	Newsome Creek	S Fk Clearwater River	2001	100% CWT 61-1-11; 1k PIT tag; Non clipped rel.
Clearwater Hatchery	CH1-SP	04/03/2003	04/03/2003	52,225	17	Papoose Creek	Lochsa River	2001	100% CWT; no fin clips.
	CH1-SP Total			**706,088**					
Clearwater Hatchery	CO-UN	07/09/2002	07/10/2002	157,391	50	Meadow Creek - SELW	Selway River	2001	Unmarked Parr Rel; 1k PIT tag.
Clearwater Hatchery	CO-UN	07/10/2002	07/10/2002	115,051	50	Meadow Creek - CLES	S Fk Clearwater River	2001	Unmarked Parr Rel; 2k PIT tag.
Clearwater Hatchery	CO-UN	07/11/2002	07/11/2002	128,270	50	Eldorado Creek	Clearwater River MF	2001	Unmarked Parr Rel; 1k PIT tag.
	CO-UN Total			**400,712**					
Clearwater Hatchery	ST-SU	04/22/2003	04/22/2003	43,070	6	Lolo Creek	Clearwater River MF	2002	No clips; .5k PIT tag.
Clearwater Hatchery	ST-SU	04/22/2003	04/22/2003	23,310	6	Meadow Creek - CLES	S Fk Clearwater River	2002	No clips.
Clearwater Hatchery	ST-SU	04/23/2003	04/23/2003	33,362	6	Mill Cr Bridge	S Fk Clearwater River	2002	No clips; .5k PIT tag.
	ST-SU Total			**99,742**					
Clearwater Hatchery Total				**1,622,673**					
Dworshak NFH	CO-UN	05/01/2003	05/01/2003	293,879	15	Clear Creek	Clearwater River MF	2001	60k CWT only; 1.5k PIT tag; 234k unmarked.
Dworshak NFH Total				**293,879**					
Eagle Creek NFH	CO-UN	03/11/2003	03/11/2003	279,500	22	Lapwai Creek	Clearwater River MF	2001	ad+CWT 5-48-42; 1k PIT tag; 222k unclip.
Eagle Creek NFH	CO-UN	03/13/2003	03/13/2003	274,125	22	Potlatch River	Clearwater River MF	2001	27k CWT 5-48-46; 27k ad+CWT5-39-15; 1k PITs; 220k unclip/unmark.
Eagle Creek NFH Total				**553,625**					
Hagerman NFH	ST-SU	04/07/2003	04/07/2003	35,549	4	Hazard Creek/Little Salmon R	Little Salmon River	2002	No clips.
Hagerman NFH	ST-SU	04/30/2003	05/05/2003	102,040	4	American River	S Fk Clearwater River	2002	No clips; .5k PIT tag.
Hagerman NFH	ST-SU	05/05/2003	05/09/2003	88,093	4	Newsome Creek	S Fk Clearwater River	2002	No clips; .5k PIT tag.
Hagerman NFH Total				**225,682**					
Lookingglass Hatchery	CH1-SP	03/17/2003	03/23/2003	109,781	16	Lostine Accim Pond	Wallowa River	2001	100% ad+CWT 9-35-35, 38, 39; 51k Elast. mark (LE Red); 6.7k PIT tag.
Lookingglass Hatchery	CH1-SP	04/01/2003	04/14/2003	132,968	17	Lostine Accim Pond	Wallowa River	2001	100% ad+CWT 9-35-7, 36, 37, 40; 50k Elast. Mark (LE Red); 9k PIT tag.
Lookingglass Hatchery Total				**242,749**					

Lyons Ferry Hatchery	CH0-FA	05/28/2003	05/28/2003	512,685	81	Cpt John Acclim Pond	Snake River	2002	200k CWT 61-1-21; 2.5k PIT tag; No fin clips.
Lyons Ferry Hatchery	CH0-FA	06/03/2003	06/03/2003	506,488	95	Big Canyon (Clearwater R)	Clearwater River M F	2002	200k CWT 61-1-22; 2.5k PIT tag; No fin clips.
Lyons Ferry Hatchery	CH0-FA	06/04/2003	06/04/2003	390,183	130	Pittsburg Landing Acclim Pond	Snake River	2002	200k CWT 63-1-23; 2.5k PIT tag; No fin clip.
Lyons Ferry Hatchery	CH0-FA	06/12/2003	06/12/2003	291,402	45	Cpt John Acclim Pond	Snake River	2002	187k CWT 61-26-54; No fin clips.
	CH0-FA Total			**1,700,758**					
Lyons Ferry Hatchery	CH1-FA	03/30/2003	04/08/2003	151,919	10	Cpt John Acclim Pond	Snake River	2001	100% ad+CWT 61-1-18; 100% VIE (LE Blue); 2.5k PIT tag.
Lyons Ferry Hatchery	CH1-FA	04/13/2003	04/14/2003	140,383	9	Pittsburg Landing Acclim Pond	Snake River	2001	100% ad+CWT 61-1-20; 100% VIE (RE Green); 7.5k PIT tag.
Lyons Ferry Hatchery	CH1-FA	04/15/2003	04/16/2003	145,331	11	Big Canyon (Clearwater R)	Clearwater River M F	2001	100% ad+CWT 61-1-19; 100% VIE (LE Green); 7.5k PIT tag.
	CH1-FA Total			**437,633**					
Lyons Ferry Hatchery Total				**2,138,391**					
McCall Hatchery	CH1-SU	03/20/2003	03/21/2003	73,000	28	Johnson Cr Idaho	South Fork Salmon River	2001	CR)+CWT 10-97-71; nonclipped.
McCall Hatchery Total				**73,000**					
Nez Perce Total				**5,684,940**					

Oregon Dept. of Fish and Wildlife

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Bonneville Hatchery	SO-UN	08/27/2002	08/27/2002	7,805	40	Pettit Lake	Salmon River (ID)	2001	100% adRV clip; 1.4 k PIT tag.
Bonneville Hatchery	SO-UN	08/27/2002	08/27/2002	6,123	43	Alturas Lake	Salmon River (ID)	2001	100% adRV clip; 1.5k PIT tag.
Bonneville Hatchery	SO-UN	08/28/2002	08/29/2002	61,500	40	Redfish Lake	Salmon River (ID)	2001	100% adRV clip; 1k PIT tag.
Bonneville Hatchery Total				**75,428**					
Irrigon Hatchery Complex	CH0-SP	05/28/2002	05/28/2002	17,880	56	Lookingglass Creek	Grande Ronde River	2001	100% ad clip; % CWT 9-35-6; Captive Brood F-1.
Irrigon Hatchery Complex	CH0-SP	05/28/2002	05/28/2002	4,660	79	Wallowa River	Grande Ronde River	2001	100% ad clip; % CWT 9-26-40; Captive Brood; F-1; Rel=Bear Cr.
Irrigon Hatchery Complex	CH0-SP	05/29/2002	05/29/2002	32,800	62	Grande Ronde River	Grande Ronde River	2001	100% ad clip; % CWT 9-35-8; Captive Brood F-1; Rel=Sheep Cr.
	CH0-SP Total			**55,340**					
Irrigon Hatchery Complex	ST-SU	04/09/2003	04/09/2003	123,266	4	L Sheep Acclim Pond	Imnaha River	2002	50k unmk/clip for NPT; 25k adLV+CWT 9-36-34; 53k ad only.
Irrigon Hatchery Complex	ST-SU	04/11/2003	04/15/2003	331,422	4	Wallowa Acclim Pond	Wallowa River	2002	100% ad clip; 25k adLV+CWT 9-36-30.
Irrigon Hatchery Complex	ST-SU	04/14/2003	04/15/2003	114,110	5	Big Sheep Creek	Imnaha River	2002	50k unmarked for NPT; 50k adLV+CWT 9-36-36.
Irrigon Hatchery Complex	ST-SU	04/14/2003	04/16/2003	165,262	4	Big Canyon Acclim Pd (G R)	Grande Ronde River	2002	100% ad clip; 25k adLV+CWT 9-36-31.
Irrigon Hatchery Complex	ST-SU	05/02/2003	05/02/2003	972	6	Deer Creek	Grande Ronde River	2002	100% ad clip + PIT tagged; RbxSthd cross.
Irrigon Hatchery Complex	ST-SU	05/07/2003	05/07/2003	136,076	4	L Sheep Acclim Pond	Imnaha River	2002	100% ad clip; 25k adLV+CWT 9-36-35.
Irrigon Hatchery Complex	ST-SU	05/07/2003	05/15/2003	192,966	4	Wallowa Acclim Pond	Wallowa River	2002	100% ad clip; 50k adLV+CWT 9-36-32.
Irrigon Hatchery Complex	ST-SU	05/08/2003	05/16/2003	126,859	4	Big Canyon Acclim Pd (Grande	Grande Ronde River	2002	100% ad clip; 50k adLV+CWT 9-36-33.
	ST-SU Total			**1,190,933**					
Irrigon Hatchery Complex Total				**1,246,273**					
Lookingglass Hatchery	CH1-SP	04/01/2003	04/15/2003	268,426	16	Imnaha Acclim Pond	Imnaha River	2001	100% ad+CWT 9-36-42..44, 59, 60; 21k PIT tag.
Lookingglass Hatchery Total				**268,426**					

Oak Springs Hatchery	ST-SU	03/13/2003	03/13/2003	28,981	5	Hood River	Hood River	2002	100% ad clip.
Oak Springs Hatchery Total				**28,981**					
Round Butte Hatchery	CH1-SP	04/11/2003	04/16/2003	336,552	9	Bel. Pelton Ladder	Deschutes River	2001	100% ad+CWT 9-35-50..53.
	CH1-SP Total			**336,552**					
Round Butte Hatchery	ST-SU	04/03/2003	04/03/2003	169,835	4	Bel. Pelton Ladder	Deschutes River	2002	100% adLM clip.
	ST-SU Total			**169,835**					
Round Butte Hatchery Total				**506,387**					
Wallowa Acclim. Pond	CH1-SP	03/31/2003	03/31/2003	66	12	Wallowa River	Grande Ronde River	2001	Captive Br (F1 Gen); rel=Bear Cr; unmarked.
Wallowa Acclim. Pond Total				**66**					
Oregon Dept. of Fish and Wildlife Total				**2,125,561**					

Shoshone-Bannock Tribe

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Hagerman NFH	ST-SU	05/12/2003	05/14/2003	131,659	5	Yankee Fk Pond	Salmon River (ID)	2002	Unmarked Rel; (no clips).
Hagerman NFH Total				**131,659**					
Shoshone-Bannock Tribe Total				**131,659**					

U.S. Fish and Wildlife Service

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Bonneville Hatchery	SO-UN	08/27/2002	08/27/2002	7,805	40	Pettit Lake	Salmon River (ID)	2001	100% adRV clip; 1.4 k PIT tag.
Bonneville Hatchery	SO-UN	08/27/2002	08/27/2002	6,123	43	Alturas Lake	Salmon River (ID)	2001	100% adRV clip; 1.5k PIT tag.
Bonneville Hatchery	SO-UN	08/28/2002	08/29/2002	61,500	40	Redfish Lake	Salmon River (ID)	2001	100% adRV clip; 1k PIT tag.
Bonneville Hatchery Total				**75,428**					
Irrigon Hatchery Complex	CH0-SP	05/28/2002	05/28/2002	17,880	56	Lookingglass Creek	Grande Ronde River	2001	100% ad clip; % CWT 9-35-6; Captive Brood F-1.
Irrigon Hatchery Complex	CH0-SP	05/28/2002	05/28/2002	4,660	79	Wallowa River	Grande Ronde River	2001	100% ad clip; % CWT 9-26-40; Captive Brood; F-1; Rel=Bear Cr.
Irrigon Hatchery Complex	CH0-SP	05/29/2002	05/29/2002	32,800	62	Grande Ronde River	Grande Ronde River	2001	100% ad clip; % CWT 9-35-8; Captive Brood F-1; Rel=Sheep Cr.
	CH0-SP Total			**55,340**					
Irrigon Hatchery Complex	ST-SU	04/09/2003	04/09/2003	123,266	4	L Sheep Acclim Pond	Imnaha River	2002	50k unmk/clip for NPT; 25k adLV+CWT 9-36-34; 53k ad only.
Irrigon Hatchery Complex	ST-SU	04/11/2003	04/15/2003	331,422	4	Wallowa Acclim Pond	Wallowa River	2002	100% ad clip; 25k adLV+CWT 9-36-30.
Irrigon Hatchery Complex	ST-SU	04/14/2003	04/15/2003	114,110	5	Big Sheep Creek	Imnaha River	2002	50k unmarked for NPT; 50k adLV+CWT 9-36-36.
Irrigon Hatchery Complex	ST-SU	04/14/2003	04/16/2003	165,262	4	Big Canyon Acclim Pd (G R)	Grande Ronde River	2002	100% ad clip; 25k adLV+CWT 9-36-31.
Irrigon Hatchery Complex	ST-SU	05/02/2003	05/02/2003	972	6	Deer Creek	Grande Ronde River	2002	100% ad clip + PIT tagged; RbxSthd cross.
Irrigon Hatchery Complex	ST-SU	05/07/2003	05/07/2003	136,076	4	L Sheep Acclim Pond	Imnaha River	2002	100% ad clip; 25k adLV+CWT 9-36-35.
Irrigon Hatchery Complex	ST-SU	05/07/2003	05/15/2003	192,966	4	Wallowa Acclim Pond	Wallowa River	2002	100% ad clip; 50k adLV+CWT 9-36-32.
Irrigon Hatchery Complex	ST-SU	05/08/2003	05/16/2003	126,859	4	Big Canyon Acclim Pd (G R)	Grande Ronde River	2002	100% ad clip; 50k adLV+CWT 9-36-33.
	ST-SU Total			**1,190,933**					
Irrigon Hatchery Complex Total				**1,246,273**					
Lookingglass Hatchery	CH1-SP	04/01/2003	04/15/2003	268,426	16	Imnaha Acclim Pond	Imnaha River	2001	100% ad+CWT 9-36-42..44, 59, 60; 21k PIT tag.
Lookingglass Hatchery Total				**268,426**					
Oak Springs Hatchery	ST-SU	03/13/2003	03/13/2003	28,981	5	Hood River	Hood River	2002	100% ad clip.
Oak Springs Hatchery Total				**28,981**					
Round Butte Hatchery	CH1-SP	04/11/2003	04/16/2003	336,552	9	Bel. Pelton Ladder	Deschutes River	2001	100% ad+CWT 9-35-50..53.
	CH1-SP Total			**336,552**					
Round Butte Hatchery	ST-SU	04/03/2003	04/03/2003	169,835	4	Bel. Pelton Ladder	Deschutes River	2002	100% adLM clip.
	ST-SU Total			**169,835**					
Round Butte Hatchery Total				**506,387**					
Wallowa Acclim. Pond	CH1-SP	03/31/2003	03/31/2003	66	12	Wallowa River	Grande Ronde River	2001	Captive Br (F1 Gen); rel=Bear Cr; unmarked.
Wallowa Acclim. Pond Total				**66**					
U.S. Fish and Wildlife Service Total				**2,125,561**					

Umatilla Tribe

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Bonneville Hatchery	CH1-FA	03/01/2003	03/07/2003	261,065	13	Thornhollow Acclim Pond	Umatilla River	2001	27k ad+CWT 9-36-27; 215k BWT; .3k PIT tag.
Bonneville Hatchery	CH1-FA	04/08/2003	04/15/2003	248,070	11	Thornhollow Acclim Pond	Umatilla River	2001	25k ad+CWT 9-36-28; 215k BWT; .3k PIT tag.
Bonneville Hatchery Total				**509,135**					
Cascade Hatchery	CO-UN	03/01/2003	03/05/2003	249,988	16	Pendelton Acclim Pond	Umatilla River	2001	25k ad+CWT.
Cascade Hatchery	CO-UN	03/28/2003	03/28/2003	188,971	15	Pendelton Acclim Pond	Umatilla River	2001	Unmarked Rel; no clips.
Cascade Hatchery	CO-UN	04/03/2003	04/10/2003	591,349	15	Pendelton Acclim Pond	Umatilla River	2001	25k ad+CWT.
Cascade Hatchery Total				**1,030,308**					
Little White Salmon NFH	CH1-SP	04/08/2003	04/15/2003	322,806	17	Imeques Acclim Pond	Umatilla River	2001	100% ad clip; 40k adRV+CWT 5-46-57, 58; .6k PIT tag.
Little White Salmon NFH Total				**322,806**					
Lookingglass Hatchery	CH1-SP	03/17/2003	03/23/2003	105,292	13	Catherine Cr Acclim Pond	Grande Ronde River	2001	100% ad+CWT 9-35-41, 42; 21k PIT tag.
Lookingglass Hatchery	CH1-SP	03/17/2003	03/23/2003	110,049	14	Grande Ronde Acclim Pond	Grande Ronde River	2001	100% ad+CWT 9-35-45, 48
Lookingglass Hatchery	CH1-SP	03/28/2003	04/14/2003	24,392	13	Catherine Cr Acclim Pond	Grande Ronde River	2001	100% ad+CWT 9-35-43+Elast. Mark.
Lookingglass Hatchery	CH1-SP	03/28/2003	04/14/2003	126,987	14	Grande Ronde Acclim Pond	Grande Ronde River	2001	100% ad+CWT 9-35-44, 46, 47, 49; 9-26-7; 26k Elast (Conv. Prog).
Lookingglass Hatchery Total				**366,720**					
Lower Herman Creek	CO-UN	03/01/2003	03/05/2003	515,859	16	Pendelton Acclim Pond	Umatilla River	2001	25k ad+CWT.
Lower Herman Creek Total				**515,859**					
Umatilla Hatchery	CH0-FA	05/01/2003	05/16/2003	332,226	42	Hells Canyon Dam	Snake River	2002	100% ad clip; 3k PIT tag.
Umatilla Hatchery	CH0-FA	05/16/2003	05/22/2003	313,383	55	Thornhollow Acclim Pond	Umatilla River	2002	100% ad+CWT 9-37-59, 61; 1.2k PIT tag.
Umatilla Hatchery	CH0-FA	05/22/2003	05/22/2003	311,406	56	Umatilla River	Umatilla River	2002	100% ad+CWT 9-37-60, 62; Dir Stream Rel = RM 48.
	CH0-FA Total			**957,015**					
Umatilla Hatchery	CH1-SP	03/01/2003	03/06/2003	459,300	12	Imeques Acclim Pond	Umatilla River	2001	100% ad clip; 161k adRV+CWT 9-36-3..9; 2.7k PIT tag.
	CH1-SP Total			**459,300**					
Umatilla Hatchery	ST-SU	04/22/2003	04/28/2003	41,369	5	Bonifer Acclim Pond	Umatilla River	2002	100% ad clip; 20k adLV+CWT 9-36-40; .5k PIT tag.
Umatilla Hatchery	ST-SU	04/22/2003	04/29/2003	42,805	4	Minthorn Acclimation Pond	Umatilla River	2002	100% ad clip; 20k adLV+CWT 9-36-39; .5k PIT tag.
Umatilla Hatchery	ST-SU	04/22/2003	04/30/2003	42,783	4	Pendelton Acclim Pond	Umatilla River	2002	100% ad clip; 20k adLV+CWT 9-36-41; .5k PIT tag.
	ST-SU Total			**126,957**					
Umatilla Hatchery Total				**1,543,272**					
Umatilla Tribe Total				4,288,100					

Warm Springs Tribe

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Oak Springs Hatchery	ST-SU	04/03/2003	05/07/2003	47,513	5	Blackberry Acclim Pond	Hood River	2002	100% adRM clip; 15.8k rel = 4/3, 4/17, 5/1; 4,647 nonmigrants.
	ST-SU Total			**47,513**					
Oak Springs Hatchery	ST-WI	04/10/2003	04/29/2003	26,343	6	Parkdale Acclim Pond	Hood River	2002	23% adLV; 77% adRV; 11.3k rel = 4/10 & 15.2k on 4/29; 200 nonmigrs.
Oak Springs Hatchery	ST-WI	04/10/2003	04/29/2003	25,090	6	E Fk Irrig Dist Sand Trap	Hood River	2002	77% adRV; 23%adLV clip; 11.2k rel = 4/10 & 13.9k on 4/29; 1,756 non-migr.
	ST-WI Total			**51,433**					
Oak Springs Hatchery Total				**98,946**					
Round Butte Hatchery	CH1-SP	04/06/2003	04/06/2003	30,661	13	Parkdale Acclim Pond	Hood River	2001	100% adLV+CWT 9-35-56; 15 nonmigrs.
Round Butte Hatchery	CH1-SP	04/07/2003	04/22/2003	55,628	11	Blackberry Acclim Pond	Hood River	2001	100% adRM+CWT 9-35-54, 55; 4,027 nonmigr rel 5/6 in Col R-3.
Round Butte Hatchery	CH1-SP	04/07/2003	04/22/2003	40,074	11	Jones Creek Acclim Pond	Hood River	2001	100% adRM+CWT 9-35-54, 55; 9,037 nonmigr rel = Col R-3.
Round Butte Hatchery Total				**126,363**					
Warm Springs Tribe Total				**225,309**					

Washington Dept. of Fish and Wildlife

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Eastbank Hatchery	CH0-SU	06/25/2003	06/25/2003	364,461	25	Turtle Rock Hatchery	Mid-Columbia River	2002	Accel. Group; 50% ad+CWT 63-17-78.
	CH0-SU Total			**364,461**					
Eastbank Hatchery	CH1-SP	04/21/2003	05/12/2003	377,544	12	Chiwawa Hatchery	Wenatchee River	2001	CWT only 63-8-76; 63-14-48, 51; 193k Forced rel = 4/22..
	CH1-SP Total			**377,544**					
Eastbank Hatchery	CH1-SU	04/22/2003	04/22/2003	150,806	11	Wenatchee River	Wenatchee River	2001	Direct Rel Group; 100% ad+CWT 63-13-83.
Eastbank Hatchery	CH1-SU	04/23/2003	04/23/2003	453,862	12	Dryden Acclim Pond	Wenatchee River	2001	100% ad+CWT 63-15-87.
Eastbank Hatchery	CH1-SU	04/24/2003	04/24/2003	248,595	8	Carlton Acclim Pond	Methow River	2001	100% ad+CWT 63-13-69.
Eastbank Hatchery	CH1-SU	04/28/2003	04/29/2003	26,642	18	Similkameen Acclim Pd	Okanogan River	2001	100% ad+CWT 63-15-50.
	CH1-SU Total			**879,905**					
Eastbank Hatchery	SO-UN	08/28/2002	08/28/2002	96,486	22	Lake Wenatchee	Wenatchee River	2001	100% ad+CWT 63-13-99.
Eastbank Hatchery	SO-UN	10/31/2002	10/31/2002	112,500	20	Lake Wenatchee	Wenatchee River	2001	100% ad+CWT.
	SO-UN Total			**208,986**					
Eastbank Hatchery Total				**1,830,896**					
Klickitat Hatchery	CH0-FA	06/03/2003	06/19/2003	3,664,100	74	Klickitat Hatchery	Klickitat River	2001	2.1 mil rel=6/3; 400k BWT; 200k ad+CWT 63-17-96, 97; 1.5 mil rel=6/16.
Klickitat Hatchery	CH0-FA	07/14/2003	07/14/2003	561,000	70	Klickitat Hatchery	Klickitat River	2002	100% marked.
	CH0-FA Total			**4,225,100**					
Klickitat Hatchery	CH1-SP	03/05/2003	03/09/2003	607,500	8	Klickitat Hatchery	Klickitat River	2001	100% ad clip; 190k ad+CWT 63-13-96, 97.
	CH1-SP Total			**607,500**					
Klickitat Hatchery	CO-NO	05/19/2003	05/26/2003	998,900	13	Klickitat Hatchery	Klickitat River	2001	100% ad clip; 45k ad+CWT 63-14-87.
	CO-NO Total			**998,900**					
Klickitat Hatchery Total				**5,831,500**					
Lyons Ferry Hatchery	CH0-FA	03/04/2003	03/04/2003	33,505	1200	Below Lewiston	Snake River	2002	Unmarked Rel; Hi-Elisa group.
Lyons Ferry Hatchery	CH0-FA	06/06/2003	06/06/2003	200,092	50	Lyons Ferry Hatchery	Snake River	2002	100% ad+CWT 63-15-45.
Lyons Ferry Hatchery	CH0-FA	06/09/2003	06/16/2003	100,019	40	Cpt John Acclim Pond	Snake River	2002	100% ad+CWT 63-13-91; 3k PIT tag; dir stream Couse Crk.
	CH0-FA Total			**333,616**					
Lyons Ferry Hatchery	CH1-FA	10/16/2002	10/16/2002	29,059	25	Below Lewiston	Snake River	2001	Unmarked excess Plant; rel = Chief Timothy I.
Lyons Ferry Hatchery	CH1-FA	12/02/2002	12/02/2002	24,573	26	Below Lewiston	Snake River	2001	Unmarked excess plant; rel = Red Wolf Bridge.
Lyons Ferry Hatchery	CH1-FA	04/01/2003	04/09/2003	518,436	10	Lyons Ferry Hatchery	Snake River	2001	100% ad+CWT 63-15-85; 304k VIE (Left Eye Red).
	CH1-FA Total			**572,068**					
Lyons Ferry Hatchery	ST-SU	04/15/2003	04/16/2003	60,001	5	Lyons Ferry Hatchery	Snake River	2002	100% ad clip; 21k adLV+CWT 63-15-16+ FB (LA2).
Lyons Ferry Hatchery	ST-SU	04/15/2003	04/16/2003	43,688	5	Curl Lake Acclim Pond	Tucannon River	2002	100% CWT 63-14-82; VIE(Rt Green); Endemic Stock; rel = Near Curl L.
Lyons Ferry Hatchery	ST-SU	04/15/2003	04/17/2003	102,975	4	Walla Walla River	Walla Walla River	2002	100% ad clip; 21k adLV+CWT 63-15-81; rel = Rkm 56
Lyons Ferry Hatchery	ST-SU	04/15/2003	04/18/2003	115,496	5	Tucannon River	Tucannon River	2002	100% ad clip; 21k adLV+CWT 63-15-79+ FB (2); Rel = Marengo/Enrich.
Lyons Ferry Hatchery	ST-SU	04/15/2003	04/30/2003	100,445	5	Dayton Acclim Pond	Touchet River	2002	100% ad clip; 20k adLV+CWT 63-15-80.
Lyons Ferry Hatchery	ST-SU	04/15/2003	04/30/2003	236,627	5	Cottonwood Acclim Pond	Grande Ronde River	2002	100% ad clip; 41k adLV+CWT 63-15-23 + FB (IC).
Lyons Ferry Hatchery	ST-SU	04/21/2003	04/21/2003	31,440	5	Dayton Acclim Pond	Touchet River	2002	100% CWT 63-15-30+VIE (left Green); Rel = Baileysburg Br.
	ST-SU Total			**690,672**					
Lyons Ferry Hatchery Total				**1,596,356**					

Methow Hatchery	CH1-SP	04/14/2003	04/25/2003	261,284	15	Chewuch Acclim Pond	Methow River	2001	100% CWT only 63-14-40, 94; 63-13-84; 15.5k PIT tag.
Methow Hatchery	CH1-SP	04/21/2003	04/22/2003	57,471	21	Twisp Acclim Pond	Methow River	2001	100% CWT only 63-10-58; 63-14-78; No clips; 15k PIT tag; 6.2k Captive Brood parentage.
Methow Hatchery	CH1-SP	04/21/2003	04/25/2003	130,887	16	Methow Hatchery	Methow River	2001	100% CWT only 63-9-76;63-14-77;63-11-79 17.5k PIT tag.
Methow Hatchery Total				**449,642**					
Priest Rapids Hatchery	CH0-FA	06/06/2003	06/18/2003	3,322,946	58	Ringold Springs Hatchery	Mid-Columbia River	2002	200k ad+CWT 7-9-48.
Priest Rapids Hatchery	CH0-FA	06/12/2003	06/21/2003	6,777,605	48	Priest Rapids Hatchery	Mid-Columbia River	2002	350k ad+CWT 63-13-92; 63-17-68; 200k PIT tag.
	CH0-FA Total			**10,100,551**					
Priest Rapids Hatchery	ST-SU	04/11/2003	04/22/2003	171,645	6	Ringold Springs Hatchery	Mid-Columbia River	2002	100% adRV clip.
	ST-SU Total			**171,645**					
Priest Rapids Hatchery Total				**10,272,196**					
Skamania Hatchery	ST-SU	05/01/2003	05/08/2003	103,200	5	Klickitat River	Klickitat River	2002	100% ad clip; Rel = Rm 10-28.
Skamania Hatchery	ST-SU	05/05/2003	05/07/2003	14,222	5	Drano Lake	Little White Salmon R	2002	100% ad clip.
	ST-SU Total			**117,422**					
Skamania Hatchery	ST-WI	04/01/2003	04/01/2003	19,950	6	Salmon Creek (WA)	Columbia River	2002	100% ad clip; final rearing at Klineline Pd.
Skamania Hatchery	ST-WI	05/01/2003	05/12/2003	23,517	5	White Salmon River	White Salmon River	2002	100% ad clip; Rel = near USFWS raceways.
	ST-WI Total			**43,467**					
Skamania Hatchery Total				**160,889**					
Tucannon Hatchery	CH1-SP	03/15/2003	04/21/2003	146,922	13	Curl Lake Acclim Pond	Tucannon River	2001	No ad clip; CWT 63-6-81 only, 100% VIE tag (Red Rt Eye).
Tucannon Hatchery	CH1-SP	04/01/2003	04/21/2003	140,396	14	Curl Lake Acclim Pond	Tucannon River	2001	Agency Tag; No ad clip; Captive Brood fish.
Tucannon Hatchery Total				**287,318**					
Turtle Rock Hatchery	CH0-SU	07/02/2003	07/02/2003	656,399	45	Turtle Rock Hatchery	Mid-Columbia River	2002	200k ad+CWT 63-17-79.
	CH0-SU Total			**656,399**					
Turtle Rock Hatchery	CH1-SU	04/12/2003	05/28/2003	111,305	7	Above Rocky Reach Dam	Mid-Columbia River	2001	100% ad+CWT63-8-89+PIT; Chelan PUD study fish.
Turtle Rock Hatchery	CH1-SU	04/30/2003	04/30/2003	203,279	8	Turtle Rock Hatchery	Mid-Columbia River	2001	100% ad+CWT 63-8-91.
	CH1-SU Total			**314,584**					
Turtle Rock Hatchery	ST-SU	04/28/2003	04/29/2003	33,528	6	Chiwawa Hatchery	Wenatchee River	2002	HxH Cross; no clips; 100% VIE (left Red).
Turtle Rock Hatchery	ST-SU	04/28/2003	04/29/2003	112,387	6	Chiwawa Hatchery	Wenatchee River	2002	HxW Cross; 100% VIE ((left Green); no clips.
Turtle Rock Hatchery	ST-SU	04/29/2003	05/01/2003	156,145	8	Nason Creek	Wenatchee River	2002	WxW Cross; 100% VIE (Left Orange); No clips.
	ST-SU Total			**302,060**					
Turtle Rock Hatchery Total				**1,273,043**					
Washougal Hatchery	CO-NO	03/31/2003	04/09/2003	2,554,300	21	Klickitat River	Klickitat River	2002	50k ad+CWT 63-9-71; Remainder unmarked; Rel = RM 20.
Washougal Hatchery Total				**2,554,300**					

Wells Hatchery	CH0-SU	06/12/2003	06/13/2003	473,100	30	Wells Hatchery	Mid-Columbia River	2002	100% ad+CWT 63-13-68, 70.
	CH0-SU Total			**473,100**					
Wells Hatchery	CH1-SU	04/07/2003	05/30/2003	127,969	10	Bel. Priest Rapids Dam	Mid-Columbia River	2001	100% ad+CWT 63-15-48+PIT; Transf Grant PUD Study.
Wells Hatchery	CH1-SU	04/21/2003	04/30/2003	185,200	10	Wells Hatchery	Mid-Columbia River	2001	100% ad+CWT 63-15-49.
	CH1-SU Total			**313,169**					
Wells Hatchery	ST-SU	04/23/2003	05/16/2003	117,495	6	Chewuch River	Methow River	2002	HxH Cross; 100% ad clip; ~37% PIT tag; Truck Scatter Plant.
Wells Hatchery	ST-SU	04/23/2003	05/19/2003	162,340	7	Methow River	Methow River	2002	100% ad clip; 37% PIT tag; HxH Cross; Scatter Plant.
Wells Hatchery	ST-SU	05/01/2003	05/16/2003	105,323	6	Twisp Acclim Pond	Methow River	2002	100% VIE (Rt eye Yellow)+PIT tag; No clips HxW Cross; Truck/Volit.
Wells Hatchery	ST-SU	05/07/2003	05/14/2003	25,110	7	Omak Creek	Okanogan River	2002	100% ad clip; HxH Cross.
Wells Hatchery	ST-SU	05/08/2003	05/19/2003	65,920	8	Okanogan River	Okanogan River	2002	100% ad clip; 37% PIT tag; HxH Cross; Truck/Scatter Plant.
Wells Hatchery	ST-SU	05/09/2003	05/19/2003	50,860	7	Similkameen Acclim Pd	Okanogan River	2002	100% ad clip; 37% PIT tag; HxH Cross; Most Truck/Scatter Plant.
	ST-SU Total			**527,048**					
Wells Hatchery Total				**1,313,317**					
Washington Dept. of Fish and Wildlife Total				**25,569,457**					

Yakama Tribe

Hatchery	Species	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
Cascade Hatchery	CO-UN	04/24/2003	05/15/2003	491,251	18	Icicle Creek	Wenatchee River	2001	LeavNFH - Dam 5; 8k PIT tag; 100% CWT 5-45-31, 33; 5-9-71; 162k - Winthrop NFH; no clips.
Cascade Hatchery	CO-UN	05/01/2003	05/15/2003	235,214	17	Nason Creek	Wenatchee River	2001	8k PIT tag; 100% CWT 5-9-68, 72; 5-43-26, 28; No clips; Rel=Butcher Cr Pd; 70k transf - Willard NFH.
Cascade Hatchery	CO-UN	05/01/2003	05/15/2003	75,040	17	Wenatchee River	Wenatchee River	2001	100% CWT 5-9-69; Rel - Beaver Cr; no clips.
Cascade Hatchery Total				**801,505**					
Cle Elem Hatchery	CH1-SP	03/14/2003	03/28/2003	39,319	18	Easton Pond	Yakama River	2001	8k PIT tag; 100% ad+CWT 21-4-18...23; +VIE (LE & RE Orange).
Cle Elem Hatchery	CH1-SP	03/14/2003	05/15/2003	81,113	18	Clark Flat Acclim Pond	Yakama River	2001	8k PIT tag; 100% ad+CWT 21-4-13,17; +VIE (LE & RE Green).
Cle Elem Hatchery	CH1-SP	03/14/2003	05/15/2003	250,852	18	Jack Creek Acclim Pond	Yakama River	2001	24K PIT tag; 100% ad+CWT 21-4-10..12,14..16 + VIE (LE & RE Red).
	CH1-SP Total			**371,284**					
Cle Elem Hatchery	CO-UN	04/30/2003	04/30/2003	82,525	19	Yakama River	Yakama River	2001	Rel = Holmes; upr Yak R; 100% CWT 5-8-91; 5-9-67; 1k PITs/CWT group.
Cle Elem Hatchery	CO-UN	05/20/2003	05/20/2003	262,046	19	Easton Pond	Yakama River	2001	100% CWT 5-8-89, 90, 96; 5-9-64, 67; 1,250 PITs/CWT group.
Cle Elem Hatchery	CO-UN	05/20/2003	05/20/2003	180,444	20	Lost Creek Acclim Pond	Yakama River	2001	100% CWT 5-8-94, 95; 5-9-66; 5-47-5; 1,250 PITs/CWT group.
	CO-UN Total			**525,015**					
Cle Elem Hatchery Total				**896,299**					
Klickitat Hatchery	CH0-SP	05/06/2003	05/06/2003	246,550	66	Klickitat River	Klickitat River	2002	ad clip only; Rel = upper Klickitat R.
Klickitat Hatchery Total				**246,550**					
Little White Salmon NFH	CH0-FA	04/28/2003	05/27/2003	1,771,129	91	Prosser Acclim Pond	Yakama River	2002	47.8k CWT 5-1-3-1-1.
Little White Salmon NFH Total				**1,771,129**					
Prosser Acclim. Pond	CH0-FA	04/21/2003	04/21/2003	18,000	90	Yakama River	Yakama River	2002	1k PIT tag; rel = Marion Drain.
Prosser Acclim. Pond	CH0-FA	04/25/2003	04/26/2003	165,011	180	Prosser Acclim Pond	Yakama River	2002	100% RV clip; 2.0k PIT.
Prosser Acclim. Pond	CH0-FA	05/21/2003	05/22/2003	200,398	140	Prosser Acclim Pond	Yakama River	2002	100k LV Clip; 2k PIT tag.
Prosser Acclim. Pond Total				**383,409**					
Stiles Pond	CO-UN	05/30/2003	05/30/2003	169,520	17	Yakama River	Yakama River	2001	100% CWT 5-8-92, 93; 5-9-65; 5-47-6; 1,250 PITs/CWT group.
Stiles Pond Total				**169,520**					
Willard Hatchery	CO-UN	04/28/2003	05/15/2003	100,234	16	Little Wenatchee River	Wenatchee River	2001	9k PIT tag; 100% CWT 5-43-24, 25, 27; no clips; Rel=Two Rivers Pd.
Willard Hatchery	CO-UN	05/06/2003	05/15/2003	37,483	15	Wenatchee River	Wenatchee River	2001	Rel - Mahar Cr Pd; 100% CWT 5-43-20; no clips.
Willard Hatchery Total				**137,717**					
Yakama Tribe Total				**4,406,129**					

APPENDIX I

Transportation Proportion Tables

Transportation Proportion in 2003

Proportion of Lower Granite Dam forebay population destined to be transported in 2003

Model to estimate proportion:
In the transportation proportion estimation procedure, the population of N smolts in Lower Granite Dam forebay is partitioned into X1 fish destined to be transported and X2 fish destined to migrate in-river. The proportion of fish in the transportation category is Pt =X1/N and the proportion of fish in the in-river category is (1-Pt)=X2/N. Below is the derivation of model for springtime migrants with three transportation dams – the procedure for summertime migrants is similar with the addition of a fourth transportation dam (McNary Dam).

The number of fish, x2, estimated to remain in-river below last transportation site for springtime migrants:

$$x2 = (((N*s1-t1)*s2-t2)*s3-t3) = N*s1*s2*s3 – t1*s2*s3 – t2*s3 –t3$$

where s1=survival from origin in Lower Granite Dam forebay to Lower Granite Dam tailrace
s2=survival from Lower Granite Dam tailrace to Little Goose Dam tailrace
s3=survival from Little Goose Dam tailrace to Lower Monumental Dam tailrace
t1=fish removed at Lower Granite Dam for transportation
t2=fish removed at Little Goose Dam for transportation
t3=fish removed at Lower Monumental Dam for transportation

To index x2 back to the starting population in Lower Granite Dam, X2, requires dividing by the survival estimate s1*s2*s3 from Lower Granite Dam forebay to Lower Monumental Dam tailrace.

$$X = x2/(s1*s2*s3) = N - t1/s1 - t2/(s1*s2) - t3/(s1*s2*s3)$$

The number of fish in the starting population destined to be transported then becomes

$$X1 = N-X2 = t1/s1 + t2/(s1*s2) + t3/(s1*s2*s3)$$

The proportion of fish in the starting population destined to be transported is

$$Pt = X1/N = t1/(N*s1) + t2/(N*(s1*s2)) + t3/(N*(s1*s2*s3))$$

The number of fish surviving to the tailrace of each dam is given by the following series of equations:

Lower Granite	N1 = N*s1
Little Goose	N2 = (N1-t1)*s2 = N1*(1-t1/N1)*s2
Lower Monumental	N3 = (N2-t2)*s3 = N2*(1-t2/N2)*s3 = N1*(1-t1/N1)*s2*(1-t2/N2)*s3

Substituting these equalities into the equation for Pt gives

$$Pt = t1/N1 + (1-t1/N1)*t2/N2 + (1-t1/N1)*(1-t2/N2)*t3/N3$$

Letting P1=t1/N1, P2=t2/N2, and P3=t3/N3 the equation for proportion of transport fish in Lower Granite Dam forebay destined for transportation becomes:

$$Pt = P1 + (1-P1)*P2 + (1-P1)*(1-P2)*P3$$

With McNary Dam transportation added the equation becomes:

$$Pt = P1 + (1-P1)*P2 + (1-P1)*(1-P2)*P3 + (1-P1)*(1-P2)*(1-P3)*P4$$

where P(J) = transport number / population number
= (transport proportion * collection) / (collection / collection efficiency)
= transport proportion * collection efficiency

The site-specific transport proportions P(J) are based on data from the run-at-large at each dam. These P1, P2, P3, and P4 proportions are computed using facility collection, transport, and population estimates for Lower Granite (J=1), Little Goose (J=2), Lower Monumental (J=3), and McNary (J=4) dams, respectively, and are presented in Table I-1 through Table I-3 for yearling chinook, steelhead , and subyearling chinook, respectively. In 2003 there was no spring time transportation at McNary Dam. However, transportation did occur in the summer time, beginning June 26, small numbers of subyearling chinook were barged, with full scale barging operations begun July 16. The estimate of proportion of Snake River subyearling chinook "destined for transport" are presented both with and without McNary Dam considered in the model. This allows direct comparison with past years when only three transportation sites are used during the springtime, and a comparison of the amount of transportation added by McNary Dam for subyearling chinook originating above Lower Granite Dam in 2003. For subyearling chinook originating in the Mid-Columbia River basin, the transportation proportion is simply estimated by P4 above, and is presented in Table I-3.

The 2003 collection efficiency is estimated using the CSJ mark-recapture model on PIT tagged yearling chinook and steelhead released from the Salmon, Snake and Imnaha River traps in 2003. The 2003 collection efficiency for subyearling chinook was based on estimated FGE's derived from the 2000 release of PIT tagged subyearling chinook at Snake River basin fall chinook acclimation ponds.

TABLE I- 1. Yearling chinook model input data for 2003.

Site	Facility Collection	Estimated Population	Spill Proportion	Estimated Collection Efficiency	Collection Transport Proportion	P(J)
LGR (J=1)	2,577,030	6,700,000	0.284	0.38	0.98	0.377
LGS (J=2)	1,832,627	5,500,000	0.262	0.33	0.998	0.332
LMN (J=3)	463,390	4,200,000	0.410	0.11	0.983	0.108

TABLE I- 2. Steelhead model input data for 2003.

Site	Facility Collection	Estimated Population	Spill Proportion	Estimated Collection Efficiency	Collection Transport Proportion	P(J)
LGR (J=1)	2,337,143	7,300,000	0.304	0.32	0.976	0.311
LGS (J=2)	1,938,459	5,400,000	0.250	0.36	0.998	0.361
LMN (J=3)	1,229,842	4,600,000	0.341	0.27	0.937	0.252

The estimated percent of smolts arriving Lower Granite Dam forebay that were destined for transportation in 2001, including McNary Dam transportation, was approximately 68% for both yearling chinook and steelhead, and 93% for subyearling chinook (Table I-4). For smolts originating in the Mid-Columbia River basin, the estimated percent of smolts arriving McNary Dam forebay that were transported was approximately 24% for subyearling chinook.

TABLE I- 3. Subyearling chinook model input data for 2003.

Site	Facility Collection	Estimated Population	Spill Proportion	Estimated Collection Efficiency	Collection Transport Proportion	P(J)
LGR (j=1)	1,169,376	2,400,000	0.17	0.49	0.982	0.477
LGS (j=2)	603,132	1,100,000	0.12	0.55	0.988	0.544
LMN (j=3)	290,325	900,000	0.15	0.33	0.877	0.292
MCN (j=4)	7,028,584	12,300,000	0.09	0.57	0.665	0.379

TABLE I- 4. Estimated proportion destined for transportation in 2003.

Species- age group	Transport Proportion		
	Origin Snake R Basin above Lower Granite Dam		Origin Mid-Columbia R Basin
	Without McNary Dam transport	With McNary Dam transport	With McNary Dam transport
Yearling Chinook	0.629	N/A	N/A
Steelhead	0.670	N/A	N/A
Subyearling Chinook	N/A	0.895	0.255

Model without McNary Dam: Pt = P1 +(1-P1)*P2 + (1-P1)*(1-P2)*P3
Model with McNary Dam: Pt = P1 +(1-P1)*P2 + (1-P1)*(1-P2)*P3 + (1-P1)*(1-P2)*(1-P3)*P4
Model for Mid-Columbia R Basin fish: Pt = P4

The proportion of smolts transported in 2003 was similar to other recent years except 2001 when low flows and lack of spill translated into high collection at Snake River dams and therefore higher proportions transported.

TABLE I- 5. Comparison of the 2003 estimate of the proportion of Snake River Basin smolt population in Lower Granite Dam forebay that are "destined for transportation" and the corresponding estimates from 1998 to 2002. For yearling chinook and steelhead, the 2001 results exclude transport at McNary Dam to mimic conditions in the other years.

Species-age group	Transport Proportion[1]					
	2003	2002	2001	2000	1999	1998
Yearling Chinook	0.629	0.683	0.980	0.71	0.777 (W) 0.862 (H)	0.66-0.81 (W) 0.69-0.77 (H)
Steelhead	0.670	0.677	0.986	0.81	0.825	0.69-0.83 (W) 0.72-0.85 (H)
Subyearling Chinook	0.895	0.929	0.962	0.93	0.870	0.91(W)

[1] In years 1999-2003, estimates of collection efficiency based on PIT tag data was used to generate a single annual estimate of proportion transported, while in 1998 assumed levels of high and low FGE and high and low spill effectiveness were used to generate a range for that year's estimate of proportion transported.

APPENDIX J

2003 System Operational Requests (SOR)

2003 System Operational Requests

SORs are drafted and presented to the U.S. Army Corps of Engineers (COE) and Bonneville Power Administration (BPA) by the Salmon Managers. The Salmon Managers are state, federal and tribal entities with legally recognized mandates and jurisdictions to manage salmon resources in the Columbia River Basin. SORs are submitted in response to river, or project-specific operations and are intended to provide both juvenile and adult salmon with the most conducive migration conditions and survival opportunities possible.
The Fish Passage Center also posts System Operational Requests from Columbia River Inter-Tribal Fish Commission. Contact Kyle Martin at CRITFC.

SOR #	Date	Subject	Response of Action Agencies
#2003-02 (USFWS)	12/15/03	Request for releases from Libby Dam for migration, spawning, incubation and larval development of burbot in the Kootenai River.	Partially Implemented
#2003-15	10/24/03	Tailwater elevation at Bonneville Dam to protect natural spawning of chum and fall chinook salmon at the Ives/Pierce Island Complex, Multnomah Falls, and partly influence the I-205 seeps.	
#2003-01 (USFWS)	10/07/03	Request for winter water level operations on Lake Pend Oreille, Idaho during 2004 and 2005, to increase egg to fry survival of kokanee, the primary forage base for listed bull trout.	Partially Implemented
#2003-10 (CRITFC)	10/03/03	Operation of the Lower Columbia Pools for the Autumn 2003 Treaty Fishery	Not Implemented
#2003-9 (CRITFC)	09/25/03	Operation of the Lower Columbia Pools for the Autumn 2003 Treaty Fishery	Not Implemented
#2003-8 (CRITFC)	09/19/03	Operation of the Lower Columbia Pools for the Autumn 2003 Treaty Fishery	Not Implemented according to CRITFC's specifications
#2003-7 (CRITFC)	09/12/03	Operation of the Lower Columbia Pools for the Autumn 2003 Treaty Fishery	Not Implemented according to CRITFC's

#2003-14	09/02/03	Water Temperature Operation for Dworshak and Lower Granite Dams	Partially Implemented according to CRITFC's specifications
#2003-6 (CRITFC)	08/22/03	Operation of the Lower Columbia Pools for the Autumn 2003 Treaty Fishery	Not Implemented according to CRITFC's specifications
#2003-13	07/29/03	Mitigate for Losses in Biological Opinion Spill at Ice Harbor Dam	Not Implemented
#2003-5 (CRITFC)	07/18/03	Operation of the Lower Columbia Pools for the Summer 2003 Treaty Fishery	Not Implemented according to CRITFC's specifications
#2003-12	07/15/03	Libby/ Arrow-Duncan Swap	Implemented
#2003-4 (CRITFC)	07/08/03	Idaho-Nez Perce Tribe Dworshak Summer Operations Plan	Partially Implemented August 7th
#2003-11	07/08/03	Dworshak Summer Operations	Not Implemented
#2003-3 (CRITFC)	07/02/03	Operation of the Lower Columbia Pools for Summer 2003 Treaty Fishery	Not Implemented according to CRITFC's specifications
#2003-10 (USFWS)	06/06/03	Libby Dam Releases for Sturgeon and Bull Trout Augmentation	Implemented
#2003-2 (CRITFC)	05/21/03	Operation of the Lower Columbia Pools for the Spring 2003 Treaty Fishery	Not Implemented according to CRITFC's specifications
2003-9	04/29/03	Dworshak Operations	Implemented
#2003-1 (CRITFC)	04/23/03	Operation of the Lower Columbia Pools for the Spring 2003 Treaty Fishery	Not Implemented according to CRITFC's specifications
	04/18/03	State of Alaska, Dept. of Fish and Game's support for SOR 2003-7 and 2003-8	

2003-8	04/17/03	Priest Rapids Flow Fluctuations	Not Implemented
2003-7	04/17/03	Priest Rapids Seasonal Flows	Implemented
2003-6	04/08/03	Lower Columbia Spill Program	Implemented
2003-5 Revised	04/01/03	Implementation of Snake River Spill Operations and MOP	Implemented
2003-4	03/26/03	Operations at Dworshak Reservoir	Implemented
2003-3	03/18/03	Fishery Operations at Dworshak Dam	Partially Implemented
2003-2	03/06/03	Spring Creek Spill	Implemented
2003-1 Revised	02/03/03	Tailwater Elevation at Bonneville Dam to Protect Chum Salmon Redds and Emerging Fry.	Not Implemented
2003-1	01/29/03	Tailwater Elevation at Bonneville Dam to Protect Chum Salmon Redds and Emerging Fry.	See Revised SOR #1

FPAC SOR's are provided below. CRITFC & USFWS SOR's can be accessed on our website at www.fpc.org.

SYSTEM OPERATIONAL REQUEST: #2003-01

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, Idaho Department of Fish and Game, Columbia River Inter Tribal Fish Commission, and the Oregon Department of Fish and Wildlife.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cathy Hlebechuk	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **January 29, 2003**

SUBJECT: Tailwater Elevation at Bonneville Dam to Protect Chum Salmon Redds and Emerging Fry.

SPECIFICATIONS: Smooth flows and limit load following to maintain an instantaneous tailwater elevation of 11.5 feet at Bonneville Dam as long as possible without impacting the refill of U.S. Reservoirs to the April 10th upper rule curve elevation. Maintain a minimum of 70 Kcfs at Vernita Bar consistent with the Vernita Bar Settlement Agreement.

JUSTIFICATION: The Ives/Pierce Islands Complex below Bonneville Dam represents an important and limited natural spawning area for ESA listed Columbia River (CR) chum salmon. Last week the Action Agencies recommended reducing the constraint on the tailwater elevation to 11.0 feet as a hard constraint and 11.2 feet as a soft constraint, in order to increase the probability of achieving higher reservoir elevations on April 10th for Biological Opinion spring flow targets. Since that time favorable tides, increased Snake River flows, and higher side flows as a result of localized precipitation have resulted in tailwater elevations exceeding those constraints.

Given these current conditions it would appear reasonable to implement whatever measures are necessary to meet the 11.5 foot tailwater, while not drafting Grand Coulee and other basin storage reservoirs (continue minimum flow from Libby and Hungry Horse reservoirs) more than needed to achieve the 70 Kcfs Priest Rapids flow for Vernita Bar protection. This will assure that chum redds are not dewatered unnecessarily pending future improved runoff volume forecasts, or other options, that might suggest an ability to meet both the chum and spring flow requirements.

SYSTEM OPERATIONAL REQUEST: #2003-01 - Revised

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, Idaho Department of Fish and Game, Columbia River Inter Tribal Fish Commission, and the Oregon Department of Fish and Wildlife.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cathy Hlebechuk	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **February 3, 2003**

SUBJECT: Tailwater Elevation at Bonneville Dam to Protect Chum Salmon Redds and Emerging Fry.

SPECIFICATIONS: Smooth flows and limit load following to maintain an instantaneous tailwater elevation of 11.5 feet at Bonneville Dam as long as possible without impacting the refill of U.S. Reservoirs to the April 10th upper rule curve elevation. Maintain a minimum of 70 Kcfs at Vernita Bar consistent with the Vernita Bar Settlement Agreement.

JUSTIFICATION: The Ives/Pierce Islands Complex below Bonneville Dam represents an important and limited natural spawning area for ESA listed Columbia River (CR) chum salmon. Last week the Technical Management Team discussed reducing the constraint on the tailwater elevation to 11.0 feet as a hard constraint and 11.2 feet as a soft constraint, in order to increase the probability of achieving higher reservoir elevations on April 10th for Biological Opinion spring flow targets. There was not full agreement from the Salmon Managers to reduce the tailwater elevation and subsequently the recommendation to reduce the tailwater was made by NOAA Fisheries based on priorities established by the Biological Opinion.

Since that time favorable tides, increased Snake River flows, and higher side flows as a result of localized precipitation have resulted in tailwater elevations exceeding those constraints. Given these current conditions it would appear reasonable to implement whatever measures are necessary to meet the 11.5 foot tailwater, while not drafting Grand Coulee and other basin storage reservoirs (continue minimum flow from Libby and Hungry Horse reservoirs) more than needed to achieve the 70 Kcfs Priest Rapids flow for Vernita Bar protection. This will assure that chum redds are not dewatered unnecessarily pending future improved runoff volume forecasts, or other options, that might suggest an ability to meet both the chum and spring flow requirements.

SYSTEM OPERATIONAL REQUEST: #2003-02

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, National Marine Fisheries Service, and the Washington Department of Fish and Wildlife.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **March 6, 2003**

SPECIFICATIONS: The Salmon Managers listed above are requesting the following fishery operations at the Bonneville Project following the March 8 Spring Creek Hatchery tule fall chinook release:

1. No operation of unscreened units at Bonneville Powerhouse I or II and follow the turbine operating priority in the Fish Passage Plan;

2. Operate Powerhouse II as first priority. Fully load PH II before operating PH I;

3. Operate turbine units within 1% of peak efficiency;

4. Operate juvenile and adult facilities according to criteria;

5. Operate the Bonneville Project to maintain a minimum 13 foot tailwater elevation. Based on estimates by the USFWS, a flow of 140-150 Kcfs is sufficient to allow approximately 50 Kcfs of spill while maintaining a maximum level of 105 % TDG (factored for depth compensation) at the chum redds in the Ives Island complex, and the expected highest elevation (11.5 foot tailwater) chum salmon redds on the Oregon shore;

6. Beginning March 10, monitor sub-samples at the Hamilton Island Juvenile Monitoring Facility (JMF) facility. If sub-sampling at the JMF indicates large numbers of sub-yearling chinook have reached Bonneville Dam before 4 p.m. March 10, contact COE Reservoir Control Center to begin a minimum 13 foot tailwater and spill program at 6 p.m.. Continue spill for a total of 36 hours. If there is no indication of large numbers of sub-yearling chinook present at Bonneville Dam by 4 p.m., then monitor sub-samples prior to 8 a.m. March 11. If sub-samples at the JMF indicate large numbers of sub-yearling chinook have reached Bonneville Dam on or before 8 a.m. on March 11, contact COE Reservoir Control Center to begin the spill program at 10 a.m.

7. At no time is spill to exceed 110% total dissolved gas measured at the downstream Warrendale and Camus/Washougal monitors, as allowed under the dissolved gas standards by the states of Oregon and Washington;

8. We request that the Action Agencies use the flexibility in the system to accomplish this SOR without jeopardizing the April 10th rule curve elevations called for by the Biological Opinion;

JUSTIFICATION:

We recognize that we are entering a water runoff season with a lower than normal (73%) runoff forecast. With this in mind, this SOR is requesting spill, flow, and duration at levels well below that normally requested by the salmon managers for full protection of the March release group. This SOR represents an option discussed among the Federal fishery managers and Action Agencies, which reflect this year's unique conditions in the Columbia Basin.

Spring Creek Hatchery is scheduled to release 7.5 million tule fall chinook by mid-day March 8, 2003. This represents one-half of the total production for brood year 2002. The overall importance of this stock to ocean and Columbia River commercial, sport and tribal fisheries has been previously documented and recently reported in the requests for a total dissolved gas waivers submitted to the Oregon Department of Environmental Quality and Washington Department of Ecology. The Spring Creek Hatchery fall chinook are an important buffer to ESA listed stocks present in ocean and Columbia River mixed stock fisheries. Current weather forecasts predict a large rain event during the weekend of fish release. By releasing the fish during the weather event, the Action Agencies should have more system flexibility to provide the flow and spill requested. Because of the accelerated growth of the fish, due to the mild winter and warmer temperatures, it is also desirable to release the March group earlier than previously envisioned. Release now would allow the densities of the remaining fish to be reduced, better maintaining hatchery rearing protocols and ultimately better fish health. The release of fish two days before spill begins should allow sufficient transit time to Bonneville Dam so that the spill will be affecting the peak passage of the release.

Spill is necessary to achieve fish passage standards. Spill at Bonneville is the safest route available for downstream migrating juvenile salmonids. Few adult migrants will be present during the time period associated with this spill. Furthermore, recent studies of radio tagged adult chinook salmon have shown that spill up to the dissolved gas limit has little potential to increase fall-back. These studies have also shown that some of the adult fish that fall back initially migrate well past Bonneville Dam before turning around and falling back past the project. These fish, which may fall back, need a safe passage route. Spill is presently the safest route for an adult fish to fall back past Bonneville Dam. By prioritizing PH II we expect to minimize usage of the Bradford Island adult ladder, which contributes the highest percentage of fall-back.

In order to protect the most sensitive developmental stages of juvenile fall chinook and chum salmon that are incubating downstream from Bonneville Dam in the Ives/Pierce Islands area and along the Oregon shore across from the Ives/Pierce areas, the total dissolved gas supersaturation levels over the redds should not exceed 105%, when factored for depth compensation. At the same time, the fishery agencies and tribes wish to provide adequate spill protection for the Spring Creek Hatchery release. To ensure the protection of incubating juvenile fall chinook and chum salmon, while providing some protection for the Spring Creek Hatchery release, spill should be provided at approximately 50 Kcfs. We estimate that a spill of approximately 50 Kcfs and a minimum tailwater elevation of 13 feet will produce a total dissolved gas supersaturation level at, or below, 110%. This would mean that the TDG (with depth compensation) for the expected highest elevation (11.5 tailwater) chum redd on the Oregon shore below Bonneville Dam would be below 105%. The flow from PH II is preferred because it provides a buffer between the more highly saturated spillway flow and the Ives/Pierce Islands area on the Washington shore, where most of the chum redds are located. If downstream TDG monitors at Warrendale and Camus/Washougal indicate TDG levels above 110%, spill is to be terminated immediately.

If this SOR cannot be implemented as requested, please provide a written response to the Fish Passage Advisory Committee documenting the rationale for the actions taken.

SYSTEM OPERATIONAL REQUEST: #2003-03

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, Idaho Department of Fish and Game, Columbia River Inter Tribal Fish Commission, Oregon Department of Fish and Wildlife, Washington Department of Fish and Game, and the National Marine Fisheries Service.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **March 18, 2003**

SUBJECT: The Salmon Managers listed above are requesting the following fishery operations at Dworshak Dam to coincide with the March 19 and 20 spring chinook release:

SPECIFICATIONS: Beginning March 19, and continuing on March 20, operate the Dworshak Dam power house at a level between 4.5 to 6.5 Kcfs beginning at 5 p.m. and ending at 5 a.m. the following morning.

JUSTIFICATION: Dworshak National Fish Hatchery is scheduling the release of 1,036,000 spring chinook smolts in two releases. The first is on the evening of March 19, the second is on the evening of March 20. This represents the entire production of brood 2001 spring chinook from Dworshak NFH. Evening releases are scheduled to minimize avian predation. The actual release date in March varies from year to year, but is keyed into the hydro-graph and flow conditions of the mainstem Clearwater River. Conditions in the mainstem appear very favorable now, with high flows (17-19 Kcfs) and turbid conditions, which further aid in protecting fish migrating downstream.

Current flow from Dworshak Dam is at the powerhouse minimum of 1.4 Kcfs. The higher flows in the mainstem cause a backwater effect in the North Fork Clearwater, into which the fish are released. In order to move the fish out into the mainstem to take advantage of those higher flows and move on downriver, a higher flow in the North Fork Clearwater is desirable. Current refill rates of Dworshak Dam indicate this operation would have little probability of affecting the April 10 upper rule curve elevation.

SYSTEM OPERATIONAL REQUEST: #2003-4

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, National Marine Fisheries Service, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, Nez Perce Tribe, Shoshone Bannock Tribe, Washington Department of Fish and Wildlife and the Columbia River Inter Tribal Fish Commission.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **March 26, 2003**

SUBJECT: Operations at Dworshak Reservoir

SPECIFICATIONS: Operate Dworshak Reservoir to the highest elevation possible. Given the below average run-off volume, to the maximum extent possible, fill above local flood control elevation to save water for the spring juvenile salmonid outmigration. Utilize available space in other reservoirs to meet system flood control requirements.

JUSTIFICATION:

As of 5:00 AM on 3-25-03, the COE increased outflows from the Dworshak Reservoir above the 1.5 kcfs minimum; at this time the reservoir was at an elevation of 1575.1 feet. The local March 31st flood control elevation for the Dworshak Reservoir is 1580.3. The present run-off volume forecast for the Snake River Basin above Lower Granite Dam is ranging between 14.7 to 16.6 MAF (March Final and March Mid-Month), which is only 68% to 77% of average. A more flexible operation of the Dworshak flood control operation could save water for the spring migration period, providing better downstream migrant flow conditions closer to the established Biological Opinion flow targets for salmon and steelhead juveniles. The present flood control operation carries risk of over drafting Dworshak reservoir and reducing the migration flow available for spring migrating salmon and steelhead, both listed and unlisted stocks. Flow and spill have been shown to be the most important variables in the survival of juvenile migrants and survival to adult (State, Federal, Tribal anadromous fish managers, NWPPC, January 2003). The mid-March unregulated runoff volume forecast of 16.6 MAF is indicating that the

conditions. Continuing analysis of smolt transportation data supports the spread-the-risk management of in-river and transportation of downstream migrants. Transportation studies for wild spring/summer chinook and steelhead have shown little to no transport benefit in most years, 1995-2000 (Bouwes et al. 2002; NMFS presentation to the Technical Management Team, March 18-19, 2002; State, Federal Tribal anadromous fish managers comments to NWPPC, January 2003). Adequate flow appears critical even for transported juveniles in the migration to and through Lower Snake River reservoirs. Flood control operations in a below average runoff year, should have the flexibility to preserve as much water as possible for in-river downstream migrants, specifically to meet the minimum flow target for the Snake River.

Alternative analyses are available that illustrate a potential range of flexibility in meeting system flood control, which would allow additional water storage in Dworshak reservoir for release later in the spring. As an example, an alternative analysis utilizing Water Supply Forecast Correction Curves (Martin 2003) indicate that there is additional flexibility in Dworshak Reservoir flood control operations that could be implemented to benefit downstream migrant anadromous fish during the spring period.

Using Water Supply Forecast Correction Curves (Martin 2003) and the COE's official forecast for Dworshak (1790 Kaf, March 1st Final), which gives a "corrected" forecast of 1640 Kaf, the analysis shows that 255 Kaf of flood control space will be needed at Dworshak by March 31st, 2003. This volume of water would lead to a March 31st URC elevation 1586 feet. About 104 Kaf of reservoir additional water could be stored between the elevations of 1580 and 1586 feet at Dworshak.

To offset this loss in system flood control, calculations, as of March 26, have shown there to be 80 Kaf of flood control space available at the Brownlee Reservoir, 1730 Kaf of flood control space available at Libby, and 940 Kaf available at Hungry Horse, all totaling 2750 Kaf of extra system-wide storage. Perhaps available storage space in these and other reservoirs in the United States and Canada can be taken into account in this year's system flood control management. Any change in Columbia River operations should minimize flow fluctuations in the Hanford Reach to minimize juvenile stranding.

NMFS was consulted on the existing flood control operations in the 2000 FCRPS Biological Opinion and recommended studies to modify flood control, to benefit the Columbia River ecosystem, including salmon. (Actions 35, 36). The Opinion establishes the need for and recognizes the potential benefit to meeting and enhancing fish migration conditions through additional flexibility in flood control management. Among a number of purposes, the intent of these studies is to reduce the effects of flood control operations on the spring freshet while achieving a high probability of reservoir refill. Potentially much higher spring flows can occur in average and below average runoff years while maintaining high levels of protection from damaging floods in high runoff years. These studies have not yet been completed. Thus, in the interim, the salmon managers are interested in any flexibility in this year's flood control operation that could help meet the intended purposes of the above recommended studies.

Reference:

Martin, K. 2003. Water Supply Forecast Correction Curves. CRITFC Science Reports (http://www.critfc.org/tech/03-forecast_report.html)

SYSTEM OPERATIONAL REQUEST: #2003-5

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, National Marine Fisheries Service, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, the Nez Perce Tribe and the Columbia River Inter Tribal Fish Commission.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **April 1, 2003**

SUBJECT: Implementation of Snake River Spill Operations and MOP.

SPECIFICATIONS:

1. Implement spill at Lower Granite Dam as described in the 2000 Biological Opinion. Begin spill at Lower Granite Dam at 1800 hours on April 3, 2003. Spill will then be phased in at the downriver projects at two-day intervals, initiating spill at Little Goose on April 5, at Lower Monumental on April 7 and at Ice Harbor Dam on April 9. (This two-day implementation interval may be modified pending collection of juvenile passage information at these downriver passage sites.)
2. Implement MOP operations beginning at Lower Granite Pool at MOP+1 on April 3 to coincide with the initiation of spill. MOP operations are then to be implemented sequentially at Little Goose Reservoir on April 4, Lower Monumental Reservoir on April 5 and Ice Harbor Reservoir on April 6.

JUSTIFICATION:

Spill is being requested in accordance with the NMFS 2000 Biological Opinion. According to the NMFS 2000 Biological Opinion 9.6.1.3.2 Action 40, “The Corps and BPA

shall continue to implement voluntary spill at all three Snake River collector projects when seasonal average flows are projected to meet or exceed 85 kcfs." Further, 9.6.1.4.3 Action 54 specifies that the annual planning dates for spill for Snake River projects detailed in Table 9.6-3 are April 3 to June 20.

Chapter 9.6.1.2.1 explains that when the April final runoff volume at Lower Granite between April and July is 16 Maf the spring flow objective at Lower Granite Dam will be 85 kcfs. The April Early Bird Forecast at Lower Granite (April-July) is 16.9 Maf, which includes recorded precipitation through the 24th of March, assumes 100% average precipitation in the future and includes snow. The March Mid-Month Forecast was 16.6 Maf at the same location, over the same period. Precipitation over the first 24 days of March has been 130% of average above the Ice Harbor Dam. Snowpacks have also been generally increasing over the month of March in the Snake River Basin. Because of steadily increasing precipitation, snowpack, and resulting water supply forecasts, it is assumed that the April Final Water Supply Forecast will be well above 16 Maf at Lower Granite and flow objectives will be equal or greater than 85 kcfs. Hence, the Biological Opinion would project average seasonal flows to meet or exceed 85 kcfs, and voluntary spill would be implemented at the Lower Snake River projects.

In the first week of monitoring efforts at Lower Granite Dam, the yearling chinook numbers have increased from 1050 to 2930. The cumulative passage index for yearling chinook at this site is approximately 12,000 fish. This is more than double the average over the last five years and second only to 1999. The wild proportion of the daily catch is approximately 50%. These numbers reflect what is occurring at the upriver sampling sites. At the Whitebird Trap the collection of juvenile chinook yearlings increased sharply, reaching 2,640 fish per day on March 24, 2003. The collection of wild yearling chinook ranged from 13 to 103 per day during the week of March 21 through 27 at the Imnaha Trap, with some higher numbers observed previous to that date (178 on March 19, 2003). Yearling chinook daily catch at the Grande Ronde Trap was significantly higher, ranging from 185 to 1215 daily over a similar time period. All four trap sites have captured small numbers of steelhead since they went into operation this season, but catches are similarly increasing. The steelhead index at Lower Granite Dam has increased from 200 to over 700 in the first week of monitoring activities at this site. All of the passage index data indicates that the spring migration is underway in the Snake River for yearling wild and hatchery chinook and steelhead.

Smolt monitoring data indicates that the juvenile fish migration has begun. This objective of this request is to implement the intent of the fish passage measures in the Biological Opinion, implementing protection when fish passage occurs. CRITFC advocates its own spill pattern and level in its 2003 River Operations Plan but supports this operation as a good start.

In addition to the upriver fish the Lyons Ferry Hatchery has begun releasing chinook from the hatchery (650,000) and the Tucannon River (300,000) release sites. These fish are expected to be passing Lower Monumental and Ice Harbor dams in the next few days. Included in these fish are listed spring chinook from the Tucannon River. The MOP operations are requested to facilitate the passage of these fish through the Lower Snake River reach. This operation is to provide the fastest travel time possible at the present flows.

SYSTEM OPERATIONAL REQUEST: #2003-5 REVISED*

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, National Marine Fisheries Service, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, the Nez Perce Tribe and the Columbia River Inter Tribal Fish Commission.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
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	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **April 1, 2003**

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SPECIFICATIONS:

1. Implement spill at Lower Granite Dam as described in the 2000 Biological Opinion. Begin spill at Lower Granite Dam at 1800 hours on April 3, 2003. Spill will then be phased in at the downriver projects at two-day intervals, initiating spill at Little Goose on April 5, at Lower Monumental on April 7 and at Ice Harbor Dam on April 9. (This two-day implementation interval may be modified pending collection of juvenile passage information at these downriver passage sites.)
2. Implement MOP operations beginning at Lower Granite Pool at MOP+1 on April 3 to coincide with the initiation of spill. MOP operations are then to be implemented sequentially at Little Goose Reservoir on April 4, Lower Monumental Reservoir on April 5 and Ice Harbor Reservoir on April 6.

JUSTIFICATION:

Spill is being requested in accordance with the NMFS 2000 Biological Opinion. According to the NMFS 2000 Biological Opinion 9.6.1.3.2 Action 40, "The Corps and BPA shall continue to implement voluntary spill at all three Snake River collector projects when seasonal average flows are projected to meet or exceed 85 kcfs." Further, 9.6.1.4.3 Action 54 specifies that the annual planning dates for spill for Snake River projects detailed in Table 9.6-3 are April 3 to June 20.

Chapter 9.6.1.2.1 explains that when the April final runoff volume at Lower Granite between April and July is 16 Maf the spring flow objective at Lower Granite Dam will be 85 kcfs. The April Early Bird Forecast at Lower Granite (April-July) is 16.9 Maf, which includes recorded precipitation through the 24th of March, assumes 100% average precipitation in the future and includes snow. The March Mid-Month Forecast was 16.6 Maf at the same location, over the same period. Precipitation over the first 24 days of March has been 130% of average above the Ice Harbor Dam. Snowpacks have also been generally increasing over the month of March in the Snake River Basin. Because of steadily increasing precipitation, snowpack, and resulting water supply forecasts, it is assumed that the April Final Water Supply Forecast will be well above 16 Maf at Lower Granite and flow objectives will be equal or greater than 85 kcfs. Hence, the Biological Opinion would project average seasonal flows to meet or exceed 85 kcfs, and voluntary spill would be implemented at the Lower Snake River projects.

In the first week of monitoring efforts at Lower Granite Dam, the yearling chinook numbers have increased from 1050 to 2930. The cumulative passage index for yearling chinook at this site is approximately 12,000 fish. This is more than double the average over the last five years and second only to 1999. The wild proportion of the daily catch is approximately 50%. These numbers reflect what is occurring at the upriver sampling sites. At the Whitebird Trap the collection of juvenile chinook yearlings increased sharply, reaching 2,640 fish per day on March 24, 2003. The collection of wild yearling chinook ranged from 13 to 103 per day during the week of March 21 through 27 at the Imnaha Trap, with some higher numbers observed previous to that date (178 on March 19, 2003). Yearling chinook daily catch at the Grande Ronde Trap was significantly higher, ranging from 185 to 1215 daily over a similar time period. All four trap sites have captured small numbers of steelhead since they went into operation this season, but catches are similarly increasing. The steelhead index at Lower Granite Dam has increased from 200 to over 700 in the first week of monitoring activities at this site. All of the passage index data indicates that the spring migration is underway in the Snake River for yearling wild and hatchery chinook and steelhead.

Smolt monitoring data indicates that the juvenile fish migration has begun. This objective of this request is to implement the intent of the fish passage measures in the Biological Opinion, implementing protection when fish passage occurs. CRITFC advocates its own spill pattern and level in its 2003 River Operations Plan but supports this operation as a good start.

In addition to the upriver fish the Lyons Ferry Hatchery has begun releasing chinook from the hatchery (650,000) and the Tucannon River (300,000) release sites. These fish are expected to be passing Lower Monumental and Ice Harbor dams in the next few days. Included in these fish are listed spring chinook from the Tucannon River.

The MOP operations are requested to facilitate the passage of these fish through the Lower Snake River reach. This operation is to provide the fastest travel time possible at the present flows.

*NOTE: CRITFC is not in support of the MOP+1 operation at Lower Granite and advocates for MOP operations at all the Snake River Dams.

SYSTEM OPERATIONAL REQUEST: #2003-6

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, National Marine Fisheries Service, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife and the Columbia River Inter Tribal Fish Commission.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **April 8, 2003**

SUBJECT: **Lower Columbia River Spill Program**

SPECIFICATIONS:

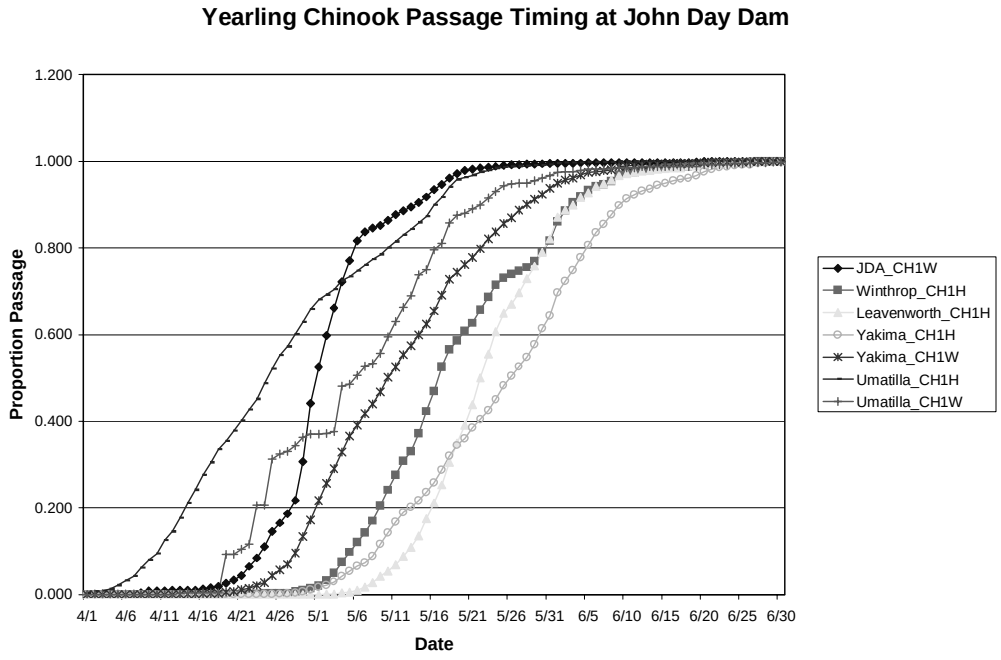
- Beginning on April 14, 2003, spill daily at Lower Columbia River projects according to the 2000 Biological Opinion up to the 120% spill cap.
- At McNary Dam spill should occur between the hours of 1800 and 0600 and instantaneous volumes should only be limited by the gas cap.
- Spill daily at John Day Dam at 60% of instantaneous flow during nighttime hours at flows up to 300 Kcfs, and up to the 120% gas cap at flows greater than 300 Kcfs. Spill should occur from one hour before sunset to one hour after sunrise.
- Spill at The Dalles Dam shall occur for 24 hours daily at a level equal to 40% of instantaneous flow. Spill at Bonneville Dam shall be up to the 120% gas cap during nighttime hours, and 75 Kcfs or up to the gas cap during daytime hours for adult passage evaluation.

JUSTIFICATION:

The passage of juvenile fish into the Lower Columbia River is presently occurring. McNary Dam sampling is occurring on alternate days and has shown the presence of juvenile yearling chinook, subyearling chinook and steelhead.

At John Day Dam passage numbers have increased steadily over the past week. While the second half of April is not normally characterized as a significant passage period for spring migrating juveniles as a whole, it does represent a period of time when significant proportions of specific stocks are migrating. Stocks migrating from the John Day, Umatilla and Yakima River basins dominate the second half of April. To-date PIT tagged wild spring/summer chinook from the Yakima and Walla Walla rivers have been detected at McNary Dam. Historic information for passage timing at John Day Dam indicates that the presence of Umatilla and John Day stocks is expected during the early part of April based on the historic passage (1998-2002) (see Figure). If spill is not initiated early enough during the migration season there is a higher likelihood that these stocks will pass under no spill conditions.

Similar to patterns observed at upstream sites, passage indices have been steadily increasing at Bonneville Dam over the past few days. As of April 3, some 13 million hatchery fish have been released above McNary Dam, with another 22 million expected in the following two weeks. All of this information together supports the initiation of spill. CRITFC advocates its own spill pattern and level in its 2003 River Operations Plan but supports this operation as a good start.



SYSTEM OPERATIONAL REQUEST: #2003-7

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, National Marine Fisheries Service and the Columbia River Inter Tribal Fish Commission.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
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	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **April 17, 2003**

SUBJECT: **Priest Rapids Seasonal Flows**

SPECIFICATIONS:

- Starting April 21, 3003 begin providing flows at Priest Rapids up to the Spring Biological Opinion Flow Objective of at least 135 Kcfs at Priest Rapids Dam; by April 24, 2003 outflows should be at the 135 Kcfs Flow Objective and be maintained through the end of June.
- Maintain weekend flows at McNary of not less than 80% of the previous five-day average.
- Refill Grand Coulee Reservoir by the July 4th weekend if flow augmentation to meet summer flow objectives is not needed until after July 4th.

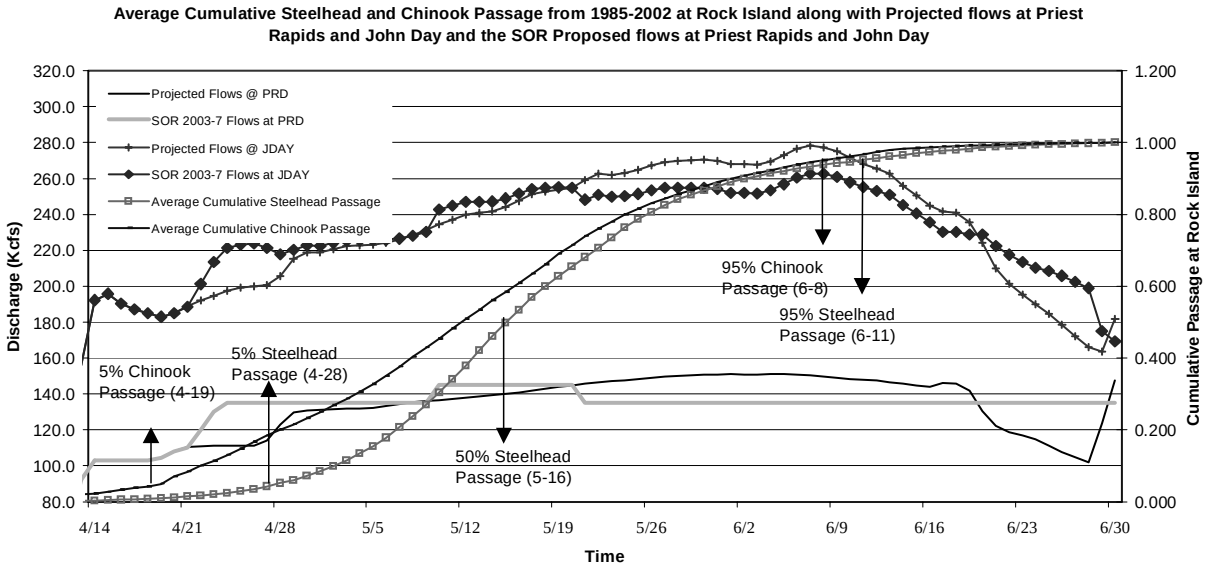
JUSTIFICATION:

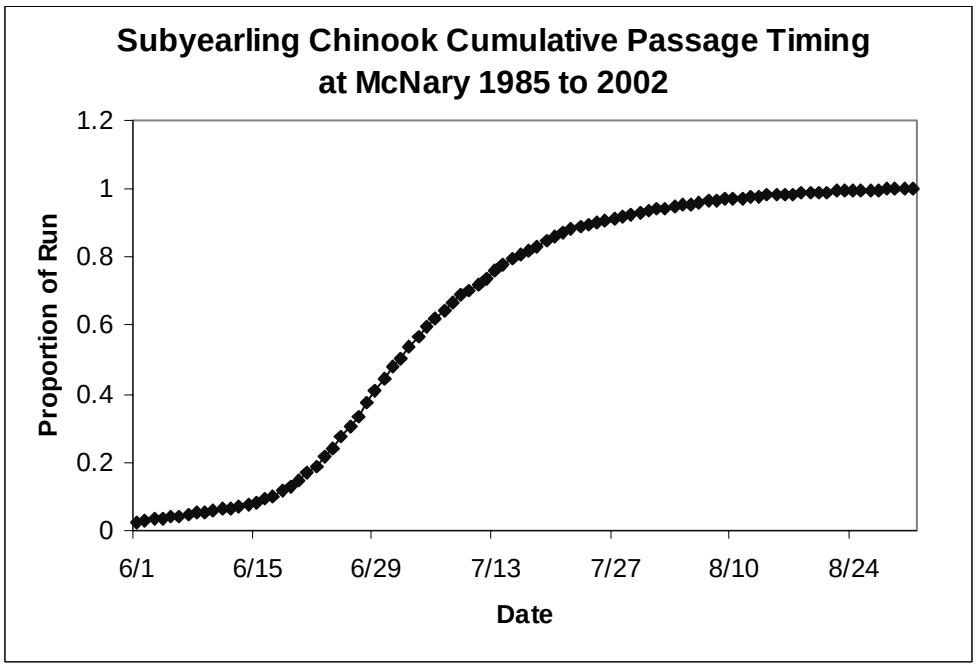
Given the STP model run (4/08/03) based on an increased water supply volume, projected flows from April 15th to June 30th, 2003 for the Mid Columbia (at Priest Rapids) show flows peaking from mid May through mid June, followed by a sharp decline in flows during the second half of June in order to refill the Grand Coulee project

by the end of the month. This projected peak in flow is not consistent with the peak of fish passage through the Mid Columbia based on observations from past years' (see graph). In addition, there is significant concern regarding the impact that reducing flows in the Mid Columbia during the second half of June will have on flows in the lower Columbia. The second half of June is a significant passage period in the lower Columbia for juvenile fall chinook from the Hanford Reach. The warmer winter this year has resulted in an earlier date of emergence for these fish, and very likely will result in an earlier migration for this population. Historic information shows that on average over 40% of fall chinook have passed McNary Dam by the end of June (see graph below). Consequently, reducing flows in the second half of June to refill Grand Coulee is not recommended.

We believe that it would be more advantageous to both spring migrating chinook and steelhead from the Mid Columbia and summer migrating fall chinook from the Hanford reach migrating through the lower Columbia, as well as Snake River stocks and Mid Columbia stocks in the lower River during the second half of June, to shape the projected flows. The flows should be shaped to maintain at least the 135 Kcfs Spring Biological Opinion Flow Objective from April 24th through the end of June and provide a peak discharge in mid May if additional water is available.

The following illustration displays the flow-shaping plan outlined in this SOR. Maintaining flows of 135 Kcfs through the last one-half of June will provide water to the Lower Columbia River at a time when flows are projected to decrease as a result of reservoir refill. The intent of the flow peak during mid May is to provide additional water for the historical (1985-2002) period of 50% passage for steelhead at Rock Island Dam.




Subyearling Chinook Cumulative Passage Timing
at McNary 1985 to 2002
Proportion of Run
1.2
1
0.8
0.6
0.4
0.2
0
6/1
6/15
6/29
7/13
7/27
8/10
8/24
Date

SYSTEM OPERATIONAL REQUEST: #2003-8

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife and the Columbia River Inter Tribal Fish Commission.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
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	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **April 17, 2003**

SUBJECT: **Priest Rapids Flow Fluctuations**

SPECIFICATIONS: **Limit flow fluctuations at Priest Rapids Dam as described below.**

JUSTIFICATION:

Hanford Reach fall chinook salmon are of economic and cultural importance to commercial fisheries in the North Pacific Ocean, in-river commercial and tribal fisheries, and ocean and in-river sport fisheries. This stock is also a principal component of the international Pacific Salmon Treaty between the United States and Canada. Juvenile fall chinook salmon, as well as other resident and anadromous fish species; use shallow, low velocity near shore areas for rearing, feeding, cover, and protection from predators. Rapid flow fluctuations are known to cause significant mortality of juvenile fish using near shore areas when streamflows drop and fish are either stranded on gently sloped stream banks or gravel bars, or entrapped in potholes formed by the receding water. Mortality results from direct stranding and desiccation on the substrate, entrapment in isolated pools and resulting lethal water temperatures, and predation on fish trapped in pools.

Recent operations in the Hanford Reach under the flow fluctuations guidelines currently in place have resulted in the stranding and entrapment of high numbers of juvenile fall chinook that are rearing in the Reach (WDFW Hanford Stranding Reports #5 and #6 and CRITFC and WDFW Hanford Entrapment Report #1). High fall chinook

emerging from redds in the Hanford Reach. A preliminary estimate of stranding losses alone indicates that about 180,000 salmon were lost in the Reach during the first week in April and about 42,000 salmon were lost the second week in April. Concurrently, when flows drop, juvenile fall chinook become entrapped in pools over a significant portion of the Reach. These pools subsequently drain or become heated very quickly causing fish mortality. Among 60 entrapments sampled during the second week in April, 34 had large numbers of fish and 40 either drained or water temperatures became lethal in the entrapment. Entrapment mortalities increased from 1700 salmon to 9,000 salmon from the first to the second week in April. These estimates are being expanded to estimate mortality in the entire Reach, and it is likely that total mortalities are in the hundreds of thousands of juvenile salmon. With the peak of emergence slated during the next two weeks, many more juvenile chinook will be susceptible to stranding and entrapment. Concern for the potential impact to this important stock of fish causes us to recommend that power peaking be restricted to avoid additional stranding of Hanford Reach juvenile chinook, especially during the key fry susceptibility period (March 15 - June 10). The tribes and fishery agencies initially recommended that ever increasing or stable flows be provided in the Reach through spring months, consistent with the recommendations of the NPPC's Independent Scientific Advisory Board (Williams et al. 1998). In the CRITFC tribes' *Spirit of the Salmon* restoration plan, fluctuation of no more than 10% of the previous day's average flow in the Reach was recommended. Recently, CRITFC established criteria during each 24-hour period (CRITFC 2003 River Operations Plan), as described below:

When PRD daily discharge is between 36 and 80 kcfs:
Limit flow fluctuations to no more than 10 kcfs in a 24-hour period. Flow bands between 36 and 80 kcfs dewater the most area with the least amount of fluctuation and have the most potential for catastrophic fish kills.

When PRD daily discharge is between 80 and 110 kcfs:
Limit flow fluctuations to no more than 10 kcfs in a 24-hour period. Flow bands between 80 and 110 kcfs hold optimal rearing habitat. Data suggests these areas hold large entrapments and some stranding sites including backwater sloughs with good rearing habitat.

When PRD daily discharge is between 110 and 140 kcfs:
Limit fluctuations to no more than 20 kcfs in a 24-hour period. Data suggests that flow bands between 120 and 190 kcfs offer reduced susceptibility but not in the reach directly below Priest Rapids Dam.

When PRD daily discharge is between 140-170 kcfs:
Limit fluctuations to no more than 20 kcfs in a 24-hour period. Data suggests that flow bands between 120 and 190 kcfs offer reduced susceptibility in the SHOALS reach, but not in the reach just below Priest Rapids Dam.

When PRD daily discharge is 170 kcfs and above:
Limit fluctuations to no more than 20 kcfs in a 24-hour period. A minimum hourly flow of 150 kcfs will be maintained. Constraints will protect the backwater areas of the sloughs (Hanford Slough and White Bluffs Slough) from dewatering.

Implementation of these recommended flow bands should minimize the impact of power peaking and significant mortalities of the Hanford juvenile fall chinook.

Note:
The WDFW acknowledges that Grant Co. proposed this flow fluctuation operation to be evaluated this year. However, in light of the recent significant mortality events observed in the study area, a more stringent flow fluctuation regime would be appropriate to reduce the mortality of juvenile fish in the Hanford Reach.

cc:
Don Goddard, Public Utility District No.2
Jim Hastreiter, FERC
Jennifer Hill, FERC

SYSTEM OPERATIONAL REQUEST: #2003-9

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, National Marine Fisheries Service, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife and the Columbia River Inter Tribal Fish Commission.

TO:	**B. G. Fastabend**	**COE-NWD**
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	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

Raymond R. Boyce

FROM: **Raymond R. Boyce, Acting Chairperson, Salmon Managers**

DATE: **April 29, 2003**

SUBJECT: **Dworshak Operations**

SPECIFICATIONS:

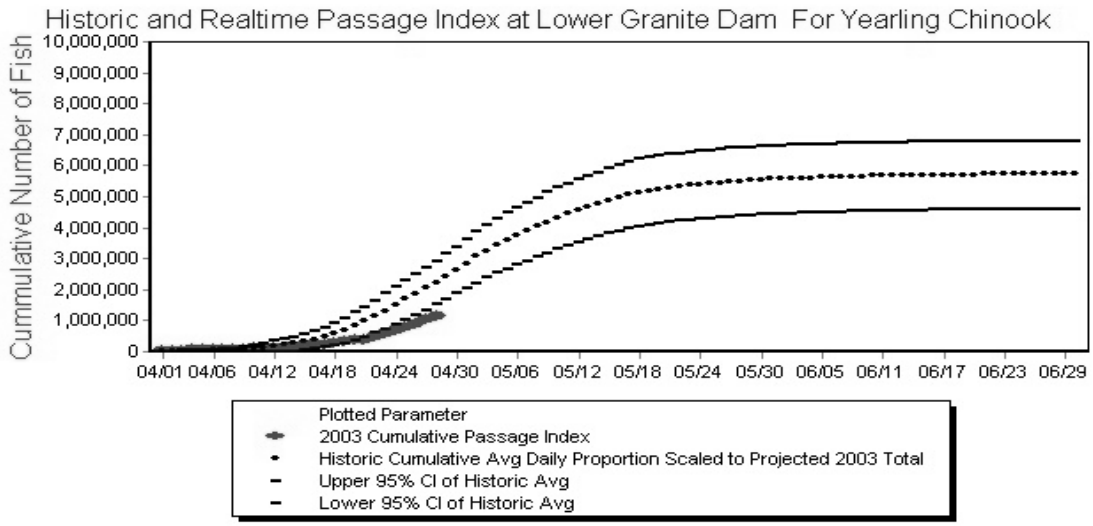
Maintain the current operation at Dworshak of 15.5-16.0 kcfs outflows unless flows at Lower Granite Dam are above the 2003 Spring Biological Opinion Flow Target of 89 Kcfs.

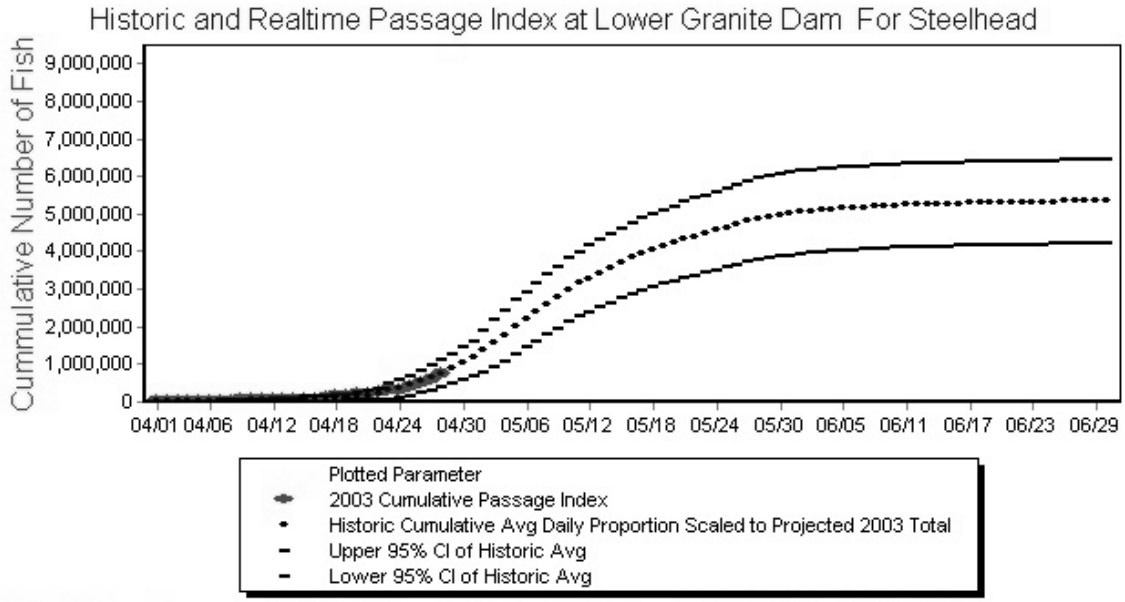
JUSTIFICATION:

The STP run dated April 22, 2003 suggests that flows at Lower Granite will decrease coincident with reductions of outflow at Dworshak Dam. Given the progress of the juvenile chinook and steelhead passage at Lower Granite, a reduction of Lower Granite flows is not advisable at this time. This proposal is designed to maintain migration conditions for salmon and steelhead in the Lower Snake River. The attached cumulative passage plot shows the current and historic passage pattern at Lower Granite Dam for both yearling chinook and steelhead. Historically, the next several weeks (late April through mid-May) represent the bulk of both yearling chinook and steelhead passage at Lower Granite Dam. The current years passage indices for both yearling chinook and steelhead have been increasing considerably over the last week, similar to historic trends

in the passage indices. Between April 22-28, passage indices for yearling chinook have averaged 108,810 fish; over the same period, passage indices for steelhead have averaged 71,936 fish. The previous weeks (April 15-21, 2003) passage indices for yearling chinook averaged 33,101 fish and steelhead averaged 23,884 fish. Furthermore, detections of Pit tagged wild spring/summer chinook have doubled since April 21st, 2003, averaging 452 fish per day during April 22-27.

During this important period of migration, flows in the river should be maintained in the range of the Biological Opinion's flow objective scale (85 – 100 kcfs).





Historic daily proportions average of 1985-02. Curve scaled to projected 2003 index, using NMFS estimated collection 30% spill

SYSTEM OPERATIONAL REQUEST: #2003-10

The following Federal Fishery Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **Susan Martin, Supervisor, Upper Columbia Fish and Wildlife Office**

DATE: **June 6, 2003**

SUBJECT: **Libby Dam Releases for Sturgeon and Bull Trout Augmentation Flows**

SPECIFICATIONS:

* From June 5 through June 26 attempt to maintain a minimum discharge target from Libby Dam of 20,000 cfs.

* Sturgeon augmentation flows should be followed by a ramp down to the tiered bull trout flow minimum flows / salmon flows per the 2000 Biological Opinions, except as noted below.

* Avoid forced spill at the Libby Project.

* Refill the project to near 2459 feet by July 1 or later if needed to avoid forced spill.

* If on June 26 additional water is available, we recommend splitting that volume equally to extend the then current target sturgeon incubation flow beyond June 26, and to achieve a higher tiered bull trout flow through July, if possibly up to the optimum tiered flow of 9,000 cfs.

* Should the actual volume available to split, as described above, be exceeded, we recommend that the remainder be used to further extend the duration of sturgeon incubation flow.

* At some point early in this sturgeon flow request, while low elevation runoff remains relatively high, we recommend up to two days of maximum power house releases to facilitate ongoing U. S. Geological Survey sediment transport studies designed to aid in conservation of the sturgeon. As much advance coordination as possible would be appreciated. The contact person is Dr. Gary Barton at 253-428-3600 ext 2613, e-mail gbarton@usgs.gov

JUSTIFICATION:

As recommended by the December 2000 U.S. Fish and Wildlife Service (Service) jeopardy Biological Opinion for the Federal Columbia River Power System (FCRPS), the current volume runoff forecast above Libby Dam indicates we are in Tier 2 of sturgeon augmentation volumes (minimum volume 0.8 MAF), and Tier 2 of bull trout augmentation (minimum flow 7,000 cfs) .

The priority for the 2003 sturgeon enhancement flows is for incubation of naturally spawned eggs over gravel substrates upstream of Bonners Ferry. Sturgeon expected to spawn this year are being captured, radio tagged, and transported to the Hemlock Bar area, approximately 10 miles upstream of Bonners Ferry. The Service has determined that sturgeon spawning has begun, effective June 5, and recommends that sturgeon flow augmentation begin now (June 5 for accounting purposes since flows were already being increased at that time). Field biologists found four eggs on June 5, which were adhered to mats in the monitored gravel spawning area, approximately 6 river miles upstream of Bonners Ferry. The eggs had been deposited within the past 24 hours.

While the bull trout tiered flow minimum recommendation would be 7,000 cfs, there are incremental benefits through progressively greater wetted usable area and increased forage production in the Kootenai River below Libby Dam for increased flows up to 9,000 cfs. However, much of this incremental benefit for bull trout may be lost if the selected flow target can not be maintained through July or to the time that releases begin for anadromous fish.

We are aware that the actual runoff volume may vary from that currently projected, and accordingly, the flow and refill targets recommended above are subject to in-season coordination and adjustment.

SYSTEM OPERATIONAL REQUEST: #2003-11

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service and the Oregon Department of Fish and Wildlife.

TO:	**B. G. Fastabend**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, USFWS**

Ron Boyce, ODFW

DATE: **July 8, 2003**

SUBJECT: Dworshak Summer Operations

SPECIFICATIONS:

- Implement the Biological Opinion measures at Dworshak Reservoir drafting to elevation 1520 feet by August 31, 2003.
- Increase outflow from Dworshak to 14 kcfs on July 8 and maintain as long as possible. Based on the July 1 STP run we estimate that an outflow of 14 Kcfs can be maintained through August 24th, with a decrease to 5.7 Kcfs the last week of August, ending in an August 31 elevation of 1520 feet.
- Initial releases temperature should be at 48°F, but should be decreased to 45°F prior to the proposed work being conducted at Dworshak Dam.

JUSTIFICATION:

We have reviewed all of the physical and biological information available and based on these data our recommendation is to implement the Biological Opinion (BIOP) as described in the specifications. It is important to consider Dworshak augmentation in terms of its ability to provide both flow augmentation and temperature mediation. Both parameters are important for the juvenile fish migration and survival. The following summarizes the data and information reviewed in developing this recommendation:

Juvenile Fall Chinook Passage Timing

The passage of juvenile fall chinook is progressing as expected. The hatchery fall chinook that were marked and released from acclimation ponds in various Snake and Clearwater River locations suggest that most of the migrants are in-river, having been detected at Lower Granite Dam. This is likely a response to the high flows experienced by these fish during the month of June. The wild subyearling fall chinook are migrating more similarly to how they were observed to migrate in past years. The latest forecast provided by the USFWS suggests that well over half the wild subyearling migrants from the Snake River have passed Lower Granite Dam. The remaining fish are expected to migrate throughout July and August.

Flows

The BIOP summer flow objective for Lower Granite in 2003 is 50.9 Kcfs. Flows at Lower Granite are already below that objective (44.6 Kcfs through July 6, 2003) and will remain so for the remainder of the summer season even with implementation of the Biological Opinion measures. Wild subyearling fall chinook salmon spend from 20 to 42 days in Lower Granite Reservoir primarily during the months of July and August. Survival of wild subyearling Snake River fall chinook is influenced simultaneously by flow and temperature. Meeting summer flow targets increases flow and decreases temperature. Meeting summer flow targets in July and August increases survival of wild subyearling fall chinook migrants. Shifting flow augmentation from July and early August to later times in the year would decrease survival of the largest portion of the wild subyearling fall chinook salmon run.

Travel Time Survival of juvenile fall chinook

In the compilation of travel time and survival data by NOAA Fisheries "Travel Time/Survival White Paper" (March 2000), NOAA Fisheries concludes that “Estimated survival probability from release points in the Snake River Basin to Lower Granite Dam was significantly correlated with flow, water temperature and turbidity”. NOAA Fisheries also concludes that the high correlation among variables precludes the determination of effects of these variables individually. A flow travel time relationship has been established for sub-yearling chinook migrants. The flow travel time relationship has been confirmed consistently in various studies and monitoring programs. Recent information (Connor, 2003) has shown statistically significant relations between flow, temperature and survival for subyearling fall chinook.

Historical passage timing and distribution of fall chinook shows that 90% of the wild chinook passage at Lower Granite occurs prior to August 30 and 97% of hatchery sub-yearling fall chinook of Clearwater and Snake River origin pass Lower Granite Dam prior to August 30.

Water Temperature

An extensive literature review was compiled for the Environmental Protection Agency entitled, “A Review and Synthesis of Effects of Alterations to the Water Temperature Regime on Freshwater Life Stages of Salmonids with Special Reference to Chinook Salmon”. This review establishes water temperature as an important factor in all life stages of salmon. The review

documents the detrimental effects of elevated water temperatures on all life stages of salmon, both juvenile and adult. The literature review has identified a water temperature of 21 degrees C as the incipient lethal temperature for adult salmon. Washington State water quality standards for temperatures in the mainstem Snake is 20°C.

Studies conducted on migration and survival of wild juvenile fall chinook in the Snake River by USFWS indicate that colder water from Dworshak Dam and water from Brownlee Dam should be released when Lower Granite tailrace temperatures exceed 17°C. The tailrace temperature at Lower Granite Dam on June 29th exceeded 17°C. Presently, the Lower Granite tailrace monitor is reading just above 19°C.

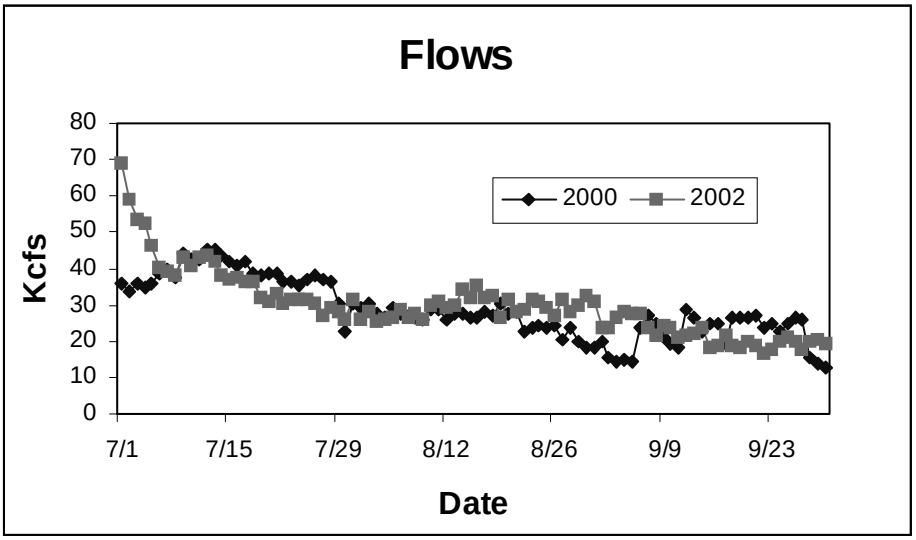
Temperature modeling provided by EPA considered several alternative scenarios for drafting water from Dworshak and its effect on flows and temperatures at Lower Granite Dam. From this information it was shown that drafting cool water from Dworshak, as anticipated in the Biological Opinion, provided the most improved flow and temperature conditions for juvenile fall chinook.

Adult Migrants

Dworshak Reservoir has been used to benefit juvenile migrants by increasing flow and moderating temperatures; and, by moderating temperature in the Lower Snake to also enhance the survival of adult migrants. No separate provisions were made in the Biological Opinion for adult migrants in the Snake River. Biological Opinion flow targets were not met in most years with full use of the mitigation water from Dworshak by August 31. However, there have been persistent recommendations to forgo some of the summer mitigation and move it into the fall time period to aid upstream migrating salmonids. The Biological Opinion is clear (Action 34) that evaluations of drafting of Dworshak to benefit adult passage was not to be done at the expense of volumes dedicated for juvenile migrations, but with volumes below the lower limit established for juvenile flow augmentation of 1520 ft (i.e.1500 ft).

A preliminary test of this management option was conducted in 2002. Water was moved out of the juvenile migration timeframe and provided at a rate of 10 Kcfs per day for a ten-day period during September.

A June 18 memo from Dr. Chris Peery (University of Idaho) discusses a comparison of 2000 and 2002 adult steelhead conversion rates (an index of survival) between Ice Harbor and Lower Granite dams. Dr. Peery concludes that 2002 was slightly better than 2000, a year with similar temperatures and flows. The data are difficult to interpret. While the two years did have similar average flows during September, it can be seen from the graph that late August flows at Lower Granite Dam in 2000 were considerably less than observed in 2002. It is difficult to assess how this might have affected conversion rates.



The memo also compares body temperatures of fish that migrated during 2002 versus fish that migrated in 2001. It is impossible to determine if Dworshak releases during September have any impact on fish body temperatures from these data. In 2001, average air temperatures during August and September at Lewiston, Idaho were much higher than in 2002, indicating the environmental impact may have been greater in 2001.

The memo concludes that there were some benefits to releasing Dworshak water during September, but the effects were not dramatic. The data does not support any conclusion on the benefits of these releases to adult migrants.

Equally important to the whole issue regarding shifting water from the summer to the fall is potential impacts to juvenile passage and survival. Estimates of juvenile survival probability (table 1) to the tailrace of Lower Granite dam for wild subyearling chinook for the latest cohort migrating through the Snake River was less than half (19.4 +/- 2.0) observed for the previous cohort (39.2 +/- 3.0), and overall survival of juvenile fish in 2002 was the second lowest observed since 1998. It is impossible to determine what role the water shifted into September, away from the July/August time frame, may have played in this survival estimate.

Table 1. Estimates of survival probability (%±SE) to the tailrace of Lower Granite Dam for cohorts of wi subyearling fall chinook salmon, 1998 to 2002. (Connor, 2003 personal communication)

Cohort	Survival by year 1998	1999	2000	2001	2002	means
1	70.8±2.9	87.7±4.6	57.1±4.1	40.1±3.1	55.4±3.0	63.9
2	66.1±3.3	77.0±3.8	53.4±4.2	20.5±2.5	48.3±3.0	54.3
3	52.8±3.1	81.2±5.8	44.4±3.6	17.2±3.0	39.2±3.0	48.9
4	35.6±2.9	36.4±3.5	35.7±4.3	4.0±1.3	19.4±2.0	27.9
Annual means	56.3	70.6	47.7	20.5	40.6	

Simulation Modeling

For the last several years the Environmental Protection Agency has been providing temperature scenarios that result from different flow management options. In 2003, the USFWS has employed the available biological information and coupled it with the physical (temperature) simulations. The approach evaluates alternative flow augmentation options in terms of expected survival of subyearling chinook. Data inputs include expected temperature and flow at Lower Granite and historical migration timing of subyearling chinook at Lower Granite based on the passage index. The expected survival rate is based on the multiple regression equations produced by Connor. Two equations are available for consideration: one is based on 1998-2000 data (Connor, 2003) and the other is based on 1998-2002 data. The outcome of this analysis was that the highest juvenile survival is obtained under the implementation of the Biological Opinion, when all of the water is used prior to August 31.

Concern was expressed regarding the potential importance of late migrating fall chinook in terms of contribution to adult returns. To address this concern additional evaluations were made incorporating preliminary information from NOAA Fisheries. These additional evaluations again indicated that the highest survivals were obtained under the Biological Opinion operation.

Summary

In conclusion, we have reviewed all existing information and recommend the operation as specified based on the fact that:

- Flows in 2003 are significantly less than the BIOP flow target to-date and are expected to continue to decrease. Any further reductions in flow are not appropriate given the relation between flow, temperature and juvenile subyearling chinook survival.
- In season information indicates that more than half the juvenile fall chinook have entered the migration corridor,
- Juvenile fall chinook respond to both flow and temperature,
- Water temperatures have already exceeded the 17°C trigger and the EPA modeling has shown the best control of summer temperatures from the implementation of the Biological Opinion,
- The information collected during the adult passage study conducted in 2002 does not demonstrate an improvement for adult migrants,
- Simulation modeling shows that juvenile survival through to adulthood is highest when all the water is used prior to August 31.

References:

Connor, W. P., H. L. Burge, J. R. Yearsley, and T. C. Bjornn. 2003. The influence of flow and temperature on survival of wild subyearling fall chinook salmon in the Snake River. North American Journal of Fisheries Management.

June 18 memo from Dr. Chris Peery to Fish Passage Advisory Committee. Preliminary summary of effects of Dworshak water on passage of adult salmon and steelhead: 2002 September releases.

Connor, W. P., R. K. Steinhorst, and H. L. Burge. 2000. Forecasting survival and passage for
migratory juvenile salmonids. North American Journal of Fisheries Management 20:650-659.

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Connor, W. P., R. K. Steinhorst, and H. L. Burge. 2003. Migrational behavior and seaward
movement of wild subyearling fall chinook salmon in the Snake River. North American Journal of Fisheries Management.

National Marine Fisheries Service (NMFS). 2000. White Paper: Salmonid travel time and survival related to flow in the Columbia River Basin. Seattle, WA. 68 p.

SYSTEM OPERATIONAL REQUEST: #2003-12

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, National Marine Fisheries Service, Idaho Department of Fish and Game, Montana Fish Wildlife & Parks, Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife and the Columbia River-Inter Tribal Fish Commission.

TO:	**B. G. Grisoli**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David Wills, Chairperson, Salmon Managers**

DATE: **July 15th, 2003**

SUBJECT: **Libby/ Arrow-Duncan Swap**

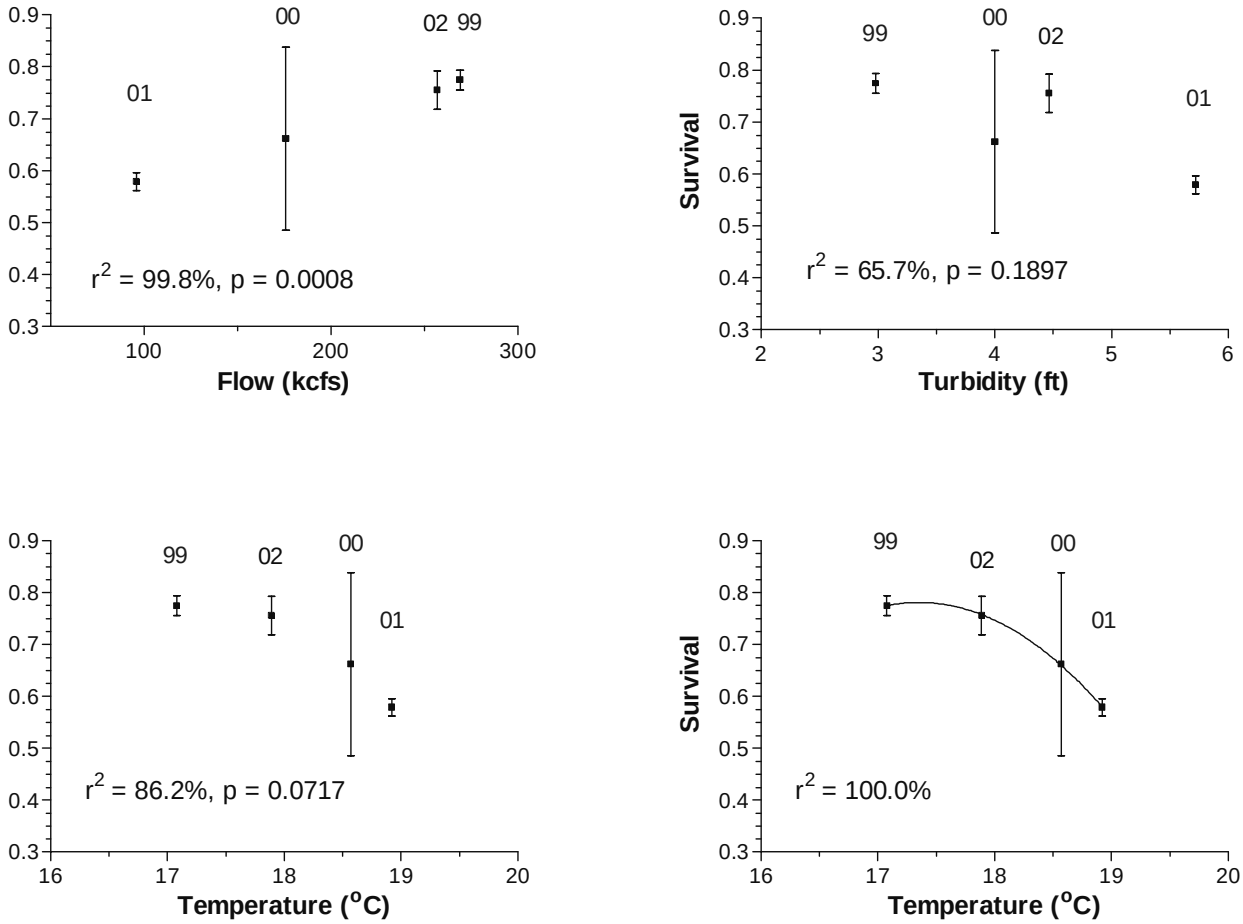
SPECIFICATIONS:

Explore the potential for a Libby/Arrow-Duncan Swap of storage water.

JUSTIFICATION:

SOR 2003MT-1 asks for drafts at Libby to be limited to 2449 feet by the end of September. Despite Montana's predicted benefit to resident fish in Libby reservoir, this operation would have a negative impact in terms of July and August Columbia River flows below Libby. Summer flows in the Columbia River are already well below the 200 Kcfs Biological Opinion Flow Objective at McNary (average daily outflow on 7-14-03 was 155.9 Kcfs). Flows are projected to continue to remain significantly below the BiOp Flow Objective even with a 20-foot draft of the Libby reservoir by August 31st. The Montana SOR states that resident fish benefit if drafts are limited to 10 feet at Libby by the end of September. If this SOR is implemented, the reduced drawdown will exacerbate the problem of flows significantly below the Biological

Opinion Flow Objectives at McNary, affecting both listed and unlisted juvenile fall chinook migrants. Juvenile fall chinook survival data collected in the lower Columbia River between McNary and John Day dams shows a significant flow survival relationship for fall chinook (attached). A water storage swap between Libby and either Arrow or Duncan would make it possible to meet the Montana SOR without further reducing flows for, and survival of, juvenile fall chinook by holding the Libby Reservoir at a higher level while also providing flows in the Columbia River. This will avoid further degradation of summer migration flows and magnitude of deviation from the Biological Opinion flow target for summer migrants.



Survival from McNary Dam to John Day Dam

(NOAA Fisheries)

SYSTEM OPERATIONAL REQUEST: #2003-13

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, and the Columbia River-Inter Tribal Fish Commission.

TO:	**B. G. Grisoli**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David Wills, Chairperson, Salmon Managers**

DATE: **July 29th, 2003**

SUBJECT: Mitigate for Losses in Biological Opinion Spill at Ice Harbor Dam over the Summer Spill Season by Increasing Spill at Lower Columbia River Projects.

SPECIFICATIONS:

Mitigate for losses in Biological Opinion spill levels at Ice Harbor Dam since the beginning of the spill season (7-21-03) by increasing spill at Lower Columbia projects. Mitigation should be volume-for-volume, i.e., volume neutral. Increases in spill in the Lower Columbia River should be equivalent to the combined 2003 seasonal deficits, past and future, from the required Biological Opinion spill operation at Ice Harbor.

JUSTIFICATION:

With reference to the State, Federal and Tribal Fishery Agencies Joint Technical Staff Letter (attached), neither the process by which the decision making took place for the 2003 bulk spill/no spill study at Ice Harbor nor the decision by NOAA Fisheries to support the federal operators in curtailing daytime spill at Ice Harbor Dam is accepted by the Columbia River Inter-Tribal Fish Commission, the Oregon Department of Fish and Wildlife, the Idaho Fish and Game, and the U.S. Fish and Wildlife Service. These decisions resulted in a 2003 spill operation at Ice Harbor Dam that was significantly less than that required under the 2000 Biological Opinion.

The concept of shifting spill volumes from project to project is not uncommon. For example, last year spill was increased at Little Goose Dam as a result of a no spill situation at Lower Monumental Dam. We estimate that over one MAF of Biological Opinion spill has been lost since the beginning of the summer spill season at Ice Harbor Dam as a result of the modifications to the 2003 spill program. Furthermore, we believe that this volume of spill water could be of biological benefit to salmonids in the Lower Columbia River. The following paragraphs outline current biological problems at McNary Dam and how mitigation water from Ice Harbor may help to alleviate these issues.

Tens of thousands of juvenile salmon are currently experiencing exposure to record high temperatures in the bypass system and forebay at McNary Dam. On July 29, temperatures at 6:30 PM were 108 degrees F (air temperature), 82 degrees F in the forebay, 80 degrees F in the screen system gate wells, and 75.9 degrees F in the bypass separator and transportation holding raceways (Tudor July 29 pers. com.). These temperatures are well above the state water quality standard of 68 degrees F and well beyond lethal range of the zone of resistance, which starts at 70 degrees F (Brett 1952; Karr et al. 1998). These temperatures also exceed the upper incipient lethal temperature of 72 degrees F (McCullough 1999). Juvenile fall chinook have been exposed to the cumulative effects of these extreme temperatures for over a week, further lowering their resistance to disease and infection. System mortality was over 4% last week before air temperatures cooled slightly. Air temperatures have again significantly increased at McNary and are expected to be around 110 degrees F for the next two days. We recommend that the following operations be immediately implemented at McNary to spread- the- risk to juvenile salmon by reducing juvenile salmon exposure to these temperatures. The goal is to take precautionary measures now to prevent a possible catastrophic loss as experienced at McNary in other years under similar circumstances.

- Provide spill at McNary; spill should be concentrated in the evening and early night hours, (i.e. 8 PM-midnight) to expediently move fish from extremely warm forebay conditions (i.e. 80 plus degrees F) to tailrace areas that are significantly cooler at 71 degrees F (Tudor July 29 pers. com.). Spill at these requested hours is during off- peak power times, avoiding direct conflict with power needs.

- Fish diverted into the bypass system should be held in a barge in the tailrace where temperatures are significantly cooler and transported every day, or should be directly bypassed to the river. Fish should not be held in raceways to be continually exposed to these extreme temperatures.

- The north powerhouse turbines should be prioritized for loading to prevent intrusion of warmer temperatures from the south units into the bypass system. Data from July 28 indicates a 6-8 degree temperature differential between southern units to northern units (Tudor, July 29 pers. comm. and unpublished data).

The Columbia River Inter-Tribal Fish Commission, the Oregon Department of Fish and Wildlife, the Idaho Fish and Game, and the U.S. Fish and Wildlife Service did not agree with the decision to modify spill operations at Ice Harbor Dam over the summer of 2003. These decisions were primarily based on preliminary data and were not available for peer review (see attached letter). We feel that the volume of Biological Opinion spill water lost at Ice Harbor as a result of these decisions could and should be used to supplement spills in the Lower Columbia River and benefit anadromous fish. The above example at McNary dam outlines one situation where increased spill would be of biological benefit in the Lower Columbia River. The Action Agencies may have additional options for mitigation at other Lower Columbia projects to offset the impact of the changes to Ice Harbor spill; these options may be discussed with the agencies and tribes if needed. For example, daytime spill at John Day and higher daytime spill at Bonneville are other options that could be considered.

References:

Brett, J.R. 1952. Temperature tolerance in young Pacific salmon genus Oncorhychus. Journal of the Fisheries Research Board of Canada. 9:265-323.

Karr, M.K., J.K, Fryer and P.R. Mundy. 1998. Snake River Temperature Control Project. Phase II. Methods for managing and monitoring water temperatures in relationship to salmon in the lower Snake River. Columbia River Inter-Tribal Fish Commission. Portland, Oregon.

McCullough, D.A. 1999. A review and synthesis of effects of alternations to the water temperature regime of fresh-water life stages of salmonids with special reference to chinook salmon. Prepared for the U.S. Environmental Protection Agency. Region 10. By Columbia River Inter-Tribal Fish Commission. Portland, Oregon.

Tudor, R. Washington Department of Fish and Wildlife McNary Project Leader. July 29, 2003. Personal communication.

Attachment:

State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

Washington Department of Fish and Wildlife

Shoshone-Bannock Tribes

July 21, 2003

Brian Brown
Assistant Regional Administrator
NOAA Fisheries
525 NE Oregon St., Suite 420
Portland, OR 97232

Jim Ruff, NMFS
Chief Hydro Operations Branch
NOAA Fisheries
525 NE Oregon St.
Portland, OR 97232-2737

Dear Mr. Brown and Mr. Ruff:

The technical staffs of the Columbia River Inter-Tribal Fish Commission, the Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, the Idaho Department of Fish and Game, the U. S. Fish and Wildlife Service and the Shoshone-Bannock Tribes have serious concerns regarding NOAA Fisheries' recent decision to support the federal operators in curtailing daytime spill at Ice Harbor Dam. This spill is required under the 2000 FCRPS Biological Opinion. A series of rapid conclusions were drawn and decisions were made primarily based upon preliminary data that has not been available for our review. At the June 20, 2003 NOAA Fisheries' Implementation Team meeting, NOAA Fisheries and the federal

operators made a decision to implement and study two options: a bulk spill pattern operation and a no-spill operation. In addition to the process by which the decision-making took place, we do not agree with the conclusions drawn or the summer post-study operations decision. We believe that the 24 hour Biological Opinion (BiOp) spill, either the existing or bulk spill pattern, should be implemented until information from ongoing studies identify alternative operations can provide higher survival benefits than the BiOp.

We have serious concerns regarding the application of the recent Ice Harbor passage study results to short and long term fishery operations decisions at Ice Harbor Dam. Our primary concern is that NOAA Fisheries is making passage mitigation decisions on the basis of data that do not adequately support those decisions. We believe that the studies recently conducted at Ice Harbor Dam are significantly flawed with respect to study design. Further, the studies are insufficient for making project operational decisions for fish passage because, among other things, they are not robust in describing project (reservoir, dam and tailrace) mortality[1] or adequate in determining indirect and delayed effects that are only possible in smolt-to-adult survival studies. In addition, the NOAA Fisheries' decision-making process did not allow for adequate participation by the co-managers, since recent results were not available for review when the decision was made. NOAA Fisheries' decision-making process was faulty because it incorporated recent study results without adequate consideration of the weaknesses of the research results. The decision process was finalized without recognition of the value of collecting data in a comparable fashion across years and without adopting a precautionary approach in examining the likely detriments of no-spill operations. NOAA Fisheries should be joining the co-managers in developing broadly-based and comprehensive monitoring and evaluation programs to provide early detection to avoid significant impacts to stock productivity from passage as noted by Hilborn (1987).

We expand on the details of our specific concerns in the following discussion. In summary, they are:

- Recent studies (in 2003) at Ice Harbor (although preliminary) raise issues regarding validity of the results from studies conducted in 2000 and 2002.

- Studies at Ice Harbor have not provided information on relative survival through specific passage routes, yet NOAA Fisheries is making management decisions on survival through specific passage routes assumed in the 2000 Biological Opinion.

A no-spill operation is not a normative river condition and will likely decrease migration rates and increase forebay delay, which could result in significant mortality via predation, disease and residualization of the run at large. A no-spill operation likely increases injury and mortality for adult fall chinook and steelhead that fall back through the powerhouse (turbines and juvenile bypass system) rather than over spillway. While NOAA Fisheries identified reduction of fall back mortality as a key concern for recovery (NMFS 1999),

[1] The 2000 FCRPS Biological Opinion specifies that project mortality should be measured as the preferred metric to assess individual project effects on salmon passing the project.

- A scientifically rigorous study design adopted with the concurrence of the fishery managers must be developed to evaluate spill passage at Ice Harbor. The results of studies conducted under such an agreed-upon design would provide a common acceptable basis for future fish passage management decisions.

As outlined in our previous technical memorandum, for a mark-recapture study to be valid, marked fish must reflect the actual conditions that fish will experience arriving at, passing through, and traveling below the dam. To date, it appears that none of the studies to estimate spillway survival at Ice Harbor have achieved this criterion, and therefore cannot be considered sufficient for changing BiOp requirements. In particular, we question the use of the hose releases in selected locations for representing the experience of a smolt passing through the spillway. This is an extremely important study design requirement at Ice Harbor since mechanical injury of fish has been shown to be highly influenced by the depth of fish passing over a spillgate with higher mortality observed for fish that were released deeper in the water column.

The only final report available addressing Ice Harbor Spillway survival is Eppard et al. (2002). In this study conducted in 2000, river-run hatchery yearling and subyearling chinook salmon were collected at Lower Monumental Dam, PIT tagged, transported to Ice Harbor Dam, and released. The treatment groups were released through a 10.2 cm diameter hose into spillbays 3, 5 and 7; release depth is not specified in the report. The control groups were released from a barge at mid-channel 0.8 km below the dam. Relative spillway survival for hatchery yearling chinook was estimated to be 97.8%. Relative spillway survival for hatchery subyearling chinook was estimated to be 88.5%. For both yearling and subyearling chinook the relative survival estimates increased with both total dam discharge and spillway gate position (number of stops). However, hose releases inject fish into a specific depth within the water column and thus do not reflect the actual conditions experienced by fish arriving at and passing through a spillway. Because the hose depth may differ from the depth at which fish pass through the spillway, the depth of the release point may affect the study results.

Eppard and Gores conducted a similar study in 2002 at Ice Harbor Dam with the addition of radio tags, but to-date only the research proposal is available for review. Consequently, we are unable to comment on the research methods or the validity of the results that were generated. However, NOAA Fisheries has repeatedly cited these results in support of the change in summer operations.

Balloon tag studies on yearling chinook were conducted at Ice Harbor Dam during the spring of 2003. In this study, the proportion of fish without injuries was estimated. Summarizing the preliminary results into a deep release group (3 feet above ogee, with 2, 3, or 4 stops) and a shallow release group (7 feet above ogee, with 5 stops or more) resulted in estimates of 82.2% and 94.4% uninjured fish, respectively. These preliminary results suggest that either the depth of release or the spillway gate position (stops) may affect the injury rate of yearling chinook. However, these results also force us to question how the depth of release and the number of stops affected the survival estimates reported in Eppard et al. (2002). If release depths or gate stops can affect injury rates, then it is reasonable to expect that these factors will also affect survival estimates. This is a significant shortcoming, which calls into question the validity of the results for 2000 and the preliminary results for 2002.

While we understand the concern these data have generated, a thorough review of all relevant studies needs to be conducted before extensive alterations are made to a study design that was agreed upon before the season. Two years of similar data are not enough to make a dramatic change in operations, especially considering the situation the region witnessed at The Dalles Dam, where two years of data showed similar results, but the third year showed significantly different results from the previous years. Each year is unique with regard to flow, temperature, time of freshet, fish condition, and migration time. Two years of data, one of which we have been unable to review, is hardly enough to justify radical changes in fish passage operations. We support continued evaluations at Ice Harbor, however, we need several (at least three) years of replicated and standardized treatments to insure that data are adequate to make management decisions.

No recent turbine survival estimates are available at this time. The only turbine survival study conducted at Ice Harbor was in 1968. This study indicated an 81 to 90% turbine survival of coho salmon with a substantially higher predation loss. While the predation loss may have improved over time with better project operations (units 4-6 were skeleton bays at that time) and predator removal, the direct turbine survival may have decreased due to substantial wear on the turbine units, particularly units 1-3 (which are scheduled for rehab in the next few years). The current turbines at Ice Harbor are getting close to the end of their design life. Fatigue and failures have occurred both recently and in the past. Turbine unit #3 is out of service for an extended period after part of the turbine blade broke off and was discharged into the draft tube. It is likely that the other turbines in the powerhouse are similarly nearing their life expectancy and not operating at peak operations, which could be negatively impacting juvenile survival through the units. It is therefore likely that the 90% survival estimate that was used in the 2000 BiOp and in model studies, is overestimating survival. The Dalles turbines, which are also

scheduled for rehabilitation over the next several years, have survival estimated to be in the low 80 percentile range. The spring migrant survival estimate for turbine passage at units 1 and 3 in 2003 was estimated at 87%. This is likely an optimistic estimate since the fish were directly released into the turbines, and therefore did not account for any forebay mortality prior to the release point in the turbine. Further, predation upon spring migrants is less of a factor than predation upon summer migrants due to lower water temperatures, predator abundance, and behavior. Summer migrants are likely to be more stressed due to high temperatures combined with disease and parasite concerns, since the Snake River regularly surpasses the 68 degree F water temperature standard. There are no summer migrant survival data related to the bypass system. Guidance has been estimated to be 54% from the 2000 FCRPS Biological Opinion, using upstream projects as an estimate. A no-spill operation could potentially put 46% of the migrants through the turbines.

A no-spill operation would also increase forebay delay. Venditti et al. (2000) studied the migration of fall chinook in the Snake River, specifically at Little Goose Dam. They compared migration times and patterns from 1995 – 1997. The July flows for this time period were considered above normal, with the years ranking eighth, tenth, and fifth in flow overall. While the bulk of the migrants passed through the upper reach within 5 days, a significant proportion, 10-20% of population, delayed in the lower reservoir and forebay reach for 7 days or more. In the slack water forebays of dams without spill, Venditti et al. found that nearly 22% of the fish reversed migration and migrated back upstream. These excursions and delays waste finite energy reserves necessary for survival to saltwater and exacerbate the low energy reserves noted in fall chinook from lack of quality food in Lower Snake River reservoirs (Bennett et al.1999). Further, delays and upstream excursions subject salmon migrants to increased exposure to high water temperatures. These temperatures are correlated with increased predation rates associated with elevated temperatures (Poe et al. 1991), diseases and parasites (McCullough 1999), impairment to migration and reversal of smoltification (Zaugg 1981). Migration times in a low flow year (e.g., 2003) would likely be even worse. This increased delay exposes migrants to two deleterious conditions (predation and high water temperatures), which can increase the likelihood for considerable mortality among smolts that experience lengthy delay. None of this was accounted for in the discussions about a no-spill option.

In conclusion, we request that NOAA Fisheries reconsider their decision to curtail daytime spill at Ice Harbor Dam and collaborate with co-managers to develop a robust study design incorporating passage through the entire project (with smolt to adult returns if feasible) that will support the management decision-making process. We encourage NOAA Fisheries to seriously consider the concerns and comments of the co-managers in short and long-term fish passage management decisions at Ice Harbor and other projects where we share management responsibility. Changes to dam operations for fish passage specified by the 2000 FCRPS

Biological Opinion are significant and should not occur based upon uncertain and inadequate technical information and without full consultation leading to concurrence by the state, tribal and other federal fishery co-managers. We request that NOAA fisheries respond to this letter and specifically describe their technical justification for recommending this variation from the spill measures contained in the 2000 Biological Opinion.

Sincerely,

David Wills, USFWS

Steve Pettit, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Shane Scott, WDFW

Keith Kutchins, SBT

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SYSTEM OPERATIONAL REQUEST: #2003-14

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, NOAA Fisheries, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife and the Columbia River-Inter Tribal Fish Commission.

TO:	**B. G. Grisoli**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cindy Henriksen	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David Wills, Chairperson, Salmon Managers**

DATE: **September 2nd, 2003**

SUBJECT: Water Temperature Operation for Dworshak and Lower Granite.

SPECIFICATIONS:

If necessary to maintain water temperature criteria, increase outflows at Dworshak to 8.0 Kcfs beginning on September 3, 2003 and continue through September 11, 2003. On September 12th, use remaining storage water to ramp outflows down to the minimum Dworshak discharge; enough storage water should remain to provide a similar three-day ramp down as modeled in the 8-25-03 STP. September 3rd through 11th outflows should be consistent at 8.0 Kcfs throughout each day with little daily load following fluctuations. Temperatures of Dworshak release water should be 44-48 ^{o}F. Whenever possible, meet both the 68 ^{o}F temperature criteria at Lower Granite and the Dworshak release water of 44-48 ^{o}F.

JUSTIFICATION:

Recent tailwater temperatures at Lower Granite dam have begun to exceed the 68 ^{o}F water temperature target. This occurred concurrently with the decrease in flow at Dworshak, spill at Dworshak associated with the outage at Lower Granite and the decrease in flow at Lower Granite Dam. Operations at the Dworshak project have included load following which contributes to the temperature fluctuations in the Clearwater while lower outflow from Dworshak contributes to the higher tailwater temperature at Lower Granite Dam.

Flow augmentation volume was shifted from August to September to protect late migrating fall chinook in the Snake River, as advocated by the Nez Perce Tribe-Idaho Plan for Dworshak. Water temperature targets should be maintained to realize the benefit of shifting the flow volume from August to September to facilitate protection of late migrating fall chinook juveniles and to avoid counteracting the benefit of the provision of flow. Maintaining the temperature targets at the Lower Granite tailrace while managing temperature to avoid impact to the Dworshak Hatchery will compliment the benefit of providing the augmentation flow. Maintaining the water temperature target at Lower Granite will benefit both juvenile fall chinook migrants and adult fall chinook and steelhead migrants in the Snake River.

SYSTEM OPERATIONAL REQUEST: #2003-15

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, NOAA Fisheries, Idaho Department of Fish and Game, Washington Department of Fish and Wildlife, Columbia River Inter Tribal Fish Commission, Shoshone-Bannock Tribe, and the Oregon Department of Fish and Wildlife.

TO:	**B. G. Grisoli**	**COE-NWD**
	William Branch	**COE-Water Management**
	Cathy Hlebechuk	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Richard Hobernicht	**COE-Portland District**
	LTC Kertis, Jr.	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Steven Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: **David A. Wills, Chairperson, Salmon Managers**

DATE: **October 24, 2003**

SUBJECT: Tailwater elevation at Bonneville Dam to protect natural spawning of chum and fall chinook salmon at the Ives/Pierce Island Complex, Multnomah Falls, and partly influence the
I-205 seeps.

SPECIFICATIONS: As required by the 2000 NMFS Biological Opinion, beginning when chum are present (no later than November 1) and continuing until further notice, provide a minimum instantaneous tailrace elevation of 11.5 feet at Bonneville Dam. On average it is anticipated that daily average flows will not exceed 125 Kcfs.

JUSTIFICATION: The Ives/Pierce Islands Complex below Bonneville Dam represents a limited natural spawning area for ESA listed Columbia River chum and unlisted Lower Columbia River bright fall chinook. The NMFS 2000 Biological Opinion (BiOp) recognizes that access to spawning habitat in the Ives/Pierce area and Hardy and Hamilton creeks is primarily a function of the water surface elevation. More so, the BiOp and experience over the last 5 years recognizes that managing water levels to a tailwater gage height rather than a flow level is preferable.

Over the last ten days the flow below Bonneville has varied between 72 and 145 Kcfs, with tailwater elevations fluctuating between 7.2 and 12.6 feet. These variable flows and tailwater elevations are not adequate to provide spawning area for chum salmon at the Ives/Pierce Islands Complex and Multnomah Falls. Additionally, these flows and tailwater elevations limit access to both Hardy and Hamilton creeks and spawning effectiveness at the
I-205 seeps. The provision of a minimum 11.5-foot tailwater elevation at Bonneville Dam will provide access to a limited area of mainstem spawning habitat for chum salmon and allow unrestricted access to Hardy and Hamilton creeks.

Data over the last five years (Figure 1) suggests that chum salmon will begin staging and spawning in the area around the first of November. Lower River bright fall chinook are already present in the vicinity of the Ives/Pierce Island Complex, and based on data collected 1998-2002 (Figure 2) have already begun to spawn in significant numbers with peak counts expected in early November. Increasing tailwater elevation will allow chinook access to some preferred shallow-water habitat in the island area. Habitat modeling results from BPA Project 1999003 for chum salmon show a significant change in available spawning habitat between Bonneville Dam discharges of 110 to 125 kcfs. For the main Ives Island chum spawning site, habitat and necessary hydraulic conditions for spawning is largely driven by the availability of Columbia River water over the hydraulic control point between Hamilton and Ives Island. Habitat is also influenced from Hamilton Creek discharge. Reliance on this creek provides uncertainty that habitat will be sustained throughout the spawning season.

An analysis of the effects of tailwater elevation on the availability of mainstem chum spawning habitat indicated that with Bonneville Dam at 110 kcfs (~10.75 foot tailwater), a condition that does not provide Columbia River water through the control point, and zero flow from Hamilton Creek, 0.13 hectares of usable habitat are available to chum (see Table below). The 0.13 hectares is produced from a downstream backwater into the site. At a discharge of 120 kcfs (~11.25 foot tailwater), which just breaches the control, and zero flow from Hamilton Creek, 0.40 hectares of usable habitat is available. This is a 308% increase over the 110 kcfs condition. At a discharge of 125 kcfs (~11.5 foot tailwater), the condition that has been managed to in previous years, and zero flow from Hamilton Creek, 0.6 hectares becomes usable and provides a 462% increase over the 110 kcfs operation. Calculations for wetted and usable area are provided in the table below. These results are for a low/average downstream Warrendale elevation (tidal and Willamette River influence) and zero discharge from Hamilton Creek, both typical of late October and early November.

Chum Study Section (S2) "Hamilton Mouth"		
Bonneville Q (kcfs)	Wetted area (ha)	Usable Area (ha)
110	2.20	0.13
120	4.50	0.40
125	4.60	0.60

(For a detailed discussion please see the report "ASSESSMENT OF CHINOOK SALMON SPAWNING HABITAT NEAR IVES AND PIERCE ISLANDS IN THE COLUMBIA RIVER" at http://www.efw.bpa.gov/Environment).

The request is for an instantaneous 24-hour tailwater elevation. This is because chum spawning behavior during nighttime hours has been observed. USFWS and USGS staff collected nighttime behavioral information of chum salmon between the hours of 1700 and
0300 h from 20 November to December 9, 2002. An acoustic under water camera was used to observe chum salmon behavior over redds from a distance of 4-5 meters. Prior to deployment, staff documented active spawning behavior 2-5 hours before sunset. In total 25 different female chum salmon were observed digging redds and all 25 continued digging into the night throughout the observation period. Of the 25 female chum salmon observed digging redds, 23 were accompanied by a presumably male fish. Male fish were observed displaying courtship behavior such as tail crossing and quivering and were also observed chasing other intruding fish.

An additional need for the 11.5-foot tailwater elevation is for the reintroduction of chum salmon into Duncan Creek. In the last month an adult trap was installed at the Skamania Landing's dam structure on Duncan Creek as part of the monitoring and evaluation portion of the Re-Introduction of Lower Columbia River Chum Salmon into Duncan Creek project (BPA Project #200105300). Beginning October 15, the lake level was decreased to zero elevation, allowing for fish passage into Duncan Creek. However, the concrete sill of the dam, on which the trap rests and fish must pass over to enter Duncan Creek, remains un-watered until Columbia River elevations rise above approximately 11.5 feet at the Bonneville Dam tailwater. Because adult trapping needs to occur as part of the Duncan Creek monitoring and evaluation and fluctuating tailwater elevations would strand fish in the trap, a consistent tailwater elevation of 11.5 beginning on November 1st, 2003 is essential to this study. All adult salmonids will be excluded from Duncan Creek if a tailwater elevation of 11.5 feet is not achieved.

The provision of flow to facilitate spawning in the shallow water habitat and tributaries will benefit both chum and fall chinook by: 1) allowing access to spawning habitat, 2) providing stable spawning conditions, 3) extending the timeframe over which spawning occurs, and 4) protecting life history diversity of early spawning fish. This approach recognizes that adequate flows can be provided without significant impacts on other fish and power operations. Based on research collected to date, the island areas and tributaries provide suitable spawning habitat for chum. Unlike chinook, chum cannot spawn in the high velocity large cobble substrate of the mainstem, and an inadequate amount of spawning habitat has been documented to support all spawners in tributaries as well as other mainstem areas. The delay of providing spawning flows poses an unnecessary risk to this population that number less than 1% of their historic

abundance. Current (October 22, 2003) STP modeling indicates that near 125 Kcfs of water will be available at Bonneville starting November 1, 2003, providing water to maintain the 11.5-foot tailwater gage height. The opportunity for enhancing natural spawning areas and production in the mainstem Columbia system is limited and should be given high priority for protection and enhancement.

***Note**: CRITFC and the Shoshone Bannock Tribe support this SOR, but only if the proposed draft at Albeni Falls down to elevation 2051 feet occurs by November 21, 2003. Otherwise, CRITFC and the Shoshone Bannock Tribe can only support a Bonneville tailwater of 11.25 feet or outflows of 120 kcfs.*

Figure 1. Chum redd counts.

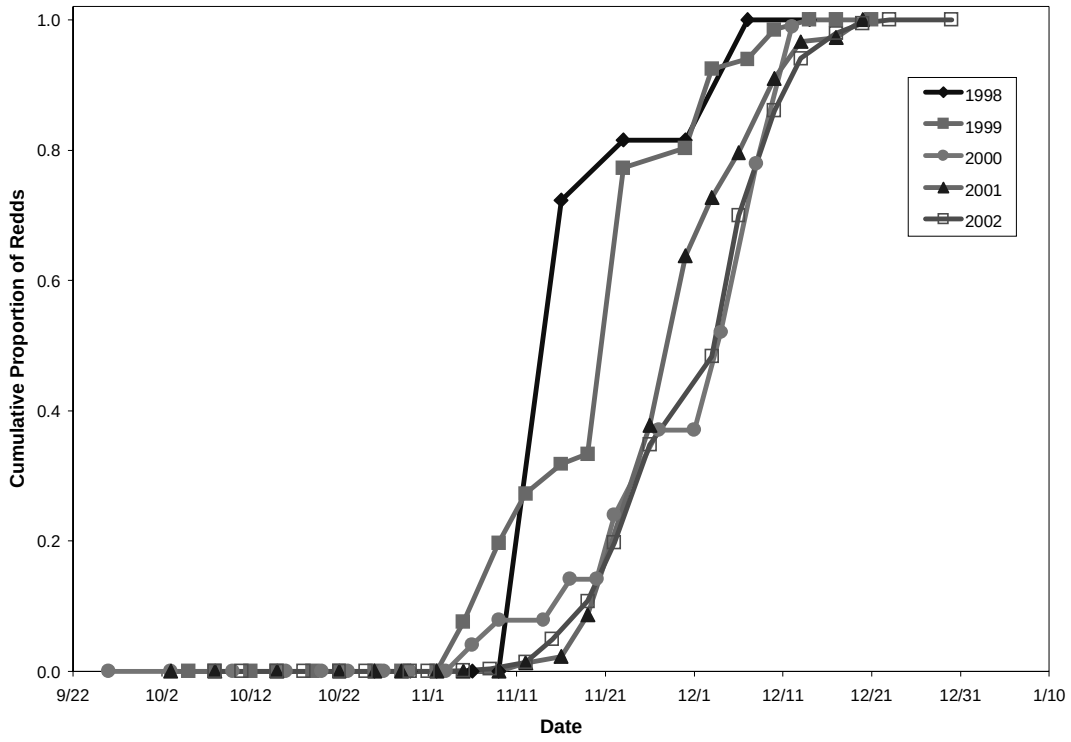
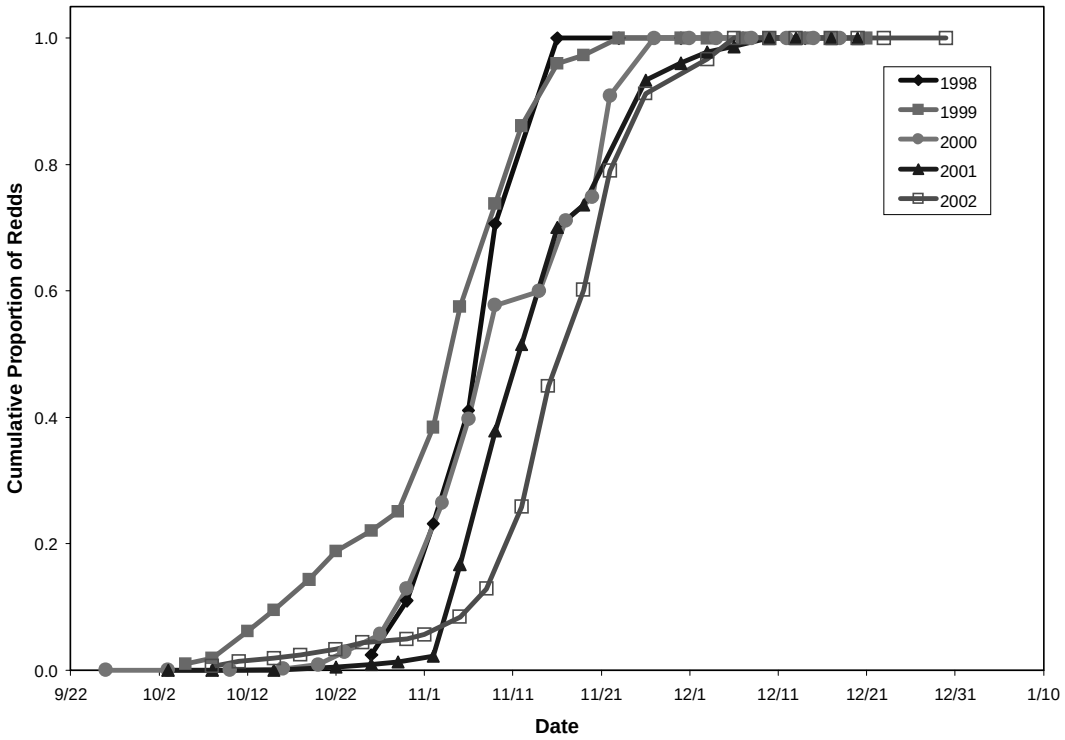


Figure 2. Fall chinook redd counts.



COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
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SYSTEM OPERATIONAL REQUEST: 2003 C-1

TO:	Brigadier General Fastabend	COE-NWD
	Steven Wright	BPA Administrator
	J. William McDonald	USBR-- Pacific Northwest Regional Director
	William Branch	COE-NWD-NP-Water Management
	Cindy Henriksen	COE-NWD-NP-WM-RCC
	Witt Anderson	COE-NWD-CM-F (Fish Management Office)
	LTC Edward Kertis, Jr.	COE-Walla Walla District
	Col. Richard Hobernicht	COE-Portland District
	Greg Delwiche, Scott Bettin	BPA-PG-5 and BPA-PGPO
	Stan Speaks, Keith Hatch	BIA, Portland Area Office

FROM: Don Sampson, *Executive Director*

DATE: April 23rd, 2003

SUBJECT: **Operation of the Lower Columbia Pools for the Spring 2003 Treaty Fishery**

The Columbia River Inter-Tribal Fish Commission, on behalf of its member tribes the Nez Perce Tribe, the Yakama Nation, the Confederated Tribes of the Umatilla Reservation, and the Confederated Tribes of the Warm Springs Reservation, requests the following reservoir operations in Zone 6 (Bonneville to McNary dams) during the 2003 spring Treaty fishery. Implement the following hydro-system operations during the ceremonial, subsistence, and commercial Treaty fishery times as established by the tribes and the Columbia River Compact.

SPECIFICATIONS: Implement the following operations as a hard system constraint as follows:

April 24th, 2003, 6 am, Thursday, through 6 pm, April 26th, 2003, Saturday.

Bonneville Pool: Operate the pool within 1.0 foot from full pool (msl elevation 77 – 76).
The Dalles (Celilo) Pool: Operate the pool within 1.0 foot (msl elevation 159.5 - 158.5).
John Day Pool: Operate the pool within 1.0 foot (msl elevation 264.5 - 263.5).

JUSTIFICATION:

The 2003 spring Treaty fishing season is of critical importance to CRITFC's member tribes. The anticipated escapement of an estimated 193,000 adult spring Chinook will create harvest opportunities that tribal fishers have not realized in the last 25 years until recent years. Many fishers will be exercising their treaty rights by participating in this harvest. Many cultural and religious ceremonies and practices will occur with the harvest of these salmon.

During a meeting at CRITFC's Law Enforcement Division in Hood River on September 2, 1999, tribal fishers explained the impacts of unstable pools and pools below full to the Treaty fishery to Colonel Mogren and Lt. Colonel Harshbarger. The tribal fishers explained that a pool fluctuation of 1.0 foot or more disrupts tribal fishery operations. Specific problems include: (1) increased local currents that sweep debris into fishing nets, (2) rapid 1-2 hour drops in water level will lead to entanglement of nets, (3) boat access problems, and (4) nets torn from their anchors. Nets and gear are costly to replace. Any delays or disruptions to tribal fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources and cultural practices.

The fishers also stressed to Corps officials that the loss of fishing opportunity during the extremely limited treaty fishery cannot be replaced. Much of the tribal fishers' income and food is generated during the brief treaty fishing season, thus, any delays or disruptions to their fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources, and cultural practices.

Implementing this request will insure that the Federal operating agencies meet their federal trust responsibilities to the Columbia Basin treaty tribes. If this SOR cannot be accommodated, CRITFC's member tribes request a detailed written response from the federal operators, with justification, by Friday May 2nd, 2003.

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SYSTEM OPERATIONAL REQUEST: 2003 C-2

TO:	Brigadier General Fastabend	COE-NWD
	Steven Wright	BPA Administrator
	J. William McDonald	USBR-- Pacific Northwest Regional Director
	William Branch	COE-NWD-NP-Water Management
	Cindy Henriksen	COE-NWD-NP-WM-RCC
	Witt Anderson	COE-NWD-CM-F (Fish Management Office)
	LTC Edward Kertis, Jr.	COE-Walla Walla District
	Col. Richard Hobernicht	COE-Portland District
	Greg Delwiche, Scott Bettin	BPA-PG-5 and BPA-PGPO
	Stan Speaks, Keith Hatch	BIA, Portland Area Office

FROM: Don Sampson, *Executive Director*

DATE: May 21st, 2003

SUBJECT: **Operation of the Lower Columbia Pools for the Spring 2003 Treaty Fishery**

The Columbia River Inter-Tribal Fish Commission, on behalf of its member tribes the Nez Perce Tribe, the Yakama Nation, the Confederated Tribes of the Umatilla Reservation, and the Confederated Tribes of the Warm Springs Reservation, requests the following reservoir operations in Zone 6 (Bonneville to McNary dams) during the 2003 spring Treaty fishery. Implement the following hydro-system operations during the ceremonial, subsistence, and commercial Treaty fishery times as established by the tribes and the Columbia River Compact.

SPECIFICATIONS: Implement the following operations as a hard system constraint as follows:

May 22nd, 2003, 6 am, Thursday, through 6 pm, May 24th, 2003, Saturday.

Bonneville Pool: Operate the pool within 1.0 foot from full pool (msl elevation 77 – 76).
The Dalles (Celilo) Pool: Operate the pool within 1.0 foot (msl elevation 159.5 - 158.5).
John Day Pool: Operate the pool within 1.0 foot (msl elevation 264.5 - 263.5).

JUSTIFICATION:

The 2003 spring Treaty fishing season is of critical importance to CRITFC's member tribes. The anticipated escapement of an estimated **203,000** adult spring Chinook will create harvest opportunities that tribal fishers have not realized in the last 25 years until recent years. Many fishers will be exercising their treaty rights by participating in this harvest. Many cultural and religious ceremonies and practices will occur with the harvest of these salmon.

During a meeting at CRITFC's Law Enforcement Division in Hood River on September 2, 1999, tribal fishers explained the impacts of unstable pools and pools below full to the Treaty fishery to Colonel Mogren and Lt. Colonel Harshbarger. The tribal fishers explained that a pool fluctuation of 1.0 foot or more disrupts tribal fishery operations. Specific problems include: (1) increased local currents that sweep debris into fishing nets, (2) rapid 1-2 hour drops in water level will lead to entanglement of nets, (3) boat access problems, and (4) nets torn from their anchors. Nets and gear are costly to replace. Any delays or disruptions to tribal fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources and cultural practices.

The fishers also stressed to Corps officials that the loss of fishing opportunity during the extremely limited treaty fishery <u>cannot</u> be replaced. Much of the tribal fishers' income and food is generated during the brief treaty fishing season, thus, any delays or disruptions to their fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources, and cultural practices.

Implementing this request will insure that the Federal operating agencies meet their federal trust responsibilities to the Columbia Basin treaty tribes. If this SOR cannot be accommodated, CRITFC's member tribes request a detailed written response from the federal operators, with justification, by Friday May 30th, 2003.

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
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SYSTEM OPERATIONAL REQUEST: 2003 C-3

TO:	Brigadier General Grisoli	COE-NWD
	Steven Wright	BPA Administrator
	J. William McDonald	USBR-- Pacific Northwest Regional Director
	William Branch	COE-NWD-NP-Water Management
	Cindy Henriksen, Rudd Turner	COE-NWD-NP-WM-RCC
	Witt Anderson	COE-NWD-CM-F (Fish Management Office)
	LTC Edward Kertis, Jr.	COE-Walla Walla District
	Col. Richard Hobernicht	COE-Portland District
	Greg Delwiche, Scott Bettin	BPA-PG-5 and BPA-PGPO
	Stan Speaks, Keith Hatch	BIA, Portland Area Office

FROM: Olney Patt, Jr., *Executive Director*

DATE: July 2nd, 2003

SUBJECT: **Operation of the Lower Columbia Pools for the Summer 2003 Treaty Fishery**

The Columbia River Inter-Tribal Fish Commission, on behalf of its member tribes the Confederated Tribes of the Warm Springs Reservation, Nez Perce Tribe, the Confederated Tribes of the Umatilla Reservation, and the Yakama Nation, requests the following reservoir operations in Zone 6 (Bonneville to McNary dams) during the 2003 summer Treaty fishery. Implement the following hydro-system operations during the ceremonial, subsistence, and commercial Treaty fishery times as established by the tribes and the Columbia River Compact.

SPECIFICATIONS: Implement the following operations as a hard system constraint as follows:

July 14th, 2003, 6 am, Monday, through 6 pm, July 16th, 2003, Wednesday.

Bonneville Pool: Operate the pool within 1.0 foot from full pool (msl elevation 77 – 76).
The Dalles (Celilo) Pool: Operate the pool within 1.0 foot (msl elevation 159.5 - 158.5).
John Day Pool: Operate the pool within 1.0 foot (msl elevation 264.5 - 263.5).

JUSTIFICATION:

The 2003 summer Treaty fishing season is of critical importance to CRITFC's member tribes. The anticipated escapement of an estimated **120,000** adult summer Chinook will create harvest opportunities that tribal fishers have not realized in the last 39 years. If realized, this forecast will be the second highest count at Bonneville dam since 1957. Many fishers will be exercising their treaty rights by participating in this harvest. Many cultural and religious ceremonies and practices will occur with the harvest of these salmon.

During a meeting at CRITFC's Law Enforcement Division in Hood River on September 2, 1999, tribal fishers explained the impacts of unstable pools and pools below full to the Treaty fishery to Colonel Mogren and Lt. Colonel Harshbarger. The tribal fishers explained that a pool fluctuation of 1.0 foot or more disrupts tribal fishery operations. Specific problems include: (1) increased local currents that sweep debris into fishing nets, (2) rapid 1-2 hour drops in water level will lead to entanglement of nets, (3) boat access problems, and (4) nets torn from their anchors. Nets and gear are costly to replace. Any delays or disruptions to tribal fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources and cultural practices.

The fishers also stressed to Corps officials that the loss of fishing opportunity during the extremely limited treaty fishery cannot be replaced. Much of the tribal fishers' income and food is generated during the brief treaty fishing season, thus, any delays or disruptions to their fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources, and cultural practices.

Implementing this request will insure that the Federal operating agencies meet their federal trust responsibilities to the Columbia Basin treaty tribes. If this SOR cannot be accommodated, CRITFC's member tribes request a detailed written response from the federal operators, with justification, by Friday, July 18th, 2003.

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
729 N.E. Oregon, Suite 200, Portland, Oregon 97232 Telephone (503) 238-0667
Fax (503) 235-4228
www.critfc.org

SYSTEM OPERATIONAL REQUEST: 2003 C-4

TO:	Brigadier General Grisoli	COE-NWD
	Steven Wright	BPA Administrator
	J. William McDonald	USBR-- Pacific Northwest Regional Director
	William Branch	COE-NWD-NP-Water Management
	Cindy Henriksen, Rudd Turner	COE-NWD-NP-WM-RCC
	Witt Anderson	COE-NWD-CM-F (Pacific Salmon Coord. Office)
	LTC Edward Kertis, Jr.	COE-Walla Walla District
	Col. Richard Hobernicht	COE-Portland District
	Greg Delwiche, Scott Bettin	BPA-PG-5 and BPA-PGPO
	Stan Speaks, Keith Hatch	BIA, Portland Area Office

FROM: Olney Patt, Jr., *Executive Director*
DATE: July 8th, 2003
SUBJECT: **Idaho-Nez Perce Tribe Dworshak Summer Operations Plan**

The Columbia River Inter-Tribal Fish Commission, on behalf of its member tribes the Nez Perce Tribe, the Confederated Tribes of the Warm Springs Reservation, the Confederated Tribes of the Umatilla Reservation, and the Yakama Nation, as well as the State of Idaho, requests the following reservoir operations during summer 2003. This Plan also complies with the State of Idaho Dworshak Operations Plan (attached)—approved by the Idaho legislature in 2000.

SPECIFICATIONS:

Implement the following operational guidelines (Figures 1 and 2). If river conditions degrade dramatically or flow varies significantly from the predicted model simulations during the period of the specified operation (1-7), in season management options will be discussed. We request that data being collected by the Corps monitoring program outlined by RPA measure #143 be made available for the weekly TMT meetings or discuss an alternative reporting schedule.

1. Hold outflows to 13,500 –14,000 cfs (TDG cap) through July 20th, 2003.
2. Ramp flows to 12,000 cfs by morning July 21st, 2003, and hold through August 3rd, 2003.
3. Ramp flows to 11,000 cfs by morning August 4th, 2003, and hold through August 10th, 2003.
4. Ramp flows to 10,000 cfs by morning August 11th, 2003, & hold through August 24th, 2003.
5. Ramp flows to 8,000 cfs by morning August 25th, 2003, and hold through August 31st, 2003.
6. Draft limit of 1535 ft by August 31st is needed to ensure a 200 KaF carryover into September.
7. From September 1st through 14th, 2003, release flows of 8,400 cfs.
8. By September 15th, 2003, reduce flows to minimum 1,400 cfs as elevation 1520 ft is reached.

JUSTIFICATION:

Idaho, Nez Perce Tribe, and CRITFC desire to meet water quality standards in the Clearwater River that afford balanced protection of sub-yearling salmonids and returning adults; maintain Dworshak elevation at or above 1520 ft; optimize the rearing of listed Clearwater River fall Chinook; and minimize impacts at the Dworshak National Fish Hatchery. The SOR is consistent with the Nez Perce Tribe-Idaho Plan for Total Dissolved Gas Short-Term Activity Exemption.

Water Temperature

Model results from EPA- Seattle imply that a natural peaking flow regime would keep Lower Granite water temperatures at 20 degC or less by late summer, which would greatly benefit returning adults (Refer to Dr. Dale McCullough's work on the benefits of cooler water on returning salmon adults during late summer: http://www.critfc.org/tech/EPAreport.htm). This SOR would keep water temperatures at or below 20 degC in Lower Granite for most of August and September (Figure 3). Current water temperatures are 0.1 degC to the initial model starting conditions. Scenario #6 in the EPA model best represents the operations outlined in this SOR.

Weather Considerations

The EPA model assumes 1978 summer weather patterns—slightly warming June and July, near normal August, and slightly cooling September. Current short-term weather forecasts and climate predictions suggest that the 1978 analog is good.

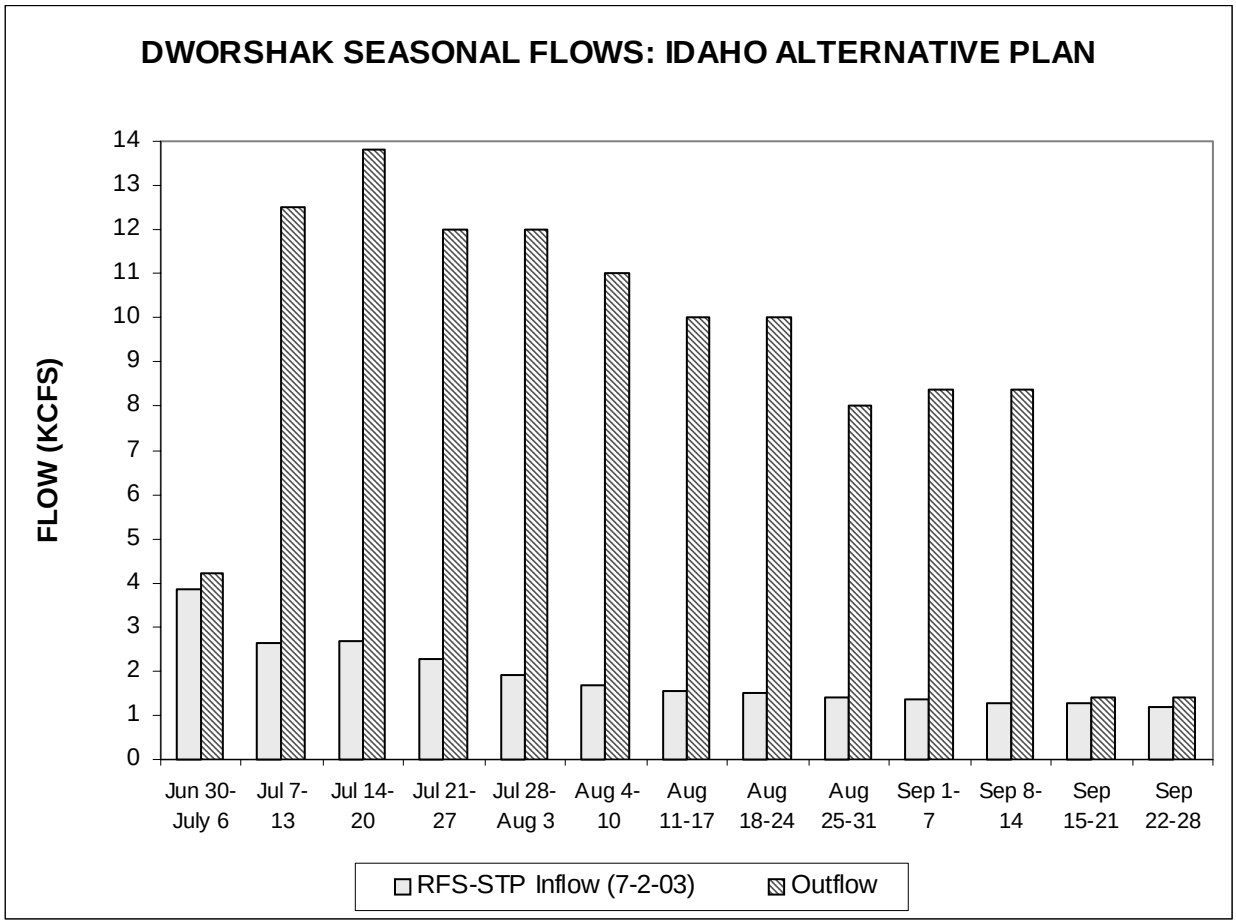

Figure 2. Summary hydrograph of proposed ID-NPT-CRITFC operation.

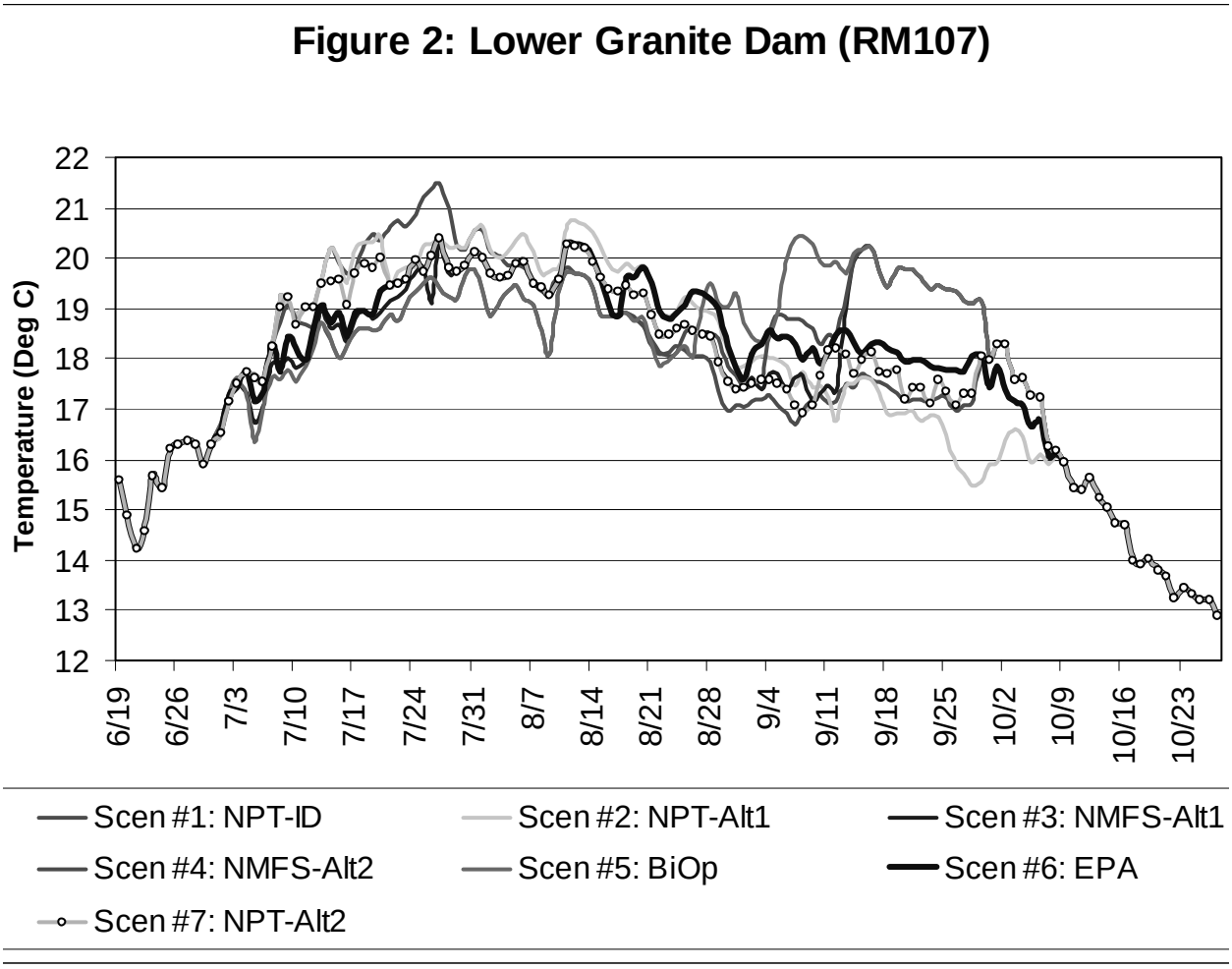

Figure 3. Summary of EPA modeling results. Scenario #6 is similar to the proposed ID-NPT-CRITFC Plan. Daily water temperatures assume WY 2000 conditions (near normal). Daily tributary flows assume WY 1981 conditions (similar percent and volume to WY 2002). Daily meteorology assumes WY 1978 (moderately dry summer with near normal temperatures).

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SYSTEM OPERATIONAL REQUEST: 2003 C-5

TO:	Brigadier General Grisoli	COE-NWD
	Steven Wright	BPA Administrator
	J. William McDonald	USBR-- Pacific Northwest Regional Director
	William Branch	COE-NWD-NP-Water Management
	Cindy Henriksen, Rudd Turner	COE-NWD-NP-WM-RCC
	Witt Anderson	COE-NWD-CM-F (Fish Management Office)
	LTC Edward Kertis, Jr.	COE-Walla Walla District
	Col. Richard Hobernicht	COE-Portland District
	Greg Delwiche, Scott Bettin	BPA-PG-5 and BPA-PGPO
	Stan Speaks, Keith Hatch	BIA, Portland Area Office

FROM: Olney Patt, Jr., *Executive Director*

DATE: July 18th, 2003

SUBJECT: **Operation of the Lower Columbia Pools for the Summer 2003 Treaty Fishery**

The Columbia River Inter-Tribal Fish Commission, on behalf of its member tribes the Confederated Tribes of the Warm Springs Reservation, Nez Perce Tribe, the Confederated Tribes of the Umatilla Reservation, and the Yakama Nation, requests the following reservoir operations in Zone 6 (Bonneville to McNary dams) during the 2003 summer Treaty fishery. Implement the following hydro-system operations during the ceremonial, subsistence, and commercial Treaty fishery times as established by the tribes and the Columbia River Compact.

SPECIFICATIONS: Implement the following operations as a hard system constraint as follows:

July 21st, 2003, 6 am, Monday, through 6 pm, July 23rd, 2003, Wednesday.

Fishery Concerns

The Nez Perce Tribe and State of Idaho strongly believe that Dworshak should not be drafted below 1535 ft elevation before September 1st in order to reserve water for a 200 KaF draft in September. This draft would benefit sub-yearling and adult fall chinook and steelhead migration.

Sub-yearling fall Chinook do not typically outmigrate from the Clearwater until an average size of 85 mm is reached. Nez Perce Tribe fish surveys on June 30th 2003 show that the wild sub-yearling average fork length is only 65 mm (with a 43-100 mm range). At an average growth rate of 1mm per day, these fish are not expected to reach smolt size (actively migrating) until mid July. Cold-water conditions may slow grow rates and delay outmigration. Passage data indicates that 40% of listed sub-yearling Clearwater fall Chinook migrate past Lower Granite Dam in September and October. Implementation of this SOR is needed to accommodate these fish.

Implementing this request will insure that the Federal operating agencies meet their federal trust responsibilities to the Columbia Basin treaty tribes. If this SOR cannot be accommodated, CRITFC requests a detailed written response from the federal operators, with justification, by Friday July 11th, 2003.

N.F. Clearwater at Dworshak (DWR)

08-Jul-03 **WY 2003** **SUMMER**	Outflow (ID-Alt) (kcfs)	RFS-STP Inflow (7-2-03) (NWRFC) (kcfs)	Storage Change (KaF)	DWR Pool Elevation (feet) end-of-week
Jun 29th		Forecast:		1600.0
Jun 30-July 6	4.2	3.9	-5	1599.5
Jul 7-13	12.5	2.6	-137	1592.5
Jul 14-20	13.8	2.7	-154	1583.5
Jul 21-27	12.0	2.3	-135	1575.5
Jul 28- Aug 3	12.0	1.9	-140	1566.5
Aug 4-10	11.0	1.7	-130	1558.0
Aug 11-17	10.0	1.6	-117	1550.0
Aug 18-24	10.0	1.5	-118	1541.5
Aug 25-31	8.0	1.4	-91	1535.0
Sep 1-7	8.4	1.3	-98	1528.0
Sep 8-14	8.4	1.3	-99	1520.4
Sep 15-21	1.4	1.3	-2	1520.3
Sep 22-28	1.4	1.2	-3	1520.1
Sep 30th				
Total (KaF):	1,570	340	-1230	

CRITFC Hydro Program **Idaho Alternative Plan**

Figure 1. Summary of proposed Dworshak operations for 2003.

Bonneville Pool: Operate the pool within 1.0 foot from full pool (msl elevation 77 – 76).
The Dalles (Celilo) Pool: Operate the pool within 1.0 foot (msl elevation 159.5 - 158.5).
John Day Pool: Operate the pool within 1.0 foot (msl elevation 264.5 - 263.5).

JUSTIFICATION:

The 2003 summer Treaty fishing season is of critical importance to CRITFC's member tribes. The anticipated escapement of an estimated **120,000** adult summer Chinook will create harvest opportunities that tribal fishers have not realized in the last 39 years. If realized, this forecast will be the second highest count at Bonneville dam since 1957. Many fishers will be exercising their treaty rights by participating in this harvest. Many cultural and religious ceremonies and practices will occur with the harvest of these salmon.

During a meeting at CRITFC's Law Enforcement Division in Hood River on September 2, 1999, tribal fishers explained the impacts of unstable pools and pools below full to the Treaty fishery to Colonel Mogren and Lt. Colonel Harshbarger. The tribal fishers explained that a pool fluctuation of 1.0 foot or more disrupts tribal fishery operations. Specific problems include: (1) increased local currents that sweep debris into fishing nets, (2) rapid 1-2 hour drops in water level will lead to entanglement of nets, (3) boat access problems, and (4) nets torn from their anchors. Nets and gear are costly to replace. Any delays or disruptions to tribal fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources and cultural practices.

The fishers also stressed to Corps officials that the loss of fishing opportunity during the extremely limited treaty fishery <u>cannot</u> be replaced. Much of the tribal fishers' income and food is generated during the brief treaty fishing season, thus, any delays or disruptions to their fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources, and cultural practices.

Implementing this request will insure that the Federal operating agencies meet their federal trust responsibilities to the Columbia Basin treaty tribes. If this SOR cannot be accommodated, CRITFC's member tribes request a detailed written response from the federal operators, with justification, by Friday, July 25th, 2003.

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SYSTEM OPERATIONAL REQUEST: 2003 C-6

TO:	Brigadier General Grisoli	COE-NWD
	Steven Wright	BPA Administrator
	J. William McDonald	USBR-- Pacific Northwest Regional Director
	William Branch	COE-NWD-NP-Water Management
	Cindy Henriksen, Rudd Turner	COE-NWD-NP-WM-RCC
	Witt Anderson	COE-NWD-CM-F (Fish Management Office)
	LTC Edward Kertis, Jr.	COE-Walla Walla District
	Col. Richard Hobernicht	COE-Portland District
	Greg Delwiche, Scott Bettin	BPA-PG-5 and BPA-PGPO
	Stan Speaks, Keith Hatch	BIA, Portland Area Office

FROM: Olney Patt, Jr., *Executive Director*

DATE: August 22, 2003

SUBJECT: **Operation of the Lower Columbia Pools for the Autumn 2003 Treaty Fishery**

The Columbia River Inter-Tribal Fish Commission (CRITFC), on behalf of its member tribes the Confederated Tribes of the Warm Springs Reservation, Nez Perce Tribe, the Confederated Tribes of the Umatilla Reservation, and the Yakama Nation, requests the following reservoir operations in Zone 6 (Bonneville to McNary dams) during the 2003 autumn Treaty fishery. Implement the following hydro-system operations during the ceremonial, subsistence, and commercial Treaty fishery times as established by the tribes and the Columbia River Compact.

SPECIFICATIONS: Implement the following operations as a hard system constraint as follows:

August 26th, 2003, 6 am, Tuesday, through 6 pm, August 30th, 2003, Saturday.
September 2nd, 2003, 6 am, Tuesday, through 6 pm, September 5th, 2003, Friday.
September 9th, 2003, 6 am, Tuesday, through 6 pm, September 12th, 2003, Friday.

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SYSTEM OPERATIONAL REQUEST: 2003 C-7

TO:	Brigadier General Grisoli	COE-NWD
	Steven Wright	BPA Administrator
	J. William McDonald	USBR-- Pacific Northwest Regional Director
	William Branch	COE-NWD-NP-Water Management
	Cindy Henriksen, Rudd Turner	COE-NWD-NP-WM-RCC
	Witt Anderson	COE-NWD-CM-F (Fish Management Office)
	LTC Edward Kertis, Jr.	COE-Walla Walla District
	Col. Richard Hobernicht	COE-Portland District
	Greg Delwiche, Scott Bettin	BPA-PG-5 and BPA-PGPO
	Stan Speaks, Keith Hatch	BIA, Portland Area Office

FROM: Olney Patt, Jr., *Executive Director*

DATE: September 12, 2003

SUBJECT: **Operation of the Lower Columbia Pools for the Autumn 2003 Treaty Fishery**

The Columbia River Inter-Tribal Fish Commission (CRITFC), on behalf of its member tribes the Confederated Tribes of the Warm Springs Reservation, Nez Perce Tribe, the Confederated Tribes of the Umatilla Reservation, and the Yakama Nation, requests the following reservoir operations in Zone 6 (Bonneville to McNary dams) during the 2003 autumn Treaty fishery. Implement the following hydro-system operations during the ceremonial, subsistence, and commercial Treaty fishery times as established by the tribes and the Columbia River Compact.

SPECIFICATIONS: Implement the following operations as a hard system constraint as follows:

September 16th, 2003, 6 am, Tuesday, through 6 pm, September 20th, 2003, Saturday.

Bonneville Pool: Operate the pool within 1.0 foot from full pool (msl elevation 76.5 – 75.5).
The Dalles (Celilo) Pool: Operate the pool within 1.0 foot (msl elevation 159.5 - 158.5).
John Day Pool: Operate the pool within 1.0 foot (msl elevation 264.5 - 263.5).

At this time we anticipate another Treaty fishery sometime during September 23 through 27. CRITFC will notify the Corps with specific times for the tribal fishery, after each Compact hearing, via a new SOR.

JUSTIFICATION:

The 2003 autumn Treaty fishing season is of critical importance to CRITFC's member tribes. The anticipated escapement of an estimated **390,000** adult fall chinook and **326,000** steelhead will create harvest opportunities that tribal fishers have not realized until recent years. Many fishers will be exercising their treaty rights by participating in this harvest. Many cultural and religious ceremonies and practices will occur with the harvest of these salmon.

During a meeting at CRITFC's Law Enforcement Division in Hood River on September 2, 1999, tribal fishers explained the impacts of unstable pools and pools below full to the Treaty fishery to Colonel Mogren and Lt. Colonel Harshbarger. The tribal fishers explained that a pool fluctuation of 1.0 foot or more disrupts tribal fishery operations. Specific problems include: (1) increased local currents that sweep debris into fishing nets, (2) rapid 1-2 hour drops in water level will lead to entanglement of nets, (3) boat access problems, and (4) nets torn from their anchors. Nets and gear are costly to replace. Any delays or disruptions to tribal fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources and cultural practices.

The fishers also stressed to Corps officials that the loss of fishing opportunity during the short treaty fishery <u>cannot</u> be replaced. Much of the tribal fishers' income and food is generated during the brief treaty fishing season, thus, any delays or disruptions to their fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources, and cultural practices. Tribal poverty rates are significantly higher than that of the general population, due in part to lost opportunities to harvest salmon. *Under this year's low water conditions, it is critical that the pools are maintained to CRITFC's requested criteria to establish the best possible fishing conditions during the limited opportunity presented to tribal fishers to harvest these treaty-guaranteed fish*.

Implementing this request will insure that the Federal operating agencies meet their federal trust responsibilities to the Columbia Basin treaty tribes. If this SOR cannot be accommodated, CRITFC's member tribes request a detailed written response from the federal operators, with justification, by Friday, September 19th, 2003.

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SYSTEM OPERATIONAL REQUEST: 2003 C-8

TO:	Brigadier General Grisoli	COE-NWD
	Steven Wright	BPA Administrator
	J. William McDonald	USBR-- Pacific Northwest Regional Director
	William Branch	COE-NWD-NP-Water Management
	Cindy Henriksen, Rudd Turner	COE-NWD-NP-WM-RCC
	Witt Anderson	COE-NWD-CM-F (Fish Management Office)
	LTC Edward Kertis, Jr.	COE-Walla Walla District
	Col. Richard Hobernicht	COE-Portland District
	Greg Delwiche, Scott Bettin	BPA-PG-5 and BPA-PGPO
	Stan Speaks, Keith Hatch	BIA, Portland Area Office

FROM: Olney Patt, Jr., *Executive Director*

DATE: September 19, 2003

SUBJECT: **Operation of the Lower Columbia Pools for the Autumn 2003 Treaty Fishery**

The Columbia River Inter-Tribal Fish Commission (CRITFC), on behalf of its member tribes the Confederated Tribes of the Warm Springs Reservation, Nez Perce Tribe, the Confederated Tribes of the Umatilla Reservation, and the Yakama Nation, requests the following reservoir operations in Zone 6 (Bonneville to McNary dams) during the 2003 autumn Treaty fishery. Implement the following hydro-system operations during the ceremonial, subsistence, and commercial Treaty fishery times as established by the tribes and the Columbia River Compact.

SPECIFICATIONS: Implement the following operations as a hard system constraint as follows:

September 24th, 2003, 6 am, Wednesday, through 6 pm, September 27th, 2003, Saturday.

Bonneville Pool: Operate the pool within 1.0 foot from full pool (msl elevation 76.5 – 75.5).
The Dalles (Celilo) Pool: Operate the pool within 1.0 foot (msl elevation 159.5 - 158.5).
John Day Pool: Operate the pool within 1.0 foot (msl elevation 264.5 - 263.5).

At this time we anticipate a Treaty fishery each week through September. CRITFC will notify the Corps with specific times for the tribal fishery, after each Compact hearing, via a new SOR.

JUSTIFICATION:

The 2003 autumn Treaty fishing season is of critical importance to CRITFC's member tribes. The anticipated escapement of an estimated **400,000** adult fall chinook will create harvest opportunities that tribal fishers have not realized until recent years. Many fishers will be exercising their treaty rights by participating in this harvest. Many cultural and religious ceremonies and practices will occur with the harvest of these salmon.

During a meeting at CRITFC's Law Enforcement Division in Hood River on September 2, 1999, tribal fishers explained the impacts of unstable pools and pools below full to the Treaty fishery to Colonel Mogren and Lt. Colonel Harshbarger. The tribal fishers explained that a pool fluctuation of 1.0 foot or more disrupts tribal fishery operations. Specific problems include: (1) increased local currents that sweep debris into fishing nets, (2) rapid 1-2 hour drops in water level will lead to entanglement of nets, (3) boat access problems, and (4) nets torn from their anchors. Nets and gear are costly to replace. Any delays or disruptions to tribal fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources and cultural practices.

The fishers also stressed to Corps officials that the loss of fishing opportunity during the short treaty fishery <u>cannot</u> be replaced. Much of the tribal fishers' income and food is generated during the brief treaty fishing season, thus, any delays or disruptions to their fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources, and cultural practices. Tribal poverty rates are significantly higher than that of the general population, due in part to lost opportunities to harvest salmon. *Under this year's low water conditions, it is critical that the pools are maintained to CRITFC's requested criteria to establish the best possible fishing conditions during the limited opportunity presented to tribal fishers to harvest these treaty-guaranteed fish*.

Implementing this request will insure that the Federal operating agencies meet their federal trust responsibilities to the Columbia Basin treaty tribes. If this SOR cannot be accommodated, CRITFC's member tribes request a detailed written response from the federal operators, with justification, by Friday, September 5th, 2003.

Bonneville Pool: Operate the pool within 1.0 foot from full pool (msl elevation 76.5 – 75.5).
The Dalles (Celilo) Pool: Operate the pool within 1.0 foot (msl elevation 159.5 - 158.5).
John Day Pool: Operate the pool within 1.0 foot (msl elevation 264.5 - 263.5).

At this time, another Treaty fishery may occur October 1st through 4th. CRITFC will notify the Corps with specific times for the tribal fishery, after each Compact hearing, via a new SOR.

JUSTIFICATION:

The 2003 autumn Treaty fishing season is of critical importance to CRITFC's member tribes. The anticipated escapement of an estimated **614,000** adult fall chinook at Bonneville and **321,000** steelhead will create harvest opportunities that tribal fishers have not realized until recent years. Many fishers will be exercising their treaty rights by participating in this harvest. Many cultural and religious ceremonies and practices will occur with the harvest of these salmon.

During a meeting at CRITFC's Law Enforcement Division in Hood River on September 2, 1999, tribal fishers explained the impacts of unstable pools and pools below full to the Treaty fishery to Colonel Mogren and Lt. Colonel Harshbarger. The tribal fishers explained that a pool fluctuation of 1.0 foot or more disrupts tribal fishery operations. Specific problems include: (1) increased local currents that sweep debris into fishing nets, (2) rapid 1-2 hour drops in water level will lead to entanglement of nets, (3) boat access problems, and (4) nets torn from their anchors. Nets and gear are costly to replace. Any delays or disruptions to tribal fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources and cultural practices.

The fishers also stressed to Corps officials that the loss of fishing opportunity during the short treaty fishery <u>cannot</u> be replaced. Much of the tribal fishers' income and food is generated during the brief treaty fishing season, thus, any delays or disruptions to their fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources, and cultural practices. Tribal poverty rates are significantly higher than that of the general population, due in part to lost opportunities to harvest salmon. *Under this year's low water conditions, it is critical that the pools are maintained to CRITFC's requested criteria to establish the best possible fishing conditions during the limited opportunity presented to tribal fishers to harvest these treaty-guaranteed fish*.

Implementing this request will insure that the Federal operating agencies meet their federal trust responsibilities to the Columbia Basin treaty tribes. If this SOR cannot be accommodated, CRITFC's member tribes request a detailed written response from the federal operators, with justification, by Friday, September 26th, 2003.

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SYSTEM OPERATIONAL REQUEST: 2003 C-9

TO:	Brigadier General Grisoli	COE-NWD
	Steven Wright	BPA Administrator
	J. William McDonald	USBR-- Pacific Northwest Regional Director
	William Branch	COE-NWD-NP-Water Management
	Cindy Henriksen, Rudd Turner	COE-NWD-NP-WM-RCC
	Witt Anderson	COE-NWD-CM-F (Fish Management Office)
	LTC Edward Kertis, Jr.	COE-Walla Walla District
	Col. Richard Hobernicht	COE-Portland District
	Greg Delwiche, Scott Bettin	BPA-PG-5 and BPA-PGPO
	Stan Speaks, Keith Hatch	BIA, Portland Area Office

FROM: Olney Patt, Jr., *Executive Director*

DATE: September 25, 2003

SUBJECT: **Operation of the Lower Columbia Pools for the Autumn 2003 Treaty Fishery**

The Columbia River Inter-Tribal Fish Commission (CRITFC), on behalf of its member tribes the Confederated Tribes of the Warm Springs Reservation, Nez Perce Tribe, the Confederated Tribes of the Umatilla Reservation, and the Yakama Nation, requests the following reservoir operations in Zone 6 (Bonneville to McNary dams) during the 2003 autumn Treaty fishery. Implement the following hydro-system operations during the ceremonial, subsistence, and commercial Treaty fishery times as established by the tribes and the Columbia River Compact.

SPECIFICATIONS: Implement the following operations as a hard system constraint as follows:

October 1st, 2003, 6 am, Wednesday, through 6 pm, October 4th, 2003, Saturday.

Bonneville Pool: Operate the pool within 1.0 foot from full pool (msl elevation 76.5 – 75.5).
The Dalles (Celilo) Pool: Operate the pool within 1.0 foot (msl elevation 159.5 - 158.5).
John Day Pool: Operate the pool within 1.0 foot (msl elevation 264.5 - 263.5).

JUSTIFICATION:

The 2003 autumn Treaty fishing season is of critical importance to CRITFC's member tribes. The anticipated escapement of an estimated **608,000** adult fall chinook at Bonneville and **321,000** steelhead will create harvest opportunities that tribal fishers have not realized until recent years. Many fishers will be exercising their treaty rights by participating in this harvest. Many cultural and religious ceremonies and practices will occur with the harvest of these salmon.

During a meeting at CRITFC's Law Enforcement Division in Hood River on September 2, 1999, tribal fishers explained the impacts of unstable pools and pools below full to the Treaty fishery to Colonel Mogren and Lt. Colonel Harshbarger. The tribal fishers explained that a pool fluctuation of 1.0 foot or more disrupts tribal fishery operations. Specific problems include: (1) increased local currents that sweep debris into fishing nets, (2) rapid 1-2 hour drops in water level will lead to entanglement of nets, (3) boat access problems, and (4) nets torn from their anchors. Nets and gear are costly to replace. Any delays or disruptions to tribal fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources and cultural practices.

The fishers also stressed to Corps officials that the loss of fishing opportunity during the short treaty fishery <u>cannot</u> be replaced. Much of the tribal fishers' income and food is generated during the brief treaty fishing season, thus, any delays or disruptions to their fishing operations caused by the excessive pool fluctuations in Zone 6 negatively impacts tribal incomes, food resources, and cultural practices. Tribal poverty rates are significantly higher than that of the general population, due in part to lost opportunities to harvest salmon. *Under this year's low water conditions, it is critical that the pools are maintained to CRITFC's requested criteria to establish the best possible fishing conditions during the limited opportunity presented to tribal fishers to harvest these treaty-guaranteed fish*.

Implementing this request will insure that the Federal operating agencies meet their federal trust responsibilities to the Columbia Basin treaty tribes. If this SOR cannot be accommodated, CRITFC's member tribes request a detailed written response from the federal operators, with justification, by Friday, October 3rd, 2003.

SYSTEM OPERATIONAL REQUEST #2003-FWS-01

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, NOAA Fisheries, Columbia River Inter-Tribal Fish Commission, Idaho Department of Fish and Game.

TO:	General.Grisoli	COE-NPD
	William Branch	COE-Water Management
	Cindy Henricksen	COE-RCC
	Witt Anderson	COE-P
	Col. Lewis	COE-Seattle District
	J. William McDonald	USBR-Boise Regional Director
	Steven Wright	BPA-Administrator
	Greg Delwiche	BPA-PG-5

FROM: Susan Martin, Supervisor, Upper Columbia Fish and Wildlife Office, U. S. Fish and Wildlife Service, in coordination with NOAA Fisheries

DATE: October 07, 2003

SUBJECT: Request for winter water level operations on Lake Pend Oreille, Idaho during 2004 and 2005, to increase egg to fry survival of kokanee, the primary forage base for listed bull trout.

SPECIFICATIONS:
By November 15, 2003, draw Lake Pend Oreille down to elevation 2051 feet to precede significant lake shore spawning by kokanee and subsequent redd dessication or redd disturbance by wave action, and to redistribute shore line gravel for subsequent years spawning. During the winter of water year 2005, hold Lake Pend Oreille at elevation 2055 feet to continue the evaluation of the effect of lake level on kokanee spawning success.

JUSTIFICATION:
In Lake Pend Oreille, bull trout are heavily dependent upon kokanee salmon as forage. Elsewhere, when forage became limiting and introduced lake trout were present, the bull trout populations have been severely depressed and lake trout have become the dominant char. Examples of this negative population interaction include Flathead Lake, Montana and Priest Lake, Idaho. Kokanee population levels in Lake Pend Oreille have become depressed to the extent that in the absence of significant habitat manipulation and concurrent management actions leading to a reduction in the lake trout population, the bull trout population is at risk. The effect of lake level on kokanee spawning success is being evaluated as a tool to benefit the kokanee population.

This recommendation addresses two of the final three years (2004 and 2005) of a 10 year (two full life cycles of kokanee) study of lake level operations intended to determine the effectiveness of variable lake level management as a tool in the maintenance of the kokanee population. Preliminary findings indicate that kokanee egg to fry survival may be increased by variable lake

level management. However, the Fish and Wildlife Service does not recommend maintaining higher levels in Lake Pend Oreille this winter for purposes of kokanee fry production because the spawning habitat available at elevation 2051 is sufficient to meet the needs of the kokanee year class that will be spawning this year. Recent monitoring of the kokanee population by Idaho Department of Fish and Game indicates large kokanee spawning populations are expected during the subsequent winter. Based on this information and input from an independent scientific peer review, the Fish and Wildilfe Service recommends, and NOAA Fisheries concurs, that Lake Pend Oreille water surface elevation be maintained at 2055 feet during the winter of 2005 to evaluate the efficacy of a higher lake level on kokanee spawning success and subsequent fry survival.

Concurrent fisheries management changes by the Idaho Department of Fish and Game on Lake Pend Oreille include: elimination of harvest of bull trout since 1996, before its listing under the Endangered Species Act; closure of the kokanee fishery; liberalized sport harvest limits on both introduced lake trout and Girard rainbow trout; and opening of a commercial fishery to most expeditiously control the large population of lake trout which includes partially subsidized trap net operations.

The 2006 lake level operation (the final year of the 10 year study) will be determined following a review of information available at that time. This will include a review of the data collected to date on the effect of lake level on kokanee spawning success and subsequent fry survival; the strength of that year's kokanee adult population and the quantity of spawning substrate needed to support the number of projected spawners; as well as the availability of water from free flowing and impounded sources to support the chum population spawning below Bonneville Dam.

SYSTEM OPERATIONAL REQUEST #2003-03

TO:	General.Grisoli	COE-NPD
	William Branch	COE-Water Management
	Cindy Henricksen	COE-RCC
	Witt Anderson	COE-P
	Col. Lewis	COE-Seattle District
	J. William McDonald	USBR-Boise Regional Director
	Steven Wright	BPA-Administrator
	Greg Delwiche	BPA-PG-5

FROM: Susan Martin, Supervisor, Upper Columbia Fish and Wildlife Office, U. S. Fish and Wildlife Service, on behalf of the following cooperating agencies and tribe: Idaho Office of Species Conservation, the Kootenai Tribe of Idaho, Idaho Department of Fish and Game, the City of Bonners Ferry and Boundary County, Idaho.

DATE: December 15, 2003

SUBJECT: Request for releases from Libby Dam for migration, spawning, incubation and larval development of burbot in the Kootenai River.

SPECIFICATIONS: Beginning December 1, 2003 and continuing through December 22, 2003, to the extent feasible, limit releases from Libby Dam to 15,000 cfs, while maintaining established ramping rates. Beginning December 18, 2003 and continuing through January 30, 2004, maintain releases between 4,000 and 10,000 cfs, and preferably less than 7300 cfs to the extent possible. If, subsequent to this request it becomes necessary to release more than 10,000 cfs, it is recommended that the new release rate be the lowest stable flow which can be sustained through January 30. We acknowledge that unforseen circumstances such as local or system flood control or power emergencies may supersede this recommendation.

Secondly, throughout this operation utilize the selective withdrawal system at Libby Dam to release the coldest water available. The objective is to maintain water temperatures in the Kootenai River between Bonners Ferry and the U. S. - Canada border below 4.0 degrees C, and as near to 1.5 degrees C as possible through operations of Libby Dam.

PURPOSE and JUSTIFICATION:

The intent of this request is to define the upper flow and temperature thresholds for burbot migration and spawning, and encourage the fish to move into and utilize its historic spawning areas in the Kootenai River. Monitoring of this operation will be conducted by the Idaho Department of Fish and Game and Bonneville Power Administration.

The burbot (*Lota lota*) population in the lower Kootenai River in Idaho and in Kootenay Lake, British Columbia, is very depressed. Harvest has been discontinued, but the burbot population has not responded as expected based on the exceptional fecundity characteristic of this species (Becker 1983; Jakob Kjellman, University of Helsinki, pers. com. in The Kootenai River Burbot

Recovery Committee 2001). Available information suggests that the most significant remaining environmental stressor is the altered flow regime during the late fall and winter. Researchers have suggested that these unnaturally high flows, associated changes in water temperature, and rapid fluctuations in flow resulting from hydroelectric load following may be altering normal burbot migration and or spawning behavior (The Kootenai River Burbot Committee 2001).

During the winter 2000, agreement was reached to curtail load following from Libby Dam for conservation of bull trout and sturgeon. In addition, 2001 flows were generally low in response to the drought and the need to retain water high in the system for a possible extended power emergency. With a couple of exceptions, releases from Libby Dam during the fall/winter migration and spawning period remained below 10,000 cfs, with the lowest flows in the 4,000 to 6,000 cfs range. During winter 2001, under these low flow conditions, some burbot did migrate to the Bonners Ferry area, and for the first time in recent years, there was evidence that spawning occurred there. Successful recruitment from that spawning event has yet to be verified (Vaughn Paragamian, IDFG. 2001, Pers. Com.).

Secondly, burbot historically were believed to have spawned when water temperatures were near 1.0 ^{o}C. Prior to operations of Libby Dam, spawning may have occurred some years beneath the ice that commonly covered the Kootenai River in Kootenai Flats during the winter. In 2003, during the third week of January when burbot were believed to have spawned in the Kootenai River, water temperatures at Bonners Ferry ranged from slightly below freezing to 3.3^{o}C. Since Libby Dam operations began, typical winter river water temperatures have been increased from about 1.0 ^{o}C to about 4.0 ^{o}C during the same time periods (Partridge 1983). Burbot would be expected to spawn when water is only about 1.5 ^{o}C (Becker 1983; MacKay 1963). It is not known whether change of this magnitude in river water temperature is affecting burbot migration, spawning behavior, egg development, larval development, the timing of any of these events, or possibly the efficiency of egg or larval predators.

We believe that the river has not frozen over in any major way since Libby Dam became operational. This is a result of unseasonally high flow releases from Libby Dam during the winter months, with associated high energy from increased velocity and friction. In addition the water released is often warmer, as a result of heat retention and delayed release from the reservoir. We believe that these effects on water temperature will be diminished when releases are within the flow range recommended above, because of increased travel time allowing for more cooling of water. The selective withdrawal structure in place at the Libby Project may be used to a limited extent to manage winter water temperature in the Kootenai River with relatively little cost. The intent here is to reduce temperature to the extent possible within constraints of the Libby Project.

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APPENDIX K

Joint Technical Staff Letters

State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

Washington Department of Fish and Wildlife

December 16, 2003

Robert E. Willis, Chief
Environmental Resources Branch
Department of the Army
Portland District, Corps of Engineers
PO Box 2946
Portland, OR 97208-2946

Dear Mr. Willis:

The installation of the new corner collector at Bonneville Power House 2 will require a study to determine its impact on juvenile passage at Bonneville Dam as a whole. The first priority of the study should be to determine the passage efficiency and survival for the corner collector. Next should be a determination of the survival through other routes of passage at Bonneville. The 2004 study should employ methodologies that best mimic run of the river fish. To date this would either require the use of pit tagged fish marked upriver or radio tagged fish released upstream from the project. Due to detection difficulties below Bonneville only radio tagged fish would be practical. With Powerhouse 2 prioritization it will be difficult to determine survival at Powerhouse 1 with any statistical power due to the low fish passage. However, the spillway and Powerhouse 2 should pass enough test fish to generate statistically sound survival estimates. The concern for the study, and the reason for this letter, is to outline the operations that should be tested.

We believe that BiOp operations should be the baseline against which other operations should be assessed. However, recent studies of adult salmon have shown that the daytime spill levels at Bonneville were probably overly conservative in terms of providing protection for adult fish fallback. Therefore, we recommend increasing the daytime spill to a level of 120 kcfs and continue with the gas cap at night. This operation should be considered the modified BiOp operation with the old BiOp operation of 75/gas cap being the baseline to be compared.

We recommend a two-treatment test of the modified BiOp operation of 120 kcfs and gas cap at night versus the 75 kcfs daytime and gas cap at night. We would further recommend that two species be tested both yearling chinook and steelhead for the spring time evaluation. This would be the best test possible and would help generate information over a range of flows and operations to better determine the potential benefits of the corner collector.

However, the System Configuration Team has been discussing the difficulty of funding the current regional program and a two species, two treatment test would represent an increase in the cost from the proposed study design. We recommend that the COE outline budgets for alternative testing schemes. We recommend the following options in order of preference:

1) Two treatments with two species and route specific survival for both
2) Two treatments with yearling chinook route specific survival and enough steelhead for guidance information and project survival
3) One treatment of the modified BiOp operations and two species with route specific survival for both
4) One treatment of the modified BiOp operations and yearling chinook with enough steelhead for guidance information and project survival

We argue for the modified BiOp operations since the operation would be moving towards improved project survival (options 3 or 4). The spillway has been shown to be one of the highest survival passage routes at Bonneville. By increasing spill more juveniles will use this passage route. Further, 2004 is planned to be one of the last years of adult telemetry and it would be prudent to utilize this evaluation to further our understanding of the potential adult delay that has been noted in the Bonneville spillway during periods of high spill. We tentatively agree with the COE's assessment that yearling chinook are an adequate surrogate for steelhead survival -- post project passage -- for the reach from Bonneville tailrace to the 205 bridge. However, with the noted reach survival difference between yearling chinook and steelhead we caution against using yearling chinook as surrogates for steelhead for other studies and point out the need to verify the adequacy of this assumption. Therefore, in consideration of budget restraints, and the historic usage of yearling chinook as test animals of choice, we would recommend option 4 -- the one treatment test of modified BiOp operations using radio-tagged yearling chinook as the primary test species with enough steelhead marked to determine percent passage via corner collector and powerhouse 2. This recommendation was initially discussed and agreed to by the technical staff of all fisheries agencies and the tribes within the AFEP process.

Thank you for your consideration and we look forward to working within the NOAA fisheries regional forum to come to resolution on this difficult issue.

Sincerely,

David Wills, USFWS

Russ Kiefer, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Rod Woodin, WDFW

Cc: Rock Peters, COE
Blaine Ebberts, COE
Mike Langeslay, COE

State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

Washington Department of Fish and Wildlife

Shoshone-Bannock Tribes

November 10, 2003

Brian Brown
Assistant Regional Administrator
NOAA Fisheries
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Portland, OR 97232

Jim Ruff, NMFS
Chief Hydro Operations Branch
NOAA Fisheries
525 NE Oregon St.
Portland, OR 97232-2737

Dear Mr. Brown and Mr. Ruff,

Thank you for your September 4, 2003 letter, which outlined your rationale for conducting a spill evaluation this summer at Ice Harbor dam. We are in agreement that spillway passage is the preferred passage route for juvenile salmon at Federal hydropower dams. However, we are in disagreement on whether there was adequate scientific basis for testing and subsequently eliminating daytime spill at Ice Harbor in summer 2003. Our technical concerns associated with the 2000 study by Eppard et al. (2001) and the preliminary data for the 2002 study significantly undermine this management decision, and were largely ignored in your response letter. We brought these concerns up in discussions about future studies at Ice Harbor, but the main point of our original letter was that the studies conducted to date did not support the changes that were made to the spill operations as required in the 2000 Biological Opinion

(BiOp). There was no communication breakdown as implied in your letter other than the lack of recognition of our technical concerns. We were frustrated by the fact that your agency chose to pass fish through the powerhouse as a "spread-the-risk" strategy over the more precautionary alternative of spilling at the levels specified by the BiOp in conjunction with a bulk spill evaluation. Finally, we question the integrity of this management process when promises to alter post-evaluation operations based on the results from 2003 study, which showed high spillway survival, went unfulfilled.

Attached is our July 21, 2003 letter which outlines our technical concerns with the past studies conducted at Ice Harbor that still remain, including the studies that were conducted in summer 2003. While we support making management decisions based upon scientific studies and understanding, we question the validity and strength of the studies that have been conducted to date at Ice Harbor. The attached letter outlines our technical concerns with those past studies.

In resource management situations where there is scientific uncertainty, it is necessary to adopt a precautionary approach to management. That is, the benefit of doubt should be given to the managed species, not to those whose interests are served under an alternative management operation. The precautionary approach is especially justified in situations where endangered species are involved, as is the case in the Snake River. Given that spill is accepted as the preferred passage route at federal hydropower dams under the NOAA Fisheries' and Northwest Power Planning and Conservation Council's programs, applying the precautionary approach implies providing spill passage when uncertainty exists in regards to the survival rates associated with the various passage routes. The precautionary approach was not used at Ice Harbor, though there were opportunities for it. The Salmon Managers support sound, rigorous study of the efficiency and survival of fish passage routes through dams. We supported continuing evaluations at Ice Harbor. However, we do not support the study that was conducted at Ice Harbor in summer 2003. In addition to the technical concerns referenced above, we strongly object to shutting off the daytime spillway passage route during the peak migration timing for Snake River subyearling chinook. An evaluation which compared the bulk spill pattern versus the BiOp spill pattern would have been appropriate. Had that been implemented, we would have had an additional year of data on the BiOp spill pattern to compare with previous years and to compare with alternative spill gate settings. NOAA Fisheries missed a valuable opportunity to improve our understanding and adopt a precautionary approach to the management of endangered species when it chose to study the bulk spill versus no spill operations at Ice Harbor in 2003.

NOAA Fisheries agreed to alter the post-evaluation operations based on the results of the 2003 study. However, the results were not provided in a timely manner, especially considering that operations were to be contingent on their outcome. If in-season management based upon in-season research (which we believe to be seriously inappropriate for both scientific and logistic reasons) is the operating mode, then the delays in results associated with the 2003 Ice Harbor

study were unacceptable. First, there is no valid reason why the results were not available July 31, as was promised by NOAA Fisheries. Second, the research results showed that the bulk spill had higher survival than the no-spill operation. Given this and the demonstrated extra delayed mortality associated with bypassed fish (NMFS 2000, Sandford and Smith 2002), the appropriate decision should have been to immediately implement bulk spill at the levels required in the BiOp on a 24-hour basis. Instead, the uncertainty in the estimates was used as justification for continuing the no-spill operation. Again, the precautionary approach to management was ignored, and the fish suffered the consequences.

We are encouraged by the recent discussions, including the Studies Review Work Group (SRWG) meeting on October 1, 2003 regarding proposed operations and studies at Ice Harbor in 2004. We understand that NOAA Fisheries agrees that tests will include a comparison of bulk BiOp versus current BiOp spill and will not include a no-spill treatment. The presentations at the October 1 SRWG meeting validated some of our technical concerns regarding the limitations of hose-releases and balloon-tag studies. As we understand it, studies in 2004 will be based on in-river migrating fish using radio telemetry. With an appropriate design and sufficient numbers of tagged fish and replication over years to address the study objectives, we believe that radio telemetry provides a stronger basis for operational management decisions. However, there are limitations to the results of these project-specific studies and these limitations need to be considered when attempting to apply the results in a management context. For example, even though collected and bypassed smolts typically have very high direct survival estimates, adult return rate data clearly indicate that collected and bypassed juveniles have lower adult return rates than uncollected (spillway or turbine passage) in-reservoir juveniles (NMFS 2000, Sandford and Smith 2002). There are also proposals to conduct studies at Ice Harbor in 2004 using balloon-tags and sensor drones; however, we believe that the value of the information from these types of studies is extremely low, especially when survival data will be provided using radio telemetry. The scientific information needs would be better served if the money for the balloon-tag and sensor drone studies were transferred to the radio-tag study, or used elsewhere in the system. Our understanding is that in 2004, two spill treatments will be evaluated. If the discharge is less than 90 kcfs, the BiOp spill pattern and the bulk spill pattern will be evaluated. If the discharge is greater than 90 kcfs, the BiOp spill pattern will be evaluated. And unlike 2003, there will not be a test of a no-spill operation.

We look forward to continuing work with NOAA Fisheries on understanding the relationships between salmon survival and dam operations through sound scientific investigations. Our hope is that we can avoid the controversy experienced regarding Ice Harbor operations in summer 2003 through better study designs, consideration of study limitations, and reliance upon sound, published, scientific studies.

Sincerely,

David Wills, USFWS

Russ Kiefer, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Rod Woodin, WDFW

Keith Kutchins, SBT

References:

National Marine Fisheries Service. 2000. Summary of Research Related to Transportation of Juvenile Anadromous Salmonids Around Snake and Columbia River Dams. White Paper. Northwest Fisheries Science Center, National Marine Fisheries Service, 2725 Montlake Blvd. E. Seattle, Washington. April 2000.

Sandford, B. P., and S. G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River Basin anadromous salmonids, 1990-1997. Journal of Agricultural, Biological, and Environmental Statistics. 7(2): 243-263.

Cc: Rebecca Kalamasz
U.S. Army Corp of Engineers
201 North 3rd St.
Walla Walla, WA 99362

Rock Peters
U.S. Army Corp of Engineers
P.O. Box 2946
Portland, OR 97208-2946

JULY 21, 2003 Joint Letter follows:

State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

Washington Department of Fish and Wildlife

Shoshone-Bannock Tribes

July 21, 2003

Brian Brown
Assistant Regional Administrator
NOAA Fisheries
525 NE Oregon St., Suite 420
Portland, OR 97232

Jim Ruff, NMFS
Chief Hydro Operations Branch
NOAA Fisheries
525 NE Oregon St.
Portland, OR 97232-2737

Dear Mr. Brown and Mr. Ruff:

The technical staffs of the Columbia River Inter-Tribal Fish Commission, the Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, the Idaho Department of Fish and Game, the U. S. Fish and Wildlife Service and the Shoshone-Bannock Tribes have serious concerns regarding NOAA Fisheries' recent decision to support the federal operators in curtailing daytime spill at Ice Harbor Dam. This spill is required under the 2000 FCRPS Biological Opinion. A series of rapid conclusions were drawn and decisions were made primarily based upon preliminary data that has not been available for our review. At the June 20, 2003 NOAA Fisheries' Implementation Team meeting, NOAA Fisheries and the federal operators made a decision to implement and study two options: a bulk spill pattern operation and a no-spill operation. In addition to the process by which the decision-making took place, we do not agree with the conclusions drawn or the summer post-study operations decision. We believe that the 24 hour Biological Opinion (BiOp) spill, either the existing or bulk spill pattern, should be implemented until information from ongoing studies identify alternative operations can provide higher survival benefits than the BiOp.

We have serious concerns regarding the application of the recent Ice Harbor passage study results to short and long term fishery operations decisions at Ice Harbor Dam. Our primary concern is that NOAA Fisheries is making passage mitigation decisions on the basis of data that do not adequately support those decisions. We believe that the studies recently conducted at Ice Harbor Dam are significantly flawed with respect to study design. Further, the studies are insufficient for making project operational decisions for fish passage because, among other things, they are not robust in describing project (reservoir, dam and tailrace) mortality[1] or adequate in determining indirect and delayed effects that are only possible in smolt-to-adult survival studies. In addition, the NOAA Fisheries' decision-making process did not allow for adequate participation by the co-managers, since recent results were not available for review when the decision was made. NOAA Fisheries' decision-making process was faulty because it incorporated recent study results without adequate consideration of the weaknesses of the research results. The decision process was finalized without recognition of the value of collecting data in a comparable fashion across years and without adopting a precautionary approach in examining the likely detriments of no-spill operations. NOAA Fisheries should be joining the co-managers in developing broadly-based and comprehensive monitoring and evaluation programs to provide early detection to avoid significant impacts to stock productivity from passage as noted by Hilborn (1987).

We expand on the details of our specific concerns in the following discussion. In summary, they are:

- Recent studies (in 2003) at Ice Harbor (although preliminary) raise issues regarding validity of the results from studies conducted in 2000 and 2002.
- Studies at Ice Harbor have not provided information on relative survival through specific passage routes, yet NOAA Fisheries is making management decisions on survival through specific passage routes assumed in the 2000 Biological Opinion.
- A no-spill operation is not a normative river condition and will likely decrease migration rates and increase forebay delay, which could result in significant mortality via predation, disease and residualization of the run at large. A no-spill operation likely increases injury and mortality for adult fall chinook and steelhead that fall back through the powerhouse (turbines and juvenile bypass system) rather than over spillway. While NOAA Fisheries identified reduction of fall back mortality as a key concern for recovery (NMFS 1999), they have not considered it in making the operational decision to curtail Ice Harbor daytime spill during hours of peak adult passage.
- A scientifically rigorous study design adopted with the concurrence of the fishery managers must be developed to evaluate spill passage at Ice Harbor. The results of studies conducted under such an agreed-upon design would provide a common acceptable basis for future fish passage management decisions.

[1] The 2000 FCRPS Biological Opinion specifies that project mortality should be measured as the preferred metric to assess individual project effects on salmon passing the project.

As outlined in our previous technical memorandum, for a mark-recapture study to be valid, marked fish must reflect the actual conditions that fish will experience arriving at, passing through, and traveling below the dam. To date, it appears that none of the studies to estimate spillway survival at Ice Harbor have achieved this criterion, and therefore cannot be considered sufficient for changing BiOp requirements. In particular, we question the use of the hose releases in selected locations for representing the experience of a smolt passing through the spillway. This is an extremely important study design requirement at Ice Harbor since mechanical injury of fish has been shown to be highly influenced by the depth of fish passing over a spillgate with higher mortality observed for fish that were released deeper in the water column.

The only final report available addressing Ice Harbor Spillway survival is Eppard et al. (2002). In this study conducted in 2000, river-run hatchery yearling and subyearling chinook salmon were collected at Lower Monumental Dam, PIT tagged, transported to Ice Harbor Dam, and released. The treatment groups were released through a 10.2 cm diameter hose into spillbays 3, 5 and 7; release depth is not specified in the report. The control groups were released from a barge at mid-channel 0.8 km below the dam. Relative spillway survival for hatchery yearling chinook was estimated to be 97.8%. Relative spillway survival for hatchery subyearling chinook was estimated to be 88.5%. For both yearling and subyearling chinook the relative survival estimates increased with both total dam discharge and spillway gate position (number of stops). However, hose releases inject fish into a specific depth within the water column and thus do not reflect the actual conditions experienced by fish arriving at and passing through a spillway. Because the hose depth may differ from the depth at which fish pass through the spillway, the depth of the release point may affect the study results.

Eppard and Gores conducted a similar study in 2002 at Ice Harbor Dam with the addition of radio tags, but to-date only the research proposal is available for review. Consequently, we are unable to comment on the research methods or the validity of the results that were generated. However, NOAA Fisheries has repeatedly cited these results in support of the change in summer operations.

Balloon tag studies on yearling chinook were conducted at Ice Harbor Dam during the spring of 2003. In this study, the proportion of fish without injuries was estimated. Summarizing the preliminary results into a deep release group (3 feet above ogee, with 2, 3, or 4 stops) and a shallow release group (7 feet above ogee, with 5 stops or more) resulted in estimates of 82.2% and 94.4% uninjured fish, respectively. These preliminary results suggest that either the depth of release or the spillway gate position (stops) may affect the injury rate of yearling chinook. However, these results also force us to question how the depth of release and the number of stops affected the survival estimates reported in Eppard et al. (2002). If release depths or gate stops can affect injury rates, then it is reasonable to expect that these factors will also affect survival estimates. This is a significant shortcoming, which calls into question the validity of the results for 2000 and the preliminary results for 2002.

While we understand the concern these data have generated, a thorough review of all relevant studies needs to be conducted before extensive alterations are made to a study design that was agreed upon before the season. Two years of similar data are not enough to make a dramatic change in operations, especially considering the situation the region witnessed at The Dalles Dam, where two years of data showed similar results, but the third year showed significantly different results from the previous years. Each year is unique with regard to flow, temperature, time of freshet, fish condition, and migration time. Two years of data, one of which we have been unable to review, is hardly enough to justify radical changes in fish passage operations. We support continued evaluations at Ice Harbor, however, we need several (at least three) years of replicated and standardized treatments to insure that data are adequate to make management decisions.

No recent turbine survival estimates are available at this time. The only turbine survival study conducted at Ice Harbor was in 1968. This study indicated an 81 to 90% turbine survival of coho salmon with a substantially higher predation loss. While the predation loss may have improved over time with better project operations (units 4-6 were skeleton bays at that time) and predator removal, the direct turbine survival may have decreased due to substantial wear on the turbine units, particularly units 1-3 (which are scheduled for rehab in the next few years). The current turbines at Ice Harbor are getting close to the end of their design life. Fatigue and failures have occurred both recently and in the past. Turbine unit #3 is out of service for an extended period after part of the turbine blade broke off and was discharged into the draft tube. It is likely that the other turbines in the powerhouse are similarly nearing their life expectancy and not operating at peak operations, which could be negatively impacting juvenile survival through the units. It is therefore likely that the 90% survival estimate that was used in the 2000 BiOp and in model studies, is overestimating survival. The Dalles turbines, which are also scheduled for rehabilitation over the next several years, have survival estimated to be in the low 80 percentile range. The spring migrant survival estimate for turbine passage at units 1 and 3 in 2003 was estimated at 87%. This is likely an optimistic estimate since the fish were directly released into the turbines, and therefore did not account for any forebay mortality prior to the release point in the turbine. Further, predation upon spring migrants is less of a factor than predation upon summer migrants due to lower water temperatures, predator abundance, and behavior. Summer migrants are likely to be more stressed due to high temperatures combined with disease and parasite concerns, since the Snake River regularly surpasses the 68 degree F water temperature standard. There are no summer migrant survival data related to the bypass system. Guidance has been estimated to be 54% from the 2000 FCRPS Biological Opinion, using upstream projects as an estimate. A no-spill operation could potentially put 46% of the migrants through the turbines.

A no-spill operation would also increase forebay delay. Venditti et al. (2000) studied the migration of fall chinook in the Snake River, specifically at Little Goose Dam. They compared migration times and patterns from 1995 – 1997. The July flows for this time period were considered above normal, with the years ranking eighth, tenth, and fifth in flow overall. While the bulk of the migrants passed through the upper reach within 5 days, a significant proportion, 10-20% of population, delayed in the lower reservoir and forebay reach for 7 days or more. In the slack water forebays of dams without spill, Venditti et al. found that nearly 22% of the fish reversed migration and migrated back upstream. These excursions and delays waste finite energy reserves necessary for survival to saltwater and exacerbate the low energy reserves noted in fall chinook from lack of quality food in Lower Snake River reservoirs (Bennett et al.1999). Further, delays and upstream excursions subject salmon migrants to increased exposure to high water temperatures. These temperatures are correlated with increased predation rates associated with elevated temperatures (Poe et al. 1991), diseases and parasites (McCullough 1999), impairment to migration and reversal of smoltification (Zaugg 1981). Migration times in a low flow year (e.g., 2003) would likely be even worse. This increased delay exposes migrants to two deleterious conditions (predation and high water temperatures), which can increase the likelihood for considerable mortality among smolts that experience lengthy delay. None of this was accounted for in the discussions about a no-spill option.

In conclusion, we request that NOAA Fisheries reconsider their decision to curtail daytime spill at Ice Harbor Dam and collaborate with co-managers to develop a robust study design incorporating passage through the entire project (with smolt to adult returns if feasible) that will support the management decision-making process. We encourage NOAA Fisheries to seriously consider the concerns and comments of the co-managers in short and long-term fish passage management decisions at Ice Harbor and other projects where we share management responsibility. Changes to dam operations for fish passage specified by the 2000 FCRPS Biological Opinion are significant and should not occur based upon uncertain and inadequate technical information and without full consultation leading to concurrence by the state, tribal and other federal fishery co-managers. We request that NOAA fisheries respond to this letter and specifically describe their technical justification for recommending this variation from the spill measures contained in the 2000 Biological Opinion.

Sincerely,

David Wills, USFWS

Steve Pettit, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Shane Scott, WDFW

Keith Kutchins, SBT

References

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MEMORANDUM

TO: Rod Sando, CBFWA

FROM: Michele DeHart, FPC

DATE: June 30, 2003

RE: Review of Issue Brief No. 2, "The Variable Impact of Dams on Columbia and Snake River Salmon Populations" by Jay O'Laughlin and the supporting paper by Levin & Tolimieri.

In response to your request a group of agencies technical staff with technical expertise in these analysis reviewed these documents. As a result of that review, we conclude that O'Laughlins' Issue Paper 2 is inaccurate and misleading and has no application to present fish passage management questions. The supporting paper by Levin & Tolimieri has technical and analytical weaknesses that raise questions about the management application of their conclusions.

Comments on Issue paper:
The variable impacts of dams on Columbia and Snake River Salmon Populations
by Jay O'Laughlin, Professor and Director
College of Natural Resources Policy Analysis Group
University of Idaho

Comments by C. Petrosky, H. Schaller and S. Haeseker

- O'Laughlin claims that 'the clear logic of breaching proposition is perhaps too simple, however, as there are other factors affecting salmon populations, including not only habitat, harvest, hatcheries, and ocean conditions, but also the variable impact of dam design and operations on salmon.' The author did not acknowledge that a past study, PATH (Plan for Analyzing and Testing Hypotheses), performed comprehensive decision analyses of various management options (including breaching of the 4 lower Snake River dams), which considered all of the factors listed above and assumptions about the effectiveness of dam operation and design on salmon survival rates. The PATH analysis found that breaching the 4 lower Snake River dams, plus actions in harvest, habitat and hatchery reform was the most likely option to recover Snake River salmon. Therefore, the logic used for justifying breaching was by no measure simple, but rather comprehensive. This work has been published in peer-reviewed journals (Deriso et al. 2001, Peters and Marmorek 2001, Peters et al. 2001, Budy et al. 2002, Petrosky et al. 2001, and Schaller et al 1999).
- In addition, recent analysis by Wilson (2003) using an analytical framework employed by Karieva et al. (2000) (and by NMFS in the 2000 Biological Opinion for the Columbia River hydrosystem) came to similar conclusions as PATH on the issue of breaching the 4 lower Snake River dams. This is a recent study, which employs sound ecological data, is based on well-constructed analyses, and was published in a well-respected international scientific journal.
- The analyses that O'Laughlin refers to (Levin and Tolimieri 2001), reanalyzes previous published data (Schaller et al. 1999, and Deriso et al. 2001) using techniques that are questionable (see comments below on Levin and Tolimieri).
- O'Laughlin claims the authors unequivocally conclude that the 4 lower Snake River dams are not preventing the recovery of salmon in Idaho. However, the authors qualify their conclusion, and the logic they present is equivocal. Levin and Tolimieri found significant declines in spawner numbers from the before to after period (pre and post lower Snake dam development) in the Snake and Upper Columbia Rivers, but not in the Middle Columbia River. The authors claim that this suggests hydropower strongly impacted both Upper Columbia and Snake River populations. Based on this finding, and their qualification that results from Ricker residuals should be interpreted cautiously, it is difficult to follow the logic how the authors concluded that dams on the lower Snake are not a potential force preventing recovery of endangered salmon.
- O'Laughlin claims that he can draw clear inferences about breaching of the four lower Snake River dams from the Levin and Tolimieri study. His hypothesis is that efforts have been taken to bypass juvenile salmon migrants around the four lower Snake River dams, and the dams are not preventing the recovery of Snake River chinook salmon populations. However, breaching was not investigated in the Levin and Tolimieri study. The results in the study were equivocal when contrasting findings from spawners, recruits/spawner, and Ricker residuals. Also, unlike the work in PATH, this study did not evaluate the operational changes in the hydrosystem versus dam breaching.

Comments on Levin & Tolimieri (2001)

Our comments are primarily focused on the ill-founded construction of Levin and Tolimieri's analyses, for these following reasons:

- The authors ignored the fact that the ESUs used for evaluation are composed of a number of independent populations (with varying productivities, capacities, and hydrosystem impacts). Even though the data they relied on are segregated by independent populations, the authors aggregated the information for their analyses. This approach has the potential to dampen the populations' response to perturbations, minimizing the individual response of the independent populations that compose the aggregate ESU. The approach of managing for these independent viable salmonid populations has been documented by NMFS in McElhany et al. (2000).
- The authors fit a parent/progeny function (Ricker function) to the entire time series of data (which includes pre and post lower Snake River dam construction). Due to major changes in the physical environment (the migration habitat impacted by four lower Snake River dams), fitting a Ricker function to all years of record would be expected to poorly describe the population dynamics for the aggregate ESU population (Walters 1987, Hilborn and Walters 1992). Analyses that have accounted for these changes in the migration habitat have been performed on these data sets (Schaller et al. 1999; Deriso et al. 2001).
- Levin and Tolimieri do not provide adequate description in the methods section to allow us to precisely duplicate their Ricker residuals presented in their figure 6 (nor do they present any results on the actual models fitted). However, it is apparent that their residual pattern grossly underestimates the actual magnitude of decline in productivity that occurred in Snake River and Upper Columbia stream-type chinook stocks coincident with hydrosystem construction and operation (Schaller et al. 1999; Deriso et al. 2001). Levin and Tolimieri residuals showed less decrease over time, particularly in the Snake River region (Fig. 1), apparently a result of their poor fitting Ricker model(s).
- Levin and Tolimieri acknowledge (p. 294) that their Ricker residuals were autocorrelated, and that "(t)herefore, significant results from analyses of Ricker residuals should be interpreted cautiously." While they caution here against type 1 error, they explicitly accept substantial type 2 error, stating (p. 294) "…absence of differences among regions that vary in dam number would be strongly suggestive that passage through the hydrosystem is not the leading determinant of population size or dynamics." If the fitted Ricker functions do not adequately describe the population dynamics, one would not expect the residuals from a poorly fit model to accurately reflect the productivity changes over time, nor would the resulting non-significant statistical results strongly suggest minimal impact from dams.

- Contrasting results between regions from other studies, the average Snake River stock productivity decreased 64%-71% compared to the Middle Columbia from the pre-dam period to the post-dam period (Schaller et al. 1999, Deriso et al. 2001). Using the Levin and Tolimieri (interpolated) residuals, ln(R/S) decreased only by 0.03, or recruits/spawner decreased by a mere 3% compared to the Middle Columbia. As discussed above, a major factor in this discrepancy appears to be due to Levin and Tolimieri's poor fitting Ricker functions.
- We analyzed the Levin and Tolimieri residuals and contrasted those to analysis of residuals from Schaller et al. (1999). Using Levin and Tolimieri's period designation (1959-65 period 1, 1980-1990 period 2) for the residuals from Schaller et al. (1999), the residuals from period 2 exhibited a significant drop from period 1 ($P<0.001$). In addition, using the period designation (1959-69 period 1, 1975-1990 period 2) from Schaller et al. (1999) for the residuals from Levin and Tolimieri (2001), the residuals from period 2 exhibited a significant drop from period 1 ($P<0.006$). It is apparent from these analyses that Levin and Tolimieri's results are highly influenced by selection of time period, their method for fitting the Ricker function, and aggregation of independent populations. Therefore, we conclude that Levin and Tolimieri's results from the Ricker residuals are questionable and their conclusion (which primarily relies on analysis of residuals) that 'dams on the lower Snake are not a potential force preventing recovery of endangered salmon' is highly equivocal.

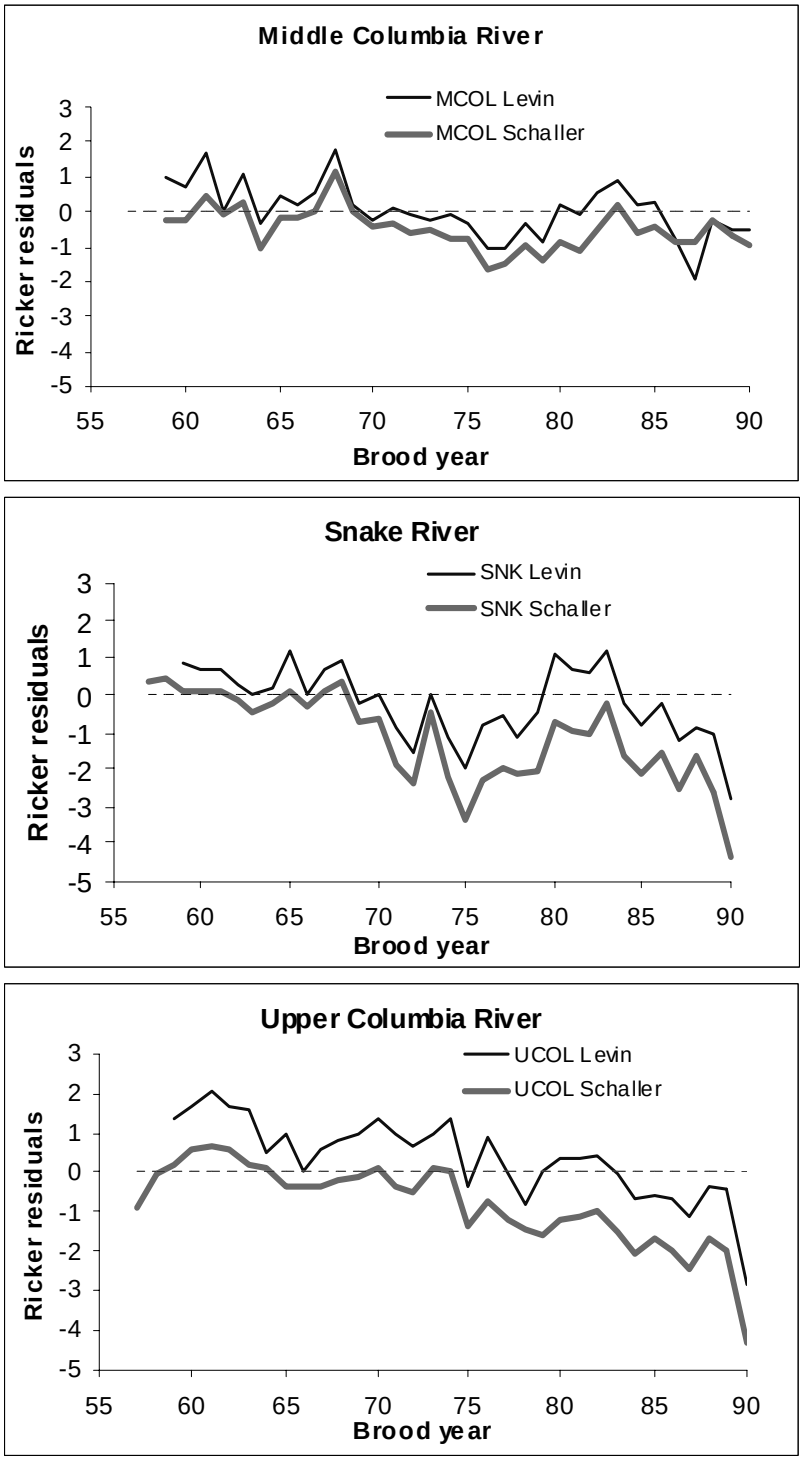

Figure 1. Residuals from Ricker functions for three interior Columbia regions, from Levin and Tolimieri (2001) and Schaller et al. (1999), 1957-1990.

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State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

National Marine Fisheries Service

Washington Department of Fish and Wildlife

June 13, 2003

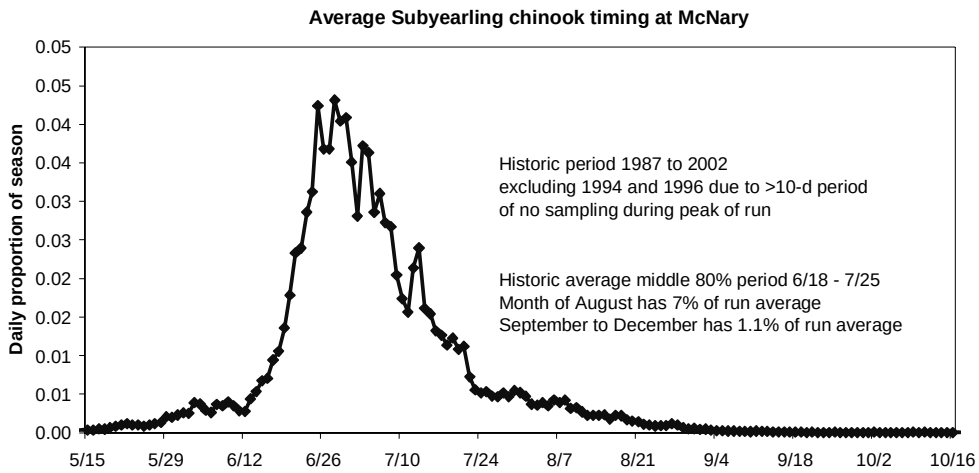
Mr. Doug Marker
Northwest Power and Conservation Council
851 SW Sixth Ave., Suite 1100
Portland, OR 97204

Dear Mr. Marker:

We have reviewed a recent analysis developed by Northwest Power and Conservation Council (Council) staff that addresses the question of the hydrosystem cost versus benefit of spill during the summer months. As our agencies have responsibility for salmon management in the Columbia Basin, our comments will focus on fish passage timing and the benefits of spill during the summer months. The graphs contained in the Council staff analysis are plots of passage indices and spill versus date. The passage indices used in the analysis include a combination of both hatchery and wild fish, and show that most of the fish pass through the lower Columbia River during July and, therefore, Council staff concludes that any changes to the summer spill program should be made in August.

We have reviewed the Smolt Monitoring Program passage data for the past thirteen years to determine the average proportions of combined hatchery and wild subyearling migrants present in the lower Columbia River during August. Based on the monitoring data approximately 7% of subyearling chinook migrants pass the McNary hydropower project during August (Figure 1).

Figure 1. Average subyearling chinook timing at McNary Dam.



However, plotting combined hatchery and wild chinook passage indices for subyearling chinook at the various spill sites does not present a complete picture and is a shortcoming of the analysis conducted by the Council staff. Different stocks of subyearling migrants, especially wild subyearlings, can display significantly different passage timing strategies. Hatchery releases and abundant stocks dominate the combined passage indices, whereas jeopardized stocks (with their low abundance) are underrepresented when displayed in this fashion.

The NOAA Fisheries recognized this phenomenon when they established planning dates for the provision of protection measures in the 1995 Biological Opinion. The 1995 Biological Opinion states that "Dates at which 95% of wild PIT-tagged subyearling chinook passed Lower Granite Dam were August 28, July 3, August 23 and September 1 in 1991, 1992, 1993 and 1994, respectively. Migration of juvenile fall chinook salmon to dams further downstream extends longer for fish not transported from Lower Granite Dam. The primary migration period for juvenile fall chinook salmon is defined as June 21 to August 31 in the Snake River and July 1 to August 31 in the lower Columbia River." These were the primary passage dates used to protect the majority of ESA listed wild fall chinook migrating from the Snake River through the lower Snake River and through Columbia River hydrosystem.

The Biological Opinion's August 31 date of the 95% passage for the subyearling fall chinook migrating from above Lower Granite Dam is conservative based on the more recent monitoring data (Table 1). There is some variability in the 95% passage date (ranging from August 16 to October 11) but it is not as extreme as observed in the earlier data set used by NOAA Fisheries. In part, this is a reflection of the more consistent sampling at Lower Granite Dam and marking above the project, but it is mainly a result of the improved survival shown for fish migrating in August due to improved summer flows and spill provided under the Biological Opinion beginning in 1995. Historically in low flow years (e.g. 1992), prior to the 1995 Biological Opinion, flows were extremely low during August and subyearling survival was low. This caused the passage indices to be truncated skewing the distribution towards an artificial earlier passage timing. The following table (Table 1) shows the 95% passage date at Lower Granite Dam for the run at large, and for the wild PIT tagged population. In some cases the 95% passage dates do not correlate well for the wild PIT tagged fish and the population at large because of variations in PIT tagged fish sample size, as well as the timing and segment of the wild population marked.

Table 1. The 95% passage date at Lower Granite Dam for the run at large (hatchery and wild combined) and the wild PIT tagged fish.

YEAR	95% Passage Date Run at Large	95% Passage Date wild PIT Tagged Fish
1995	Oct 11	Sept 14*
1996	Sept 20	Aug 27
1997	Sept 23	Sept 14
1998	Sept 26	Aug 15
1999	Sept 22	Aug 15
2000	Sept 08	Sept 14*
2001	Aug 16	Aug 18
2002	Aug 31	July 28

*Last date category actual date may be later

As seen from Table 1 the 95% passage date often occurs late in September for the run at large and wild PIT tagged fish. With the exception of 2001 when the poor migration conditions likely truncated the population due to higher mortality rates, the August 31 planning date has not been adequate to protect 95% of the summer migrants. Thus the August 31 planning date represents a compromise where most of the fish are considered to be past Lower Granite Dam.

The salmon managers also expanded the analysis conducted by the Council staff by considering the passage timing of individual groups of subyearling fall chinook at the lower Columbia River hydropower projects. Available information is limited due to the relatively low abundance of these stocks and few numbers of fish marked. However, based on the PIT tag recaptures the following information is being provided: the Snake River Basin wild fall chinook passage timing at McNary Dam (Figure 2); the Hanford reach wild fall chinook passage timing at John Day Dam (Figure 3); and, the Yakima River Basin wild fall chinook passage timing at John Day Dam (Figure 4). We believe that these graphs more accurately reflect the passage of stocks of concern, which may be masked in a graph depicting the overall passage indices such as presented by the Council staff.

Figure 2. Snake River Basin wild fall chinook passage timing at McNary Dam.

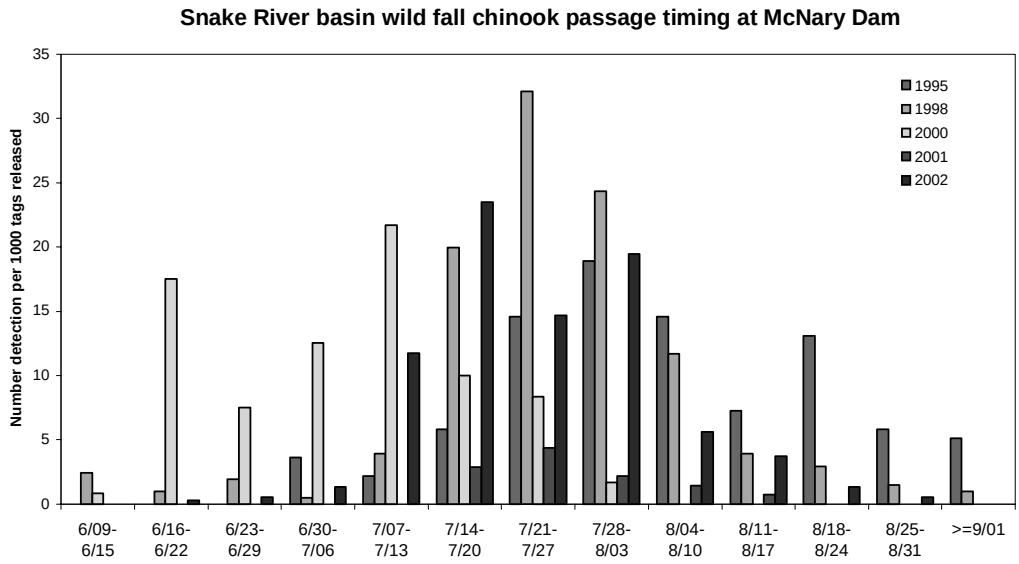


Figure 3. Yakima River Basin wild fall chinook passage timing at John Day am.

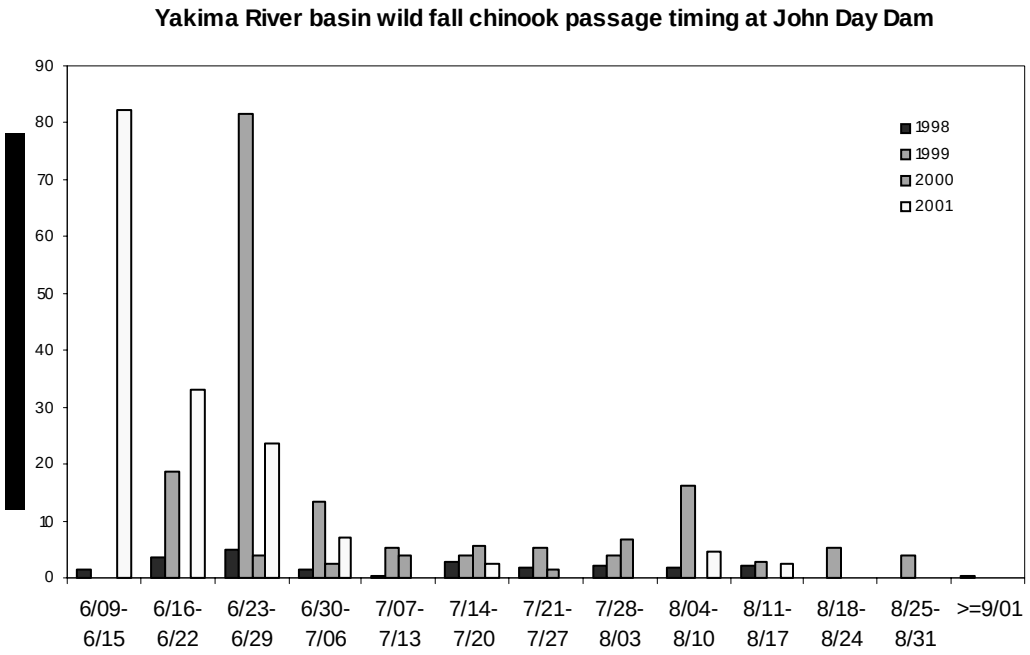


Figure 4. Hanford Reach wild fall chinook passage timing at John Day Dam.

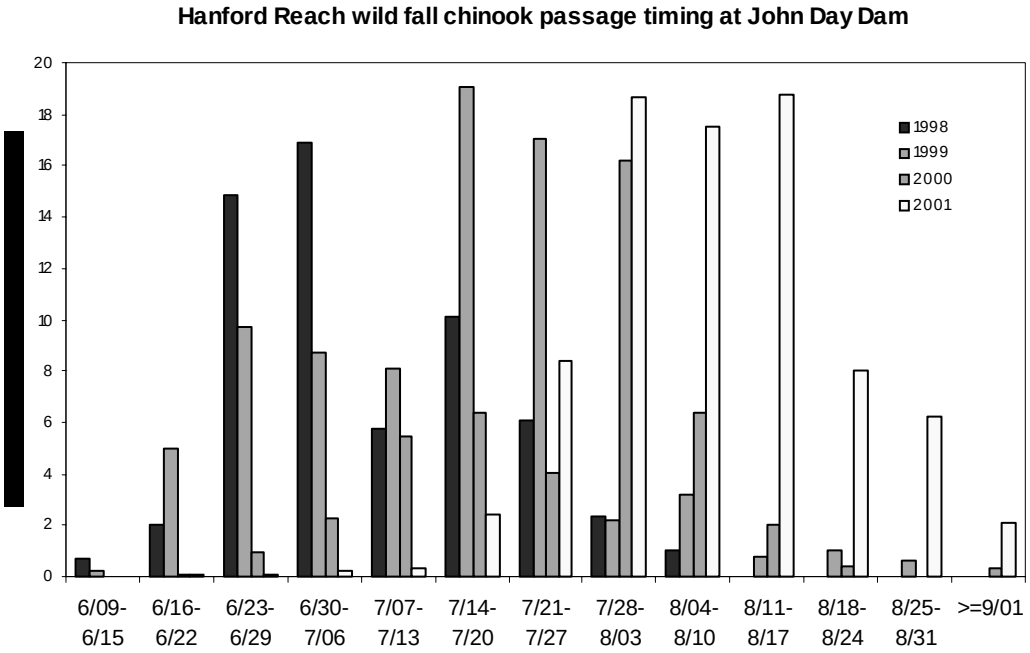


Table 2. Summary of proportions of individual groups of subyearling migrants passing through the lower Columbia during August.

Percentage of Subyearling Chinook Migrants Observed during August			
Year	**Snake River Wild***	**Yakima River Wild****	**Hanford Reach Wild****
1995	48.8		
1998	19.6	19.6	2.3
1999		20.0	9.2
2000	7.8	20.8	44.7
2001	21.4	4.5	66.7
2002	19.1		

* Observed at McNary Dam
** Observed at John Day Dam

As can be seen from both the graphs and Table 2, significant proportions of individual groups of subyearling migrants can and do pass into and through the Lower Columbia River during the month of August. Consequently, it is not advisable to use passage indices for the run-at-large to justify curtailing mitigation measures, such as spill. An analysis using only the total run-at-large may seem to indicate that the impacts of changing spill would only be imposed on a small portion of the run, whereas when specific groups of fish are considered, the impacts would be more significant. The need to protect most portions, unique life histories and genetic characteristics of the run was the foundation which led to the dates for providing spill protection that were specified in the Biological Opinion.

Moreover, summer spill is an essential element of providing improved inriver passage conditions, and it should be continued while the evaluation of juvenile fish transportation for summer migrants is being conducted. This becomes even more significant when the delayed mortality factor, i.e. the difference in mortality between transported and non-transported fish, or "D" value, is applied to the fish that are transported. The current information on "D" for subyearling fall chinook indicates that the survival of inriver fish is important to the overall survival of fall chinook.

The Council staff analysis did not evaluate the effect of adult passage past the projects in the absence of spill. Fallback estimates for adult fall Chinook from the 1998 radio telemetry indicated that a significant percentage of fish fall back throughout the system (Table 3).

Table 3. Fallback Rates of Fall Chinook in 1998 from Radio Tracking Studies by University of Idaho.

	Bonn	**TDA**	**JDA**	**MCN**	**IHR**	**LMN**	**LGS**	**LGR**
Rate	5%	10%	5%	2%	7%	2%	NA*	NA*

*Too few fish for statistical analysis

The mortality rate for fish that fall back varies greatly depending on the route of passage. Mortality through the spillway has been estimated to be approximately 2-3%, while bypass systems and turbines have much higher morality. Mortality from falling back through the turbines was particularly high with estimates of 22% and 41% for adult summer steelhead at Foster, Wagner and Ingram dams (1973). Buchanan and Moring (1986) reported a 51% mortality for adult steelhead at Foster Dam. Liscom and Stuehrenburg (1985) noted adult summer steelhead suffered a 46% turbine mortality when they were subjected to passage at Lower Monumental Dam. Mortality rates for falling back through bypass systems have not been studied extensively, but bypass systems have been shown to have much higher rates of mortality than spillways. In addition, adult salmonids have been noted with significant injuries after passing through gatewells and orifices. This is not surprising since juvenile bypass systems were not designed for adult passage. Without spill at hydropower projects the mortality rate associated with falling back will likely increase, since the remaining routes of passage have significantly higher mortality than the spillway. A comprehensive analysis to determine the impact of reduced spill should include impacts to adult salmonids, as well as the impacts to juvenile salmonids.

We hope that you find this information helpful when considering any potential recommendations for modifications to the Biological Opinion summer spill program. We urge the Council and staff to coordinate any proposed changes in summer spill or research needs with the region's federal, state and tribal salmon managers through the Regional Forum process. We offer to work closely with the Council and its staff on the specifics of actions that will meet the intent and performance standards of the National Marine Fisheries Service 2000 Biological Opinion, as well as the intent of the Council's Mainstem amendments to the fullest extent possible.

Sincerely,

David Wills, USFWS

Steve Pettit, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Paul Wagner, NMFS

Shane Scott, WDFW

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Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

Washington Department of Fish and Wildlife

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Dear Mr. Brown, Ms. Kalamaz, Ms. Fodrea and Mr. Peters:

The Bonneville Power Administration has developed and distributed a proposal to the Corps of Engineers Study Review Work Group (SWRG) to discontinue the 1% peak turbine efficiency turbine operating limits included in the NMFS Biological Opinion. We understand and support the ongoing process of evaluating hydrosystem operations and how they relate to fish survival. However, we find that the available evidence strongly suggests that operations outside the 1% of peak efficiency would be detrimental to fish. Therefore we cannot support the draft proposal submitted by BPA to discontinue operations within the 1% of peak efficiency in all mainstem federal projects. We support the implementation of the Biological Opinion (BiOp) measures requiring that turbines operate within 1% of their efficiency range.

State and tribal co-managers have reviewed the proposal and have summarized their comments and concerns below which are presented in detail in the following discussion. In addition we have attached our comments on a specific study proposal presented to the SRWG to study the 1% turbine efficiency operating criteria at McNary Dam in 2003.

- Our review of historic and recent data only finds evidence that supports maintaining the 1% peak efficiency limits included in the NOAA Biological Opinion.
- The BPA proposal shifts the burden of proof of risks to the fishery resource in favor of apparently more certain economic benefits for the hydropower system.
- The BPA proposal abandons the precautionary approach to hypothesis testing which is warranted in an endangered species context.
- The BPA proposal reflects a management priority, which is inconsistent with the fishery management priorities of the state, tribal and federal fishery managers submitting these comments. The BPA proposal to expend effort and limited funds to test fish survival relative to turbine efficiency ranges above levels that are safer for fish is establishing a federal operator priority for increasing hydropower revenue rather than fish protection. A priority established for fish protection would direct expenditures at keeping fish out of turbines and providing alternative passage routes rather than increasing passage of fish in turbines and operating turbines at levels that reduce fish survival. Expenditure of fish mitigation funds for this study is unacceptable to the natural resource managers.
- The BPA proposal does not address the deterioration of conditions in the gatewells and on the vertical barrier screens that will result from higher turbine flows. Gatewell and vertical barrier screen and orifice conditions will deteriorate and result in significantly increased fish injury, stress and mortality.

Our review of historic and recent data only finds evidence that supports maintaining the 1% peak efficiency limits for turbines included in the NOAA Fisheries Biological Opinion.

The NOAA Fisheries 2000 Biological Opinion (BiOp) includes the requirement that turbine operations be limited to within 1% of peak efficiency based upon evidence (both empirical data and expert opinion) suggesting that smolt survival was higher within these limits compared to operations beyond them. In an effort to re-evaluate this BiOp requirement, Bonneville Power Administration (BPA) has submitted a draft proposal (dated May 19, 2003) to discontinue these turbine operating limits. However, in our review of this proposal, historic data, and recent data, we only find evidence that supports maintaining the 1% of peak efficiency limits, and therefore do not support the BPA proposal on turbine operations. Our basis for this conclusion is outlined below.

Milo Bell Compendiums

Bell et al. (1967) and Bell et al. (1981) provided the first basis for the 1% of peak efficiency limits. These reports present published and unpublished data on survival of small fish passing through Kaplan- and Francis-type turbines. The Bell Compendiums provide compelling evidence that fish survival is generally higher when turbines are operated within the 1% limits than when they are operated beyond these limits. In addition, survival appears to decrease linearly as turbines are operated beyond peak efficiency.

These results make sense from a mechanistic perspective as well. Mechanistically, when turbines are operated beyond peak efficiency, flow fields in the turbines are disrupted, resulting in cavitation and damage to the metal surfaces in contact with the water. Clearly, this is an undesirable condition for fish, and therefore operations that create these conditions (i.e., operations beyond the 1% of peak efficiency limits) are expected to reduce survival. The data provided by the Bell Compendiums clearly support this expectation.

Eicher and Associates (1987)

In a comprehensive review of fish mortality through turbines, Eicher and Associates for EPRI (1987) reported the conclusions of a panel of experts that the maximum survival of fish coincides with the greatest turbine efficiency. Further they noted that turbine efficiency is determined by wicket gate openings and resulting flow qualities and design head in relationship to operation head, and that efficiency falls off after reaching a peak of 60-80% maximum flow into a unit. Eicher and Associates also note that the hydraulic character of the backroll of the turbine discharge into the tailrace is a function of overall flow into the turbine unit. They note as was described by NMFS in Bonneville Dam survival studies (Gilbreath et al. 1993) that the backroll carries fish into heavy predation zones. Eicher and Associates concluded by noting that diverting fish from turbines is probably the most cost-effective way of reducing fish mortality.

Skalski et al. (2002)

The data evaluated in Skalski et al. (2002) provide a second basis for maintaining the 1% efficiency limits. While their analysis was primarily focused on evaluating the academic question of whether peak survival coincides with peak efficiency, they do provide a useful summary of more recent data on the relevant operational question of maintaining the 1% of peak efficiency limits. Based on the data provided in Skalski et al. (2002, Table A.1), mean survival is reduced by 1.13% (for Columbia/Snake River projects) to 1.64% (for all projects) when Kaplan-type turbines are operated beyond the 1% of peak efficiency limits (Figures 1 and 2). In addition, survival decreases linearly as turbines are operated beyond peak efficiency for Columbia/Snake River projects (Figure 3).

Normandeau et al. (2003)

The presence of several study design flaws severely limits the utility of the 2002 McNary turbine survival study results summarized by Normandeau et al. (2003) for evaluating the BiOp turbine efficiency requirement. These flaws stem from both how the study was conducted and how the results can be interpreted given the greater context of fish passage at dams. We condense some of these issues into five main points, below.

First, operations beyond peak efficiency increase turbulence and flow within the gatewells, resulting in screen and orifice clogging, increased current velocities, and fish mortality along the intake and vertical barrier screens. During times of high debris loading, this problem is especially severe. Because fish were released within the gatewells in the 2002 McNary study, the survival estimates do not reflect this known problem. Furthermore, the estimates do not incorporate the changes in fish guidance efficiency that would occur with operations beyond the BiOp regulations.

Second, the sole use of large chinook salmon smolts prevents the application of study results to other species and size classes. As found in Skalski et al. (2002), turbine survival is significantly related to fish size, with smaller fish showing lower survival rates. Species that are more sensitive to turbine passage or are smaller than the large chinook smolts used in the 2002 McNary study will show reduced survival compared with results presented in Normandeau et al. (2003). Therefore using the 2002 McNary study results to overturn the BiOp turbine efficiency operating requirements, which in nature apply to all species and size classes, is inappropriate.

Third, spill operations and sample sizes were not consistent across the treatments in the 2002 McNary study. Treatments outside of the 1% limits (i.e., the 14 kcfs and 16.4 kcfs operations) had no spill during 6 of the 7 study days, whereas the treatments inside of the 1% limits had no spill for 4 of the 9 study days. This inconsistency in spill operations creates the question of whether the differences in survival estimates are the result of differences in turbine operations or of differences in spill. The number of fish released also differed among the treatments. Between 350 and 390 fish were released for 5 of the 6 treatments, but only 270 fish were released for the 14 kcfs treatment. The fact that this treatment also showed the highest survival is curious. Further, based on the results from previous studies, we expect survival to decline linearly as turbines are pushed beyond peak efficiency. Because the survival estimate at the 14 kcfs treatment is well above an interpolation between the 11.2 kcfs and 16.4 kcfs treatment estimates, this casts additional doubt upon the validity of the 14 kcfs survival estimate.

Fourth, we question the use of 48 h survival rates for evaluating delayed turbine mortality. Studies have shown that delayed mortality associated with turbine passage can be significant, and often is not manifested until several days following passage (Kostecki et al. 1987). Without holding the fish for longer periods, we cannot ensure that operations outside the BiOp limits will not jeopardize the long term survival of smolts. Further, forebay and tailrace mortality must be evaluated. Extended holding to assess delayed mortality presents other biases that make this approach difficult experimentally.

These delayed and indirect effects may only be understood through studies that evaluate effects on smolt-to-adult survival rates.

Fifth, the efficiency levels chosen for the 2002 McNary study are not informative for comparing fish survival inside and outside of the 1% of peak efficiency operations. The 8 kcfs and 11.2 kcfs treatments lie at the boundary of the 1% limits and the other two treatments are beyond the limits. To evaluate whether operations outside the 1% limits do not negatively impact fish, data must be collected well inside of the 1% limits. Studies operating at the limits and beyond (e.g., the 2002 McNary study) do not provide information on the effects of turbine efficiency on survival because estimates are only collected at operations beyond the efficiency limits. Furthermore it is important to note the fact that Normandeau et al. (2003) report the planned discharges (8, 11.2, 14 and 16.4 kcfs) rather than the actual discharges (7.7, 12, 13.4, and 16.6 kcfs) throughout the document. This was misleading, as was the practice of claiming that the 11.2 kcfs treatment was near peak efficiency when in fact it was at the 1% boundary. We encourage proper and accurate documentation of study outcomes and request the authors of Normandeau et al. (2003) in the future refrain from reporting misleading and inaccurate treatment data and results.

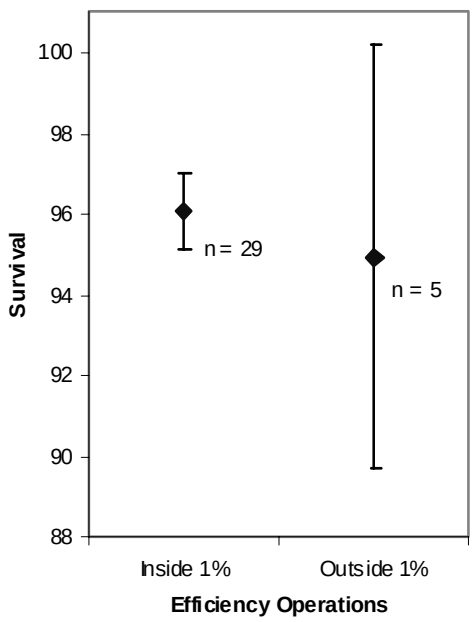

Figure 1. Mean survival and 95% confidence intervals for Kaplan-type turbines operated inside and outside of the 1% of peak efficiency bounds for Columbia/Snake River projects [Data from Skalski et al. (2002, Table A.1)].

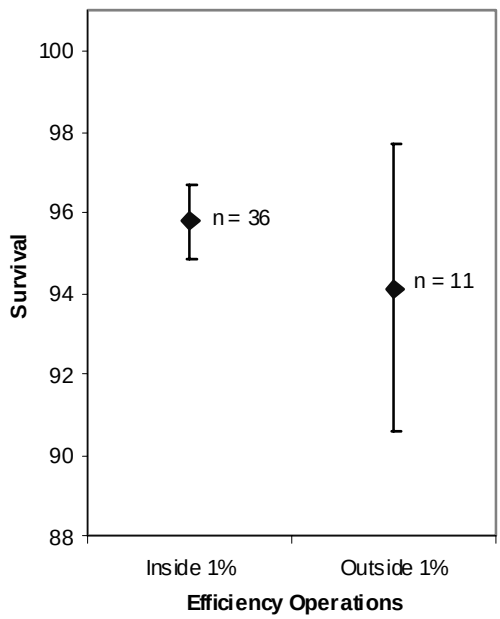

Figure 2. Mean survival and 95% confidence intervals for Kaplan-type turbines operated inside and outside of the 1% of peak efficiency bounds for all projects [Data from Skalski et al. (2002, Table A.1)].

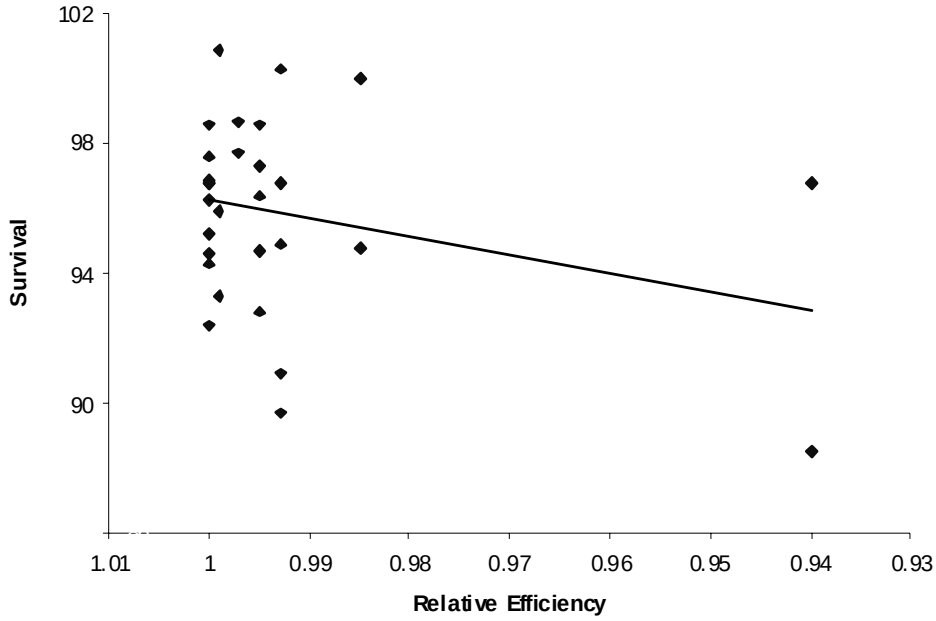

Figure 3. Relationship between survival and relative efficiency of Kaplan-type turbines for Columbia/Snake River projects [Data from Skalski et al. (2002, Table A.1)].

With respect to risks, the BPA proposal shifts the burden of proof to the fishery resource in favor of apparently more certain economic benefits for the hydropower system. The BPA proposal abandons the precautionary approach to hypothesis testing which is warranted in an endangered species context.

The BPA proposal is based upon BPA's decision to place the burden of proof for protection upon the ESA listed salmon, and other anadromous fish resources in favor of anticipated economic benefits to BPA.

The choice of a significance level determines the relative frequency of two kinds of mistakes, either rejecting the H_0 when it is correct making a Type I error, or failing to detect the truth of H_A when it is correct making a Type II error (Snedecor &Cochran, 1989) The failure rate β of not rejecting the null hypothesis when the alternative is "true" is termed the "Type II error" and the failure rate α of rejecting the null hypothesis when the null hypothesis is "true" is termed the "Type I error". In ecological studies, it is often desirable to balance these errors by applying the same failure rates to each type of error or even setting the failure rate such that $\beta < \alpha$.The proposal indicates that BPA is more willing to accept a Type II error than a Type I error. However, there are reasons why a more

precautionary approach to hypothesis testing is warranted in endangered species contexts (Peterman 1990, Dayton 1998). Steidl and Thomas (2001) cite investigators who have suggested that Type II errors be considered paramount when monitoring endangered species; or at least that Type I and Type II errors be balanced based on their relative costs. In endangered species recovery activities, if a Type II error is committed, a population could be on its way to extinction before the decline is detected and preventative action is taken. Conversely, if the population is monitored after initiating recovery actions (such as implementing turbine efficiency limitations), and the population is actually increasing, a Type II error would lead to the mistaken inference that the actions are not having the desired effect, perhaps jeopardizing continuance of those actions. The limitations of empirical data and ability to determine small differences in survival should not result in placing listed stocks at additional risk. If the data and methods do not allow differentiation of small differences a precautionary approach to management of endangered species require adoption of the measures that provide conservation and protection of the species.

Proper consideration of the possible detrimental effects of failing to meet turbine efficiency requirements requires acknowledging the limitations inherent in the available empirical data on turbine efficiency and survival. It should be kept in mind, for instance, that it's difficult to accurately characterize exact turbine conditions experienced by individual release groups in the turbine survival studies. The most relevant question we can ask in light of these limitations of data is not whether we can tease out effects on highly variable survival estimates from small variations in turbine operations within a season. Many factors affecting turbine survival probability will always remain outside of management influence. A more relevant question is, over a longer time series, given a representative range of uncontrolled variation in factors affecting survival, are turbine operations within their efficiency ranges associated with higher survival rates?

The BPA proposal does not address the deterioration of conditions in the gatewells, on the vertical barrier screens, and in the tailrace which would result from higher turbine flows. Gatewell and vertical barrier screen conditions would deteriorate and result in fish injury, stress, and direct and delayed mortality.

During 1997 and 1998 studies were conducted (Brege et al. 1998, Brege et al. 2001) to evaluate the vertical barrier screens and outlet flow control devices at McNary Dam. In those studies turbines in the test units were operated at low load 60 MW and high load 80 and 75 MW. Those tests with spring migrants showed that there was significantly higher levels of descaling under high turbine load operations. Under high load conditions descaling averaged 17 % versus 6.7% at low loads.

Present studies indicate that delayed mortality is an important factor in return of adult transported salmon and steelhead. Smolt to adult return data (CSS status report 2001) indicates that smolt to adult return rates for bypassed smolts are lower than spill passage. The BPA proposal to operate turbines at higher loads, given the results of gatewell vertical barrier screen descaling data, will potentially exacerbate and add to delayed morality for transported smolts and reduced survival of bypassed smolts.

The current proposal outlines BPA's justification for operating turbines, specifically at McNary Dam, outside the current 1% efficiency guidelines. The 1% operation was implemented based upon previous research that showed a relationship between peak efficiency of the turbine and maximum survival. BPA has outlined their rationale for believing that this data may not be accurate. Regardless of the debate over operating ranges and juvenile survival through the turbines, operating the turbines outside of 1% percent to increase generation will divert more flow through the turbines. This will likely increase the number of juveniles using this route of passage. As flow through a route increases so does the number of juveniles that use the specific route. This has been shown through countless passage evaluations. Thus, more juveniles will pass via the turbines; only the percent increase is uncertain. Current estimates for passage through the turbines are 86% and 87% from the radio tagged fish evaluation in the 2002 survival study conducted at McNary dam to test the 11.2 and 16.4 kcfs flow rates through the turbines. The project goal is to attain project survival in the high to upper 90's, ideally a route specific survival would be 98%. By increasing the number of juveniles using the turbines, project survival is going in the wrong direction, making it more difficult to attain the goals set out in the 2000 BiOp.

While gatewell releases during the April 2002 evaluation showed no difference in fish condition or survival, the gatewells were clean and operating at an ideal condition. During this time of year, there is little debris and no temperature problems; hence, this evaluation did not test a worst-case situation. By increasing flow through the turbines, more flow will be directed up the gatewell. Peak debris loads normally occur during the spring freshets and during the late summer. As debris and grasses are guided up into the gatewells with the migrating fish, increased head differentials across the barrier screens become evident and normally fish quality/condition problems start to manifest itself at the project. Not only is this hard on the screen mesh and other associated equipment in the gatewells, but fish that are guided into the slots can be injured or worse yet killed as hot spots (increased velocities) along the screen mesh develop. In past years and at present, to best counteract this problem, the project biologists would advise the project to reduce turbine loading to minimum operating levels and where warranted the unit would be taken down and the barrier screens cleaned. Increasing megawatts at McNary for example would only exasperate a "known" condition that currently exists at the project and is counter to improved fish survival goals stated in the 2002 BiOp.

Furthermore, the 2002 spring evaluation measured a much reduced residence time for fish released into the gatewell at 16.4 kcfs. Reductions in gatewell residence have been noted in the past when gatewell conditions become more turbulent and more aggressive hydraulically, which make it more difficult for juveniles to avoid the orifices. Under these condtions the juveniles are more similar to buoyant particles than active swimmers. This situation can be very injurious to fish, even under medium debris loads. This would also likely lead to reduced survival for fish using the bypass system, which would again drive project survival in the opposite direction of the survival goals for McNary as outlined in the 2002 BiOp.

The BPA proposal states that the SIMPASS model showed no difference in project survival. Notably the evaluation is missing the summer component. The evaluation used in the proposal used spring conditions. However the current operation under region discussion will continue through the summer. Current operations at McNary involve daytime involuntary spill. By increasing turbine flow, more fish will be passed via the powerhouse and turbine units as daytime involuntary spill is reduced. Because of the limited powerhouse capacity at McNary, involuntary spill was included in the biological effects analysis during the ESA consultation in 2000. By reducing the involuntary spill, project survival will be decreased and once again the separation between current conditions and the survival targets in the BiOp will be increased.

Table 3 in the BPA proposal, on page 27 describes the SIMPASS assumptions, has questionable values for turbine survival. BPA used balloon tag survival estimates for turbine survival. Balloon tag survival is not an appropriate technique to get a route specific survival due to the interaction of the tag and test animal. Balloon tags only estimate direct survival at best, and do not look at indirect survival post passage. Balloon tags are commonly used to identify areas of concern for passage, not to estimate route specific survival. A radio tag survival study was conducted along with the balloon tag study in 2002. Estimates for survival between the two turbine levels where 86% versus 87% as opposed to the 95% and 93% survival used by BPA in the SIMPASS model. Furthermore, BPA did not model any changes in FGE or FPE as more flow was passed by the turbines, which is questionable when doing a sensitivity analysis for turbine and project survival.

We understand that Bonneville Power Administration's objective is to enhance hydropower production without reducing fish survival. However, the proposal eliminate the 1% turbine efficiency operating criteria included in the NOAA Biological Opinion does not accomplish that objective.

BPAs proposal for operations and study does not represent a prudent expenditure of funds or assignment of priorities from a fish protection standpoint or a Biological Opinion progress check in dates. The BPA proposal is counter to BPA's historical position that turbines should run at peak efficiency during fish migration season. The primary objective of the BPA proposal is to increase hydrosystem revenue.

However, running turbine units outside of 1% peak efficiency will cause cavitation and poor operational conditions that would require more frequent shutdowns of units to repair cavitation damage (Shelton and Loupin 1995). In Europe, turbine units are never operated outside peak efficiency criteria because the costs of shutdowns and repairs are prohibitive. Increased repair costs and unit shutdowns for repairs may actually reduce overall FCRPS hydro revenues, or simply shift anticipated revenue gains to BPA with repairs costs to the Corps.

Precautionary management as anticipated by ESA would place the highest priority on increasing fish survival at the projects which would place the highest priority for expenditure of funds on actions that would reduce injury through the bypass, reduce fish passage through the turbines and provide alternatives to turbine passage. Fish survival is lowest through turbines than any other passage route even within the most efficient turbine operating range, , the BPA proposal will increase the proportion of fish passing through the most lethal project route.

Study design

Studies conducted to date have not shown that survival is improved or unchanged under high load turbine operations. The precision of the balloon tag studies does not support a management decision to eliminate the turbine efficiency requirements of the NMFS Biological Opinion. Please refer to our specific comments (attached) on the BPA,COE proposal to study the 1% turbine efficiency criteria at McNary Dam in 2003.

Conclusions

- Historical and present data does not support the BPA proposal to eliminate turbine efficiency requirements of the BIOP.
- The BPA proposal inappropriately shifts the burden of proof to the fishery resource, placing a higher level of risk on listed and non-listed fish stocks.
- The BPA proposal if implemented is likely to exacerbate issues of delayed mortality on transported fish, and reduced survival of bypassed fish and turbine passed fish due to increased stress, injury and descaling in the gatewells and degraded tailrace conditions.
- Studies of survival relative to turbine operations are turbine operations are a low funding priority in comparison to funding alternatives to turbine passage.
- Funds intended for current fish mitigation programs should not be expended on these proposed studies.
- A proposal to increase fish passage through turbines is counter to the aggressive, non-breach all-H recovery plan that BPA to this point has supported.

Sincerely,

Dave Wills, USFWS

Steve Pettit, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Keith Kutchins, SBT

Shane Scott, WDFW

Bob Heinith, CRITFC

State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

Washington Department of Fish and Wildlife

Shoshone-Bannock Tribe

May 29, 2003

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Dear Mr. Brown, Ms. Kalamaz, Ms. Fodrea and Mr. Peters:

Less than a week ago, at the SRWG meeting, the Corps of Engineers and the Bonneville Power Administration distributed a study proposal entitled, " 2003 Summer Test Proposal – 1% McNary". Although the time allowed for review is short, the state, federal and tribal fishery management agencies have reviewed the study proposal and offer the following response comments and recommendation. Although our comments are specific to this proposal, they illustrate wider concerns regarding the scientific design, analysis and data requirements to support management decisions relative to listed species protection. The following is a discussion of the specific technical concerns, which form the basis of our objection to the conduct of this study as proposed.

Despite the recent workshops on the proper use of mark-recapture methods for estimating smolt survival rates, the recent proposal for a study on the 1% of peak efficiency criteria at McNary in summer 2003 illustrates that the necessary experimental designs and research methods are not being incorporated. In an effort to clarify what elements constitute a valid research study for

changing hydrosystem operations, we have outlined the critical components that are necessary for addressing a question of this type. Based on the failure to address these components, we conclude that the proposed 2003 study at McNary is deeply and critically flawed, will not support a management decision to eliminate the 1% peak efficiency turbine operating criteria under the Biological Opinion (BIOP) protection measures and should not proceed until these problems are addressed.

Critical Elements for Mark-Recapture Studies:

1) Tag types and limitations. One of the most basic assumptions of the mark-recapture methodology is that test fish are representative of the population(s) about which inferences are made. Applying research results to species or size-classes that were not represented in the tagging operations for the studies is not acceptable. In the context of studies to evaluate potential changes in hydrosystem operations, this assumption requires that the study include representative samples from the populations that would encounter the hydrosystem during the proposed time that operations would change. Because of tag limitations, we believe that PIT tags allow the most flexibility for representing populations of various lengths. Radio tags are not suitable, because their size restrictions limit the populations about which inferences can be drawn. Balloon tags are not suitable because they are only usable on larger fish and because of their influence on the fish behavior.

2) Sample sizes. To provide a sound basis for changing hydrosystem operations, sample sizes must be adequate to address the relevant research question. Conducting a study with too few samples to detect an effect with sufficient statistical power will only result in scientifically invalid results that have very limited use in management decisions. With regard to the proposed McNary study, we estimate that survival is 1.1% to 1.6% lower when the turbines are operated outside of the 1% of peak efficiency bounds. Therefore studies to evaluate operations outside of the BiOp recommendations must have sample sizes that can detect a 1% difference in survival with sufficient power (80%, or $\beta = 0.2$) for the results to be meaningful.

3) Base conditions. We believe that fish survival is greatest when turbines are operated at peak efficiency. Development of the 1% of peak efficiency bounds in the BiOp was intended to provide operational flexibility, not as a starting point for evaluating alternative operations. Therefore studies to address this BiOp requirement need to include the test condition at which survival is expected to be highest (i.e., include operations at peak efficiency). If alternative operations are proposed for study, then they must include a comparison against peak efficiency.

4) Delayed and predation mortality. The components of dam passage involve a series of direct and indirect events that can influence fish survival. Premature removal of tagged fish from the hydrosystem experience (as with balloon tags) does not allow for a representative study on direct, indirect and delayed mortality as a result of hydrosystem passage.

5) Representation of migration route conditions. Changes in system operations will affect the fish that encounter the hydrosystem. Therefore studies investigating changes in system operations need to reflect the actual conditions that fish will experience arriving at, passing through, and traveling below the dam. This means that marked fish must be released upstream of the dam, allowed to experience gatewell conditions, pass through the turbines and the tailrace, and be detected at some downstream location. These effects are cumulative and cannot be studied by separating out the individual components.

Conclusion, Evaluation of the 2003 Proposed McNary study

Based on these criteria, we find that the proposed 2003 McNary study does not contain the elements necessary for an adequate evaluation of the 1% of peak efficiency requirements. Specifically,

- Operations at peak efficiency are not included
- Use of 3% effect size rather than 1% in sample size calculations
- Use of balloon tags
- Releasing fish into gatewells rather than upstream of project
- Inappropriate control group with two release locations
- Tagged fish not representative of all sizes/species that would encounter the dam

We hope these comments are useful in your consideration of this issue as well as future project specific studies that are intended to support management of protection measures for listed species. We have discussed some of these issues within the context of our response to the BPA original draft proposal to eliminate the 1% turbine efficiency protection measures included in the Biological Opinion.

Sincerely,

Dave Wills, USFWS

State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

National Marine Fisheries Service

Washington Department of Fish and Wildlife

May 6, 2003

Ms. Cindy Henriksen
COE-RCC
PO Box 2870
Portland, OR 97208

Dear Ms. Henriksen,

Recently some issues have come to our attention that have been raised regarding the implementation of the Biological Opinion Spill Program within the constraints of the waivers associated with levels of total dissolved gas (TDG). We recognize the difficulty of managing a dynamic system, such as the hydrosystem, to specific waiver limitations. However, we have been frustrated this year as well as the past few years with the COE's conservative approach to implementation of the Biological Opinion Spill Program, which is an integral component of the mitigation program designed to address impacts of the Federal Columbia River Power System.

First, we would like to state that it is not our intention to request the COE to specifically violate the State water quality agency waiver requirements. However, we are asking the COE to recognize the limitations of instrumentation, as well as the effect of environmental variables such as solar radiation, wind and changes in barometric pressure, in the way they are presently managing the spill program. The COE presently errs on the side of the water quality waivers, staying well below the waivers at some projects when many of these excursions of 1% change in total dissolved gas readings are likely due to the environmental and instrument effects. This type of management compromises the implementation of the Biological Opinion Spill Program and directly affects juvenile fish survival at COE projects.

A specific example of this type of management occurred at Little Goose Dam this spring. It is our understanding that spill at Little Goose Dam was being limited based on forebay readings at Ice Harbor Dam – two projects downstream. Spill was being constrained based on excursions of 1-2% in the TDG readings at Ice Harbor forebay. These excursions were likely due to environmental variables, given that the readings at the Ice Harbor tailrace monitor are often less than observed at the forebay. It is our understanding that the Lower Monumental forebay has now been substituted as the control point for Little Goose spill. At the request of FPC and NOAA Fisheries staff, spill was increased by a few Kcfs over several days. The Little Goose Dam tailrace has been consistently at 116% to 117% and the Lower Monumental forebay has never exceeded the water quality waiver of 115% for the highest 12 hours in a 24-hour period. However, based on a single daily reading of 115% for the highest 12 hours on May 2, 2003, spill levels were immediately decreased. We believe this action was not consistent with the spirit of managing spill for fisheries mitigation, within the intent of the water quality waivers.

Additional examples have occurred, and are occurring in the lower Columbia River as well. Specifically, from April 16 to April 24 the average of the twelve highest hours in a 24-hour period for John Day Dam tailrace was 116.8%. The spill volume at JDA is supposed to be 60% of the total river flow. During the same time period the average spill was only 53.3 % of the river flow. At The Dalles Dam the COE has consistently provided 39% of daily average flow as spill, while the Biological Opinion calls for 40%. The consistency of being able to provide 39% suggests that the COE is capable of consistently providing 40% as required by the Biological Opinion. Attached is a table showing 12–hour TDG averages observed over the past two weeks at the forebay and tailrace locations of the Lower Snake River and Columbia River projects. From inspection of this table it can be observed that at some projects TDG levels are considerably below the gas waivers, and are not violating the gas levels at the next downstream project.

Further justification for meeting Biological Opinion Spill Program can be obtained from the gas bubble trauma monitoring that has been conducted for several years in association with the Smolt Monitoring Program. Historically, the biological criteria established by NOAA Fisheries for decreasing spill levels have not been exceeded at gas levels similar to those presently being observed in the system. The 2003 monitoring effort confirms those historic observations

We look forward to working with the COE to assure providing the full benefits of spill in the recovery of Columbia and Snake River salmon, while meeting the intent of the water quality waivers, which were specifically designed to allow full implementation of the Biological Opinion Spill Program.

Sincerely,

Howard Schaller, USFWS

Steve Pettit, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Paul Wagner, NMFS

Shane Scott, WDFW

Cc: Russell Harding, OR DEQ
Chris Maynard, WA DOE
Mary Lou Soscia, EPA

Total Dissolved Gas Data at Lower Snake and Columbia River Sites

	LGO				LGO Tailwater				LMN				LMN Tailwater				IHR				IHR Tailwater			
	24h	12h		#	24h	12h		#	24h	12h		#	24h	12h		#	24h	12h		#	24h	12h		#
Date	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr
22-Apr	110	110	111	24	113	116	116	24	112	113	114	24	118	119	120	24	115	116	116	24	114	115	117	24
23-Apr	111	111	111	14	113	114	116	14	112	112	113	14	117	117	119	13	114	114	115	14	113	113	114	13
24-Apr	110	110	111	16	112	113	116	16	112	112	113	23	117	118	118	23	112	113	114	24	114	114	115	24
25-Apr	108	110	111	24	111	115	116	24	112	113	113	24	118	119	120	24	113	114	116	24	114	115	116	24
26-Apr	108	109	110	24	111	115	116	24	110	112	112	24	118	118	119	24	112	112	113	24	114	114	115	24
27-Apr	107	108	109	24	111	116	116	24	109	111	113	24	118	119	120	24	112	113	116	24	114	115	115	24
28-Apr	107	108	109	24	112	116	116	24	111	113	114	24	119	120	120	24	114	116	118	24	114	115	117	24
29-Apr	107	109	112	24	111	116	117	24	112	113	115	24	118	119	120	24	115	115	115	24	114	115	117	24
30-Apr	108	109	111	24	112	116	116	24	111	113	115	24	118	119	120	24	114	115	115	24	113	114	114	24
1-May	110	110	111	24	113	116	116	24	111	112	113	24	118	119	120	24	115	115	116	24	113	113	114	24
2-May	110	110	111	24	114	117	118	24	112	113	114	24	118	120	121	24	115	116	116	24	113	114	117	24
3-May	110	111	111	24	113	116	117	24	114	115	116	24	118	118	120	24	116	116	116	24	114	114	117	24
4-May	109	110	110	24	113	116	116	24	113	114	115	24	117	118	118	24	114	115	115	24	112	113	115	24
5-May	107	107	108	24	111	115	116	24	110	111	112	24	117	117	118	24	110	111	112	24	111	112	113	24

	McN OR				McN WA				McN Tailwater				JDA				JDA Tailwater			
	24h	12h		#	24h	12h		#	24h	12h		#	24h	12h		#	24h	12h		#
Date	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr
22-Apr	109	109	110	24	109	110	110	24	117	119	122	24	108	108	109	23	112	117	118	24
23-Apr	108	109	112	24	108	108	109	24	116	120	122	24	109	110	111	23	113	118	119	24
24-Apr	107	107	108	24	108	108	109	24	116	119	120	24	110	110	110	23	113	117	118	24
25-Apr	108	109	110	24	109	111	111	24	115	120	122	24	109	110	110	23	113	117	118	24
26-Apr	109	109	110	24	110	111	111	24	117	121	122	24	108	108	109	23	113	118	119	24
27-Apr	110	112	115	24	110	111	113	24	115	120	121	24	109	110	113	23	113	117	118	24
28-Apr	110	111	112	24	111	111	112	24	115	120	121	24	109	110	111	23	113	117	118	24
29-Apr	112	114	117	24	113	114	114	24	116	119	120	24	109	110	110	23	113	116	117	24
30-Apr	112	113	114	24	112	113	113	24	116	119	120	24	109	110	110	24	113	117	118	24
1-May	113	115	116	24	114	115	116	24	116	119	120	24	111	112	114	23	114	117	118	24
2-May	115	117	119	24	115	116	116	24	117	119	120	24	114	115	116	23	116	118	119	24
3-May	114	114	115	24	116	116	116	24	117	119	119	24	114	114	115	23	116	118	119	24
4-May	113	113	114	24	113	114	115	24	116	119	119	24	112	113	113	23	115	117	118	24
5-May	108	109	110	24	108	109	110	24	114	118	119	22	110	110	111	23	114	118	119	24

	TDA				TDA Downstream				BVL				Warrendale				Camas/Wash			
	24h	12h		#	24h	12h		#	24h	12h		#	24h	12h		#	24h	12h		#
Date	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr
22-Apr	108	109	111	23	115	116	117	24	109	109	110	23	117	118	118	23	112	115	116	24
23-Apr	109	112	114	23	116	118	120	24	109	110	111	23	117	118	118	23	113	114	116	24
24-Apr	110	112	113	23	116	117	118	24	111	112	112	23	114	116	118	23	113	114	115	24
25-Apr	111	113	114	23	117	117	118	24	112	113	113	23	115	117	118	23	112	113	118	24
26-Apr	111	113	115	23	117	118	119	24	113	114	115	23	115	116	118	23	113	115	121	24
27-Apr	111	114	116	23	116	118	119	24	114	114	115	23	115	117	118	23	115	117	124	24
28-Apr	113	115	116	23	118	119	120	24	115	116	116	23	119	119	120	23	115	115	118	16
29-Apr	111	113	115	23	117	118	119	24	115	116	116	23	119	119	120	23	116	117	118	24
30-Apr	111	112	113	24	116	117	118	24	114	115	115	24	118	118	118	24	116	116	117	24
1-May	111	113	114	21	117	118	119	24	113	113	114	23	117	117	118	23	115	116	117	24
2-May	112	114	115	23	117	118	118	24	116	116	116	23	116	116	117	23	116	117	118	24
3-May	113	113	114	23	117	117	118	24	114	115	115	20	114	115	116	23	113	114	115	24
4-May	112	113	114	23	116	116	117	24	111	112	112	23	113	114	114	23	111	111	112	24
5-May	110	111	113	23	115	116	117	24	111	111	111	23	114	115	115	23	111	112	113	24

State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

April 23, 2003

Brian Brown
National Marine Fisheries Service
525 NE Oregon St., Suite 420
Portland, OR 97232

Subject: Lower Monumental Spill Operational Change

Dear Mr. Brown:

The stilling basin repairs and end bay deflector construction were completed by the end of the 2003 in-water work period. Spill was approved for the 2003 spill season at the Implementation Meeting and again at the Technical Management Meeting on April 9, 2003. We apologize for the late date of this letter, but until only a few weeks ago spill in the Snake River was unlikely to occur because flow forecasts were below the BiOp 85 kcfs trigger. Thus, efforts to review spill operations lagged. However, after reviewing the proposed change and the rationale for altering Lower Monumental spill levels, several noteworthy issues need consideration.

After reviewing the Fish Passage Plan and considering discussions at regional meetings, it has become apparent that NOAA Fisheries and the Action Agencies have agreed to reduce the spill for fish passage level at Lower Monumental from the proposed Biological Opinion (BiOp) level of 24-hour Total Dissolved Gas cap, (approximately 45 – 50 kcfs); to a spill level of 45% – 50% of the river flow depending on the river volume. After extensive discussions with NOAA Fisheries staff, we cannot agree with the reduction in spill volume below the BiOp levels for the following reasons:

- **The BiOp, 24-hour spill to the gas cap test has never been completed at Lower Monumental Dam**. This operational change was developed with limited regional consideration and coordination with the state, tribal and other federal fishery agencies. A test had been proposed in 2001 and again in 2002, but an energy emergency declared by BPA in 2001 coupled with low flows in the Snake basin and concerns with erosion in the stilling basin and dam safety issues in 2002, lead the Corps to halt the proposed evaluations. Consequently, no biological information has been gathered pursuant to the 24-hour spill program to the gas cap at Lower Monumental dam, as described in the BiOp.

- **There is no project specific biological information that indicates that the reduction of spill at the project will improve survival.** The rationale for changing the spill level at Lower Monumental presumes that lower survival occurs when juvenile migrants encounter large-scale eddies in the tailrace after passing the hydroelectric project. Currently, there is no project specific biological data to support this assumption and no site-specific information at Lower Monumental Dam. NOAA fishery is relying on survival data from studies conducted at Ice Harbor Dam in 2000 and 2002 to justify this operational change. This is problematic since the 2002 results have not been widely distributed, reviewed or finalized. In fact the Ice Harbor study will continue in 2003 to further investigate fish passage at Ice Harbor Dam. Since the indication of a problem at Ice Harbor Dam has only been observed in one year and is largely undefined, we do not believe it is appropriate to try to conclude that the presence of an eddy will reduce survival and subsequently apply results of this site-specific study to other projects for these reasons: First, the formation of an eddy under BiOp spill levels is one of many possibilities for the reduced survival. Migrants that encounter an eddy take longer to leave the tailrace area and it is hypothesized that this increased time spent in the area, the migrants are more likely to encounter predators, which has not been verified with field studies. Second, there is also concern about mechanical injury occurring in the Ice Harbor spillway and stilling basin. Third, the information has also indicated that as tailwater and flow levels increased, mortality decreased. This information suggests that there are several factors potentially acting in concert that should be considered when trying to understand the causal mechanisms for juvenile mortality below Ice Harbor Dam. However, the potential reason for concern at Ice Harbor cannot be directly translated to Lower Monumental because field information has not been collected pursuant to the BiOp prescribed 24-hour spill regime. We strongly caution against taking information collected at a specific project and applying it to another without corollary site information. It would be prudent to evaluate the BiOp proposed spill level at Lower Monumental prior to implementing a decrease in BiOp measures.

- **Utilizing hydraulic model results to draw conclusions about biological effects is not appropriate**. The presence of tailrace eddies does not necessarily translate to biological effects. In 2002, Grant County Public Utility District evaluated a top spill bulkhead in one of the spillways at Wanapum Dam in the Mid Columbia. Tailrace conditions were not ideal. A large-scale eddy was present in the tailrace, similar to the one at Ice Harbor. However, according to the 2002 radio tag survival report prepared for the Grant County PUD by LGL consultants, a decrease in survival in the tailrace could not be detected despite the presence of the large eddy. While it is ill advised to apply information from one location to another due to the site specific conditions, (i.e. bathymetry, hydraulic conditions, test fish, abundance of predators, etc.) the LGL study illustrates the potential that large scale eddies in the tailrace do not necessarily lead to lower survival. This would again argue for site-specific data to aid in making the best management decision possible.
- **Reducing the spill level at Lower Monumental Dam will reduce, Fish Passage Efficiency, FPE.** Lower Monumental is equipped with standard length traveling screens and has lower fish guidance efficiency than projects with extended screens. Under the proposed spill level change, more fish will pass via the turbines, which will reduce FPE and project survival. Reduced spill is also likely to increase forebay residence time further reducing survival. Spillway passage has consistently provided higher survival than turbine passage. Furthermore, reduced spill will increase the number of migrants transported, which will negatively affect a spread the risk policy for the percentage of migrants transported from the Snake River. Thus, it would seem that the operation with the least risk to juveniles this year would be to continue with the BiOp spill level until site-specific studies demonstrate that project survival is provided at BiOp versus lower spill levels.

- **This year promises to have one of the strongest wild yearling spring/summer chinook out migrations in recent history and thus should be afforded the maximum protection.** The number of migrants passing Lower Monumental Dam will likely be larger than expected when one considers the potential increase in juvenile passage from the Removable Spillway Weir, RSW, at Lower Granite, which could increase the number of in river migrants in the Snake River. The proposed change in spill levels could reduce spill volume by half at lower flows at Lower Monumental Dam. This represents a significant deterioration in the BiOp spill measures at this project without any certainty of biological benefit.

In summary, without any biological information to support any change we do not agree with the proposed change and would strongly recommend a return to the BiOp spill level for the 2003 spill season.

Sincerely,

David A. Wills, USFWS

Steve Pettit, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Cc: FPAC
Jim Ruff, NOAA Fisheries
Dave Hurson, COE- Walla Walla
Rebecca Kalamasz, COE- Walla Walla
Gary Fredricks, NOAA Fisheries
Steve Rainey, NMFS
Cindy Henrikson, COE

State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-Tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

April 10, 2003

Rock Peters
United States Army Corp of Engineers
Portland District
P.O. Box 2946
Portland, OR 97208-2946

Subject: John Day Spring Survival Test 2003

Dear Mr. Peters:

We have reviewed and discussed the proposed spring survival test at John Day. At present, there are several issues of concern with the proposed study. This study was originally developed to address preliminary results from the 2002 study at John Day, which suggested that bypass survival declined with increased spill levels. The 2002 report has not been made available for review. Without a final or preliminary report of this work, we are unable to evaluate the strength of this conclusion.
Further, we are aware of several study design issues that could compromise conclusions based on the 2002 study results. The primary concern, discovered after hydraulic evaluations done last month, was that turbine unit priority at the powerhouse during the 2002 studies was not what had been agreed upon in the Fish Passage Plan, FPP. In fact, the wrong turbine unit priority has been used since at least 1999. The FPP had designated for the fish passage season a priority of units 5, 1, 2, 3, 4, and then 6-16 in any order. By concentrating turbine operations to the south, more flow was concentrated at the bypass outfall, increasing velocity over 4 ft/sec and entraining the majority of the bypass flow downstream instead of drawing the outfall flow to the north towards the middle of the river. After reviewing the actual unit operations in previous years it was discovered that this operation has not occurred. Once the FPP operation was modeled, conditions at the outfall improved, raising the strong possibility that powerhouse operations could account for the lower survival at the outfall under Biological Opinion (BiOp) spill operations.

Due to these, and other concerns, the Columbia River Inter-Tribal Fish Commission, U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, and Idaho Department of Fish and Game feel it would be prudent to alter the proposed 2003 John Day spill test. The project survival in 2002 was estimated for 24 hour 30% spill at 96.3% (93 – 99.6%), which was higher than the BiOp 12 hour 60% spill condition at 92.9% (89.5 – 96.3%). Since the evaluation in 2002 was compromised because of turbine operating conditions it would seem logical to only test BiOp 12 hr 60% spill to determine if there is a need to consider alternatives. Our specific concerns are detailed below.

1. The test proposed by the COE would evaluate BiOp spill of 60% night vs. 45% night spill. While the BiOp states that nighttime spill at John Day is 60% of the flow, actual spill percentages historically have not attained these levels. The seasonal average for spill percent during the previous evaluations has been in the range of 51% in 1999 to 52% - 54% in 2000 and 2002. Consequently, it will be very difficult to discern a survival difference between these two operations (45% spill and 52-54% spill). Further, 45% Spillway Passage Efficiency (SPE), has been shown in previous years to be lower than BiOp spill SPE. The 2003 juvenile out migration is projected to be one the largest out migrations in recent history with over 1.6 million wild spring/summer chinook alone predicted for the Snake. Based on the preliminary and potential inconclusive basis for this test, we are apprehensive about reducing the number of juvenile salmonids through the spillway and thus increasing the passage through the powerhouse. More so when one considers the current estimates for turbine survival range from 77.8 (67.3 – 87.0%) for yearling chinook for BiOp spill and 70.3 (48.4 – 88.5%) for wild steelhead during BiOp spill, some of the lowest turbine survivals ever observed at Corps projects. This operation would not aid in reaching BiOp survival standards since more juveniles would be routed through the turbines, which is the lowest estimated survival route at John Day.

2. Another point of concern is that after looking at the velocity profiles generated from the hydraulic model at the Corps facility in Vicksburg it became apparent that the hydraulic difference at and around the outfall for the 45% spill and BiOp spill levels under FPP turbine priority was very minor. Additionally, this was only done at one river flow condition of 180 kcfs, a flow less than recommended in the Biological Opinion for the spring migration. As river flows are increased past this level, these subtle differences diminish even further. The model runs were done assuming 60% for the BiOp spill level, but as discussed lower levels (51-54%), due to Total Dissolved Gas concerns, will likely be observed during the evaluation. As the BiOp spill level is reduced closer to the proposed 45% test level the differences between the hydraulics at the outfall for the two test conditions will further be reduced. This will only exacerbate the concern about detecting a difference between the test blocks.

3. The BiOp 60% spill has not been achieved due to Total Dissolved Gas (TDG) constraints at The Dalles Dam forebay. Because of TDG levels, the volume of spill for the BiOp test block did not achieve the 60% level. The Water Quality Team is evaluating the current fixed monitoring sites and is considering moving The Dalles Dam forebay monitor because its current location is not representative of forebay gas levels. If this evaluation were done under full implementation of the BiOp 60% spill level, an evaluation of 45% spill compared to BiOp would be technically feasible. In the interim, however, it would make more sense experimentally and from a fish safety perspective to first evaluate whether powerhouse turbine operations were the cause for the apparent reduced short-term survival at the outfall under BiOp spill levels in past years' studies.

4. With only one test block more fish could be released through other routes to reduce variability and improve survival estimates. Currently turbine estimates have large confidence intervals on the order of +/- 10% for yearling chinook and +/- 20% for steelhead. The bypass was on the order of +/- 5% for both groups. This information could be compared to previous years' information.

5. After reviewing previous studies it is apparent that daytime spill in the spring is very effective at passing the fish that are actively migrating during the day. The concern with daytime spill is that some juveniles tend to be holding in the forebays, especially steelhead, during the day. However it would seem prudent to test an RSW or some other surface spill option in the future to determine if it is possible to induce these juveniles to continue to migrate, which would further improve FPE. Perhaps efforts this spring should consider evaluating this concept (or some part of it) possibly using a bulk weir like was tested in 1997.

6. Lastly, if 2003 tests of BiOp spill following FPP turbine operating criteria prove that bypass survival is unacceptably low, we recommend that consideration be given to evaluation of alternative bypass outfall sites that would improve bypass survival at BiOp spill levels. Although this could result in lengthy evaluations and an expensive fix to bypass outfall problems at John Day, it could be the prudent long-term solution that provides the greatest survival at the project rather than trying to fix the problem by reducing spill that has a high likelihood of reducing project survival.

We appreciate the opportunity to discuss the John Day spring study and understand that these discussions are occurring very close to the beginning of the season. However, because of our high concern on how we should proceed with this study we urge the Corps to not proceed until full agreement can be reached on the study. We look forward to discussing these issues with you.

Sincerely,

David A. Wills, USFWS

Steve Pettit, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Cc: FPAC

State, Federal and Tribal Fishery Agencies Joint Technical Staff

US Fish and Wildlife Service

Columbia River Inter-tribal Fish Commission

Idaho Department of Fish and Game

Oregon Department of Fish and Wildlife

February 26, 2003

Mark Walker
Director, Public Affairs Division
Northwest Power Council
851 SW Sixth Avenue, Suite 1100
Portland, OR 97204

Dear Mr. Walker,

We thank you for the opportunity to provide comment on the Independent Scientific Advisory Board's (ISAB) draft document "Review of Flow Augmentation: Update and Clarification" as it relates to the Northwest Power Planning Council's Draft Mainstem Amendments. The document provides several conclusions with which we agree:

- The ISAB's theoretical model (Appendix 4) of reach survival and the existing empirical evidence support the existence of a flow and survival relation. The alternative hypothesis of no flow survival relationship would require instantaneous mortality rates to increase as flows increased, contrary to the available empirical evidence on survival and fish travel time. In addition, for this alternate hypothesis to be true, numerous hypotheses about the interactions of fish with the biological and physical environment would also need to be true (see Attachment 1, specifically the new analysis on instantaneous mortality).

- We agree with the ISAB that for the Snake River, the empirical data show the most significant benefit to in-river survival results from flows of 100 Kcfs for spring migrants and 50 Kcfs for summer migrants. Survivals are adversely affected below these flows. These flow inflection points coincide with the Biological Opinion flow objectives.

- The ISAB appears to recommend that when flows are below the threshold of 100 and 50 kcfs for spring and summer migrants, which is lower than the Biological Opinion targets, the elimination of load following and peaking would maintain survival at higher levels. Although untested, this presents an interesting concept that warrants further consideration.

- We agree with the ISAB conclusion that with respect to the Lower Snake proper, the greatest deviation from the Biological Opinion flow objectives resulting from the proposed amendments will occur during the summer months. Empirical data suggest the outcome will be a reduction in juvenile subyearling survival. However, we believe the proposed amendments would likely reduce peak flows in the Mid-Columbia and the lower Columbia. This would also reduce reach survival of juvenile Snake River migrants through the Lower Columbia and estuary and impact smolt to adult survivals of these salmon.

We do not agree with the ISAB's characterization of the flow augmentation paradigm, which they state, "asserts that in-river smolt survival will be proportionately enhanced by any amount of added water." Establishing reservoir draft limits and augmenting base flows with additional water are only the tools whereby the objective of providing migration flows is accomplished. The regions fishery agencies have long been working in concert with the National Marine Fisheries Service to ensure that, at a minimum, the flow levels specified in the Biological Opinion are provided during the juvenile fish migration. These levels of flow were originally selected based on existing data that suggested juvenile survival below these flows would be severely impacted. Others have recommended alternatives: the Columbia River Inter-Tribal Fish Commission has recommended a normative flow regime that more nearly resembles a natural hydrograph under various runoff conditions, and generally provides spring flows that are significantly greater than the existing targets. Data collected before and since the implementation of the Biological Opinion and presented to the ISAB both by the NMFS and the other fishery agencies and tribes in the FPC October 14 memo and the State, Federal, and Tribal Anadromous Fish Managers Comments on the Northwest Power Planning Council Draft Mainstem Amendments as they Relate to Flow/Survival Relationships for Salmon and Steelhead, substantiated the relation between flow and salmonid survival and validated the existing Biological Opinion flow targets at a minimum.

The ISAB undertook the task of accomplishing this significant review of flow augmentation at the Council's request, and admittedly there was limited progress that could be made within the short (two and a half month) time frame allotted. We recognize the time limitations forced the ISAB to narrowly focus on responses to specific questions formulated by the Council. Also, the short time frame made it difficult for the ISAB to review all materials submitted. In spite of this narrow focus the ISAB Report ventures beyond that objective. Consequently, the report raises several issues that were not adequately studied and suggests alternatives that were not fully considered. For example,

- The report concludes, "it may be possible to achieve improved survival of juvenile salmonids through the lower Snake River reaches and their dams, even at lower flows". This statement is not supported by empirical evidence. The premise in the ISAB report that survival could be maintained with lower flows if load following or peaking were eliminated and flat stable flows were provided is an interesting concept. However, load following is reflected in the data that has been collected to-date that shows a flow survival relation. Elimination of load following might provide benefit that would be additive to flow augmentation, but should not be substituted for flow augmentation without a long time series of empirical data justifying substitution.

- The ISAB assessment of the peaking and load following effects was based upon peaking regimes in January and February at which time there are few juvenile migrants present. The magnitude of the load following in January is significantly greater than observed during the juvenile migration, during the passage period specified in the Biological Opinion. This is because during the juvenile migration period the Snake River reservoirs under the Biological Opinion are restricted to a one foot operating range above minimum pool levels, which limits the amount of load following that can be accomplished (see Attachment 2).

- The ISAB bases a significant amount of their review on an October 14 memo from the Fish Passage Center and data presented by the National Marine Fisheries Service describing the relation between flow and juvenile survival. Many questions raised by the ISAB in this report have already been addressed in a more comprehensive document, "State, Federal, and Tribal Anadromous Fish Managers Comments on the Northwest Power Planning Council Draft Mainstem Amendments as they Relate to Flow/Survival Relationships for Salmon and Steelhead." This report was provided to the ISAB during their review period and questions posed by the ISAB regarding the report were addressed both verbally (December 17, 2002) and in writing (Jan. 10, 2003 memo to ISAB) (Attachment 3). This comprehensive document among other topics includes smolt to adult return (SAR) information and its relation to flow levels experienced during the juvenile migration. Had there been sufficient time allotted for this important review the ISAB could have used the SAR information, which may have enriched their view of the importance of flow to all life stages of salmon. Including adult return analysis would have been beneficial in assessing the potential effect of the draft NWPPC amendment. We strongly recommend that the ISAB complete their review of flow augmentation by including the adult return analysis.

- The ISAB comments that the radio tagging information on subyearling migrants implies that load following for subyearling migrants is a key factor in the increase in mortality observed. The ISAB suggests an untested hypothesis regarding fish response to turbulent flow as a potential mechanism for increasing mortality. However, the ISAB did not consider a real time proven response for subyearling migrants, the potential use of spill operations to facilitate juvenile passage and

reduce delay through slack water, low velocity forebays. Spill does not require additional water from storage reservoirs.

- Although the ISAB report primarily focused on in-river migrants, the issue of arrival in the estuary too early for survival is discussed as part of their perceived paradigm of the relation between flow and survival. However, early arrival to the estuary is unlikely to apply to in-river migrants and most likely is more important to fish that are transported. We agree with the ISAB that there is a need to determine the relation between early arrival in the estuary for transported smolts and its subsequent effect on survival to adulthood.

The NWPPC specifically requested that comments address the implications for the Council's deliberations on the mainstem amendments. While we agree with the ISAB conclusion that a significant impact of the proposed amendments will occur during the summer months and will be observed as a reduction in juvenile subyearling survival, as we stated above, we do not agree with the ISAB's conclusion that there will be no discernable effects on the survival of spring migrating salmonids. Data were provided to the ISAB depicting the different migration timing associated with stocks of spring chinook. These data suggest that early migrating stocks, the Imnaha spring/summer chinook in the lower Snake, as well as the John Day and Umatilla stocks in the lower Columbia that migrate in April prior to peak discharges are in peril of experiencing significantly lower flows during their migration period due to the implementation of the proposed amendments. The relaxation of the April 10 upper rule curve requirement of the Biological Opinion is likely to lead to deeper winter drafting of reservoirs for power needs and result in the need to refill reservoirs more intensely in early spring during the time periods when these fish migrate.

In conclusion, we believe that the ISAB report supports the biological rationale for the minimum flow objectives contained in the NMFS Biological Opinion. The ISAB report presents additional hypotheses for future study that are of some interest, although there is little data at the present time to support these hypotheses. The ISAB does suggest some operational changes in river operation that may offer benefits when Biological Opinion flow objectives cannot be met, which warrant further study and consideration.

Sincerely,

Howard A Schaller, USFWS

Steve Pettit, IDFG

Ron Boyce, ODFW

Bob Heinith, CRITFC

ATTACHMENT 1. Appendix A of US Fish and Wildlife Service comments on *Draft Mainstem Amendments to the Columbia River Basin Fish and Wildlife Program*

Appendix A - US Fish and Wildlife Service review of the Northwest Power and Conservation Council's approach to the flow-survival relationships for spring migrant juvenile salmon and steelhead contained in the *draft Mainstem Amendments to the Columbia River Basin Fish and Wildlife Program*
February 4, 2003

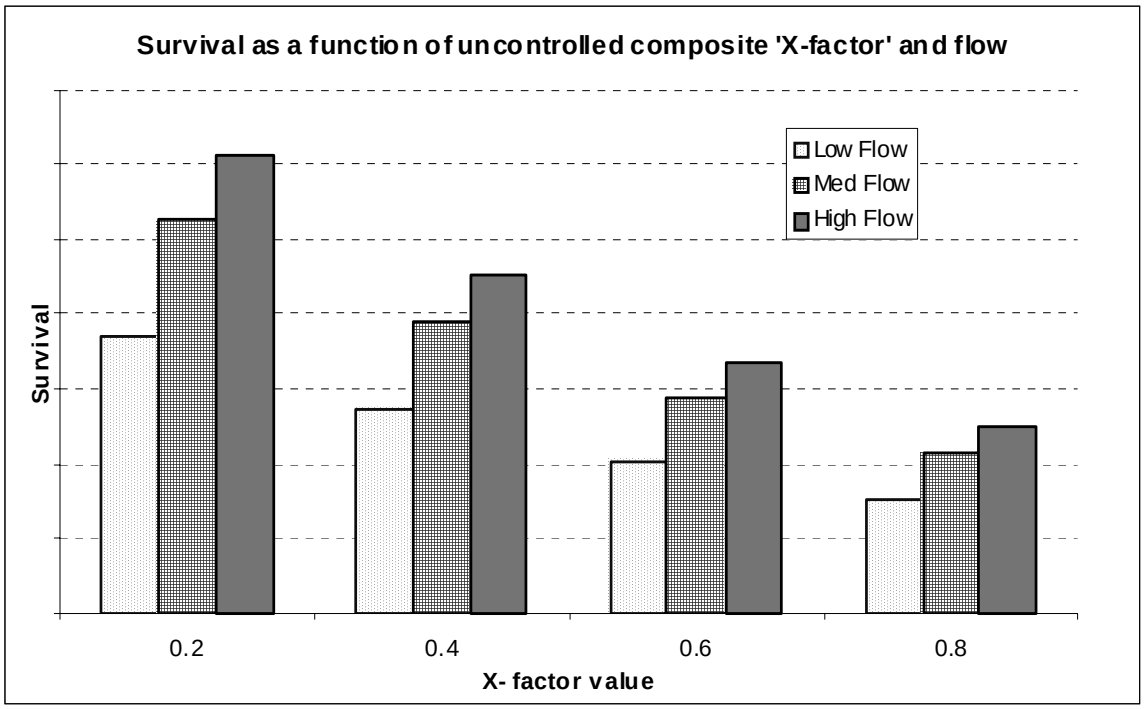
We are concerned about the way the document frames and makes inferences from hypotheses about the existence of a relationship between volume of flow, acting through its effect on water particle velocity, and survival of migrating smolts. The draft mainstem amendments document, as part of the rationale for repudiating the flow targets of the Biological Opinion (BiOp), states that "[r]esearch has not validated the predicted benefits of flow augmentation from upstream storage reservoirs" (p. 31, lines 9-10). This viewpoint, together with the conclusion that available evidence for a flow-survival relationship is lacking, imply that a particular hypothesis test has been set up, and inferences made. Specifics of the test are not provided by the Council, but can be inferred. The document contains no indication that alternatives to the chosen hypothesis test were considered, that alternative methods of analyzing relevant data were considered, or that the vast amount of information about juvenile salmonid migration was factored into the conclusions.

The Council appears to have implicitly formulated a null hypothesis that there is no flow-survival relationship (or more specifically, that providing greater volumes of flow to meet targets, thus increasing water particle velocity, does not in general lead to increased survival rates). The alternative hypothesis is presumably that there is a positive relationship between flow and survival. A formal decision analysis to distinguish the relative likelihood of these hypotheses can be conducted in a number of ways. A statistically appropriate test would at the least explicitly state both the choice for acceptable level of probability of Type I error (incorrectly rejecting the null hypothesis) and the resulting power of the test (= 1 – Type II error probability, where a Type II error is failing to reject the null hypothesis when it is in fact false). The statistical power of the test (the probability of correctly rejecting the null hypothesis, given that the alternative hypothesis is true) will also depend on the natural variability and error in measuring data on survival at different flow levels, as well as the effect size. The effect size in this case is the degree to which survival depends on flow (e.g. the slope of a line relating survival and flow), and should be a biologically significant amount. The Council's position that no flow-survival relationship has been demonstrated is not accompanied by analyses of statistical power estimating the ability to find such a relationship in existing data, if it does in fact exist. Power would likely be low with short data sets, given error and uncertainty in survival estimates and natural variability.

The Council's conclusions are influenced by their decision about where the burden of proof lies, i.e. that unless meeting flow targets can be proven conclusively to increase survival rates, they should be abandoned in favor of presumably more certain upstream biological and economic benefits. Presumably, the Council would be more willing to accept a Type II error than a Type I error. However, there are reasons why a more precautionary approach to hypothesis testing is warranted in endangered species contexts. Steidl and Thomas (2001) cite investigators who have suggested that Type II errors be considered paramount when monitoring endangered species; or at least that Type I and Type II errors be balanced based on their relative costs. Shrader-Frechette and McCoy (1992) give reasons why in applied cases, Type I error is often more acceptable than Type II error, whether the null hypothesis is "positive" (no harm) or "negative" (no benefit). Type II error leads to possible harm or loss of benefit, respectively. In endangered species recovery activities, if a Type II error is committed, a population could be on its way to extinction before the decline is detected and preventative action is taken. Conversely, if the population is monitored after initiating recovery actions (such as implementing hard flow targets), and the population is actually increasing, a Type II error would lead to the mistaken inference that the actions are not having the desired effect, perhaps jeopardizing continuance of those actions.

Proper consideration of the possible detrimental effects of failing to meet flow targets requires acknowledging the limitations inherent in the available empirical data on flow and survival. It should be kept in mind, for instance, that it's difficult to accurately characterize exact hydrological conditions experienced by individual release groups in the survival studies: "Identifying and quantifying relationships between environmental variables and travel times or survival of PIT-tagged migrant juvenile salmonid release groups in the Snake River present difficult challenges. Among these is defining the environmental conditions to which a release group is exposed." (NMFS 2000). The most relevant question we can ask in light of these limitations of data is not whether we can tease out effects on highly variable survival estimates from small variations in flow within a season. Many factors affecting survival probability will always remain outside of management influence. A more relevant question is, over a longer time series, given a representative range of uncontrolled variation in factors affecting survival, are greater flows *on average* associated with higher survival rates?

A plot of survival rate under different flows and different uncontrolled factors may help illustrate the difficulties in detecting a true relationship between flow and survival, given that uncontrolled factors also are certain to affect survival rate. Uncontrolled (and unmeasured) factors might be intrinsic, such as smolt physiological condition, or they could be largely external (e.g. predator density-dependent functional response). If we consider a component of survival (or mortality) that is influenced by uncontrolled factors, and one that is influenced by flow, the flow-survival relationship could be obscured by either random or directional variation in uncontrolled survival factors. Variation within a season will tend to obscure an intra-annual flow-survival relationship, and variation


Survival as a function of uncontrolled composite 'X-factor' and flow
Low Flow
Med Flow
High Flow
Survival
0.2
0.4
0.6
0.8
X- factor value

between years will tend to obscure an inter-annual flow-survival relationship. In Figure 1, a hypothetical composite factor, which can take values from 0 to 1, is shown on the x-axis, with resulting survival rate shown for low, medium, and high flows. The x-factor survival component varies as a negative exponential function of x-factor value, while flow-induced survival varies as a positive exponential function of flow. We can see from the figure that even though there is positive flow-survival relationship (i.e. at a given uncontrolled factor level, higher flows always result in higher survival), it could be lost in the data if the uncontrolled factors vary within a season or between years. For example, a year with higher flow may have also have a higher x-factor, resulting in lower overall survival than a year with lower flow but lower x-factor.

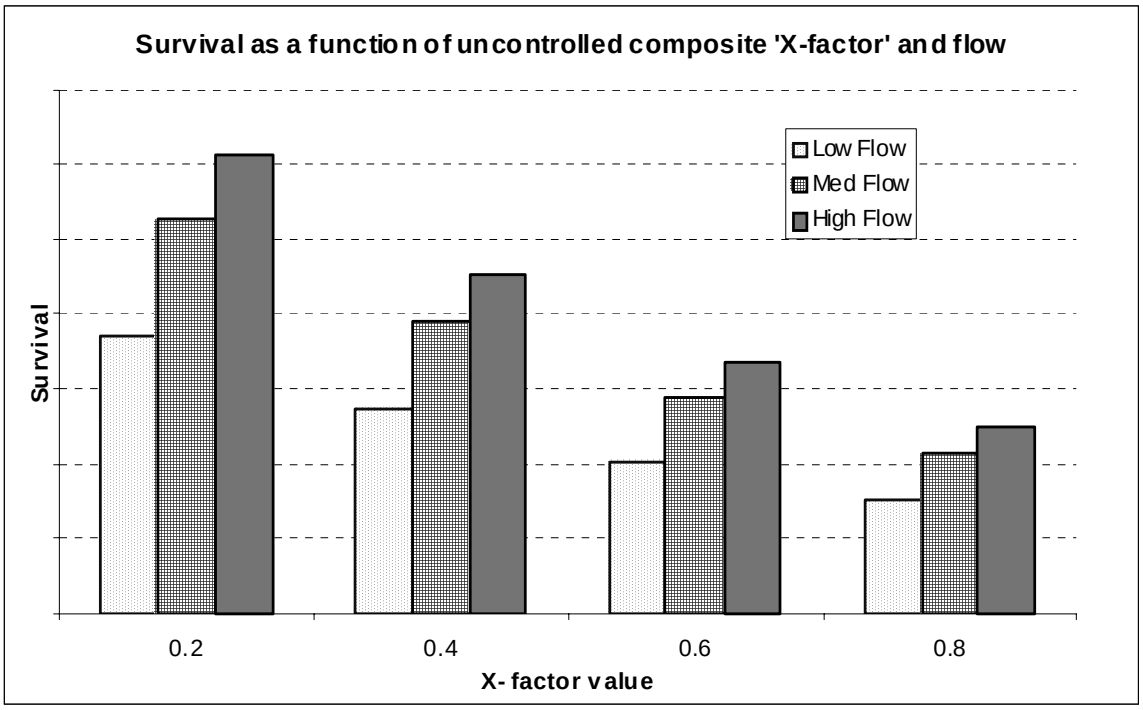


Figure 1. Hypothetical response of survival to composite uncontrolled factors and flow.

Given these caveats, we can look at how estimates of survival rates, from the 1970s through the most recent years, vary with water particle travel time (WTT). WTT is used as a surrogate for flow, since at constant reservoir volumes, there is a strong inverse correlation between flow volume and WTT, and because WTT estimates over reaches which include the Snake and Columbia rivers integrate the effect of flows in the relevant reservoirs. We plotted empirical survival rate-per-kilometer (s/km) estimates from NMFS studies against water travel time. The s/km and WTT values are derived from the longest reach estimate over which NMFS made a survival estimate in that year, and the length in km of that reach. Survival estimates in figures are standardized to the approximate length of hydrosystem (500 km). Flow values corresponding to selected points are shown in parentheses (Snake flow, Columbia flow) to place the variation in flow between years in context. Survival-per-km is a better index than per-project for

comparing survival rates among different years and different reach lengths In 2001, for example, per-project survivals for short reaches would have grossly overestimated survival through the entire hydrosystem (FPC 2002). An alternative method of comparing survival among years, using the data sets with consistent reaches over years demonstrated a relationship between flow and reach survival (FPC 2002).

Figure 2 shows data for yearling chinook, from the full time series. With data from the 1970s included, there is a significant survival /WTT relationship.

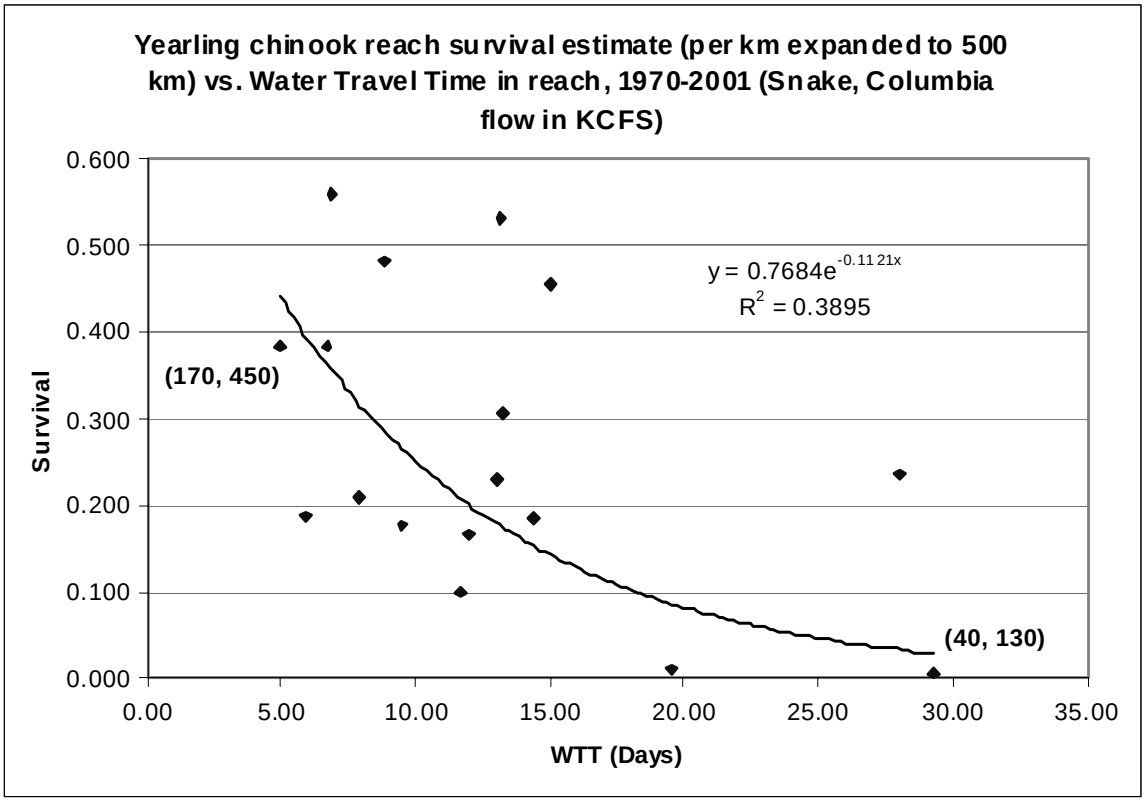


Figure 2.

The inclusion of data from 1970-80 is controversial, as some believe unique conditions in some of those years resulted in some low flow/low survival years that would not occur again. For yearling chinook, with the recent, PIT-tag data only, no survival/WTT relationship is apparent (Figure 3).

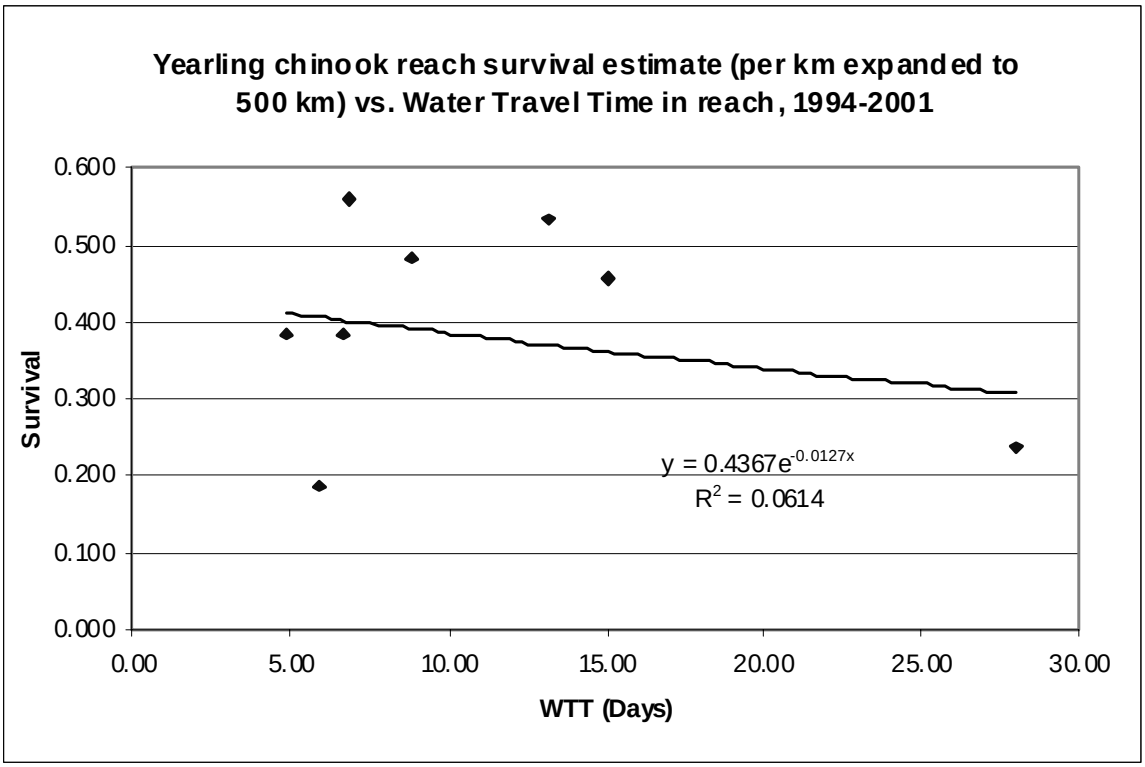


Figure 3.

Figure 4 shows the results for migrating steelhead with the full time series. A strong survival-WTT relationship is indicated.

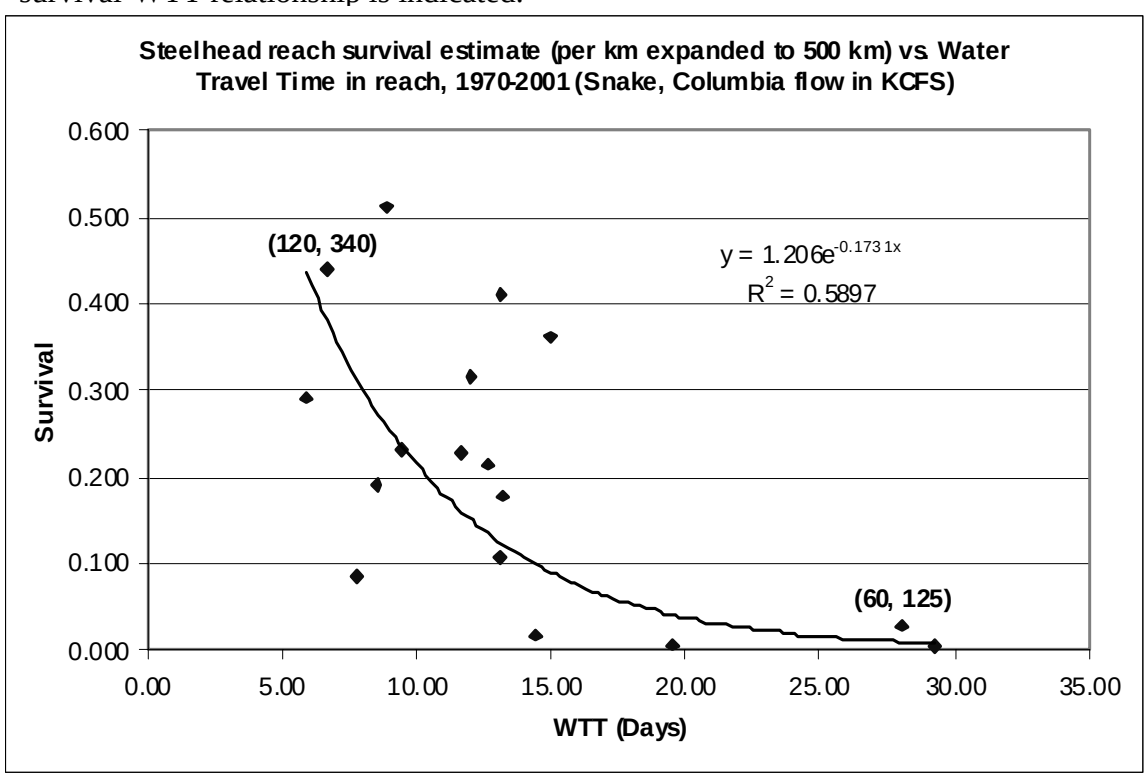


Figure 4.

When we exclude the older data, and use only the PIT-tag data, the survival-WTT relationship for steelhead seems even stronger (Figure 5).

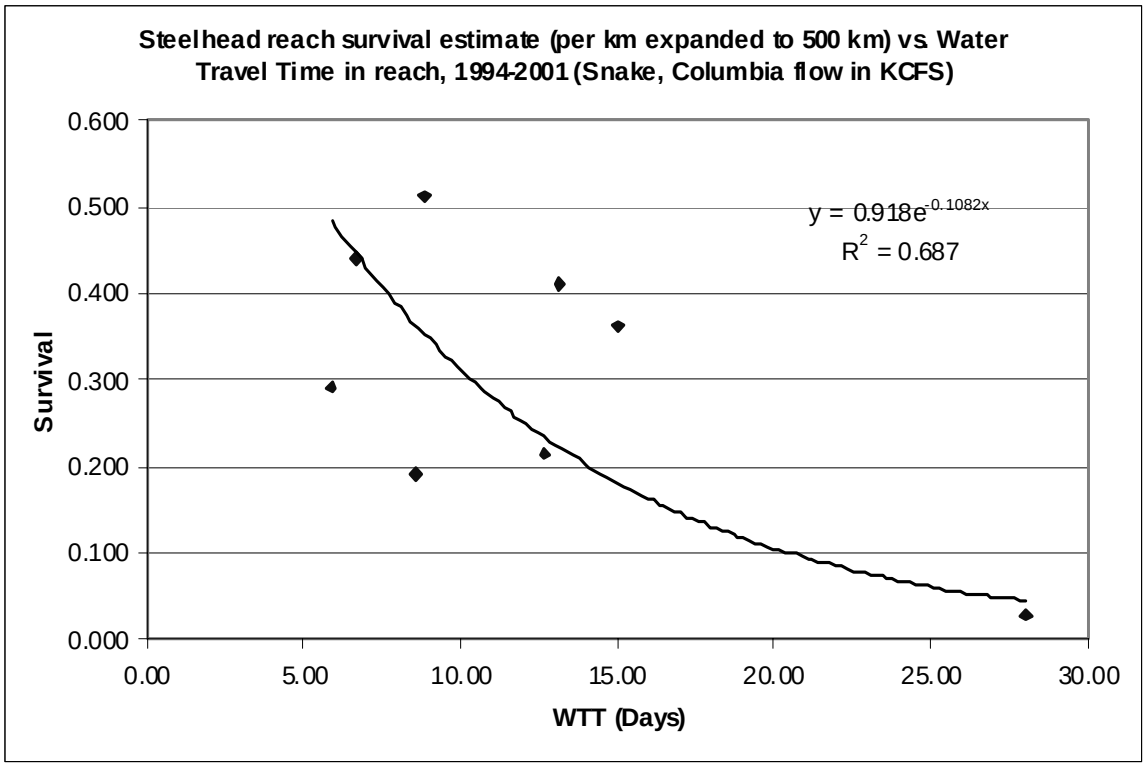


Figure 5.

A formal power analysis can be done for the data presented. Because no relationship was found for chinook using PIT-tag data only (Fig. 3), we perform an analysis of power to detect an exponential survival-WTT relationship on this data set. We assume a one-tailed hypothesis test on the slope of natural log of survival vs. WTT; i.e. the null hypothesis is that $b \geq 0$; and the alternative hypothesis is $b < 0$ (representing a positive relationship between flow and survival). The observed standard deviations of the X and Y values are used, with different levels of "true" underlying values of b. Power for the regression is estimated as in Zar (1984, section 19.4) using the correlation coefficient r (which is directly proportional to b if the ratio of standard deviations of X and Y is held constant). An alpha value (Type I error rate) of .05 is used. The results are shown in Figure 6 for the 8 years of PIT-tag data.

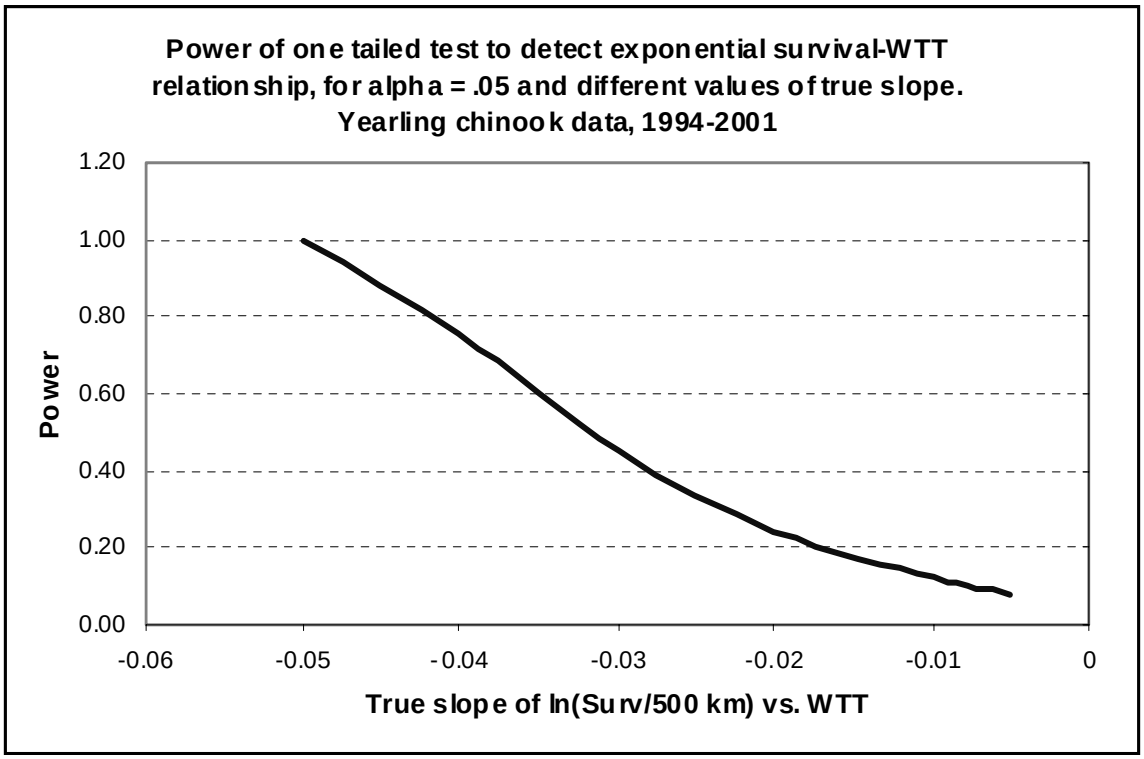


Figure 6.

A commonly accepted target value of statistical power to reject the null hypothesis at alpha = .05 is 80%. Figure 6 shows that this much power would not be expected unless the absolute value of the slope were greater than .04. In other words, there is a substantial chance that a true relationship of as much as -.04 is going undetected in the data. A *b* value of -.04 represents an additional 4% mortality for every additional day of water travel time.

The appropriateness of using data from the 1970s to help inform management of the hydrosystem today is in dispute. However, it is telling that, despite the inherent natural variability, anthropogenic sources of variability, and error in estimation of survival rates, leading to low statistical power to detect flow-survival relationships, three of the four relationships show a significant survival-WTT relationship. We also note that the figures presented fit a simple exponential curve to the data. Using a more realistic and flexible two-parameter curve, such as was used in FLUSH (one of the juvenile passage models used in PATH: Marmorek and Peters 1998), would doubtless result in higher R^2 for the cases where a significant relationship was found.

Another caution applies to the analyses above, and to any inferences made from the reported NMFS annual survival rates. There is a misconception among some in the region that annual reach survival estimates from PIT-tags are "primary data", not sensitive to assumptions or method of calculation. The Comparative Survival Study (CSS) has calculated reach survival estimates for yearling chinook and steelhead for the years 1994-2002 with a validated survival estimation program using raw PIT-tag data. CSS found that annual PIT-tag survival estimates are sensitive to the way that tag release groups at Lower Granite Dam are blocked within the season (i.e. daily blocks, weekly blocks, or longer periods). Calculating the season aggregate or using 3-7 time blocks (cohorts) sometimes gives very different values than using daily LGR cohorts, as NMFS does. Uncertainty about the best estimate of annual reach survival may hamper the ability to detect flow-survival relationships, and it should be acknowledged as a possible confounding factor when evaluating evidence for flow-survival relationships in PIT-tag data.

It's useful also to look at evidence for relationships between flow (WTT) and migration rate or travel time of spring migrants. Speeding up the journey through the hydrosystem is a candidate mechanism for increased flow leading to increased survival. Both historical and recent data provide strong, uncontroversial evidence of a flow-fish travel time relationship for yearling chinook and steelhead. For example, both passage models in PATH had strong positive fish travel time-WTT relationships, despite the fact that the survival-fish travel time relationships in the models differed substantially (Marmorek and Peters 1998). NMFS (2000) found "A strong and consistent relationship exists between flow and travel time for spring migrants. Increasing flow decreases travel time." Smith et al. (2002) found that for both chinook and steelhead, travel time strongly correlated with flow volume. These findings that spring migrating smolts appear to rely on swiftly moving water to get downstream is consistent with evolutionary life-history strategies of both species in their natural environment.

Given that WTT (and hence flow) is closely linked to fish travel time, a hypothesis about existence or strength of flow-survival relationship necessarily implies a hypothesis about whether or how much mortality rate (or survival rate) changes with time in the system. In PATH, this was a key point of controversy: disagreement between the two passage models revolved around the rate of mortality. In CRiSP the daily rate of mortality was essentially constant over time while in FLUSH the rate of mortality increased the longer fish are in the river (Marmorek and Peters 1998, Section 4.2, WOE Submission 14). Whether mortality rate increases with time, or stays constant with time, there will be a flow-survival relationship since fish travel time is directly proportional to water travel time. This is because under either assumption, total mortality increases with time, and since over a fixed distance, faster water velocity results in fewer days spent in the hydrosystem, there will be less mortality when flows are higher (all else being equal). In contrast, the hypothesis that there is no flow-survival relationship necessarily implies that, on average, daily mortality rate increases with flow, since in years with higher flows fish are traveling faster but experiencing the same total mortality (all else being equal) through the system as at lower flows.

A graph of the form of the relationship between daily mortality rate and WTT (flow) for the three hypotheses is shown in Figure 7. The FLUSH hypothesis, of course, results in a fairly strong survival-WTT relationship, when the increasing daily mortality rate combines with the fish travel time-WTT relationship. The CRiSP constant mortality hypothesis also results in a survival-WTT relationship because of the fish travel time-WTT relationship, though not as strong as in FLUSH. The hypothesis which reflects the assumption of no-flow survival relationship (No Q-S) requires that daily mortality rate increases with flow.

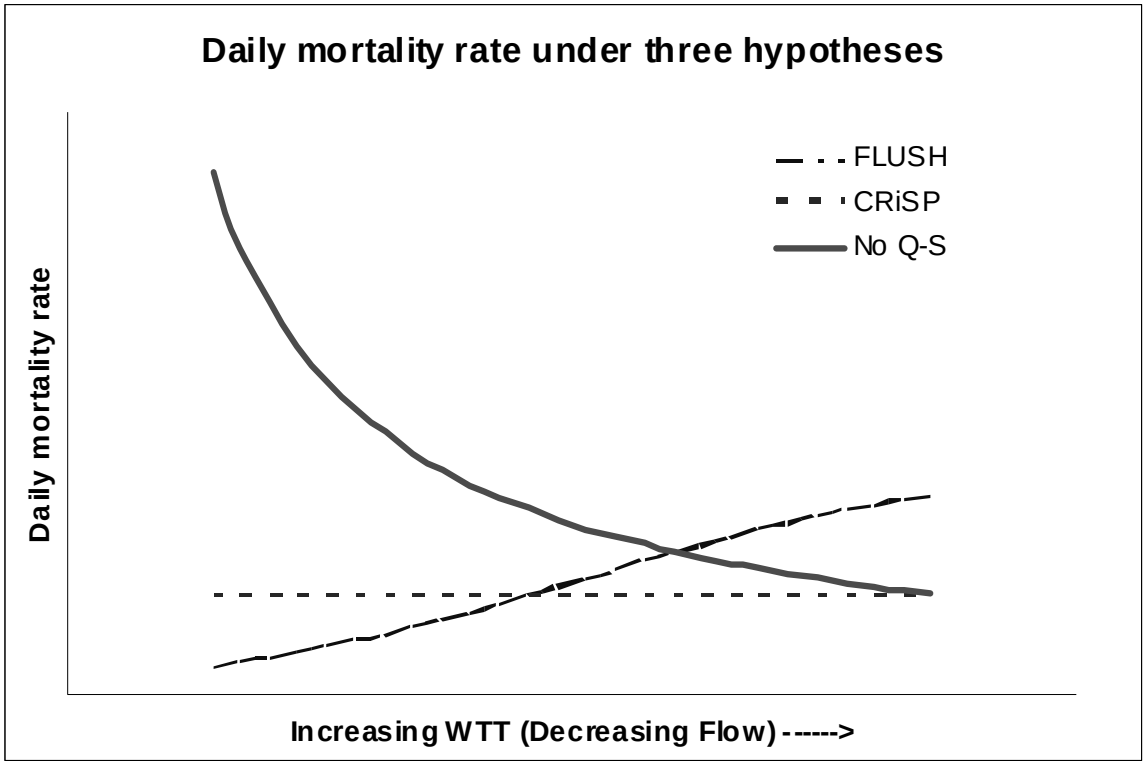


Figure 7.

The "no flow-survival" hypothesis implies specific hypotheses about the interaction of the fish and the biological and physical environment. These hypotheses must be true for survival to be independent of flow, given that fish move faster as flow increases. The overall set of hypotheses has been termed the "gauntlet" hypothesis. For the gauntlet hypothesis to be true, mortality agents the fish face in the hydrosystem must not be, on average, appreciably affected by the amount of flow. This requires that:

- Predator *distribution* is not modified so as to alter consumption rates
- Predator *behavior* is not modified so as to alter consumption rates
- Predator consumption rates are not related to prey migration speed (i.e. encounter time not related to consumption rate)
- Exposure of smolts to increased temperatures under low flows (due to migration extending longer into season) does not affect consumption rates
- Exposure to increased temperatures does not increase smolt mortality from sources other than predation
- Survival per day must be higher in low flow years than in high flow years

Using the available survival and fish travel time data, we can evaluate evidence for the no flow-survival hypothesis, versus for those which imply a positive relationship between flow and survival. To do this, we need to use data from a consistent reach; otherwise variations in the rate of survival (or mortality) per day between years could be attributable to differences in the reaches traversed, rather than any relationship between flow and mortality per day. We use published estimates of annual survival rates and median travel times for primary release groups from the PIT-tag studies, for both yearling chinook and steelhead. The reach over which survival was estimated has included more projects as PIT-tag detectors have been installed at lower river dams. However, the longest reach (Lower Granite Dam to Bonneville Dam) has been available for only the last few years. From 1995 to 2001, for both chinook and steelhead, survival estimates were made for the reach from LGR Dam tailrace to McNary Dam and this was the reach used (estimates were made from LGR to Lower Monumental Dam in 1994 as in other years; however this reach was judged too short to give relevant information). In years when travel times were estimated from LGR to MCN dam, annual median travel time is estimated by weighting each release group's median by the group's proportion of the total number of PIT-tagged fish released at LGR dam. In the other years (1995 for both chinook and steelhead and 1996 for steelhead), weighted median travel times from Port of Wilma to MCN and from Port of Wilma to LGR were estimated, and the latter subtracted from the former to come up with median LGR to MCN travel time. Survival rate per day was then calculated by taking the tth root of LGR to MCN survival rate, where t is LGR to MCN median fish travel time. Daily mortality rate is 1 – daily survival rate.

Table 1 shows the data sources for survival rate and travel time estimates. The results of the mortality rate calculations plotted against spring migration water travel time estimates are shown in Figures 8 and 9.

Table 1. Sources of data used in mortality per day analysis: reference (table numbers).

Year	Chinook survival rate	Chinook travel time	Steelhead survival rate	Steelhead travel time
1995	1 (2)	2 (D1, D9)	1 (2)	2 (D2, D10)
1996	1 (2)	3 (19, D3)	1 (2)	3 (C1, C5)
1997	1 (2)	4 (11)	1 (2)	4 (9)
1998	1 (2)	5 (25)	1 (2)	5 (23)
1999	1 (2)	6 (26)	1 (2)	6 (28)
2000	7 (1)	7 (27)	7 (10)	7 (31)
2001	8 (1)	8 (27)	8 (10)	8 (31)

1 Williams et al. (2001)
2 Muir et al. (1996)
3 Smith et al. (1998)
4 Hockersmith et al. (1998)
5 Smith et al. (2000a)
6 Smith et al. (2000b)
7 Zabel et al. (2001)
8 Zabel et al. (2002)

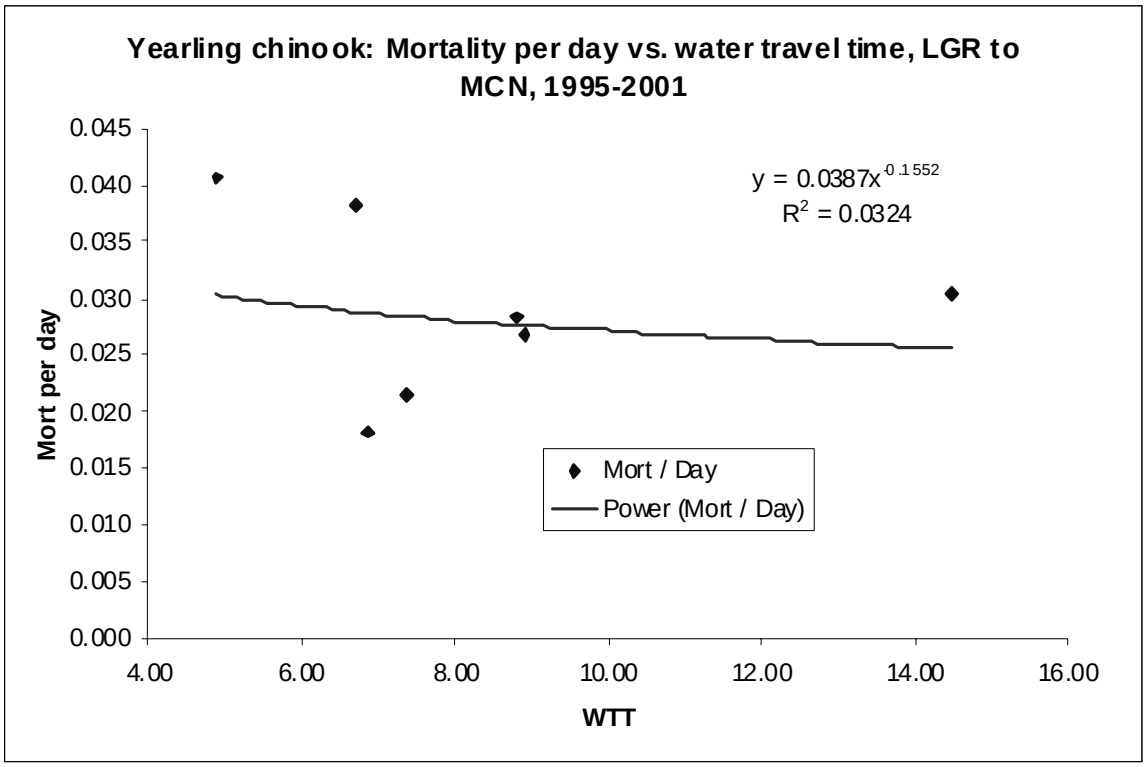


Figure 8.

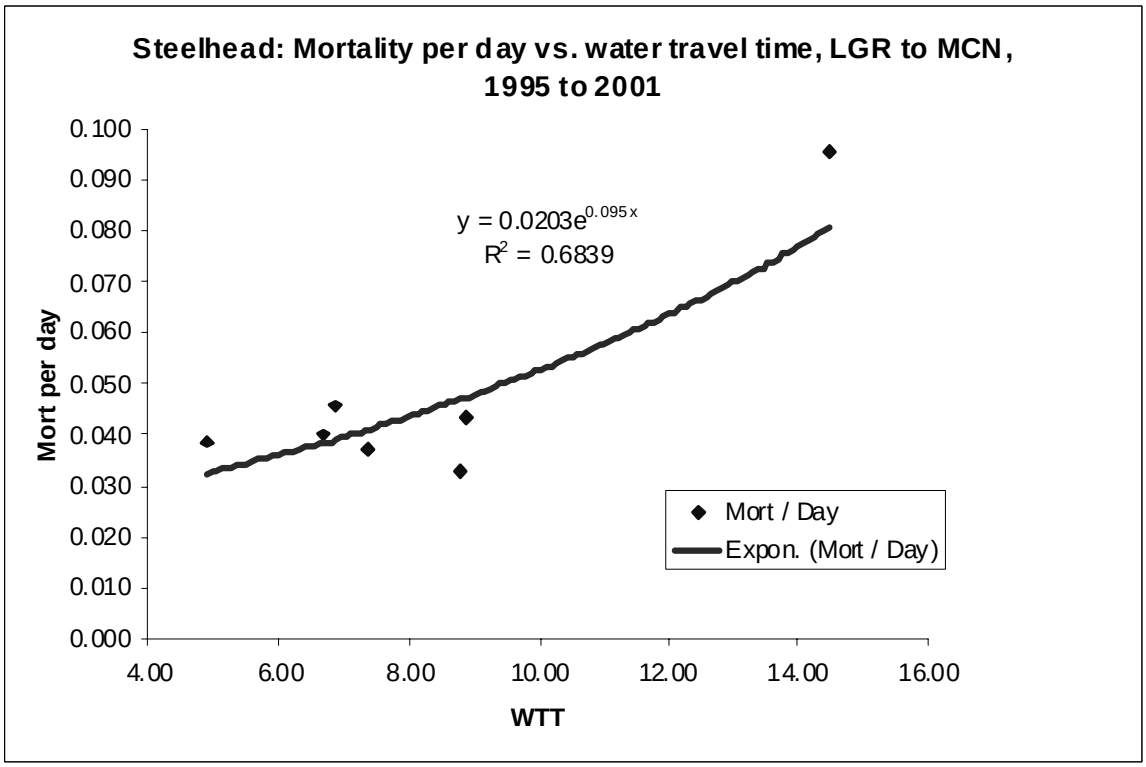


Figure 9.

The trend line fitted for chinook in Figure 8 is a power curve. If the no flow-survival hypothesis were correct, we would expect mortality per day as a function of water travel time to tend to follow a power curve with a negative exponent. The low R^2 suggest that the data do not follow this kind of curve, and the no-flow survival relationship hypothesis is not supported. With steelhead (Fig. 9), fitting a power curve gives a positive exponent. An exponentially increasing trend (shown) fit the data even better. The steelhead data also do not support the no flow-survival hypothesis, and in fact show evidence of mortality rate increasing, rather than decreasing, with time.

A weight of evidence process that compared the evidence for the different hypotheses could be undertaken. This would include any empirical information from the river system under discussion, as well as evidence from the general literature about the mechanisms affecting chinook, steelhead, and related species in other systems. The last bullet point above was examined here using annual survival rates and weighted annual median travel times from the annual reports of NMFS survival studies and CSS PIT tag studies.

Finally, apart from the question of whether there is an observable, or expected, relationship between flow and survival of juvenile migrants within the hydrosystem, there are other reasons to be cautious about abandoning flow targets. These include the appropriate placement of the burden of proof (discussed earlier), effects to survival outside of the hydrosystem (discussed elsewhere), the precautionary principle, and the wisdom of a formal decision analysis removed from the traditional null/alternative hypothesis testing format. A rigorous weight of evidence approach would include findings and considerations from previous work, seen in the context of the species' entire life cycle and the greater management framework. Sample considerations can be found in the NMFS white paper on flow and survival (NMFS 2000):

- "Thus, higher flows, while decreasing travel time, may also improve conditions in the estuary and provide survival benefits to juvenile salmonids migrating through the estuary or the Columbia River plume. By reducing the length of time smolts are exposed to stressors in the reservoirs, higher flows also likely improve smolt condition upon arrival in the estuary."
- "Since a migration rate/flow relationship has been established repeatedly for spring migrants, the focus of flow augmentation in the spring should be to decrease travel times and hence shift arrival timing in the estuary closer to historical timing, with the assumption that arrival timing has been under evolutionary control."
- "Certainly, increased flows, particularly when base flows are low, will not harm spring migrants. Given the critical levels of many spring migrating stocks, continuing the flow augmentation program is consistent with a 'spread the risk' strategy."

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Additional analysis for response to ISAB report 2003-1, Review of Flow Augmentation: Update and Clarification

We extended the analysis performed in Appendix A of these comments ("US Fish and Wildlife Service review of the Northwest Power and Conservation Council's approach to the flow-survival relationships for spring migrant juvenile salmon and steelhead contained in the draft Mainstem Amendments to the Columbia River Basin Fish and Wildlife Program", February 4, 2003) to perform the tests for a flow-survival relationship suggested in Appendix 4 of the ISAB report. The data used and sources are the same as in our Appendix A, pages 10-13. Here we assume an exponential decay of survival rate with travel time (Eq. 3 of ISAB Appendix 4), which allows estimation of an instantaneous mortality rate (μ) for each study year. Regressing annual estimates of μ against annual water travel time estimates is a practical test of the hypothesis that flow and instantaneous mortality are linearly related, as suggested by the ISAB in Eq. 8 of Appendix 4. Water travel time is used instead of flow for reasons provided in our Appendix A (e.g. it integrates the effect of the different flows in the Snake and Columbia rivers, which is necessary because the test reach extends from Lower Granite dam to McNary dam).

The results are displayed in Figures 1 and 2. Figure 1 shows no relationship between μ and WTT ($p = 0.72$) for yearling chinook; Figure 2 shows an apparent positive relationship between μ and WTT ($p = 0.01$) for steelhead. As expected, these results closely mimic the results for daily mortality rate in Figures 8 and 9 of Appendix A, and suggest the same conclusions: the available evidence provides no reason to reject the null hypothesis of constant mortality rate for chinook, but does provide reason to reject the null hypothesis for steelhead in favor of a mortality rate that increases with water travel time (i.e. increases as flow decreases). In other words, the analysis for chinook supports the ISAB's contention that the available data are suggestive of the null model, with no relationship between flow and instantaneous mortality rate. The steelhead analysis does not support this contention. In both cases, a positive flow-survival relationship is supported, as fish migration speed through the hydrosystem is strongly and positively related to flow. The alternative hypothesis of no flow survival relationship would require instantaneous mortality rates to increase as flows increased, contrary to this empirical evidence on survival and fish travel time.

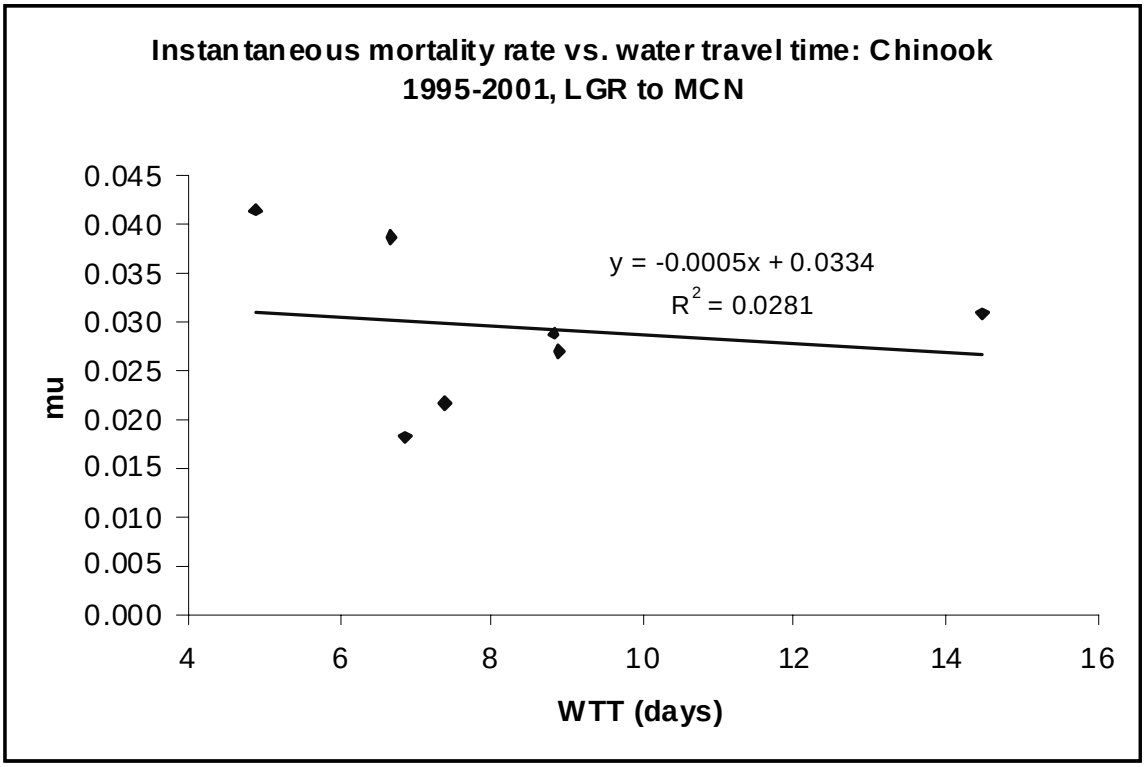

Figure 1.

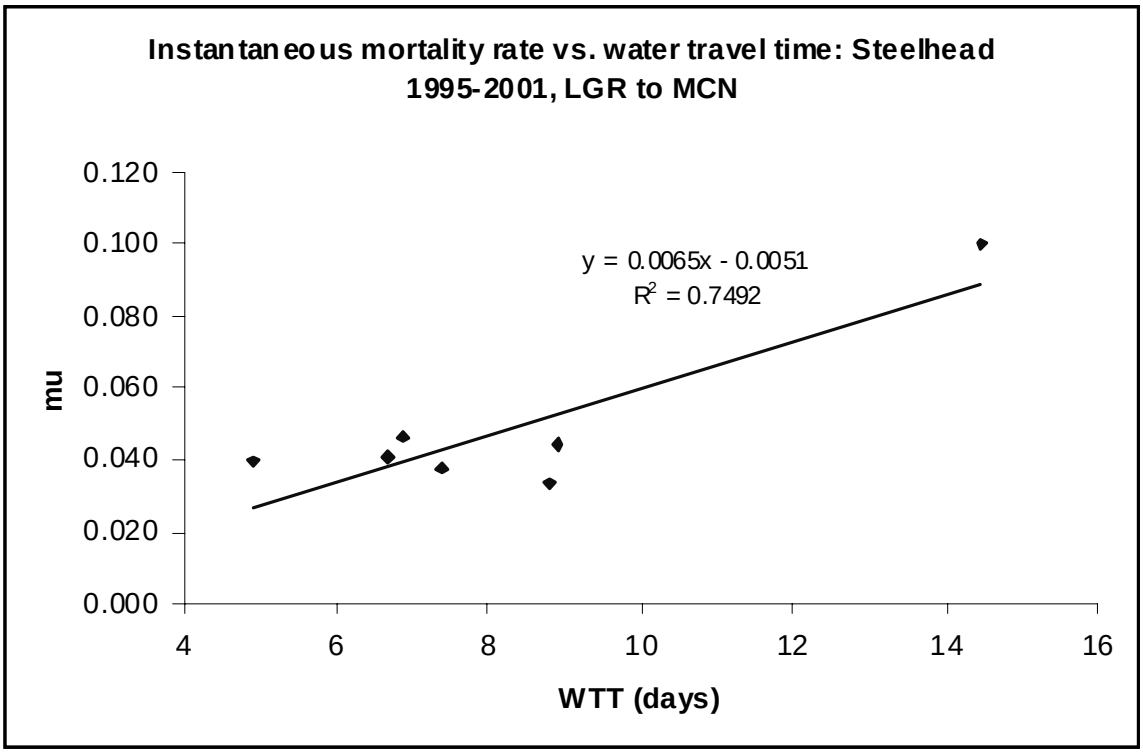

Figure 2.

ATTACHMENT 2. January 13, 2003 letter to Dr. Richard Whitney

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January 13, 2003

Dr. Richard Whitney
Independent Scientific Advisory Board
Northwest Power Planning Council
851 SW 6th Avenue, Suite 1100
Portland, OR 97204-1348

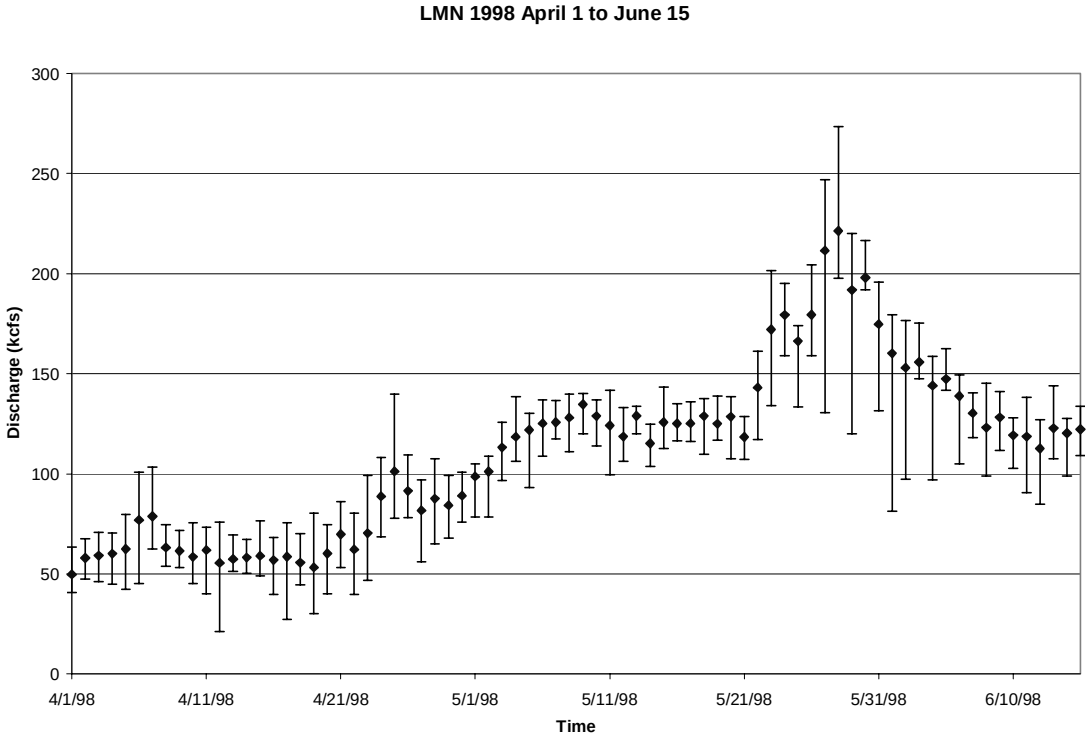
Dear Dick,

This letter is in response to your data request to the Fish Passage Center. On December 17th, 2002 the Fish Passage Center staff, together with other fishery agency technical staff, met with the ISAB relative to some recently conducted analyses of flow and fish survival. Subsequent to the meeting you contacted the Fish Passage Center and requested that we explore the relation between flow and juvenile survival using minimum flows during the migration period rather than the average daily flows that we used to calculate water transit time in our analyses.

Input Data:

The following graphs depict the range of flows observed for each daily average flow observed during the migration seasons used in our analyses (1998-2002) at Lower Monumental Dam. We chose Lower Monumental as the reference point since it is the mid point of the migration corridor. The minimum for each day is the lowest hourly average within the 24-hour period. Similarly the maximum is the highest hourly value for that same 24-hour period.

You will note from the graphs that the minimum flow varies in the same pattern as the average flow. This is true for the relation between the average flow and the maximum flow. The correlation between the minimum daily flow and the average flow has an $r^2 = 0.95$ and for the maximum daily flow and the average daily flow the $r^2 = 0.98$. We would anticipate that given the high correlations among the maximum, minimum and the average, we would get the same relations regardless of which measurement we choose.


LMN 1998 April 1 to June 15
Discharge (kcfs)
300
250
200
150
100
50
0
4/1/98
4/11/98
4/21/98
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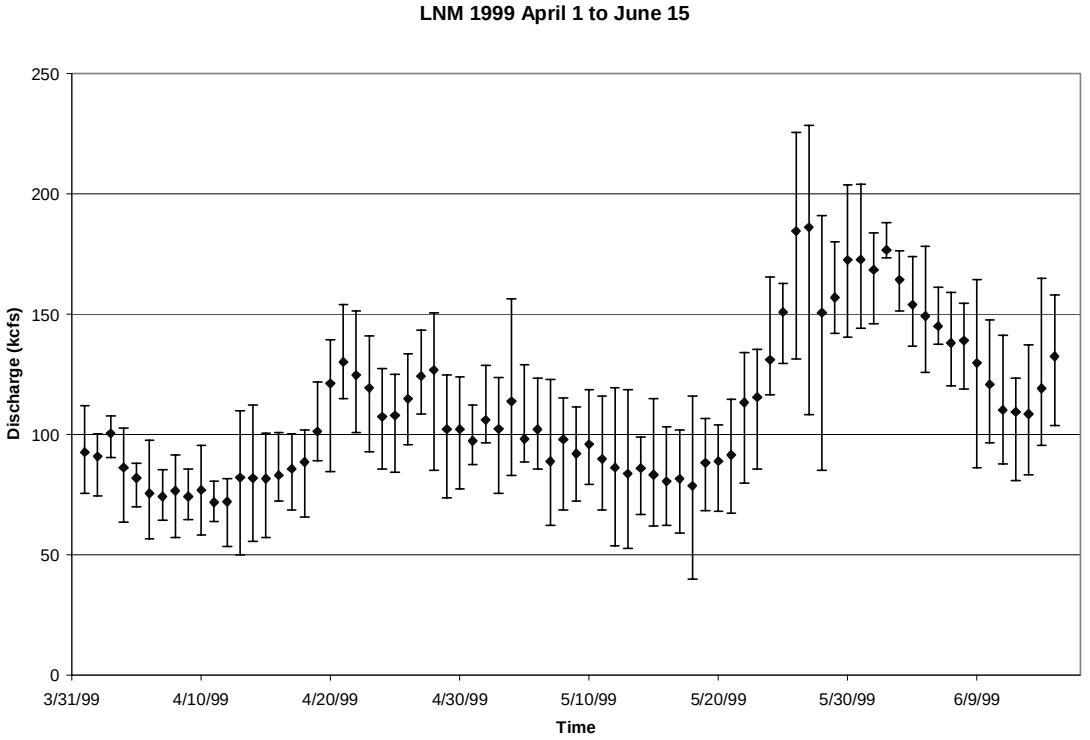
5/31/98
6/10/98
Time


LNM 1999 April 1 to June 15
Discharge (kcfs)
250
200
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0
3/31/99
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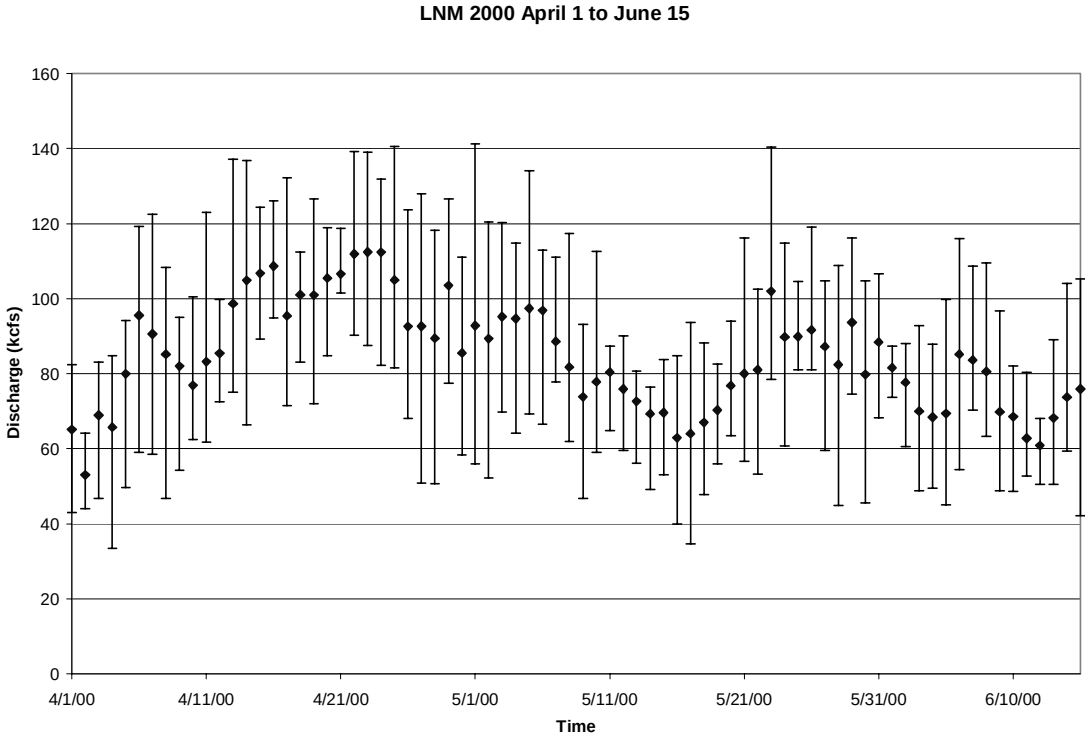
Time


LNM 2000 April 1 to June 15
Discharge (kcfs)
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140
120
100
80
60
40
20
0
4/1/00
4/11/00
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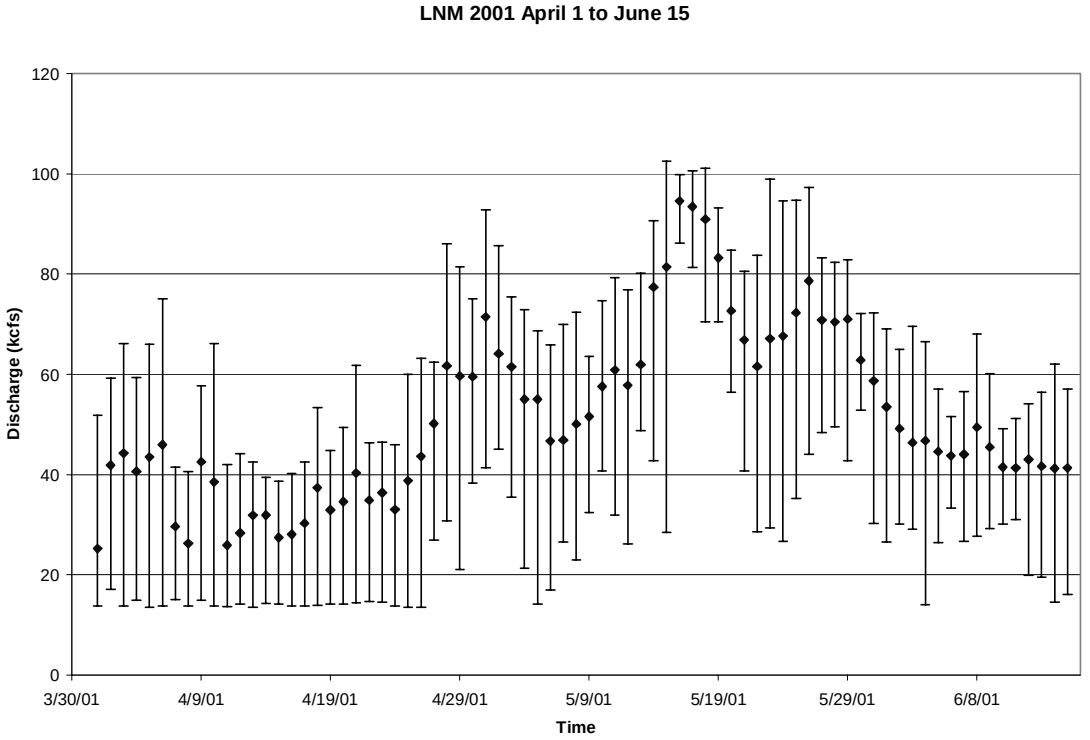
Time


LNM 2001 April 1 to June 15
Discharge (kcfs)
120
100
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0
3/30/01
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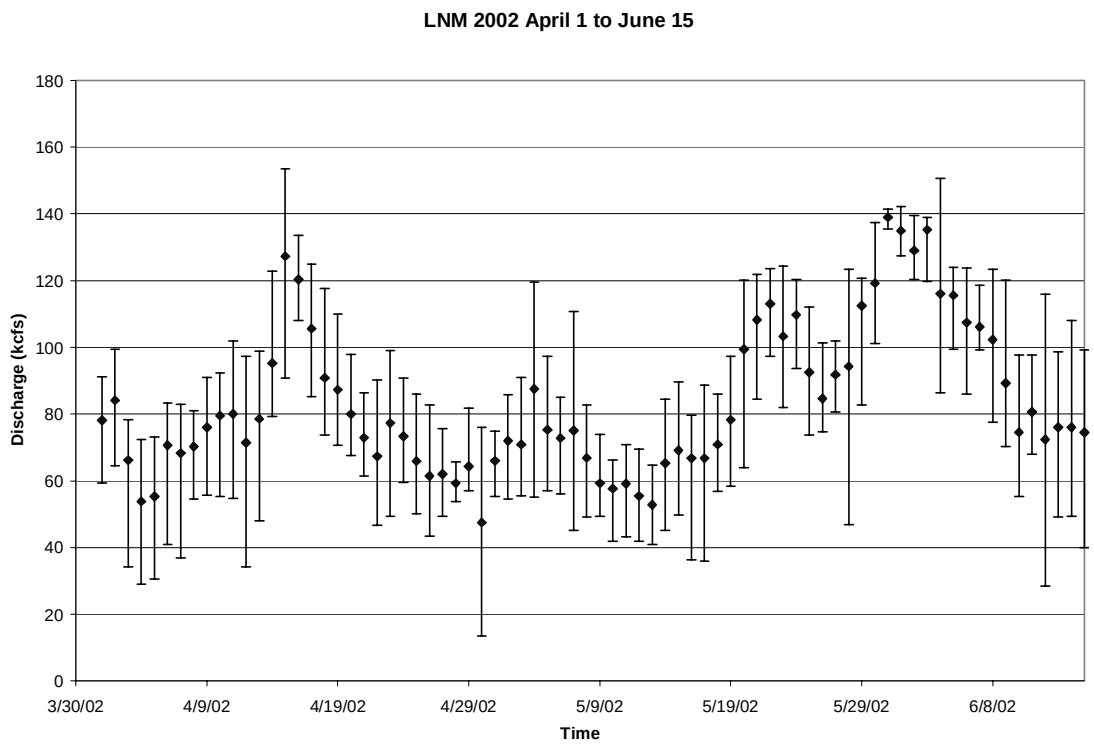
Time



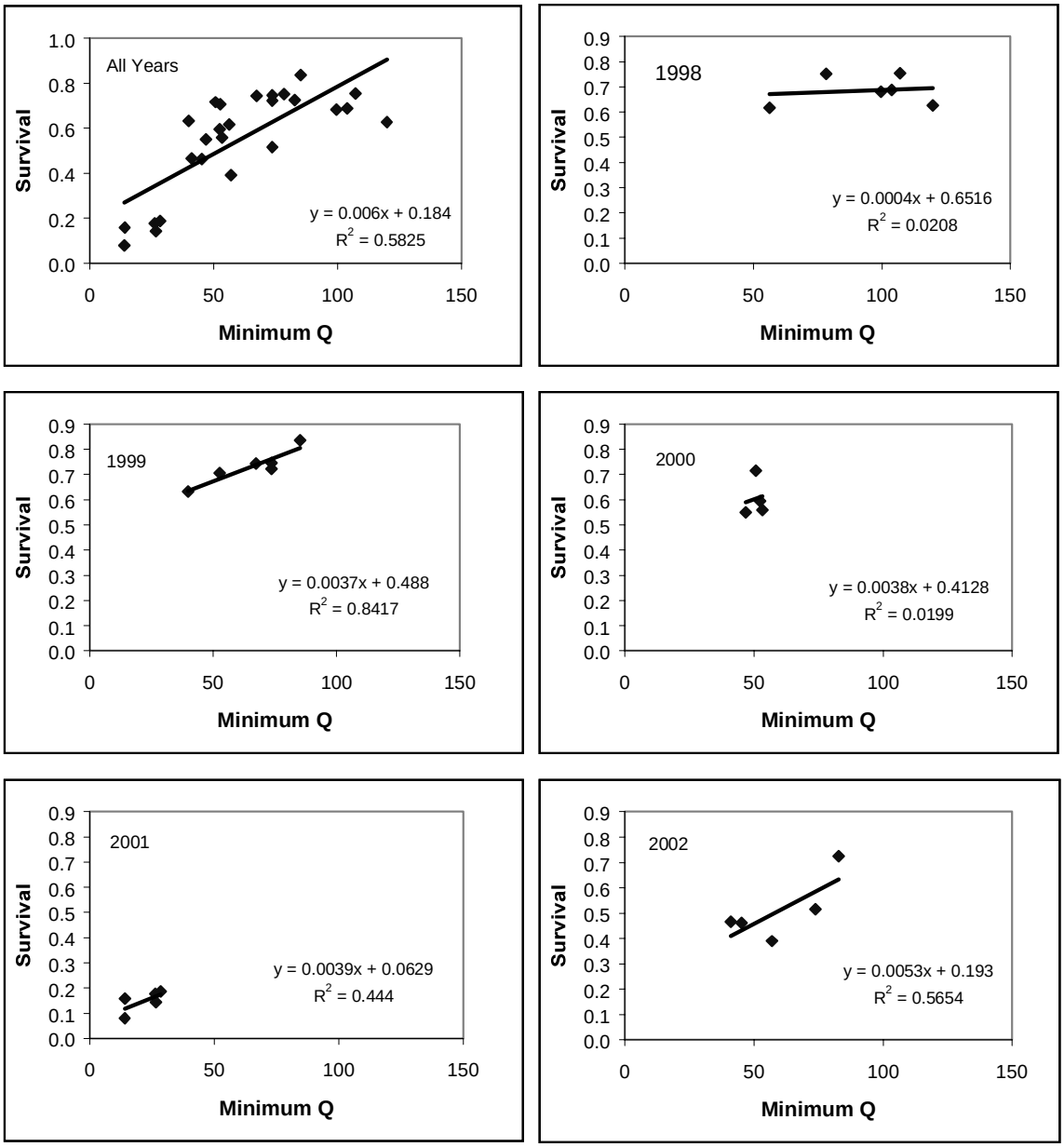
Analysis:

We initially conducted the analysis using our steelhead groups, since in our original study steelhead exhibited the most significant relation to water transit time. We looked at the relation between flow and juvenile survival using:

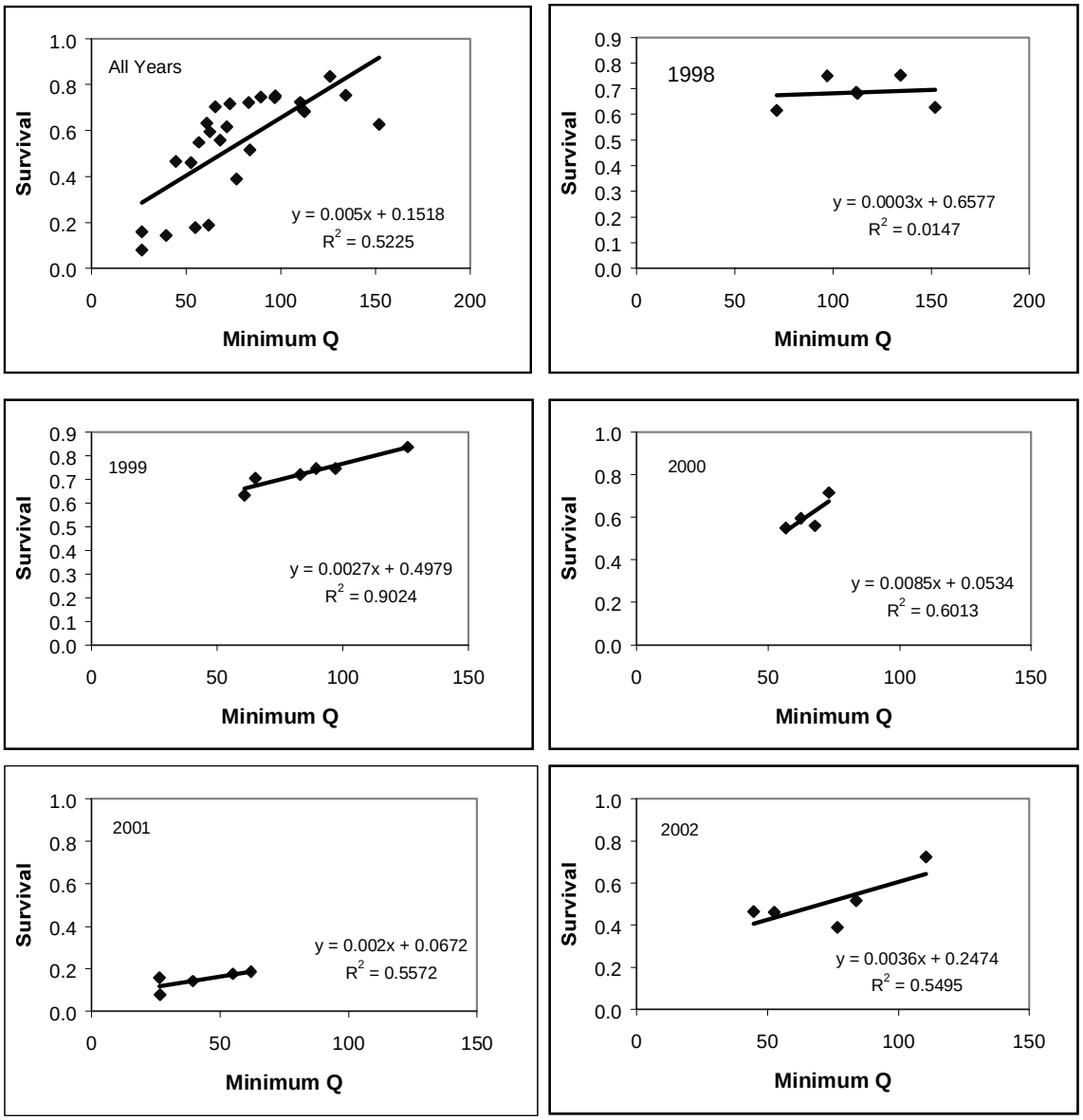
1) the minimum hourly flow observed during the time period;
2) a weekly average of the minimum hourly flows observed in a day;
3) the average of the daily flows for the period;
4) the maximum hourly flow observed during the time period;
5) a weekly average of the maximum hourly flows observed in a day.

The following pages summarize for steelhead the relation observed using each characterization of flow for all survivals observed for all years combined and for each year separately.

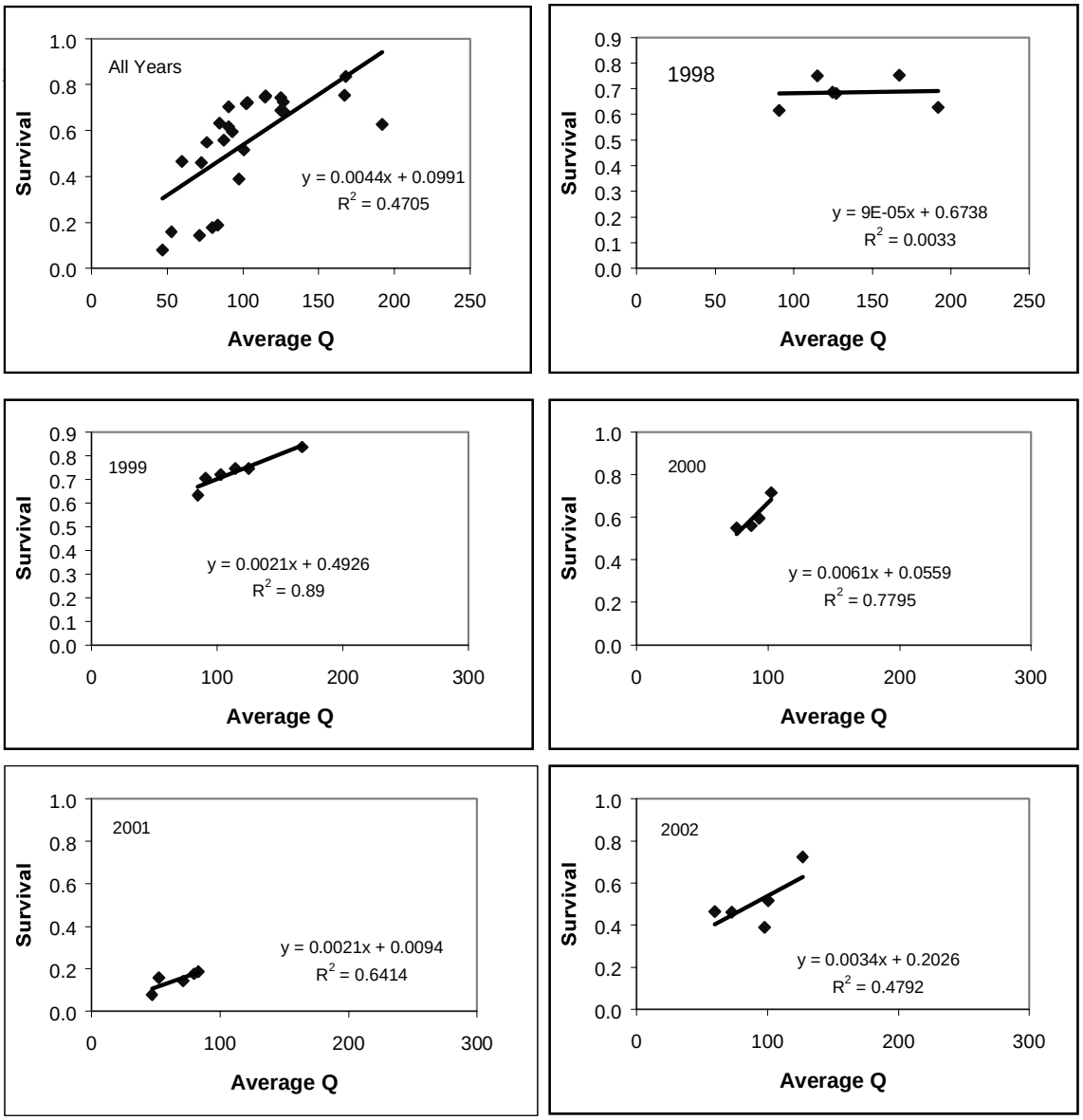
Steelhead Survival LGR to MCN versus Minimum Q at Lower Monumental Dam



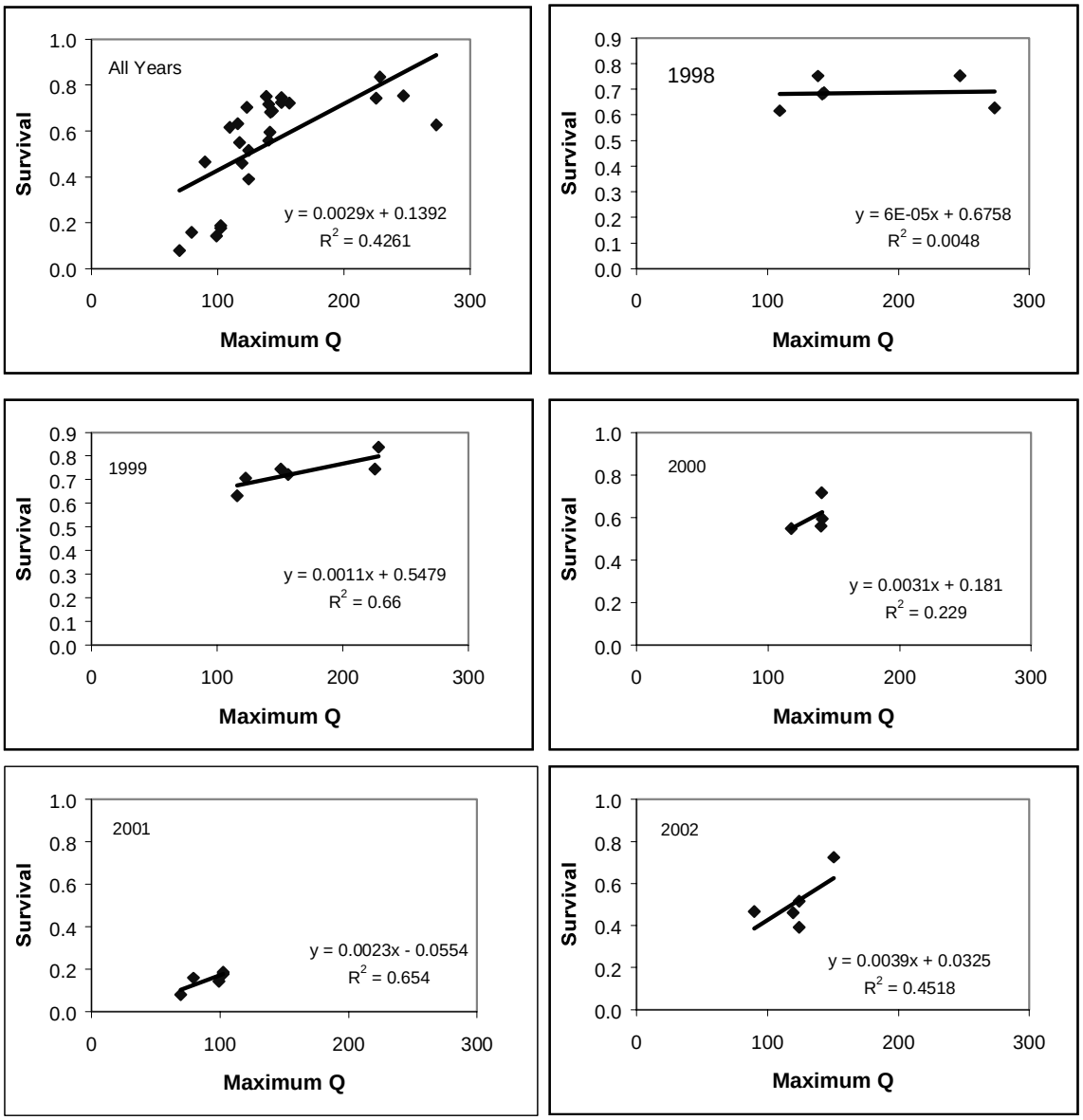
Steelhead Survival LGR to MCN versus Weekly Avg MinQ at Lower Monumental Dam



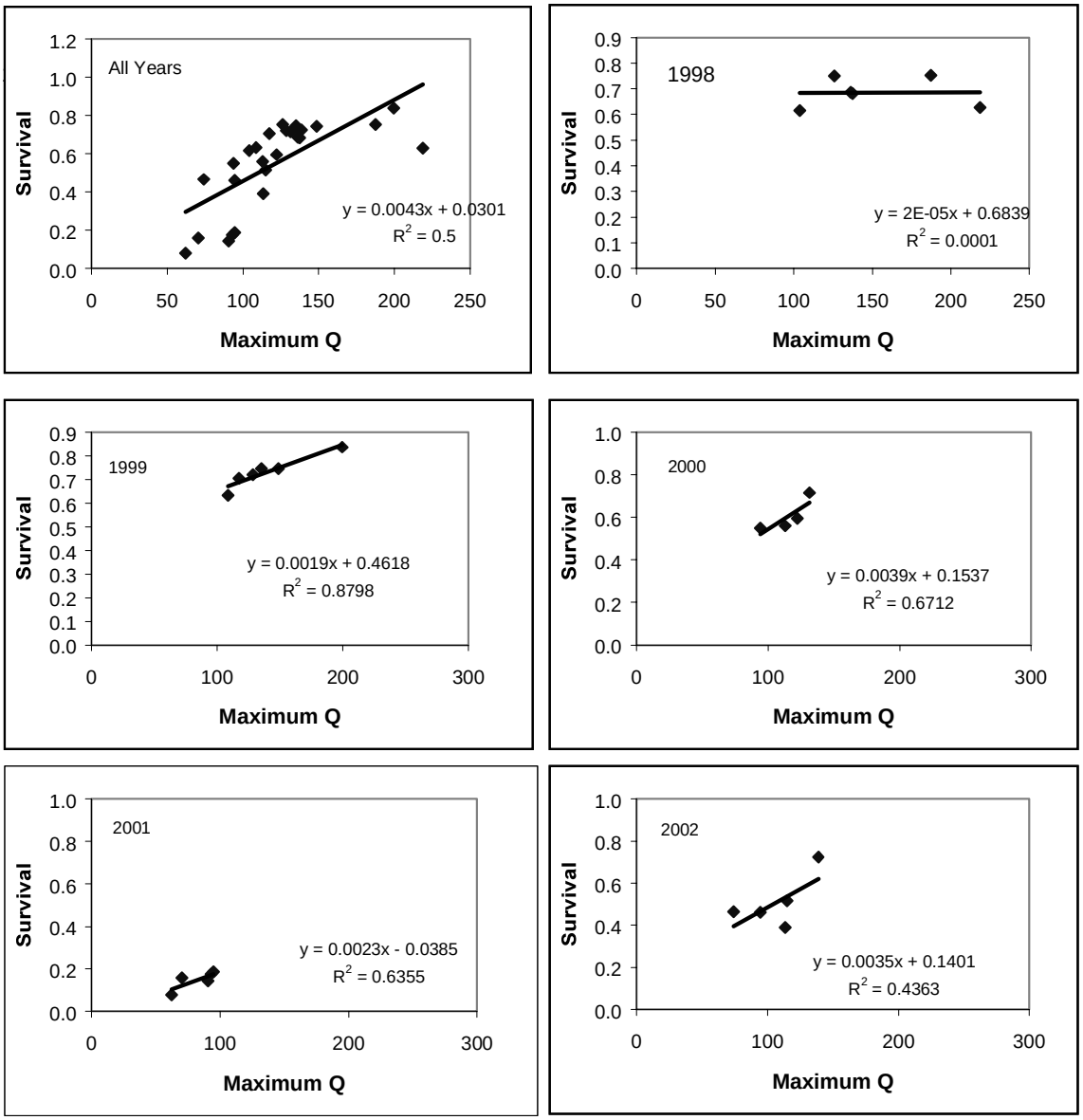
Steelhead Survival LGR to MCN versus Weekly Avg Q at Lower Monumental Dam



Steelhead Survival LGR to MCN versus Maximum Q at Lower Monumental Dam



Steelhead Survival LGR to MCN versus Weekly Avg MaxQ at Lower Monumental Dam



Conclusions:

We performed the requested analysis on the steelhead survival for the Lower Granite to McNary Dam river reach. These data showed the highest relation to water transit time in our original analysis. The flows were indexed to Lower Monumental Dam as representative of flow in the reach. We also looked at some yearling chinook data, which showed similar results.

The Biological Opinion calls for the Snake River reservoirs to operate under a restricted elevation range during the juvenile fish migration, which can only vary up to one foot above the minimum operating range (MOP). The result of this action restricts the daily fluctuations that occur in river flow, which is evidenced by the high correlation of maximum and minimum flow with average flow. When the Biological Opinion measures were developed for flow targets an average sliding scale of 85-100 Kcfs was chosen for Lower Granite Dam. This was based on past information that incorporated daily load following and fluctuations in flow.

We see no evidence in this information to suggest that anything other than the average flow in the present hydrosystem configuration determines survival for Snake River migrants. The results obtained for the minimum flow reflect the results obtained for average flow. However, it could not be expected that the same results would be obtained if the hydrosystem were operated consistently at a lower flow. As we said in our original analyses a full range of flows is necessary to show the relation between water transit time (or flow) and survival and this is best demonstrated when all years of data are combined. Within year flow and survival relations are difficult to show due to the overlap in time of smolt release groups.

We recognize that flow fluctuations and minimum flows play an important role in the survival of emerging Hanford Reach fall chinook. Similar operating range restrictions are not required for the Mid Columbia projects and, consequently, wide fluctuations in daily flow occur that have been documented as a factor in stranding emergent fall chinook. However, Snake River migrants are not prone to the same stranding issues because of several differences that exist including the general age and size of the juvenile migrants, the geology of the area (more steep sided reservoirs) and the restrictions on hydrosystem operating ranges.

We hope these analyses are of help to you in your review of the NWPPC proposed amendments.

Sincerely,

Michele DeHart

Michele DeHart
Fish Passage Center Manager

Attachment 3. Written response to the questions posed by ISAB prior to December 17th 2002 meeting with ISAB, which were responded to orally at the meeting.

FISH PASSAGE CENTER

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January 10, 2003

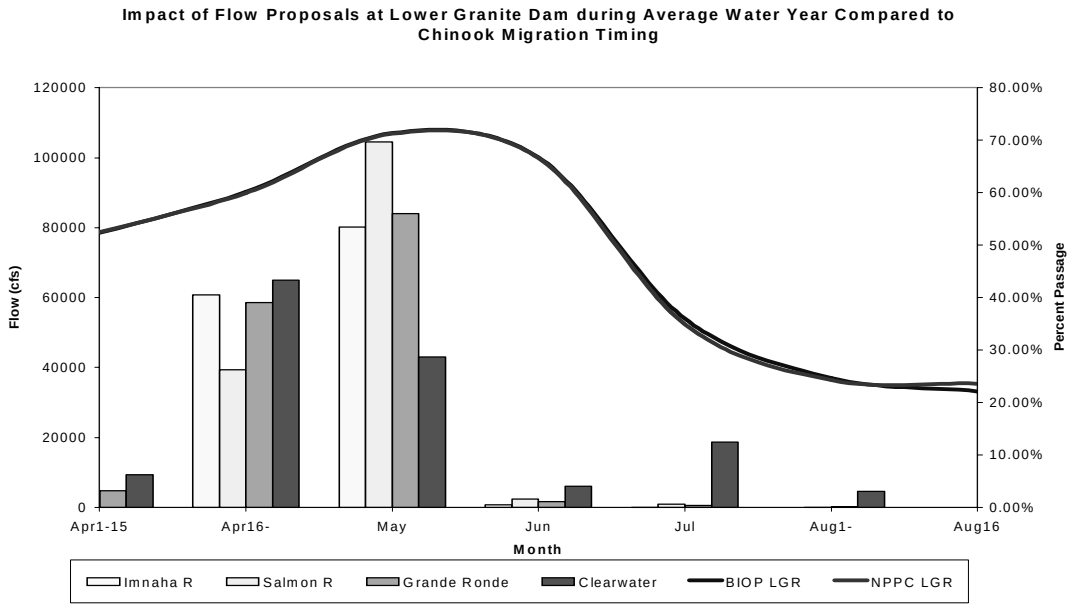
Independent Scientific Advisory Board
Northwest Power Planning Council
851 SW 6th Avenue, Suite 1100
Portland, OR 97204-1348

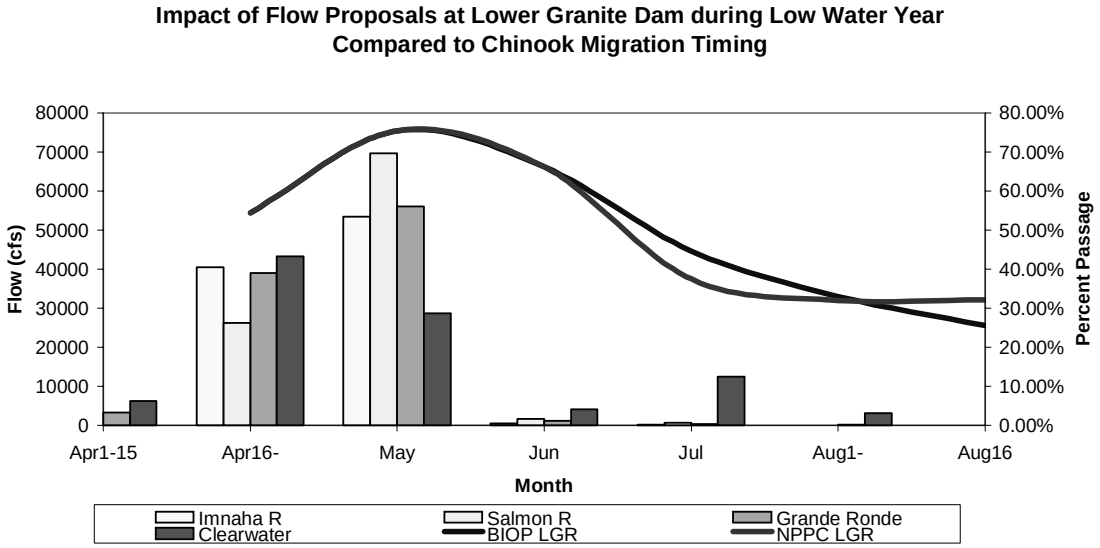
Dear ISAB Members,

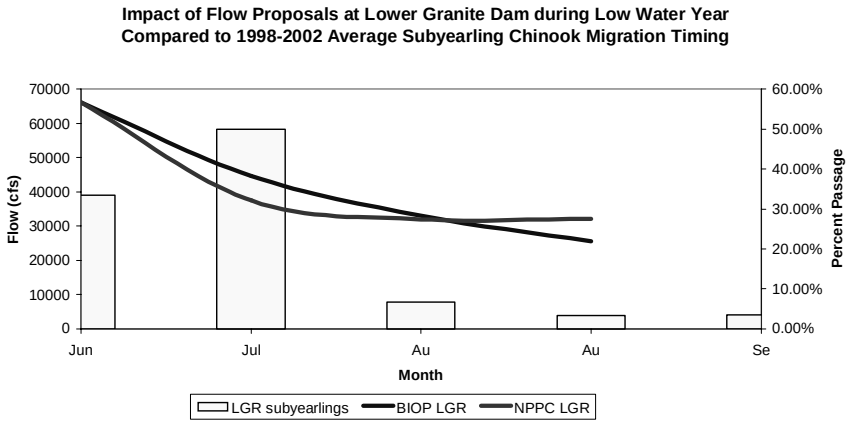
On December 17, 2002 a group of fishery agency and Fish Passage Center staff met with the Independent Scientific Advisory Board (ISAB) to discuss the comments developed by the State, Federal, and Tribal Anadromous Fish Managers on the Northwest Power Planning Council's (NWPPC) Draft Mainstem Amendments as they Relate to Flow/Survival Relationships for Salmon. A series of questions were developed by the ISAB prior to the meeting and the attendees responded to those questions during the meeting. As a follow up to the meeting we are providing a written response to the questions (Attachment A).

Additionally, at the meeting we expressed concern regarding the range of timing exhibited by the different stocks of salmon. We told the ISAB that we would provide them with that information for consideration during their present review. The following graphs depict the timing of specific stocks together with the flows that occur under low and average flow levels for the 50 year historic record, both under the implementation of the Biological Opinion and under the proposed NPPC amendments.

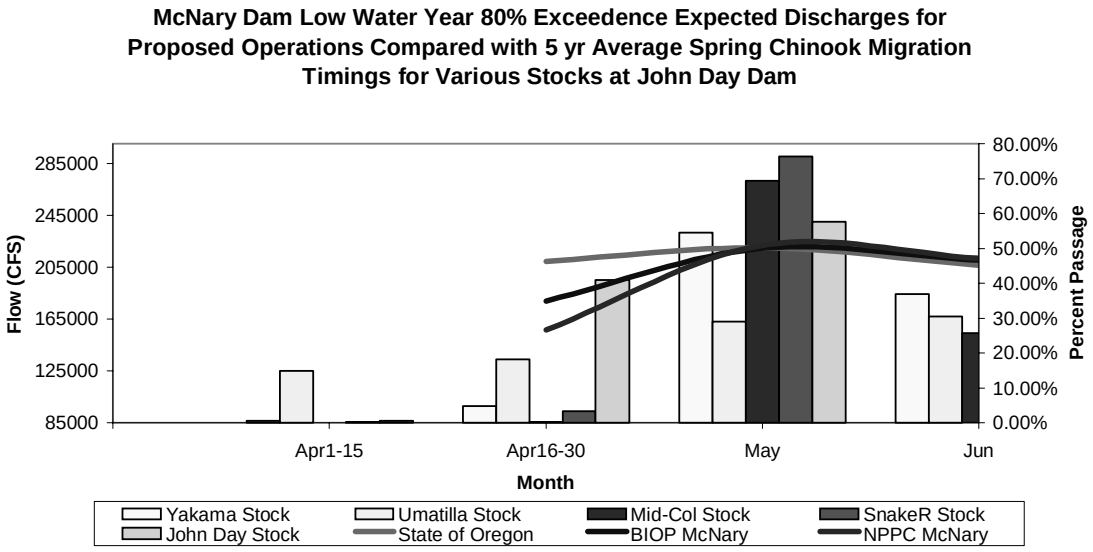
The first two graphs look at arrival time at Lower Granite Dam of yearling and subyearling chinook stocks migrating over the entire spring and summer periods for available PIT tag information. The third graph focuses on the summer period and the migration timing of subyearling chinook. As seen from the graphs, shifting water out of July could have serious impacts to a large proportion of the chinook migrants.

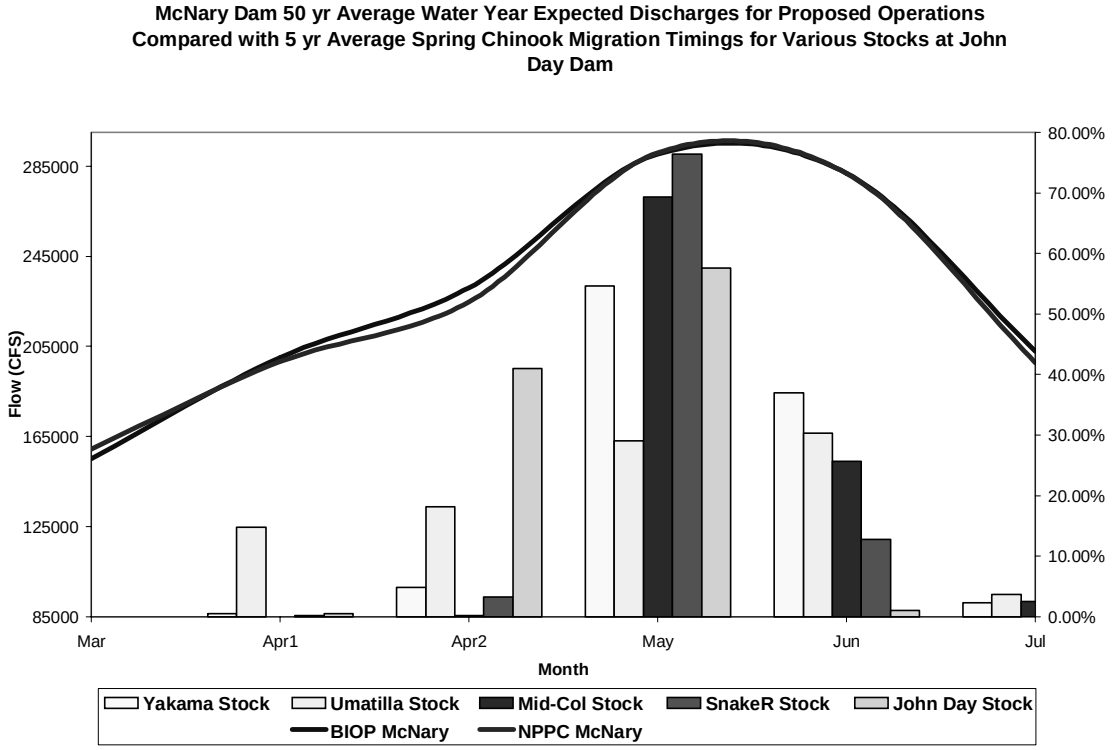

Impact of Flow Proposals at Lower Granite Dam during Average Water Year Compared to Chinook Migration Timing
Flow (cfs)
Percent Passage
Month
Apr1-15
Apr16-
May
Jun
Jul
Aug1-
Aug16
Imnaha R
Salmon R
Grande Ronde
Clearwater
BIOP LGR
NPPC LGR


Impact of Flow Proposals at Lower Granite Dam during Low Water Year Compared to Chinook Migration Timing
Flow (cfs)
Percent Passage
Month
Apr1-15
Apr16-
May
Jun
Jul
Aug1-
Aug16
Imnaha R
Salmon R
Grande Ronde
Clearwater
BIOP LGR
NPPC LGR



The next two graphs show the migration timing of chinook stocks in the Lower Columbia River. Here we can see that while the second half of April is not normally characterized as a significant passage period for spring migrating juveniles as a whole, it does represent a period of time when significant proportions of specific stocks are migrating. Stocks migrating from the John Day, Umatilla and Yakama river basins dominate the second half of April.





We hope this information is helpful to you in your present review. Please feel free to contact us if you need any additional information.

Sincerely,

Michele DeHart
Fish Passage Center Manager

ATTACHMENT A

Documentation of December 17th, 2002 responses to the ISAB questions on the Benefits of Flow Augmentation document.

I. What do you mean by "…the discrete relation between flow and water transit time (WTT) (also known as water particle travel time)" see (Figures 1 and 2 showing relation between WTT and average flow in the Snake River and McNary Dam reservoir). How is WTT computed for the rest of the analyses in your report?

The word "discrete" relation was poor wording – it should read "direct" relation (or possibly it would be better to say "inverse" relation). The reason flow and water transit time are related is that water transit time is computed as a function of flow. For a single reservoir and its respective dam, water transit time is computed as Volume/Flow where river discharge (flow) and volume at the associated reservoir elevations for the time period of interest is used. This approach allows a specific water transit time to be generated for each individual segment of the overall reach for which travel time and survival estimates are being generated. This is an improvement over the methods used in the past where flow was simply indexed over a calculated number of days at a particular dam such as Lower Monumental Dam or Ice Harbor Dam (e.g., dates of middle 50% passage at the dam and dates from release to median passage at the dam are two common methods of averaging flows).

II. Karl Dreher in his presentation to the Council on 12/11/02 seems to claim that there is no relationship between flow and water particle travel time, i.e., velocity. This seems to be in direct conflict with Figures 1 and 2. Please explain the difference interpretations. How were the figures developed? Formula? Assumptions? What is the evidence for a relationship?

We were not present at the Karl Dreher presentation and, therefore, cannot respond to what was said during his presentation. However, the relation between flow and water transit time is a physical relation. Water transit times through the reservoirs were calculated using the storage replacement method, of which flow is inversely related. This method was suggested as the preferred option by Hydrological Engineering Center at the COE. Furthermore, the COE Hydrological Engineering Center ran their HEC-2 model over the Lower Snake River over the same range of conditions as used in the FPC analysis (the data used to compute water transit times) and it is consistent with the results obtained using the storage replacement method. Marshall C. Richmond, Chief Engineer at the Pacific Northwest National Laboratory in Richland, Washington provided estimates of water transit times through the Hanford Reach at various discharges using their 1D unsteady flow model (MASS1) (Richmond, Perkins, Chien, 2002).

III. What is "Average Q", e.g. at McNary Dam.

Average Q at any project is the average over the period of interest of the COE's daily average discharge values for that project.

IV. What do you mean by "Whenever a component survival estimate was greater than 1, then the standard error divided by 1 was used as the threshold criteria."

When a component survival estimate (e.g., LMN to MCN) is estimated to be greater than 1, then we simply used the value of the standard error divided by 1 in the decision of whether the CV was greater than 0.25. This was to avoid shrinkage in the CV as the point estimate increased 100% survival. The goal was to not compute an overall reach survival estimate from the product of a the various segments of the overall reach if any individual segment's survival point estimate was so imprecise as to have a confidence interval of approximately +/- 50% of the point estimate.

V. In Figures 3, 4, and 5, e.g., "Wild yearling chinook travel time versus water transit time. Hatchery Yearling Chinook Median Travel Time versus Water Transit Time Lower Granite Dam to McNary Dam 1995 to 2002" why is the one year (upper center) so far from the others? High travel time but mid water transit time?

The data point with an estimated high travel time and mid-range water transit time is from the April 1-7 release block in 2002. Water temperature on April 1 was approx 8$^{?}$C (46$^{?}$F), the lowest of the years considered. Smolt travel time from LGR to LGS was 19 days (approx 60% of total reach travel time) for these early fish, while water transit time was only 4 days. Cold water and low smoltification apparently contributed to the long travel time estimate, which for the reach was about 50% longer than the next weekly block.

VI. In Figures3, 4, and 5, e.g., "Wild yearling chinook travel time versus water transit time. Hatchery Yearling Chinook Median Travel Time versus Water Transit Time Lower Granite Dam to McNary Dam 1995 to 2002" why is the one year (upper center) so far from the others? High travel time but mid water transit time?

The three data points with extremely long travel times are not from three years, but instead are simply the three temporal periods of 2001. The travel time/water transit time plots for the Mid-Columbia River reach include up to three temporal (two-week) periods per year.

VII. When is multicollinearity a problem? My rule was always to see if there were wild changes in the coefficients with minor changes in the data set. See the quote "The correlation between WTT and SPILLPROP for steelhead was r = -0.87, a level still low enough so that multicollinearity is not a problem."

Multicollinearity was considered to be a problem in the strictest interpretation of when it creates singularity in the inverse of the variance-covariance matrix. The rule of thumb from Myers' regression text was used. Since multicollinearity is less than the extreme case still has an unfavorable effect of inflating the variances of the parameters being estimated, we cannot rule out a particular parameter may not be important just because its slope parameter was not significant when in the presence of its moderately collinear pair in the model. But when both moderately collinear pairs of factors are able to remain in the model jointly, then it good evidence that each factor is important to the relation being modeled.

VIII. In regression modeling with highly correlated variables, I (McDonald) have used "ridge regression" to help stabilize the coefficients, i.e., usually one coefficient is large and negative and the other is large and positive, but residuals continue to look good, and they jump around if small changes are made in the data. Have you considered using ridge regression to include both temp and flow in the models when temp and flow are highly correlated? If no, why not?

We did not attempt to run ridge regression. The technique in Myers' regression textbook was reviewed. However, the dangers of arrive at an improper shrinkage factor *k*, which is key to properly adjusting the variance-covariance matrix before inverting it, lead us away from pursuing that approach further.

IX. Have you conducted any new analysis of Billy Connor's data? Starting on page 23 it seems like you are mostly quoting and repeating his results. Are there any differences in your interpretation of the data and Connor's?

The document was developed collectively by a group of State, Federal and Tribal staff and FPC staff. Billy Connor took part and was responsible for developing this section.

X. Do you have any concerns with the methods used by Connor to estimate "…mean flows and water temperatures recalculated to represent those that would have occurred if flow were not augmented (from Table 3)." What are the assumptions and methods?

This is the methods section from Connor et al. (in press b). The flow exposure index was recalculated after subtracting the daily volume of water released for summer flow augmentation (Appendix 1). The water temperature exposure index was recalculated using temperatures that were simulated for the tailrace of Lower Granite Dam under the flow conditions had the summer flow augmentation not been implemented (Appendix 2). Water temperatures were simulated using a one-dimensional heat budget model developed for the Snake River by the U.S. Environmental Protection Agency (Yearsley et al. 2001). Past model validation showed that daily mean water temperatures simulated for July and August were within an average of 1.1oC of those observed (Yearsley et al. 2001).

XI. This is the first time that we have seen three variables in the regression models to predict survival. What is different or what data have been added to previous analyses? See, e.g., "Table 7. Multiple regression models for predicting survival of combined hatchery and wild yearling chinook salmon in the Snake River from the tailrace of Lower Granite Dam to the tailrace of McNary Dam." Please review the criteria used for selection of the models. In particular was AIC used? Maybe I missed it.

Using more than simply a flow-related variable to determine a relation with smolt survival is not a new idea. NMFS in publish papers has utilized several predictor variables in the regression models. In studies of smolt travel time in the past we have utilized several predictor variables in regression models. In the present application to smolt reach survival, the predictor variables were water transit time, proportion of spill, and water temperature. Because each of these predictor variables are linked to conditions at can influence survival, the model that contained the most predictor variables that each had slope parameter significantly different than zero was chosen as the best model with explanatory capability. Even when spill proportion did not remain in a model in the presence of water transit time, we acknowledged that its influence was still present because the spillway route is a dam's highest survival route based on past NMFS studies.

XII. Explain the interpretation of "Figure 21. Survival of PIT tagged yearling chinook from McNary Dam tailrace to Bonneville Dam tailrace based on time of passage at McNary Dam, 2001." What is this figure telling us?

Figure 21 simply shows the estimated survival of yearling chinook temporally blocked based on dates of passage at McNary Dam to the tailrace of Bonneville Dam. Superimposed on the resulting survival estimates over the season is the annotation as to whether or not spill was occurring at downstream dams in the reach of interest, and if so, at how many dams. The point of the plot is to show that there was a trend in increasing survival in the lower Columbia River in 2001 that was coincident with the increase in spill be provided at dams within the reach. Flows were only moderately changing in 2001 and water temperatures followed the normal course of increasing over time, which links well with increasing predation activity over time. Under these conditions, one would expect reach survival to decrease over the season had spill never been used in the lower Columbia River. The fact that this trend was not observed lends more support to the benefit of the limited spill periods over which the additional spillway route of passage

was available at the dams to improving smolt survival over what would have otherwise occurred without any spill provided.

(Then answers to questions 13-15 were previously provided to the ISAB and are attached here.)

XIII. Are there confounding factors that would explain the negative relationship noted in the quote "We found a moderate to strong relationship between chinook SARs and transportation proportion (r 2 =0.64, p<0.001); however this relationship was negative suggesting years in which the proportion transported increased the SARs decreased (Figure 27)." Are the years with low SAR just the years with bad ocean conditions and high proportion of transported fish?

XIV. How do we interpret the information in Figure 28 dealing with mu, i.e., "…direct and delayed hydrosystem survival of Snake River spring/summer chinook relative to downriver spring/summer chinook, estimated in PATH by the parameter mu (Deriso et al. 2001)"?

XV. What is the parameter "delta" derived in the Plan for Analyzing and Testing Hypotheses (PATH), as a measure of climate/ocean mortality influences? How is it measured? See Table 22 and Figure 29. Help interpret Figure 29.

Additional Questions e-mailed on December 12th, 2002.

1. A major criticism of flow augmentation coming from the upper basin folks is that the interannual patterns of flow, travel time, and survival that the FPC generally has used are not relevant to the within-year amounts of additional water that are provided by flow augmentation policies. Over the broad span of flows among years, there is a clear trend (amplified by recent extreme high and low flow years). On this most folks seem to agree. However, they say that a relatively small amount of added water volume within a year may not mean much for fish. In fact, they say it means most for fish depending on when and how (what temperatures, etc.) that water is added, not the volume. The ISAB said as much in its last report on the subject. That seems to be one reason they suggest shifting the timing of the water that is used for FA. Would the FPC provide their evidence that within-year flow augmentation is important for survival, and specifically when and under what conditions they believe it is most valuable (e.g., late summer flows of cold water from Dworshak for cooling the Lower Snake).

The difficulty in determining the effect of "flow augmentation" is that flow augmentation implicitly means that flow is being added to a level of flow provided for other uses. The present hydrosystem operations as anticipated by the Biological Opinion are the result of consideration and melding of power, flood control, recreation, resident fish and fish passage needs. It is difficult therefore to quantify actual "flow " for fish passage. Flows provided for fish migration also generates power and other benefits. The separation of flows provided for fish benefits versus power or other benefits is an accounting issue that has never been clearly resolved. For example, the accounting of flow for fish or power was raised during the winter months of 2001, when power demand required higher flows during the winter months, which also benefited the natural spawning area below Bonneville Dam. Similar accounting issues have been raised regarding spill. The Biological Opinion identifies specific levels of spill for fish passage; often spill levels are higher because of flood control or flow in excess of power generation needs. The accounting for this excess spill separately from the BIOP spill levels is a prevailing question. We do not know how to accurately and separately account for the amount of flow that results from each of the purposes of system operations. Our analysis addresses the benefit of flow for fish passage regardless of whether the flow is the result of flood control releases or hydropower generation.

The effect of flow increases and decreases on fish travel time can be estimated using the flow/water transit time and travel time relationships developed for specific River reaches. These relationships have been developed over several decades over a wide variation of conditions. The recent data and the historical data have remained consistent over the years. This is because the mechanisms of travel time are less complicated and involve fewer variables. Flow is the direct and determining factor over fish travel time. On the other hand, juvenile survival estimates are an index describing the juvenile migration. Determination of incremental flow and survival is difficult because of the actual complex mechanisms that determine survival. A within year flow survival relationship does not emerge in the present data, not because flow is not important but, because of several factors including the limitations of data collection and analysis. First, juvenile survival is the result of many direct and indirect environmental and biotic variables. By necessity these variables such as flow are described as averages over a period of time. This dampens the effect of that variable. Second, within year flow survival relationships are not apparent from available data because the individual survival release groups overlap and the environmental variables such as flow is averaged over many days and many overlapping release groups. Third, annual estimates of survival address the problem of overlap to some degree, however the annual flow average (even over large groups) had not changed substantially until 2001, when the Biological Opinion measures were not implemented. Our present data shows a significant flow survival relationship as a result of the large change that occurred in the flow variable when the Biological Opinion measures were not implemented.

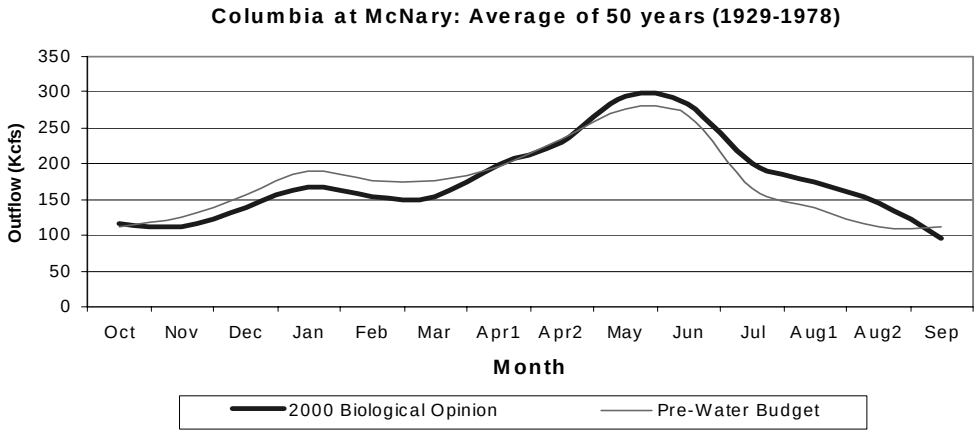
The FPC identified these issues in memorandums to the Fishery Managers in 1992 and again in 1995 that the problem of excessive overlapping of PIT tagged release groups as they migrate through the study reach will not allow discrete partitioning of the incremental effects of environmental or biotic variables that affect survival. NMFS recognized this phenomenon after implementing the methodology for several years. Smith and Muir (1996) state, "Identifying and quantifying relationships between environmental variables and survival and travel time of release groups of PIT tagged migrant juvenile salmonids have presented difficult challenges. Chief among these is that fish from a single release group do not migrate as a group but spread out over time. If conditions change over a short period of time relative to the time it takes for the bulk of the release group to migrate through a particular river section then different fish from the group experience different levels of various environmental factors. In this situation estimated survival probabilities (defined for the entire release group) are usually valid estimates of average survival for the group. However, it is difficult to accurately quantify the environmental conditions to which the entire release group was exposed and to relate that to the survival estimates. More over, if a series of releases is made and migrations are protracted the various release groups may have considerable overlap in passage distributions, further clouding the relationship between survival probabilities and environmental variables by decreasing the contrast in the levels of exposures among the various groups."

The above problems created by overlapping environmental and biotic conditions within a single year are reduced when comparisons are made across years. Nevertheless, the environmental and biotic conditions observed across years must span a fairly wide range of values to offset the natural variability inherent in them. Therefore the regression analyses demonstrate statistical significant differences in survival due to these environmental and biotic conditions. The year 2001 is so an important in these regression analyses because it defines the true range of conditions that are possible in the present hydrosystem. When 2001 survival data is considered, the FPC analyses demonstrate that statistically significant relations between reach survival of yearling chinook and steelhead smolts and the flow-related variable of water transit time are obtainable. But even these relations do not allow the determination of incremental effects of flow augmentation alone. In our answer to your Question 9, we discuss how spill also influences the smolt survival in the reach by providing the route of highest survival at each dam to the proportion of smolts that utilize that route. Therefore, in every reach survival estimate there are contributions of both spill passage at the dams and flow-related variables in the reservoirs to the overall smolt survival estimates. We have been successful in demonstrating that analyses of survival data must include a series of years in order to get a wide enough range of environmental and biotic conditions to show statistically significant relations between smolt survival and a joint set of predictor variables which include a flow-related variable.

The fact that among year flow, water transit time, fish transit time relations can be established provides significant reasons to achieve, at a minimum, Biological Opinion flow objectives in any given year. The proposed NWPPC Program measures would move water from the fish migration period, back to the winter period, affecting flow during the fish migration period. This would be contrary to the intent of the Biological Opinion. Seasonal flow targets were derived in order to meet minimal hydrosystem survival rates in conjunction with harvest, hatchery and habitat measures, which are required to achieve overall population survival and recovery. Flows should be met throughout the migration period because of differences in passage timing for individual populations. Within populations there are different out migration timing for various life-history strategies (e.g. differing overwintering locations within a tributary). The importance of providing protection measures across populations and life-history types has been thoroughly documented, such as ISG Return to the River(1996, 2000) and NMFS Viable Salmonid Populations (McElhany et al. 2000). In addition, in river survival estimates represent only one component of the life cycle, which flows can effect. Other effects of flow include the additional direct mortality that occurs down stream of reach studies and the indirect or delayed mortality that occurs as a result of fish condition, arrival timing and estuary and plume conditions.

2. With the Canadian Treaty dams providing most of the reshaping of the annual hydrograph for the Columbia River from its historical pattern, how much influence on the lower Columbia discharge (and therefore changed fish survival) can we realistically expect from augmented flows from Hungry Horse, Libby, Dworshak, and the Hells Canyon project? Aren't the changed flows and survivals fairly trivial? (Unless carefully timed, as above).

The operation of the Canadian Projects was factored into the development of the actions necessary to implement the Biological Opinion flow measures. The changes in flow that result from operating the US Reservoirs to the April 10th upper rule curve, and the augmentation volumes from these reservoirs are not trivial in achieving the Biological Opinion flows and affecting survival. A comparison could be made to the operation of the power system prior to the implementation of the Water Budget and the subsequent implementation of the Biological Opinion. Both scenarios occurred with the Canadian Treaty dams in place, yet significantly more water was moved into the fish migration period.



Answers to Questions 13-15 from the ISAB on Fish and Wildlife Managers-NWPPC Response Flow and Spill Update Summary of Data Analysis and Review Regarding Mainstem Fish Passage Relating to Flow

Answers Prepared by:

Charlie Petrosky
Idaho Fish and Game

and

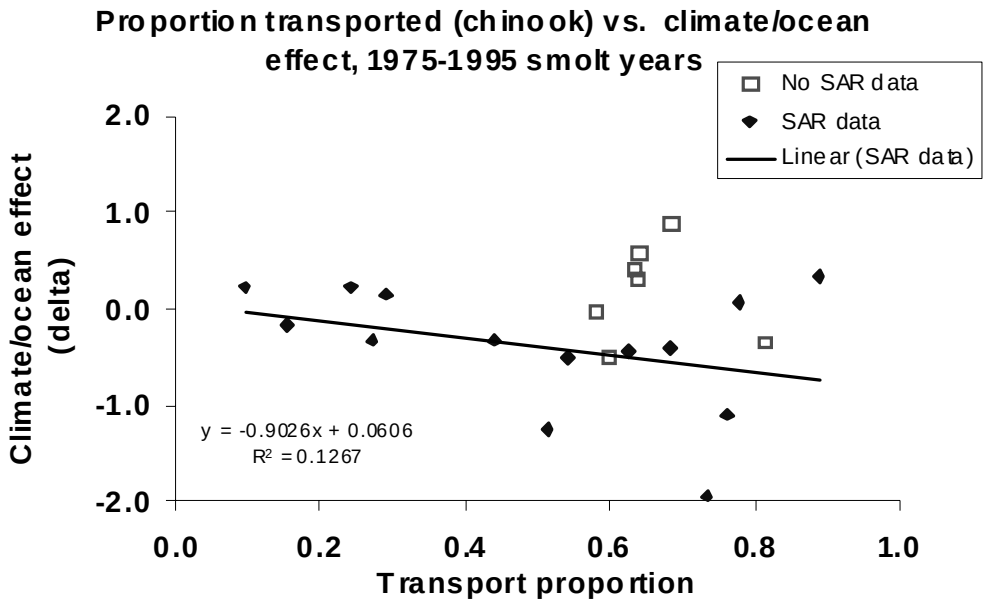
Howard Schaller
US Fish and Wildlife Service

December 17, 20002

ISAB Question XIII

Graphed the two variables in question relating to potentially confounding factors

Transport Proportion Vs Delta



Any relationship between proportion transported and delta appears to be weak

It is apparent from the data that the years with high transport proportions are not always the years with bad ocean conditions

ISAB Question XIV
In the Model from figure 28:
μ represents the relative difference in mortality between upriver and downriver stocks;

In Deriso et al. (2001) μ is subtracted from ln(R/S) in linear Ricker function

$$\ln(R/S) = (a + \delta_t - X_n - \mu_t) - b*S$$

where;

- **a** =intrinsic rate of population growth 'Ricker a'
- δ_t = common year effect (climatic/ocean effect)
- X_n =direct hydrosystem mortality for lower river stocks
- μ_t =differential mortality (relative difference in mortality between upriver and downriver stocks)
- $_t$ =year

e.g., for μ = 1 (Snake River stocks had a relative mortality increase of 1.0);
translates to a relative survival of 0.366; exp(-μ)

1975-1995 range of observed μ was 0.19 to 2.77;
Snake River stocks survived 6% to 83% as well as the downriver stocks

μ	relative survival
0.0	1.00
0.5	0.61
1.0	0.37
1.5	0.22
2.0	0.14
2.5	0.08
3.0	0.05

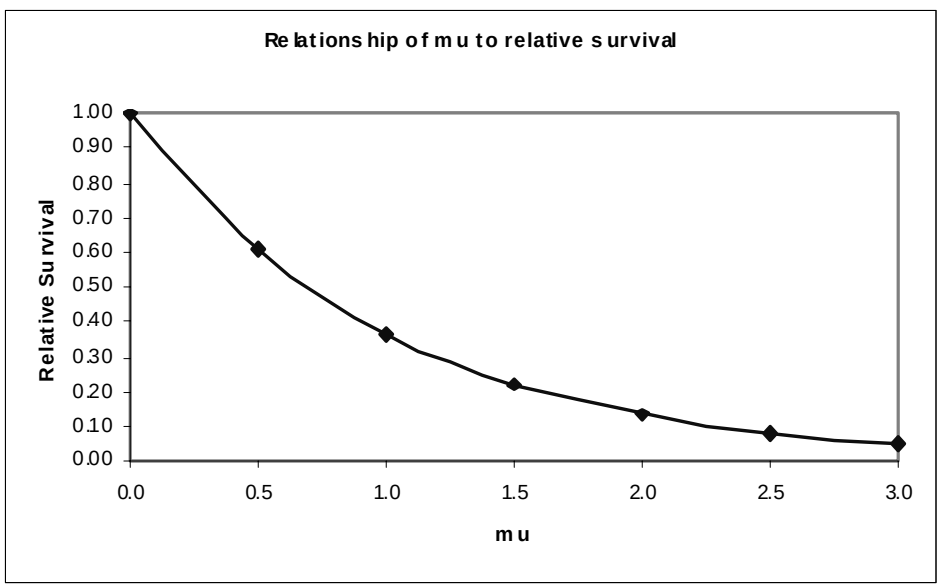


Figure 28 indicates that relative hydrosystem mortality increased with increased water travel times

ISAB Question XV part 1

In the Model from figures 29-31 where;
δ is defined as common year effect (climatic/ocean effect)
from Deriso et al. (2001) see derivation from description of μ

ln(SAR) = WTT + delta or ln(S/S) = WTT + delta

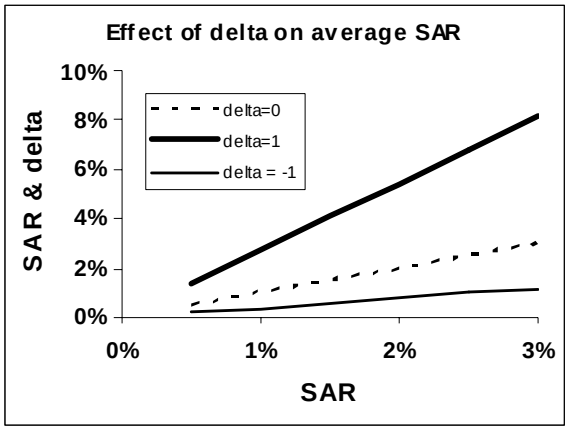
effect of delta is additive to ln(SAR) and productivity (ln(R/S) or ln(S/S))

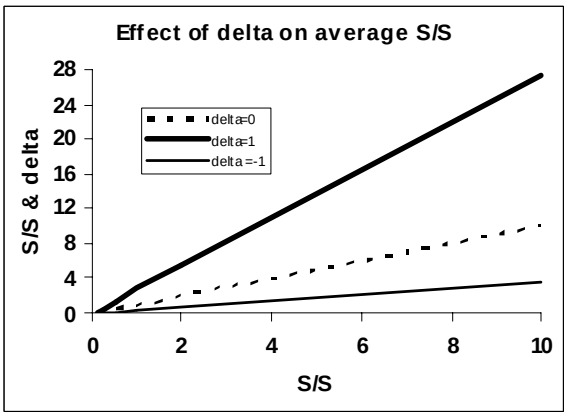
ln(SAR) delta=0	ln(SAR) delta=1	ln(SAR) delta = -1	ln(S/S) delta=0	ln(S/S) delta=1	ln(S/S) delta = -1
-5.30	-4.30	-6.30	-2.30	-1.30	-3.30
-4.61	-3.61	-5.61	-1.61	-0.61	-2.61
-4.20	-3.20	-5.20	-0.69	0.31	-1.69
-3.91	-2.91	-4.91	0.00	1.00	-1.00
-3.69	-2.69	-4.69	0.69	1.69	-0.31
-3.51	-2.51	-4.51	2.30	3.30	1.30

effect of exp(delta) is multiplicative to SAR and R/S or S/S

SAR delta=0	SAR delta=1	SAR delta = -1	S/S delta=0	S/S delta=1	S/S delta = -1
0.50%	1.36%	0.18%	0.10	0.27	0.04
1.00%	2.72%	0.37%	0.20	0.54	0.07
1.50%	4.08%	0.55%	0.50	1.36	0.18
2.00%	5.44%	0.74%	1.00	2.72	0.37
2.50%	6.80%	0.92%	2.00	5.44	0.74
3.00%	8.15%	1.10%	10.00	27.18	3.68

e.g., if SAR = 1%, effect of delta =1 is a 2.72 fold increase in SAR
e.g., if SAR = 1%, effect of delta =-1 is a 1/2.72 fold change in SAR





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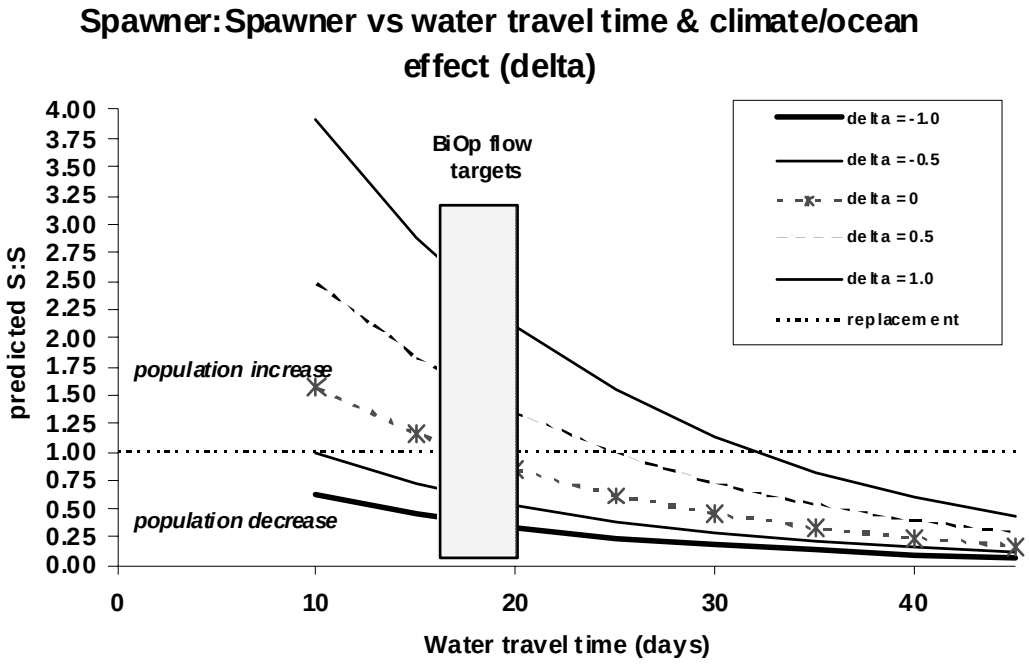

A water velocity and survival (population productivity) relationship is apparent when assessing adult spring/summer chinook information

Focusing on the yellow bar, which represents the water travel time (velocity) generated by BIOP flow targets (yellow bar), we can observe the population performance relative to replacement (the dashed horizontal line)

For the BIOP Flow target velocities the populations approach or exceed replacement under average to good climate/ocean conditions

However, below Biop Flow targets the populations approach or exceed replacement only under good climate/ocean conditions

Risk of further population decline is greater below the BIOP flow targets

APPENDIX L

A c r o n y m s

List of Acronyms used in Fish Passage Center Annual Report

APRE	Artificial Production Review and Evaluation
BC Hydro	British Columbia hydro
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
CJS	Cormack, Jolly, Seber
COE	United States Army Corps of Engineers
CRITFC	Columbia River Inter-tribal Fish Commission
CWT	Coded wire tag
DEQ	Oregon Department of Environmental Quality
DOE	Washington Department of Ecology
ESA	Endangered Species Act
FCE	Flood control elevation
FPC	Fish Passage Center
FPE	Fish passage efficiency
GBT	Gas bubble trauma
HCC	Hells Canyon Complex
HGMP	Hatchery genetic management plan
IDFG	Idaho Department of Fish and Game
IPC	Idaho Power Company
IT	Implementation Team
NFH	National Fish Hatchery
NOAA Fisheries	National Oceanic and Atmospheric Administration Fisheries
NPT	Nez Perce Tribe
NTS	Non-treaty storage
NWPPC	Northwest Power Planning Council
NWRFC	Northwest River Forecast Center
ODFW	Oregon Department of Fish and Wildlife
Opinion	NOAA Fisheries 2000 Biological Opinion
PIT	Passive Integrated Tag
PSMFC	Pacific States Marine Fisheries Commission

PUD	Public Utility District
RPA	Reasonable and prudent alternative
RSW	Removable spillway weir
SMP	Smolt Monitoring Program
SOR	System Operational Request
SPILLPROP	Spill proportion variable
TAC	Technical Advisory Committee
TDG	Total dissolved gas
TDGS	Total dissolved gas supersaturation
TEMP	Temperature variable
TMT	Technical Management Team
TREATY	Columbia River Treaty
TSR	Treaty storage regulation
USFWS	United States Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WES	Waterways Experiment Station
WSF	Water Supply Forecast
WTT	Water particle transit time
WY	Water year