FISH PASSAGE CENTER

2007 ANNUAL REPORT

***Fish Passage Center
of the
Columbia Basin Fish &
Wildlife Authority***

August 2007

Final

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ANNUAL REPORT

2007

This report responds to the Fish Passage Center annual reporting requirements to the Northwest Power and Conservation 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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Fish Passage Center 2007 Annual Report

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2007 Executive Summary

The January-July runoff volume above the Dalles Dam in 2007 was 89% of the average runoff volume for the 1971-2000 historical record. The April-July runoff volume at Lower Granite Dam was 68% of the 1971-2000 historical record. Over the 79 year historical record from 1929 through 2007, the 2007 January-July runoff volume at the Dalles was the 50th lowest year out of the 79th year record. The January through July runoff volume at Lower Granite was the 65th lowest runoff year out of 79 on record.

This year can be characterized by steadily decreasing snowpack which was below average in the Columbia Basin by the end of April. The combination of runoff volume, decreasing snowpack and reservoir operations resulted in spring migration flows at McNary Dam averaging 239 Kcfs, slightly above the Biological Opinion flow objective of 237 Kcfs. However the spring period migration flows in the Snake River averaged 61 Kcfs at Lower Granite Dam, substantially below the Biological Opinion flow objective of 85 Kcfs. Summer migration period Biological Opinion flow objectives averaged 163 Kcfs at McNary Dam, substantially below the summer flow objective of 200 Kcfs. Summer migration period flows in the Snake River at Lower Granite Dam averaged 29 Kcfs, also substantially below the Biological Opinion flow objective of 50 Kcfs. Overall spring migrants in the Columbia River experienced better migration flows than spring migrants in the Snake River reach. Summer migration flow objectives were not achieved in either the Columbia or Snake rivers.

The 2007 FCRPS Operations Agreement represents an expanded and improved spill program that goes beyond the measures contained in the 2004 Biological Opinion. During the spring period, spill now occurs for twenty-four hours per day at all projects, except for John Day Dam where the daily program remains at 12 hours. A summer spill program provides spill at all the fish transportation collector projects (Lower Granite, Little Goose, Lower Monumental and McNary dams), whereas prior to 2005 spill was terminated at these projects after the spring period. In addition, the 2007 operations agreement provided regardless of flow conditions. For the first time spill for fish passage was provided in the low flow conditions that prevailed in the Snake River throughout the spring and summer migration periods. Gas bubble trauma (GBT) monitoring continued throughout the spill period. A higher incidence of rank 1, GBT signs were observed in late arriving steelhead smolts arriving after the 95% passage date had occurred. During this time dissolved gas levels were generally below the 110% water quality standard in the forebay where fish were sampled. This occurrence was due to prolonged exposure and extended travel times due to low migration flows. The 2007 migration conditions differed from any year in the historic record. The migration conditions combined low river flows in the Snake River with spill throughout the spring and summer season.

The juvenile migration characteristics observed in 2007 were unique compared to past years in that high levels of 24 hour spill for fish passage were provided in low flow conditions, and with a delayed start to the smolt transportation program a smaller proportion of the total run being transported. This resulted in relatively high spring juvenile survival despite the lower flows. The seasonal spring average flow in the Snake River was 61 Kcfs much lower than the spring time average of 120 Kcfs that occurred in 2006. However juvenile steelhead survival through the Lower Granite to McNary reach in 2007 was nearly 70% which was similar to the juvenile steelhead survival seen in 2006 under higher migration flows. The low flows in the May-July period of 2007 were similar to the 2001 low flow year, yet survival for fall chinook juveniles in this period in 2007 was much higher. In 2001 the reach survival estimate for juvenile fall Chinook from Lower Granite to McNary Dam ranged from 0.25-0.34, while survival in the same reach ranged between 0.54-0.60 in 2007. In addition travel time estimates showed that summer migrants traveled much more rapidly in 2007 than in 2001, even under similar flows. The median travel time through the Lower Granite to McNary reach for summer migrants averaged 22 days compared to a range of 32 to 42 days in 2001. The primary operational difference between 2001 and 2007 low flow years was the provision of 24 hour spill in 2007.

Hatchery production of summer steelhead, fall chinook and coho increased in 2007 compared to 2006. However, hatchery production of fall chinook decreased in the Snake River zone in 2006. Coho production is still lower than the peak production level which occurred in 2004. Although hatchery steelhead releases increased in the Lower Columbia zone, the Snake River zone accounts for over 80% of the steelhead production in the Columbia Basin above Bonneville Dam. Hatchery production of sockeye increased in the Snake River and decreased slightly in the Columbia River Reach. Overall hatchery production of spring chinook decreased in 2007 compared to 2006. Most of these decrease occurred in the Snake River zone.

Adult counts at Bonneville Dam for most species decreased in 2007 compared to previous years and were less than the ten year average. The spring/summer and fall Chinook jack counts at Bonneville Dam increased when compared to both the 2006 counts and the 10 year average counts. Notably, the adult counts for fall chinook, spring/summer chinook, coho, sockeye and steelhead were above the 2006 counts at Lower Granite Dam in 2007. In addition, fall chinook, coho, sockeye, and steelhead adult counts were above the ten year average at Lower Granite Dam in 2007. Returns of Lower Columbia River fall chinook declined in 2007.

I. Water Supply

A. Water Supply

Water Year (WY) 2007 was variable throughout Columbia Basin. At The Dalles Dam, the observed runoff volume recorded between January and July of 2007 was 95.7 Maf, which was 89% of the average runoff volume between 1971 and 2000 (Table 1). Runoff volumes at other Columbia Basin locations varied, ranging between 59% and 115% of average. In general the Snake River contained less than average water supply, (the runoff volume at Lower Granite Dam was 59% of the average) whereas the mid and upper Columbia contained an average or better water supply. Over the 79-year record between 1929 and 2007, the 2007 January-July runoff at Lower Granite and The Dalles ranked 65th and 50th, 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 WY 2007. Data taken from the River Forecast Center's website at http://www.nwrfc.noaa.gov/water_supply/ws_verif.cgi.

Site	January Final Water Supply Forecast (Kaf)	April Final Water Supply Forecast (Kaf)	Observed Runoff (Kaf)	Percent of 1971-2000 Average (%)
The Dalles (Jan-July)	105000	100000	95738	89
Grand Coulee (Jan-July)	62600	65900	63939	102
Libby Res. Inflow, MT (Jan-July)	6520	6700	7262	115
Hungry Horse Res. Inflow, MT (Jan-July)	2130	2070	1916	86
Lower Granite Res. Inflow (Apr- Aug)	21500	16000	13458	59
Dworshak Res. Inflow(Apr-July)	2780	2200	1799	68

Table 2. Observed Runoff at Lower Granite and The Dalles from January-July from 1990 to 2007 along with each years rank in terms of the 79-year record between 1929 and 2007 (lower rank = higher water year).

Year	Lower Granite (Jan-July)		The Dalles (Jan-July)	
	Runoff (Maf)	Rank	Runoff (Maf)	Rank
1990	20.2	61	99.7	44
1991	18.9	65	107.1	33
1992	14.1	77	70.4	70
1993	26.7	37	88.1	58
1994	15.9	74	75.0	68
1995	29.4	33	104.0	40
1996	42.4	8	139.3	5
1997	49.5	1	159.0	1
1998	31.3	27	104.1	39
1999	36.1	17	124.1	12
2000	24.6	47	98.0	45
2001	14.4	76	58.2	77
2002	24.0	50	103.8	41
2003	23.8	52	87.7	59
2004	20.7	59	83.0	61
2005	18.1	69	81.4	64
2006	32.2	22	114.7	20
2007	18.9	65	95.7	50

Precipitation was also variable over WY 2007. Seasonal (October through September) precipitation was: 98 percent of average (1971-2000) at Columbia above Coulee, 79 percent of average at the Snake River above Ice Harbor, and 94 percent of average at Columbia above the Dalles. Figure 1 displays precipitation by month over 2007 at the Columbia above Coulee, the Snake River above Ice Harbor, and at the Columbia above The Dalles.

Figure 1. Monthly precipitation from October 1, 2006 to September 30th, 2007 at select locations within the Columbia Basin in percent of normal (1971-2000). Data from CRITFC Hydro Program.

Snow pack throughout the Columbia Basin diminished with respect to average as the season progressed. By the 1st of March, most basins were near or below the 1971-2000 average at the same time of year. By the start of April, snowpack diminished between 14 and 18% relative to early March snowpack and as a result many Columbia sub-basins were below average (1971-2000) snowpack (Table 3). By the end of April, Columbia River Basin snowpack had diminished another 6-16%, resulting in below average snowpack for the season (Table 3). Snake River basins contained the lowest snowpack by the end of April, at approximately 45% of average.

Table 3. Seasonal snow water equivalents at select basins during various points of WY 2007.
Data from <ftp://ftp.wcc.nrcs.usda.gov/data/snow/update/columbia/>

Basin	3-1-07 Snow Water Equivalent (% Avg.)	3-31-07 Snow Water Equivalent (% Avg.)	4-30-2007 Snow Water Equivalent (% Avg.)
<i>Columbia Above the Snake River Confluence</i>			
Kootenai River in Montana	100	88	81
Flathead River	88	74	77
Upper Clark Fork River	89	75	79
Bitterroot	86	74	59
Lower Clark Fork River	88	75	66
Idaho Panhandle Region	92	79	72
Columbia Above Methow	103	93	82
Chelan, Entiat, Wenatchee	107	93	93
Yakima, Ahtanum	112	84	74
<i>Average*</i>	96.1	81.7	75.9
<i>Snake River</i>			
Snake Above Palisades	77	66	57
Henry Fork, Teton, Willow, Blackfoot, Portneuf	79	63	48
Big and Little Wood	74	56	41
Big and Little Lost	72	57	37
Raft, Goose, Salmon Falls, Bruneau	82	70	62
Weiser, Payette, Boise	80	66	50
Owyhee Malheur	66	44	10
Grande Ronde, Powder, Burnt, Imnaha	75	53	39
Clearwater and Salmon	86	73	63
<i>Average*</i>	76.8	60.9	45.2
<i>Lower Columbia Between Bonneville and McNary</i>			
Umatilla, Walla Walla, Willow	76	58	39
Deschutes, Crooked, John Day	82	63	57
Lower Columbia, Hood River	104	86	89
<i>Average*</i>	87.3	69.0	61.7

* 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

Grand Coulee (GCL)

Figure 2 shows how GCL was operated throughout the winter with respect to flood control. The COE implemented a flood control shift between Grand Coulee and Dworshak Dam over the winter of 2007. This shift provided more flood control space in Grand Coulee Dam and less space in Dworshak Dam. Grand Coulee was operated near its flood control elevations over the winter period (Figure 2). Grand Coulee ended April 10th at an elevation of 1259.6 feet, very close to its shifted April 10th FC elevation (1259.2 ft) (Figure 2, Table 4). Reaching the April 10 flood control elevations ensures a high probability of both meeting spring flow objectives and refill by June 30. Grand Coulee reached its peak elevation on July 9th, 2007 of 1289.9 feet, just 0.1 feet below its full pool elevation (1290 ft.).

In 2007, the end of August summer draft limit at Grand Coulee was 1278 feet. On August 31st, 2007 at midnight, Grand Coulee was exactly at an elevation of 1278.0 feet.

Figure 2. Operations at Grand Coulee over WY 2007.

Dworshak

The COE implemented a flood control shift between Grand Coulee and Dworshak Dam over the winter of 2007. This shift provided more flood control space in Grand Coulee Dam and less space in Dworshak Dam. On March 21, 2007 the ODFW, USFWS, The Shoshone-Bannock Tribe and Columbia River Inter-Tribal Fish Commission (CRITFC) submitted SOR 2007-4 to the Action Agencies which asked for a cautious operation of Dworshak to ensure that the shifted April 10th elevation was met. On April 10th Dworshak was at an elevation of 1568.2 feet, 0.4 feet above its shifted April 10th FC elevation of 1567.8 feet (Figure 3, Table 4); however, it should be pointed out that the Action Agencies did have to reduce outflows from 10 Kcfs near the end of March to 2.3 Kcfs beginning April 5th to refill to the April 10th shifted FC elevation. As the spring Biological Opinion flow period begins on April 3rd on the lower Snake River, by not reducing outflows sooner, this operation did effectively move some water out of the spring flow period (April 3-June 20).

Dworshak reached an elevation of 1599.1 feet by June 13, 2007 and reached a peak elevation of 1600 feet June 20th, 2007. Dworshak remained one foot from full (1600 feet) over the last 18 days of June. Over the summer months Dworshak was drafted to elevation 1533.5 feet on August 31st, 2007 for flow and temperature regulation in the lower Snake River, leaving approximately 180 Kaf of Dworshak water to be released over the first portion of September. Dworshak reached elevation 1520 feet on September 15, 2007.

Figure 3. Operations at Dworshak over WY 2007.

Libby

Libby was drafted to elevation 2410.8 by December 31st, 2006. As the winter/early spring months progressed Libby was below flood control elevations early but was able to refill back to flood control by April 10th. By the end of February, Libby was approximately 7 feet below its end of February FC elevation (Figure 4); however, could not refill any further as the project was already on minimum outflows (4 Kcfs). Libby stayed on minimum outflows of 4 Kcfs until March 26, 2007. By April 10th, Libby was able to refill to its April 10th Biological Opinion flood control elevation of 2395.5 feet (Table 4).

On June 12th, 2007 the Montana Fish Wildlife and Parks and the Kootenai Tribe of Idaho submitted System Operational Request (SOR) 2007 MT-1 to the Action Agencies, which asked for flat flows out of Libby Dam of 15 Kcfs from July 1 through July 21st, and then approximately 12 Kcfs for the rest of July, August, and September. This SOR was discussed at the TMT level on June 20th, 2007. On June 26th, 2007, USFWS, ODFW, CRITFC and the Nez Perce submitted SOR 2007-7 which asked for flat flows out of Libby of approximately 17.4 Kcfs in July and August, which was intended to draft Libby to approximately 20 feet from full by August 31st, 2007. Both SORs were discussed at the TMT, IT, and the Federal Executive level. At the Federal Executive Level it was decided to implement the 2007 fish operation plan and the 2004 Biological Opinion; both of which include a 20-ft draft of Libby Dam by August 31st. Libby was operated to a flat flow of 17.3 Kcfs from July 3rd through August 22nd and then flows were ramped down to 15 Kcfs for a week, then lowed further to 9 Kcfs by the start of September. On August 31st at midnight, Libby was at an elevation of 2438.9 feet (Figure 4).

Figure 4. Operations at Libby over WY 2007.

Hungry Horse

Hungry Horse began Water Year 2007 (Oct. 1, 2006) at an elevation of 3541.3 feet. Throughout much of the water year, Hungry Horse was operating to meet the Columbia Falls minimum flow. On April 10th, Hungry Horse was at an elevation of 3534.3 feet, 0.9-feet above its April 10th Flood Control elevation of 3533.4 feet (Figure 5, Table 4). Hungry Horse was within one foot of full from 6/15/2007 through July 5th, 2007 and reached a peak elevation of 3559.9 feet on June 28th, 2007.

As previously mentioned, on June 12th, 2007 the Montana Fish Wildlife and Parks and the Kootenai Tribe of Idaho submitted SOR 2007 MT-1 to the Action Agencies, which asked for flat flows out of Hungry Horse Dam of 4.0 Kcfs from July through September. This SOR was discussed at the TMT level on June 20th, 2007. On June 26th, 2007, USFWS, ODFW, CRITFC and the Nez Perce submitted SOR 2007-7 which asked for flat flows out of Libby of approximately 4.4 Kcfs in July and August which was intended to draft Hungry Horse to approximately 20 feet from full by August 31st, 2007. Both SORs were discussed at the TMT, IT, and the Federal Executive level. At the Federal Executive Level it was decided to implement the 2007 fish operating plan the 2004 Biological Opinion; both of which include a 20-ft. draft of Hungry Horse by August 31st. Outflows at Hungry Horse were between 4.4-4.5 Kcfs in July and August of 2007. On August 31st at midnight, Hungry Horse was at an elevation of 3542.2 feet (Figure 5), 2.2 feet above the 20-foot end of August draft elevation.

Figure 5. Operations at Hungry Horse over WY 2007.

Brownlee

Brownlee began the 2007 Water Year at (Oct. 1, 2006) an elevation of 2051.3 feet. On April 10th, Brownlee was at an elevation of 2064.7 feet, 5.2 feet above its Flood Control elevation of 2059.5 feet (Table 4). Brownlee was within two feet of full from 5/7/2007 to 6/22/2007 and reached its peak elevation of 2076.6 feet on June 5th, 2007 (Figure 6).

Figure 6. Operations at Brownlee over WY 2007.

Table 4. April 10th Biological Opinion elevations at Grand Coulee, Libby, Dworshak, Hungry Horse, and Brownlee along with actual elevations on April 10th, 2007.

Site	April 10th BiOp Elevation	Actual April 10th Elevation
Grand Coulee (Shifted)	1259.2	1259.6
Libby	2395.5	2395.5
Dworshak (Shifted, local)	1267.8	1268.2
Hungry Horse	3533.4	3534.3
Brownlee	2059.5	2064.7

** April 10th BiOp Elevations were linearly interpolated between the April 1st and April 15th flood control elevations issued in March of 2007.

1. Spring/Summer Flow Objectives

The following table (Table 5) summarizes the spring and summer Biological Opinion (BiOp) flow objectives and actual flows for 2007 at Lower Granite, Priest Rapids, and McNary. Bold font would indicate that the spring or summer actual average flow was equal to or greater than the flow objective.

Table 5. Spring and summer flow averages at Lower Granite, McNary, and Priest Rapids during their respective spring and summer Biological Opinion periods.

	2007			
	Spring Flow Objective	Spring Average	Summer Flow Objective	Summer Average
Lower Granite	85	61	50	29
McNary	237	239	200	163
Priest Rapids	135	169	Na	Na

Overall, taking into account all of the projects with BiOp flow objectives (all blocks in the above table), Biological Opinion flow objectives were met over the spring of 2007 at both Priest Rapids and McNary Dams but not met during the spring period at Lower Granite or during the summer period at either Lower Granite or McNary dam (Table 5). Table 6 displays weekly average flows at Lower Granite and McNary Dams over the spring and summer period. Figures 7 and 8 display daily flows and flow objectives at Lower Granite and McNary Dams over the spring and summer periods. 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 6. Spring and summer weekly flow averages at Lower Granite and McNary during the 2007 spring and summer Biological Opinion periods.

Week	Average flow at Lower Granite (Kcfs)	Average flow at McNary (Kcfs)
April 3-9	38.9	
April 10-16	48.8	224.4
April 17-23	46.8	222.6
April 24-30	55.5	226.9
May 1-7	82.0	271.0
May 8-14	85.6	276.0
May 15-21	89.6	271.1
May 22-28	69.7	257.7
May 29-June 4	56.8	236.6
June 5-11	54.9	250.2
June 12-18	50.8	231.7
June 19-25	38.3	202.0
June 26-July2	33.2	178.6
July 3-9	34.7	173.4
July 10-16	34.6	199.2
July 17-23	29.3	176.9
July 24-30	28.0	172.3
July 31-August 6	27.5	165.0
August 7-13	25.5	155.5
August 14-20	22.5	144.1
August 21-27	22.3	129.5
August 28-31	21.4	147.5

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

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

2. Dworshak Operations for Temperature Regulation at Lower Granite

Water temperatures in the Lower Granite Tailwater exceeded the 20°C temperature standard during 1.2% of the hours (27 of 2208 hours) between July 1st and September 30th, 2007. Figure 9 displays tailwater temperatures at Lower Granite as well as the temperature and magnitude of discharges from Dworshak Reservoir.

From Figure 9, temperatures in the Lower Granite Tailrace exceeded the 20°C temperature standard in early July 2007. Because the Lower Granite Tailrace temperatures were above 20°C for a 26-hour period in early July, outflows from Dworshak Dam were increased to approximately 11.8 Kcfs on July 5th, 2007, these outflows were held until July 15th, 2007 when Dworshak outflows were ramped down to approximately 9.5-10.0 Kcfs. Dworshak outflows were held at approximately 9.5-10.0 Kcfs until August 11th, 2007. During the period with outflows of 9.5-10.1 Kcfs (July 16-Aug 11), Lower Granite tailrace temperatures did exceed 20°C for a period of one hour on August 1st, 2007. On August 12th, 2007, outflows from Dworshak were reduced to approximately 7.7-7.9 Kcfs and held at this level through September 9th, 2007.

On August 31st, 2007 Dworshak was at an elevation of 1533.5 feet, leaving approximately 180 Kaf of flow augmentation for the first portion of September.

Figure 9. Tailwater temperatures at Lower Granite Dam as well as the temperature and magnitude of discharges from Dworshak Reservoir from July 1st to September 30th, 2007.

3. Canadian Operations

Treaty Operations

The Columbia River Treaty (Treaty) with Canada provides for cooperative measures between the US and Canada for power generation and flood control in the Columbia River Basin. The US (BPA and the Corps of Engineers) and Canadian (BC Hydro) entities develop an Assured Operating Plan annually for the operating year six years in the future. As required by the Treaty, these plans are prepared for power and flood control purposes. Prior to the beginning of each operating year (starting 1 August and running through 31 July) the Entities develop a Detailed Operating Plan that includes any mutually agreed revisions to the Assured Operating Plan for that year. Typically, revisions in the Detailed Operating Plan have been few and of limited scope. During the operating year, the Columbia River Treaty Operating Committee, with representation from each Entity can negotiate supplemental operating agreements within the operating year which include mutually agreed, mutually beneficial changes in operations.

Supplemental Operating Agreements

Supplemental Operating Agreements are negotiated during the operating year and must provide benefits to both the U.S. and Canada. Typical agreements provide a balance of non-power benefits for each country. Although there may be occasional agreements that trade off power and non-power needs, the concept of water “purchases” have not been supported by Canada. In addition, Canada has not been willing to incur significant non-power impacts in Canada to provide non-power benefits in the US.

Agreements for the 2007 Operating Year

For the 2007 operating year (1 August 2006 through 31 July 2007) the United States and Canadian Sections of the Treaty Operating Committee developed two supplemental operating agreements that allowed for shaping of Treaty storage releases during the October through July period for power/non-power benefits.

The first is the Fall Storage Agreement which was developed to provide mutual power and non-power benefits. The agreement allowed for mutually-agreed storage of water during October and November 2006, with release of stored water to occur by the end of March 2007. Under terms of this Agreement, a total of 621 Ksfd of water was stored in Arrow between October 7th and November 10th and the stored water was released from late November through March.

The second is the Nonpower Uses Agreement, signed in December 2006, which provides for 1 Maf of flow augmentation storage for the US in exchange for improved flows in Canada for whitefish spawning in January and trout spawning and emergence in the April-June period. Under this agreement, 1 Maf of flow augmentation water was stored in Mica reservoir during January and early February 2007 for release in May through July.

As of 15 April 2007, 586 Ksfd of water above the Treaty Storage Regulation (TSR) 15 April level was held in Treaty storage. All flow augmentation storage was released by 31 July under the Nonpower Uses Agreement and Treaty storage was essentially at TSR levels by the end of the month.

Non-Treaty Storage

The Non-Treaty Storage Agreement (NTSA) between BPA and BC Hydro is a commercial agreement signed in 1990, enabling use of some space in projects in Canada not governed by the Columbia River Treaty. The NTSA expired in June 2004, following a 1-year extension. Under the 1990 NTSA, the parties are required to refill their accounts by 30 June 2011.

BPA and BC Hydro have worked toward refilling accounts under the 1990 NTSA as flow and power conditions permit. Approximately 383 Ksfd of water was stored into non-Treaty space during the 2007 operating year. Non-Treaty storage accounts are currently 78 percent full.

4. Snake River

The BOR released 428,425 acre-feet for flow augmentation in 2007 from the Upper Snake above Milner, the Payette, the Boise, and natural flows. The BOR targeted a release volume of 427,000 acre-feet in 2007 from these locations.

C. Conclusions

- At The Dalles Dam, the observed runoff volume recorded between January and July of 2007 was 95.7 Maf, which was 89% of the average runoff volume between 1971 and 2000. In general the Snake River contained less than average water supply, where as the mid and upper Columbia contained an average or better water supply.
- Over the 79-year record between 1929 and 2007, the 2007 January-July runoff at Lower Granite and the The Dalles ranked 65th and 50th, respectively.
- Seasonal (October through September) precipitation was: 98 percent of average (1971-2000) at Columbia above Coulee, 79 percent of average at the Snake River above Ice Harbor, and 94 percent of average at Columbia above The Dalles.
- By the end of April, Columbia River Basin snowpack was below average for the season.
- The COE implemented a flood control shift between Grand Coulee and Dworshak Dam over the winter of 2007. Grand Coulee ended April 10th at an elevation of 1259.6 feet, very close to its shifted April 10th FC elevation (1259.2 ft). Grand Coulee reached its peak elevation on July 9th, 2007 of 1289.9 feet, just 0.1 feet below its full pool elevation (1290 feet). The end of August summer draft limit at Grand Coulee was 1278 feet. On August 31st, 2007 at midnight, Grand Coulee was exactly at an elevation of 1278.0 feet.
- On April 10th Dworshak was at an elevation of 1568.2 feet, 0.4 feet above its shifted April 10th FC elevation of 1567.8 feet; however, the Action Agencies did have to reduce outflows from 10 Kcfs near the end of March to 2.3 Kcfs beginning April 5th to refill to the April 10th shifted FC elevation. Dworshak reached a peak elevation of 1600 feet June 20th, 2007. Over the summer months Dworshak was drafted to elevation 1533.5 feet by August 31st, 2007 for temperature and flow regulation in the lower Snake River, leaving approximately 180 Kaf of Dworshak water to be released over the first portion of September. Dworshak reached elevation 1520 feet on September 15, 2007.
- Libby was drafted to elevation 2410.8 by December 31st, 2006. By April 10th, Libby was able refill to its April 10th Biological Opinion flood control elevation of 2395.5 feet. In response to several SORs, the Federal Executive group decided to implement the 2007 Fish Operations Plan and the 2004 Biological Opinion, which called for a 20 foot draft of Libby Dam by August 31st. Libby was operated to a flat flow of 17.3 Kcfs from July 3rd through August 22nd and then flows were ramped down to 15 Kcfs for a week then lowed further to 9 Kcfs by the start of September. On August 31st at midnight, Libby was at an elevation of 2438.9 feet.

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- On April 10th, Hungry Horse was at an elevation of 3534.3 feet, 0.9-feet above its April 10th Flood Control elevation of 3533.4 feet. Hungry Horse reached a peak elevation of 3559.9 feet on June 28th, 2007. In response to several SORs, the Federal Executive group decided to implement the 2007 Fish Operations Plan and the 2004 Biological Opinion, which called for a 20 foot draft of Hungry Horse Dam by August 31st. Outflows a Hungry Horse were between 4.4-4.5 Kcfs in July and August of 2007. On August 31st at midnight, Hungry Horse was at an elevation of 3542.2 feet, 2.2 feet above the 20-foot end of August draft elevation.
 - On April 10th, Brownlee was at an elevation of 2064.7 feet, 5.2 feet above its Flood Control elevation of 2059.5 feet. Brownlee was within two feet of full from 5/7/2007 to 6/22/2007 and reached its peak elevation of 2076.6 feet on June 5th, 2007.
 - Spring flows at Lower Granite Dam averaged 61 Kcfs, below the Biological Opinion flow objective of 85 kcfs. Summer flows at Lower Granite averaged 29 Kcfs, also below the Biological Opinion flow objective of 50 Kcfs.
 - Spring flows at McNary Dam averaged 239 Kcfs, above the Biological Opinion flow objective of 237 Kcfs. Summer flows at McNary averaged 163 Kcfs, below the Biological Opinion flow objective of 200 Kcfs.
 - Spring flows at Priest Rapids Dam averaged 169 Kcfs, above the Biological Opinion flow objective of 135 Kcfs.
 - Water temperatures in the Lower Granite Tailwater exceeded the 20°C temperature standard during 1.2% of the hours (27 of 2208 hours) between July 1st and September 30th, 2007.
 - For the 2007 operating year (1 August 2006 through 31 July 2007) the United States and Canadian Sections of the Treaty Operating Committee developed two supplemental operating agreements that allowed for shaping of Treaty storage releases during the October through July period for power/non-power benefits. The first is the Fall Storage Agreement which was developed to provide mutual power and non-power benefits. Under terms of this Agreement, a total of 621 Ksfd of water was stored in Arrow between 7 October and 10 November and the stored water was released from late November through March. The second is the Nonpower Uses Agreement, signed in December 2006, which provides for 1 Maf of flow augmentation storage for the US in exchange for improved flows in Canada for whitefish spawning in January and trout spawning and emergence in the April-June period. Under this agreement, 1 Maf of flow augmentation water was stored in Mica reservoir during January and early February 2007 for release in May through July.

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- As of 15 April 2007, 586 Ksfd of water above the Treaty Storage Regulation 15 April level was held in Treaty storage. All flow augmentation storage was released by 31 July under the Nonpower Uses Agreement and Treaty storage was essentially at TSR levels by the end of the month.
 - The Non-Treaty Storage Agreement (NTSA) between BPA and BC Hydro is a commercial agreement signed in 1990, enabling use of some space in projects in Canada not governed by the Columbia River Treaty. The NTSA expired in June 2004, following a 1-year extension. Under the 1990 NTSA, the parties are required to refill their accounts by 30 June 2011. BPA and BC Hydro have worked toward refilling accounts under the 1990 NTSA as flow and power conditions permit. Approximately 383 Ksfd of water was stored into non-Treaty space during the 2007 operating year. Non-Treaty storage accounts are currently 78 percent full.
 - The BOR released 428,425 acre-feet for flow augmentation in 2007 from the Upper Snake above Milner, the Payette, the Boise, and natural flows. The BOR targeted a release volume of 427,000 acre-feet in 2007 from these locations.

II. 2007 Spill Management

A. *Spill*

1. Overview

In December of 2004 a new Biological Opinion was released. In February 2005, the National Wildlife Federation and several other parties asked the court to invalidate the 2004 FCRPS BiOp. In October 2005, US District Court Judge James Redden found the 2004 FCRPS BiOp invalid and remanded it to NOAA Fisheries. The provisions contained in the 2004 BiOp remained in place for the 2005 migration, with the exception of the requirements for summer spill.

On December 29, 2005 the court granted the plaintiffs a preliminary injunction which provided for spill operations in 2006 that were, in part, different than the 2004 BiOp. On January 7, 2007 an agreement was signed between the Bonneville Power Administration and the Colville, Yakama, Umatilla, Warm Springs, and Nez Perce tribes regarding the Federal Columbia River Power System Operations (FCRPS) for 2007 (2007 FCRPS Operations Agreement). This operational plan was implemented for 2007. On May 23, 2007 FCRPS the 2007 Operations Agreement was made into a Court Order.

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. In addition, spill is used to provide an alternate route for fish at transportation collector projects, allowing an increased proportion of juvenile salmonids to migrate in-river to below Bonneville Dam. Presently, this “spread the risk” management option is employed since transportation does not provide the survival to adulthood needed for population recovery for ESA listed spring/summer Chinook, steelhead, sockeye and fall Chinook.

It is recognized that spilling water generates atmospheric gas supersaturation of the river that may possibly have detrimental effects on fish. In providing spill as an alternate passage route the associated potential for mortality due to dissolved gas supersaturation needs to be balanced against mortality of turbine passage. However, monitoring migrating populations for signs of gas bubble trauma since 1994 has shown that problematic dissolved gas levels have not occurred with voluntary levels of spill for fish passage. Problematic total dissolved gas levels usually are observed when spill exceeds voluntary spill levels due to flows in excess of hydraulic capacity or generation needs.

2. Spill Planning and Operations

Spill according to the 2007 FCRPS Operations Agreement was to occur under all flow years. The 2007 migration year was unique in that spill occurred throughout the spring period in a low flow year. The 2007 FCRPS Operations Agreement states that in water years when the projected seasonal average flow is greater than 70 kcfs, transportation is initiated between April 20 and May 1 at Lower Granite Dam, and at

staggered dates at the downstream transport collector projects. In years where projected flows are less than 70 Kcfs, transport is initiated on April 20. The early projections were for spring flows to exceed 70 Kcfs and therefore transport operations were not initiated until May 1 at Lower Granite Dam.

The following describes the planned spill levels for 2007 according to the 2007 FCRPS Operations Agreement.

Season/Project	2007 FCRPS Operations Agreement Spill Levels
SPRING	
Lower Granite	20 kcfs day/night
Little Goose	30% day/night
Lower Monumental	Gas Cap day/night
Ice Harbor	30% day/night vs. 45 Kcfs day/gas cap night
McNary	40% day/night
John Day	0 day / 60% night
The Dalles	40% day/night
Bonneville	100 kcfs day/night
SUMMER	
Lower Granite	18 kcfs day/night
Little Goose	30% day/night
Lower Monumental	17 kcfs day/night
Ice Harbor	30% day/night vs. 45 Kcfs day/gas cap night
McNary	40% day/night vs. 60% day/night
John Day	30% day/night
The Dalles	40% day/night
Bonneville	75 kcfs day / gas cap night

The 2007 FCRPS Operations Agreement specifies spill level that exceed those contained in the 2004 Biological Opinion. Spring spill at Lower Granite Dam has expanded from 12 to 24 hours daily to accommodate the continuous operation of the removable spillway weir. Spill hours at Little Goose and McNary Dams increased from twelve to twenty-four hours daily.

The 2007 FCRPS Operations Agreement also incorporates a summer spill program at the Snake River Transport collector projects (Lower Granite, Little Goose and Lower Monumental Dams) as well as at McNary Dam. Prior to the summer of 2006 spill was terminated at these projects after the spring spill period.

In general spill during 2007 met the objectives of the 2007 FCRPS Operations Agreement, within the constraints: of research study requirements, managing to the dissolved gas criteria of 120% TDG in the tailraces of a dams and 115% in the forebays of the dams; and the minimum turbine operation requirements for each project.

While, in general, 2007 spill met objectives there were some specific issues that were encountered in the hydrosystem. These included: a) no spill was provided for the March Spring Creek Hatchery release and high mortality was observed for this release; b) there was a failure to meet 2007 FCRPS Operations Agreement spill levels at the beginning of the season that resulted in the changing of the 2007 FCRPS Operations

Agreement into a Court Order; and, c) spill volumes were again constrained by forebay total dissolved gas readings.

a) The provision of spill for the Spring Creek Hatchery release.

The Spring Creek Hatchery juvenile tule fall Chinook were presented with several obstacles to survival in 2007. The USFWS has been releasing tule fall chinook in March for several years. Spill has been provided annually since the early 1980's to facilitate the passage of the fish past Bonneville Dam. In recent years, providing spill for these fish has proven to be contentious because they migrate outside of the BiOp spring spill program (that begins April 10th in the Lower Columbia) and because they are not ESA listed fish. The Action Agencies in 2004 proposed to operate the new Bonneville Second Powerhouse Corner Collector in lieu of providing spill for fish passage. This proposal was not regarded as sufficient by the agencies and tribes since the corner collector had not been tested and, therefore, any benefits at the time were speculative. The USFWS coordinated with the Action Agencies and agreed to a three-year operation: spill and study in 2004 and no spill for 2005 and 2006. Spill in subsequent years for Spring Creek hatchery releases was to be dependent on the outcome of the research.

This year System Operational Request #2007-2 was submitted to the Action Agencies for 75 Kcfs spill and operation of the corner collector for four days following either the March 5 or March 9 release, and operation of the corner collector alone for the other release. The request was based on the results of the USFWS 2004 study results that suggested statistically significant benefits to adult survival for fish that passed via spill. The SOR was cognizant of the fact that limited data was available, but the differences relative to passage route were compelling. Spill during 2007 would have enabled the collection of additional data to further investigate the relation between route of passage at Bonneville Dam and survival to adult. The Technical Management Team did not reach agreement regarding the SOR and elevated the issue to the Implementation Team. The COE and BPA objected to the request at the Implementation Team citing recent juvenile direct survival studies conducted using radio tagged juvenile spring Chinook yearlings and summer migrating fall Chinook subyearlings as justification. The SOR for spill for Spring Creek hatchery fish was not implemented.

Approximately 6.5 million subyearling Chinook were released on March 5 and an additional 1.2 million were released on March 9. Based on the sampling data, the fish began arriving on March 6, with the peak number passing on March 8, when the passage index reached 429,000. The numbers declined quickly on March 9, to 300,000. Smolt Monitoring personnel at the site reported unusually high mortality in the Spring Creek smolts collected at Bonneville Dam. They reported 4.5% mortality on March 8th and 8% mortality on March 9th when typical mortality rates are less than 1%. The mortalities examined showed no descaling or sign of virus or bacteria, and all of the released fish had passed their detection tests before leaving the hatchery.

Based on the high mortality the Salmon Managers submitted SOR #2007-3 on March 9 requesting emergency spill at Bonneville Dam in order to provide fish with an alternate route past the powerhouse. The Action Agencies denied the request and continued operating the Bonneville Second Powerhouse corner collector citing no information indicated that the bypass system was causing the mortalities.

The second Spring Creek Hatchery release occurred on April 12, 2007. Spill was provided at Bonneville Dam as part of normal spring spill operations. The subyearling Chinook also showed elevated rates of moribund and dead fish. As a result, a special operation with a reduction in turbine loading to the low end of the 1% efficiency range for units in Powerhouse 2 that had been modified with minimum gap closure devices to improve fish guidance was requested. The COE complied with the request and a substantial reduction in mortality was observed (from 10% to 2.7%).

A third release of 3.5 million subyearling Chinook from Spring Creek Hatchery occurred on May 1, 2007. The survival of this release was of particular concern given the unexpected mortality incurred by the previous March and April releases. Consequently, the Salmon Managers requested the turbine units equipped with gap closure devices operate at the low end of the 1% efficiency range prior to the arrival of this third release of fish. The mortality observed for this release was considerably less than observed for the March and April releases.

b) Failure to Meet Court Ordered Operations at the beginning of the spill season

On April 3, 2007, the first day of spill at the Snake River projects, a combination of errors created a situation where the specified spill levels were not provided. On Monday morning, April 2, the control room operator at Little Goose had to manually enter forebay elevations into the computer because a technician was working on calibrating the automated GDACS system. Because this was a departure from the normal automated operation and the operator was distracted from this task, the forebay elevation dropped below the minimum operating pool of 633-634 feet elevation. BPA schedulers received incorrect information (received via computer) and managed the system accordingly. This created problems at all the other projects downstream of Little Goose Dam resulting in fluctuating spill volumes to maintain the minimum operating pool. To restore the reservoir to the proper elevation, the Corps reduced power generation and spill discharge at Little Goose dam, which resulted in similar reductions at each of the other Lower Snake River dams.

The issue was compounded because in the few days before April 3, 2007, BPA overestimated, and consequently oversold the amount of surplus power it expected to generate that day. To meet its April 3, 2007 obligations, an unsuccessful effort was made to purchase the needed power to cover the shortfall. Since they could not purchase the power BPA generated additional power by operating Bonneville, The Dalles, and McNary

dams outside the 1% peak turbine efficiency standard for several hours on April 3, 2007.

The 9th Circuit Court reviewed the circumstances surrounding the event and decided on May 23, 2007 to incorporate the terms of the 2007 FCRPS Operations Agreement into a Court Order.

c) Spill volumes were again constrained by forebay total dissolved gas readings

In spite of the fact that 2007 was a very low flow year, the total dissolved gas from spill often exceeded the TDG forebay criteria. The issue was most often observed at Lower Monumental and Bonneville dams. The forebay monitors are often affected by localized biological processes and physical processes, such as temperature. Spill caps at the project were often reduced in order to meet the downstream forebay criteria, while at the same time tailrace TDG levels were well below waiver limits.

3. Project Specific Operations

Dworshak Dam

Spill at Dworshak occurred in early July during 2007 (July 05 - July 15) when flow was increased to address temperature concerns at Lower Granite Dam. Temperatures during this period were near, or exceeding water quality standards at Lower Granite Dam. At all other times Dworshak was releasing powerhouse capacity or less than powerhouse capacity (Figure 10).

Figure 10. Dworshak Dam flow and spill for spring and summer of 2007.

Lower Granite Dam

The Court Order specified that the project spill 20 Kcfs on an instantaneous basis during the spring periods (April 3 to June 20) and an instantaneous 18 Kcfs during the summer spill period (June 21 to August 31). The spill met the 2007 FCRPS Operations Agreement during the spring period and during the summer period, except during the

summer when flow was too low to provide 18 Kcfs spill in addition to the operation of one turbine unit. Spring spill occurred from April 3 through June 20 and summer spill occurred from June 21 to August 31 (Figure 11).

Figure 11. Lower Granite Dam flow and spill for spring and summer of 2007.

Little Goose Dam

Spill according to the Court's 2007 FCRPS Operations Agreement was to be 30% of instantaneous flow throughout the spring and summer period. Spill was also to occur as 30% of instantaneous flow during daylight hours and gas cap spill during nighttime hours for a 14 day period chosen by the Salmon Managers, between April 22 and May 15. The recommendation was for nighttime gas cap spill to begin at this project on the night of April 29. During some periods in May spill at Little Goose Dam was limited to less than the 2007 FCRPS Operations Agreement based on the 115% TDG criteria at the Lower Monumental forebay (Figure 12).

Figure 12. Little Goose Dam flow and spill for spring and summer of 2007.

Lower Monumental Dam

According to the 2007 FCRPS Operations Plan spill at Lower Monumental Dam was planned to be to the gas cap throughout the spring period and 17 Kcfs throughout the summer period. Spill to the gas cap was originally estimated at 27 Kcfs under bulk spill operations and was often restricted lower during the spring based on the forebay TDG criteria at the Ice Harbor forebay monitor. The spill during the summer period was less than the 17 Kcfs from mid July through August 31 because of low flows and the minimum turbine operation requirements of the project (Figure 13).

Figure 13. Lower Monumental Dam flow and spill for spring and summer of 2007.

Ice Harbor Dam

Spring and summer spill generally occurred according to the 2007 FCRPS Operations Agreement. Testing of 30% instantaneous spill versus 45 Kcfs during daytime hours and gas cap during nighttime hours was tested through July 22, 2007. After that time spill was provided as 45 Kcfs during daytime hours and gas cap spill during nighttime hours, within the constraint of operating one turbine unite and meeting TDG requirements (Figure 14).

Figure 14. Ice Harbor Dam flow and spill for spring and summer of 2007.

McNary Dam

Spring spill according was initiated on April 10 and continued through June 3. Spill during the spring period was 40% of instantaneous river flow. Summer spill began on July 1 and was a test of 40% instantaneous spill versus 60% instantaneous spill alternating every two days (Figure 15). Summer spill ended on August 31, 2006.

Figure 15. McNary Dam flow and spill for spring and summer of 2007.

John Day Dam

Spill was provided from April 10 through August 31 for spring and summer migrants as required in the 2007 FCRPS Operations Agreement. Spill occurred as 0 kcfs during daytime hours and 60% of instantaneous flow during nighttime hours. Spill changed to 30% of instantaneous flow for 24-hours during the summer spill period (Figure 16).

Figure 16. John Day Dam flow and spill for spring and summer of 2007.

The Dalles Dam

Spring spill began on April 10 and continued through the summer spill period until August 31, 2006 (Figure 17). Both spring and summer spill were provided as 40% of instantaneous flow.

Figure 17. The Dalles Dam flow and spill for spring and summer of 2007.

Bonneville Dam

Spill was provided from April 10 through June 20 at 100 Kcfs for 24 hours a day. However, spill was routinely moderated to meet the gas cap below the project at Camas/Washougal (Figure 18). On June 20th the summer spill program was initiated at Bonneville Dam, ten days earlier than normal, for research purposes. The research was to address observed “bad” eggress conditons at 75 Kcfs spill. During the research study spill was increased to 85-87 Kcfs during daytime hours and gas cap spill at night, which was implemented until July 15. After July 15 the project reverted to the 2007 FCRPS Operations Agreement levels of 75 Kcfs during daytime hours and gas cap spill at night. Summer spill continued until August 31.

Figure 18. Bonneville Dam flow and spill for spring and summer of 2007.

4. Summary and Conclusions

The 2007 FCRPS Operations Agreement represents an expanded and improved spill program that goes beyond the measures contained in the 2004 Biological Opinion. The 2007 migration year was unique in that spring spill occurred at the Snake River transportation collector projects (Lower Granite, Little Goose and Lower Monumental) during a low flow year, when spill would not normally have been invoked under the Biological Opinion. In addition, the initiation of fish transportation was delayed until after May 1 at Lower Granite Dam allowing more spring migrants from the Snake River to continue to migration in-river.

The 2007 FCRPS Agreement specifies daily spill programs to occur for twenty-four hours per day at all projects, (except for John Day Dam where the daily program remained at 12 hours). The Agreement also specifies that summer spill program for

spill at all the fish transportation collector projects (Lower Granite, Little Goose, Lower Monumental and McNary Dams). Whereas, according to the 2004 Biological Opinion, and prior to the 2005 Court ordered summer spill program, spill terminated at these projects after the spring period.

In summary, the 2007 migration conditions differed from any year in the historic record. The migration conditions combined low river flows with spill throughout the spring summer season. The improved spill measures in the low flow year likely increased the probability of survival of juvenile salmonids migrating in-river. Spill in 2007 was implemented according to the FCRPS Operations Agreement for 2007 with some exceptions.

This operational plan was made into a Court Order on May 23, 2007 after the 9th circuit court reviewed the circumstances surrounding the spill operations that occurred the first day of spill.

Spill did not occur for the March release of tule fall Chinook from the Spring Creek Hatchery despite several system operation requests submitted from the salmon managers.

Court ordered spill levels continued to be constrained on the basis of forebay TDG monitor readings. The two projects where spill was and most severely constrained because of these readings were Lower Monumental and Bonneville dams.

B. Gas Bubble Trauma Monitoring and Data Reporting for 2007

1. Overview

The monitoring of juvenile salmonids in 2007 for Gas Bubble Trauma (GBT) was conducted at Mid Columbia, Lower Columbia and Snake river sites. Fish were collected and examined for signs of GBT 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. Prior to 2005, monitoring was conducted at all sites during the spring spill season and at Mid Columbia and lower Columbia river sites during the summer spill program. However, beginning in 2005 summer monitoring at the Snake River sites started as a result of the Court ordered summer spill program. This year summer spill in the Snake River occurred from June 20, 2007 until August 31, 2007.

Yearling Chinook and steelhead were sampled through the spring at all the sites. Once subyearling Chinook predominated smolt collections, the sampling of subyearling Chinook occurred until the end of August.

Sampling occurred two days per week at the Columbia River sites and one day a week at each of the Snake River sites during the time period that spill was implemented. 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 (Table 7).

Table 7. Ranking criteria used in monitoring for signs of gas bubble trauma in fins.

Rank	Sign
0	no bubbles present
1	up to 5% of a fin area covered with bubbles
2	6% to 25% of a fin area covered with bubbles
3	26% to 50% of a fin area covered with bubbles
4	> than 50% of a fin area covered with bubbles

The eyes of the fish were also examined and the eye with the highest amount of bubbles 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 similar 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.

The runoff for the 2007 water year was 63% of average (1971-2000) at Lower Granite and 89% of average at The Dalles Dam. This below average water year resulted in markedly low flows during most of the 2007 spill season at Lower Granite Dam (Figure 19).

Figure 19. Average daily flows at Lower Granite Dam (2007, 2006, and the 10 year average)

2. Results

In all, 13,054 juvenile salmonids were examined for GBT between April and August of 2007 (Table 8).

Table 8. 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 2007 as part of the GBT Monitoring Program.

Site							
Species	BON	MCN	LMN	LGS	LGR	RIS	Total
Chinook Subyearlings	1,785	1,957	43	609	1	1,145	5,540
Chinook Yearlings	1,609	1,157	344	311	259	992	4,672
Steelhead	252	186	605	972	318	509	2,842
Total	3,646	3,300	992	1,892	578	2,646	13,054

Fin signs were found in 319 or 2.4% of the fish sampled at all sites (Table 9). Four fish were found with severe fin signs (rank 3 or higher) while, 47 and 268 fish had less severe fin signs of rank 2 and 1, respectively. Table 10 compares the 2007 estimates of the overall percentage of fish with signs of GBT to past years' estimates.

Table 9. Number of juvenile salmonids found with fin GBT at dams on the Lower Snake River and on the Columbia River from April to August 2007 as part of the GBT Monitoring Program.

Site							
Species	BON	MCN	LMN	LGS	LGR	RIS	Total
Chinook Subyearlings	2	0	0	19	0	6	27
Chinook Yearlings	38	0	1	2	0	7	48
Steelhead	10	0	51	180	0	3	244
Total	50	0	52	201	0	16	319

Table 10. Percent of sampled fish with signs of fin GBT estimated for the total fish observed.

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total % Signs	3.3	3.2	1.0	0.3	0.2	0.001	0.7	1.5	0.18	0.46	1.6	2.4
% signs excluding RIS	4.2	4.3	1.6	1.4	0.2	0.1	0.7	0.5	0.18	0.11	1.4	2.9

The Biological Opinion Spill Program was managed using the data collected for total dissolved gas (TDG) levels. However, signs of GBT in fins of juvenile fish, examined as part of the biological monitoring, were used to complement the physical monitoring program. NOAA Fisheries originally established the action criteria for the biological monitoring program at 15% prevalence of total fish having fin signs or 5% with severe signs (rank 3 or greater) in fins. At times these criteria were exceeded in 2007. The criteria were exceeded in the Snake River at Little Goose Dam during early and mid-June and again in late July. The criteria were also exceeded at Lower Monumental Dam sporadically throughout June and July.

The Fish Passage Center Staff provided information on the incidence of gas bubble trauma (GBT) in juvenile Snake River steelhead on June 8, 2007 (<http://www.fpc.org/documents/memos/90-07.pdf>) and again on June 11, 2007 (<http://www.fpc.org/documents/memos/92-07.pdf>) and technical discussions took place among the Salmon Managers at the Fish Passage Advisory Committee. In past years' the Snake River GBT sampling program typically ended on June 20th (or earlier) since, until 2005, there was no summer spill program at the fish transportation sites in the Snake River. In the few years of monitoring at the Snake River projects since 2005 it has been observed that typically the incidence of

GBT in steelhead tends to increase slightly towards the end of the season, although not to the degree that occurred in 2007. The question then arose as to why the higher incidence of GBT in steelhead was being observed in 2007.

a. Steelhead Sampling at Little Goose and Lower Monumental Dams:

In an effort to understand the implications of the increase in incidence of Rank 1 signs of GBT, the frequency of monitoring was increased at Little Goose and Lower Monumental dams. During this time the projects were requested to initiate the collection of subyearling Chinook for GBT monitoring, as their passage numbers had begun to increase.

Table 11 shows the percent GBT for steelhead at Little Goose Dam and Table 12 shows that data for Lower Monumental Dam. Three things can be noted regarding the observations:

1. An increased proportion of steelhead smolts were observed with mostly Rank 1 signs of GBT, but at the same time very few subyearling migrants exhibited signs of GBT.
2. The goal of obtaining 100 individuals of the predominate species was often not achieved.
3. With the exception of the first June observation at either site, the TDG levels observed in the forebays were below the state and federal standards of 110% and not within the range of the waiver standards.

Table 11. Observation of GBT in yearling Chinook, steelhead, and sub-yearling Chinook at Little Goose Dam in 2007.

Date	Yearling Chinook		Steelhead		Subyearling Chinook		All Species % GBT	Percent TDG	
	# Exam.	% GBT	# Exam.	% GBT	# Exam.	% GBT		LGS-FB	LGR-TW
5-Jun	6	0%	94	14.9%	0	N/A	14.0%	112.8	112.9
8-Jun	2	50.0%	92	39.1%	6	0.0%	37.0%	108.2	112.2
10-Jun	0	N/A	50	26.0%	100	3.0%	10.7%	110.9	113.6
12-Jun	2	0.0%	50	22.0%	98	5.1%	10.7%	109.3	111.8
19-Jun	2	0.0%	61	55.7%	14	7.1%	45.5%	109.6	115.7
26-Jun	1	0.0%	2	50.0%	99	3.0%	3.9%	109.3	114.8
3-Jul	3	0.0%	4	25.0%	97	2.1%	2.9%	110.3	113.6
10-Jul	0	N/A	12	66.7%	90	5.6%	12.7%	109.2	113.6
24-Jul	0	N/A	82	28.0%	16	0.0%	23.5%	107.5	111.0

Table 12. Observation of GBT in yearling Chinook, steelhead, and sub-yearling Chinook at Lower Monumental Dam in 2007.

Date	Yearling Chinook		Steelhead		Subyearling Chinook		All Species % GBT	Percent TDG	
	# Exam.	% GBT	# Exam.	% GBT	# Exam.	% GBT		LMN-FB	LGS-TW
4-Jun	2	0%	64	18.8%	0	N/A	18.2%	114.3	113.8
7-Jun	4	0%	18	27.8%	0	N/A	22.7%	109	112.2
11-Jun	3	33%	33	48.5%	5	0%	41.5%	110.2	109.4
25-Jun	0	N/A	1	0.0%	0	N/A	0.0%	106.9	108.3
1-Jul	0	N/A	2	50.0%	23	0%	4.0%	107	107.8
8-Jul	0	N/A	1	100.0%	3	0%	25.0%	107.6	109.3
22-Jul	0	N/A	3	0.0%	3	0%	0.0%	105	107.6
29-Jul	0	N/A	5	40.0%	3	0%	25.0%	106.3	107.9

From the data it was apparent that the late migrating juvenile steelhead were disproportionately displaying the signs of GBT. The Salmon Managers were addressing a situation that affected the tail end of the steelhead migration, where water quality standards were not being exceeded, and where there was a desire to maintain protection for the increasing subyearling population. Given the low TDG levels at the projects the Salmon Managers investigated the potential causes of this occurrence from a project operations and migration conditions perspective.

b. Passage Timing and Travel Time

Historically steelhead smolt passage at Lower Granite Dam peaks in early May (50% passage date) with over 90% of steelhead migrants passing by late May, which was the migration pattern exhibited in 2007 (Figure 20).

Figure 20. The 2007 steelhead passage index compared to historic data at Lower Granite Dam.

Observations of steelhead smolts displaying an increase in Rank 1 signs of GBT were first detected at Little Goose Dam on June 5, 2007. Based on migration timing data, approximately 95.1% of the steelhead population had passed Little Goose Dam by this date (Figure 21). However, while most of the steelhead had passed the project, the subyearling migration was beginning to increase significantly with 5.3% of the subyearling Chinook past Little Goose Dam on that date and with the magnitude of the subyearling population ten times that of the steelhead migrants. There was a desire to provide good in-river migration conditions for subyearling Chinook as long as they were not exceeding criteria for GBT.

Figure 21. Cumulative proportion of yearling and subyearling Chinook and steelhead passing Little Goose Dam. The GBT incidence in steelhead was first observed on June 5, 2007 at Little Goose Dam.

c. Fish Travel Time Conditions in 2007

From laboratory studies that had been conducted (Mesa et al., 2000) it had been shown that up to 80% of Chinook would display minor signs of GBT at low levels of TDG if left sufficiently long in the water at that exposure. There were no mortalities in this group throughout the duration of the experiment, which lasted for 22 days. Given this information the Salmon Managers began to consider the flow and fish travel time conditions that existed in 2007.

As pointed out above, flow at Lower Granite Dam during June was significantly less than observed in 2006, or as represented by the ten year average. Steelhead juvenile migrants are particularly sensitive to changes in flow as expressed by their fish travel time estimates. The hypothesis was that steelhead travel time was longer during June of 2007 due to extremely low flows, and the few late migrating steelhead were displaying minor signs of GBT because of the long exposure to these sub-lethal levels of TDG.

The hypothesis was evaluated by plotting travel time of steelhead smolts between Lower Granite and Little Goose dams as a function of their arrival timing at Little Goose Dam. From the graph (Figure 22) it can be seen that the later arriving fish in 2007 had much longer travel times in 2007 than observed in 2006. This is consistent with the hypothesis that a higher incidence of signs of GBT in steelhead juveniles at Snake River projects in 2007 was a result of longer travel times between projects. These long travel times were most likely due to the low flows seen in 2007 as steelhead tend to residualize late in the season when flows are low.

Figure 22. Travel time of steelhead juveniles migrating between Lower Granite and Little Goose Dam in 2007 as a function of arrival time at Little Goose Dam.

D. Steelhead Survival

Finally, it is worth mentioning that, despite the higher incidence of GBT in steelhead at Little Goose and Lower Monumental dams in 2007, in-river survival for steelhead juveniles in 2007 was higher than recent years and not significantly different from the high survivals seen in 2006 (Table 13).

Table 13. Reach survival (s.e.) for juvenile Snake River steelhead (data from NOAA Technical Staff Memo released August 31, 2007)

Reach	2001	2002	2003	2004	2005	2006	2007
LGR-MCN	0.168 (0.006)	0.536 (0.025)	0.597 (0.013)	0.379 (0.023)	0.593 (0.018)	0.702 (0.016)	0.695 (0.020)
LGS-BON	0.042 (0.003)	0.262 (0.050)	0.309 (0.011)	N/A	N/A	0.455 (0.056)	0.386 (0.069)

3. Discussion

GBT sampling was successfully accomplished for the 2007 migration season. In general, the incidence of GBT in migrating salmonids was low in 2007, with the exception of a short time period in the Snake River where higher incidence of mostly Rank 1 GBT signs were observed among late arriving steelhead. The higher levels were observed for steelhead smolts passing in the tail of the migration (>95% passed) when TDG levels were generally below the 110% standard for TDG in the forebay of the projects where fish were sampled. From the observations presented above, it is clear that the high incidence of GBT among steelhead juveniles in 2007 was likely due to the prolonged exposure to non-lethal TDG due to longer travel times, as a result of low flows in the Snake River. Finally, according to survival studies conducted by NOAA Fisheries juvenile steelhead survival in 2007 was comparable to the high levels of survival observed in 2006 and among the highest observed in recent years.

References:

Matthew G. Mesa, Lisa K. Weiland, and Alec G. Maule, 2000. Progression and Severity of Gas Bubble Trauma in Juvenile Salmonids. *Transactions of the American Fisheries Society* 129:174–185.

Preliminary survival estimates for passage during the spring migration of juvenile salmonids through Snake and Columbia River reservoirs and dams, 2007. *Memo* from John Ferguson to Bruce Suzumoto, August 31, 2007. NOAA-National Marine Fisheries Service.

III. 2007 Smolt Monitoring

A. Summary

The 2007 out-migrant survival, timing and travel time from the Snake River basin reflected the court ordered spill operations that took effect in what was otherwise a low flow year. The start of transportation was delayed at Snake River dams which resulted in a significant reduction in the proportion of fish transported. Survival of spring migrants was relatively high in 2007, with higher flows and 24-hour spill at all projects in the Snake River.

Migrant subyearling fall Chinook also posted some relatively high reach survivals from Lower Granite Dam to McNary Dam in 2007, likely due to the continued implementation of summer spill. Again flows in May to July of 2007 were similar to 2001 for the Snake River and yet the reach survivals in 2007 were much higher. In 2001 the survival estimates (LGR to MCN) ranged from 0.25 to 0.34 while those for 2007 ranged between 0.54 and 0.60. Over-wintering fish in the reservoirs of the Snake River would not be included in those survival comparisons. In addition to high survivals, travel time estimates showed that summer migrants traveled much more rapidly in 2007 than in 2001. The median travel times from Lower Granite Dam to McNary Dam in 2007 of 22 days for both groups were much lower than that seen for 2001, when reach travel times ranged between 32 and 42 days. That improvement in travel time was likely due to decreased delay associated with spill during the summer period

B. Special Operations at Sites in the Lower Snake and Lower Columbia in 2007

There were notable changes in operations at several dams in 2007. During spring operations transportation start was delayed again as in 2006 to May 1 at Lower Granite, with collected fish bypassed back to river. In the Lower Columbia River operations were altered due to the installation and testing of temporary spillway weirs, and for the third year, Court Ordered summer spill occurred at all the Snake River dams as well as at McNary Dam.

C. Smolt Monitoring Sites and 2007 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 Smolt Monitoring Program (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 information for management of flows and spills, and 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 20 years or more at some locations, the program also provides historic perspective for comparison both 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 14 for sites and dates of operation for 2007). Monitoring was conducted at four traps in the Snake River Basin above Lower Granite Dam, 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 14. Smolt monitoring sites and schedules for 2007.

Site	Sampling Method	Dates of Operation	Primary Fish Data
Bonneville Dam	PH2: Timed sub-sample from bypass PH1: trap sample	March 1 to October 31	C, FQ, GBT(2)
John Day Dam	Timed sub-sample from bypass	April 1 to September 15	C, FQ
McNary Dam	Timed sub-sample from bypass	April 6 to September 14	C, FQ, GBT(2)
Lower Monumental Dam	Timed sub-sample from bypass	April 1 to September 30	C, FQ, GBT(1)
Little Goose Dam	Timed sub-sample from bypass	April 1 to October 31	C, FQ, GBT(1)
Lower Granite Dam	Timed sub-sample from bypass	March 25 to November 1	C, FQ, GBT(1)
Rock Island Dam	PH2: Census of fish captured in volitional bypass	April 1 to September 1	C, FQ, GBT(2), PIT
SNAKE RIVER TRAP (rkm 225)	Rotating Drum Dipper Trap	March 5 to May 26	C, FQ, PIT
SALMON RIVER TRAP (rkm 123)	Inclined Plane Trap	March 5 to May 26	C, FQ, PIT
Grande Ronde Trap	Inclined Plane Trap	March 5 to May 26	C, FQ, PIT
Imnaha Trap	1-2 Screw Traps	March 2 to June 26	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

D. Collection Counts, Relative Abundance and Population Indices

Collection counts are estimates of the total number of juvenile salmonids entering the bypass at a particular dam. The collection estimate is derived from timed sub-samples taken at intervals throughout a daily twenty-four hour period. 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 15). 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. In 2007 FPC developed a population index for estimating the relative population size of Chinook salmon and steelhead smolts at Lower Granite and Little Goose dams. The population index is described in a technical memorandum available at the following link on the FPC web page; http://www.fpc.org/smolt/juvenile_popindex/35-08.pdf. The population index relies on daily estimates of PIT-

tag collection efficiency over recent years to develop functions that predict daily detection probability based on flow, spill and passage date. The population index is then computed by dividing the daily collection by the estimated daily collection efficiency. The population index more accurately captures the effects of changing spill passage efficiency with increasing spill proportion than the passage index does, which assumes 1 to 1 efficiency.

Due to recent changes at Lower Granite Dam in detection probability with operation of the RSW, the population index was developed to better account for passage magnitude of yearling Chinook and steelhead in particular. Often in recent years the passage index at Lower Granite Dam has been lower than at Little Goose Dam, causing some confusion among fisheries managers trying to manage transport operations. While the passage index remains useful for timing related data, the population index is a better gauge of the population magnitude. However the population index requires a large volume of PIT-tag data in order to develop accurate predictive functions for estimating detection probability. For these reasons, the daily passage index was chosen over attempts to estimate daily absolute abundance. Post-season, the daily passage indices remains the best estimation method of fish timing for all but Lower Granite and Little Goose Dams and is still limited at those dams to Chinook and steelhead smolts. The passage index is not applicable to trap sites because collection efficiencies of the traps are not calculated; therefore only collection counts are reported for the four SMP traps in Table 16.

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 from 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 15. Formulas to compute passage indices (collection/flow expansion factor) at dams.

Sampling Site	Years	Collection	Flow expansion factor
Rock Island Dam (PH 2)	1985-2007	Catch / 1	$PH2/(PH1+PH2+SP)$
Lower Granite Dam Little Goose Dam Lower Monumental Dam McNary Dam	1984-2007 1984-2007 1993-2007 1984-2007	Catch / sample rate	$PH/(PH+SP)$
John Day Dam (bypass) John Day Dam Unit 3	1998-2007 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)	2000-2007	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. Snake River

The cumulative counts of salmonids at the four traps above Lower Granite Dam were summarized over the scheduled operation dates in 2007 (Table 16). 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 2007.

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 each species at the level of combined hatchery and wild fish in our weekly reports and annual report tables (Table 17). However, since all hatchery chinook released in tributaries above Lower Granite Dam were 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 Tables 18 through 20). 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. In addition, for the first year, information was recorded in the SMP data system on holdover fall chinook collected at Snake and Lower Columbia River sites.

Table 16. Sampled numbers of composite wild/hatchery chinook, steelhead, coho, and sockeye at the four traps used in the Smolt Monitoring Program in 2007.

Species	No. of Fish Sampled	Species	No. of Fish Sampled
Salmon River Trap (above Whitebird)		Snake River Trap (at Lewiston)	
Chinook 1's	43,491	Chinook 1's	6,553
Steelhead	3,734	Steelhead	7,792
Sockeye	27	Sockeye	413
		Coho	57
Chinook 0's	0	Chinook 0's	255
Imnaha River Trap		Grande Ronde River Trap	
Chinook 1's	86,299	Chinook 1's	15,108
Steelhead	46,002	Steelhead	1,940
Chinook 0's	0	Chinook 0's	90

Holdover fall chinook were differentiated based on morphology and timing; yearling fish seen at most sites in April, exhibiting deeply forked tail, very little descaling, and eye orientation consistent with fall chinook were considered holdover yearling fall chinook. Within the database, the code “HC” was used in the special species category to indicate these fish. Steelhead with fin erosion typical of a hatchery fish was also used to distinguish additional hatchery fish at the Salmon and Snake River traps. Fin erosion of steelhead has also been incorporated into sampling data at Snake River dams. These data were necessary 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 and to assist FPC in providing greater differentiation of hatchery fish from wild. We reported information on two categories of fish “hatchery” and “unmarked”. The unmarked category includes fish that may be either wild or hatchery origin, but cannot be distinguished. The use of fin erosion was extended to Lower Snake River dams (Lower Granite and Lower Monumental) beginning in 2004. Rearing types are combined in this report. More detailed information can be found in appendices to the report as well as via queries on the FPC web page. 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.

Table 17. Sample, collection, passage indices, and population indices of salmonids at Snake River dams in 2007 and comparison with recent annual passage indices.

Dam	Species	2007				2006 Passage Index	2005 Passage Index	2004 Passage Index
		Sample	Collected	Passage Index	Population Index			
Lower Granite	Chinook Age 0	36,977	201,239	338,790	NA	1,755,890	1,034,532	1,413,192
	Chinook Age 1	18,514	1,578,374	2,247,751	6,849,464	5,676,994	5,176,632	3,599,259
	Coho	651	38,308	50,750	NA	305,073	259,509	132,928
	Steelhead	16,296	1,367,798	1,859,332	7,209,497	5,935,708	5,828,675	3,355,830
	Sockeye/kokanee	231	15,939	20,701	NA	38,484	8,053	16,399
Little Goose ¹	Chinook Age 0	29,199	304,831	438,167	NA	1,287,921	493,436	685,932
	Chinook Age 1	10,901	451,027	637,797	1,782,304	2,475,848	2,658,622	3,644,755
	Coho	926	39,911	55,685	NA	191,698	127,985	116,669
	Steelhead	25,673	1,304,931	1,847,725	4,010,611	2,921,864	1,917,941	2,583,409
	Sockeye/kokanee	222	12,002	17,115	NA	41,369	4,846	8,126
Lower Monumental ²	Chinook Age 0	14,280	42,697	78,577	NA	207,821	191,594	341,254
	Chinook Age 1	9,000	279,174	355,612	NA	706,774	913,852	785,329
	Coho	353	13,545	18,050	NA	24,370	15,934	37,604
	Steelhead	15,732	574,389	740,935	NA	675,547	343,355	1,865,478
	Sockeye/kokanee	38	4,156	5,737	NA	8,217	962	4,543

¹ Full Index sampling (i.e. 24 hour sub-sample to estimate collection) at Little Goose Dam began May 7, 2007

² Full Index sampling (i.e. 24 hour sub-sample to estimate collection) at Lower Mon. Dam began May 12, 2007

The FPC has made annual estimates of the hatchery and unmarked yearling chinook migrating past Lower Granite Dam each year as well as total numbers of steelhead (Tables 5, 6 and 7). Comparisons between population estimates, derived from seasonal PIT-tag detection probability or collection efficiency are compared to population indices for the same years are provided for hatchery yearling Chinook, unmarked yearling Chinook and combined steelhead.

Table 18. Hatchery yearling chinook population estimates and indices at Lower Granite Dam in 2007, with a sum of hatchery production above Lower Granite Dam as well.

Year	Collection efficiency	Collection	Passage index	Population estimate	Population Index	Hatchery release ^a
2003	0.32	2,014,435	2,813,499	6,300,000	7,705,568	12,111,740
2004	0.55	4,846,456	5,175,978	8,700,000	7,629,143	12,268,500
2005	0.72	4,257,329	4,349,634	5,900,000	6,435,820	10,005,428
2006	0.22	2,028,033	3,097,934	8,026,460	8,759,725	13,262,951
2007	0.29	1,268,598	1,849,028	4,374,476	5,607,767	11,454,372

^a Total hatchery release includes only fish released during the year of migration.

It was a relatively low flow year in 2007, and with a fixed spill volume it resulted in relatively high spill proportion at Lower Granite Dam compared in other recent years. As a result collection efficiency at the site for yearling Chinook and steelhead was relatively low (Tables 5,6 and 7). 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 were lower in 2007, while survival from hatcheries to Lower Granite were also lower, resulting in a lower population arriving at the site (Table 18). The estimated wild yearling chinook population (includes wild and a small portion of unmarked hatchery fish) at Lower Granite Dam in 2007 was between 770,000 and 1.2 million smolts, depending on the method used to obtain the estimate. By whichever method, this resulted in the lowest population of wild fish since 2003.

Table 19. Wild yearling chinook (Unmarked) population estimates and indices at Lower Granite Dam in 2007, with a sum of hatchery production above Lower Granite Dam as well.

Year	Collection efficiency	Collection	Passage index	Population estimate	Population Index
2003	0.42	562,595	785,759	1,300,000	1,327,279
2004	0.61	1,042,762	948,424	1,700,000	1,495,186
2005	0.76	1,283,153	1,327,323	1,700,000	2,025,047
2006	0.30	379,613	594,669	1,209,811	1,902,298
2007	0.32	246,831	369,567	771,347	1,241,676

Steelhead collection efficiency at Lower Granite Dam was relatively low again in 2007. As with yearling Chinook the low collection efficiency was likely due to high spill percentages related to low flows and a fixed (20 Kcfs) spill volume associated with the RSW with training spill operation. The population index for steelhead was similar to 2004, but higher than 2005 or 2006. The hatchery releases were similar to other recent years.

Table 20. Steelhead population estimates and indices at Lower Granite Dam in 2007, with a sum of hatchery production above Lower Granite Dam as well.

Year	Collection efficiency	Collection	Passage index	Population estimate ¹	Population Index	Hatchery release
2003	0.32	2,337,143	3,355,823	7,300,000	11,495,239	9,627,940
2004	0.73	5,677,412	5,828,611	7,800,000	7,930,473	9,068,327
2005	0.68	5,590,788	5,935,714	8,300,000	6,951,415	8,661,461
2006	0.33	2,820,402	4,483,096	8,136,226	5,265,979	9,975,214
2007	0.22	1,367,798	1,859,330	6,217,264	7,209,504	8,715,659

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.

2. Columbia River

The cumulative number of fish sampled at each dam in 2006, along with expanded annual collection and passage indices, were summarized for the Columbia River dams (Table 21). Caution should be used in comparing the magnitude of passage indices between years at a given site, however patterns that are consistent at multiple sites likely suggest changes in population passing through a segment of the river. When spill passage efficiency is greater than one to one the between year comparison of the magnitude of passage indices becomes more difficult.

Passage indices at Rock Island Dam in 2007 were higher than in other recent years, especially for spring migrants. While for subyearling Chinook the index was lower than other recent years.

At McNary Dam, sampling occurred every other day from April 3 to August 17. On alternate days fish were either, sampled and run through the full facility, or fish were routed back to the river through the primary bypass. There were some exceptions to this pattern early in the season, when fish were collected for research purposes on non-sampling days. Every other day sampling in the spring has occurred since 2003. In 2007 every other day sampling continued into August, while in earlier years it ended in late June or early July. In order to make indices comparable year to year, for dates when there was no sampling, or limited sampling the index was estimated by taking the average index of the date prior to and after the date. For seasonal totals and timing this standardized index allowed better comparisons between years. Spring migrant annual indices were variable at McNary Dam in 2007 relative to other recent years. Yearling Chinook and sockeye indices were higher than all of the recent years. The steelhead index was below that seen in 2006, but higher than other recent years. The coho index was similar to that of 2005 and 2006, but slightly higher than 2004. For subyearling Chinook the annual index was higher than 2006 but similar to 2005. To some extent the lower indices for summer migrants at McNary Dam could be a function of summer spill operations, which would have resulted in lower collection efficiency at the project.

At John Day Dam annual indices for all species were above recent years' totals. For spring migrants indices were substantially above totals for 2004 through 2006. For subyearling Chinook the indices were above those seen in 2005 and 2006 but similar to that seen in 2004. While at Bonneville in 2007, the annual indices for yearling Chinook, steelhead and sockeye were higher than 2006, but lower than at least one other recent years. The coho annual index was below all other recent years. It may be that the Bonneville 2 corner collector is very effective at guiding coho and that could explain the declining pattern in indices over the past four years (the corner collector came on line in 2004).

Table 21. Sample, collection, and passage indices of salmonids at Columbia River dams in 2007 and comparison with 2004-2006 annual passage indices.

Dam	Species	2007			2006 Passage Index	2005 Passage Index	2004 Passage Index
		Sample	Collected	Passage Index			
Rock Island Dam	Chinook Age 0	10,692	10,692	15,744	22,360	25,928	28,113
	Chinook Age 1	15,576	15,576	23,753	14,586	12,571	15,355
	Coho	43,542	43,542	64,418	35,640	28,673	41,690
	Steelhead	12,540	12,540	18,551	15,656	10,733	15,507
	Sockeye/kokanee	11,211	11,211	16,430	1,963	7,101	10,306
McNary Dam ^a	Chinook Age 0	61,818	2,400,491	9,384,505	6,067,725	9,164,208	10,115,938
	Chinook Age 1	23,269	1,316,847	4,449,695	3,120,901	2,415,949	2,065,653
	Coho	1,082	58,662	198,166	204,152	203,820	173,534
	Steelhead	4,259	222,772	752,786	886,290	386,518	230,173
	Sockeye/kokanee	5,233	304,461	1,027,417	991,889	103,827	595,464
John Day Dam	Chinook Age 0	25,335	2,146,676	3,006,184	2,300,846	1,720,827	2,713,873
	Chinook Age 1	36,601	3,150,848	4,262,624	1,409,477	1,005,402	2,074,671
	Coho	2,571	257,747	347,365	192,566	175,315	258,282
	Steelhead	7,678	710,670	961,371	526,642	257,198	553,522
	Sockeye/kokanee	6,869	589,692	790,337	84,481	235,900	726,177
Bonn. Power- house 2	Chinook Age 0	57,562	1,840,002	1,890,671 ^b	2,107,112 ^b	2,034,744 ^b	2,846,510 ^b
	Chinook Age 1	30,961	722,183	1,949,987	1,527,240	1,466,448	4,043,776
	Coho	12,583	238,100	628,616	771,275	938,113	2,116,570
	Steelhead	5,049	103,419	267,152	186,563	92,894	1,635,181
	Sockeye/kokanee	3,345	66,280	171,315	41,901	189,695	1,261,375

^a McNary sampled every other day from April 3 to June 23, in 2004 and 2005; April 3 to July 6 in 2006 and April 3 through August 17 in 2007. Because of these changes to sampling, passage indices were adjusted for comparison to historic data by interpolating values for dates not sampled or only partially sampled (project operated primary bypass) between two sample dates. As an example, for yearling chinook the unadjusted passage index for 2006 was 1,560,871 compared to adjusted value of 3.12 million which is more comparable to historic indices.

^b Upper brights annual values were summed commencing June 1 in each of the years presented in the table due to tule chinook releases from hatcheries prior to that date in each year.

E. Migration Timing

The distribution of daily passage indices provides a good measure of migration timing at a given site. From the passage distributions at 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 22. 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 the ten-year-average. The 10% date (4/18) was two days earlier than the ten-year-average, and the 90% date of May 13 was 5 days earlier than historic average. For steelhead the 10% passage date of April 25, was 1 day earlier than the ten year average, and the 90% date of May 20 was 6 days earlier than the ten year average. Coho and Sockeye timing were intermediate compared to 2005 and 2006. Similar to last year, run-at-large subyearling chinook, which is now predominantly hatchery released fish, showed a much earlier migration than past years' especially in relation to the ten year average. The 10% passage date was the same as the ten year average of June 3, but the 90% passage date of July 3, was much earlier than the 10 year average of August 5.

Yearling chinook began to pass McNary Dam later than historic average with the 10% date occurring on May 1, compared to April 26 for the ten-year-average. But the 50% and 90% dates of passage for yearling Chinook on May 10 and May 24 (respectively) were 5 days earlier than the ten year average. Steelhead timing showed a similar pattern to yearling Chinook; the 10% passage date was of April 29 was 6 days earlier than historic average; the 50% passage date was reached on May 9, four days prior to historic average; while the 90% date of May 23, was eight days earlier than historic average. Coho passage timing was earlier than 2006, but similar to 2005. Sockeye timing was compressed in 2007, compared to historic passage. In 2007 10% passage was on May 12 and 90% passage was on June 1, a total of 21 days. The middle 80% passage the past 3 years averaged 24-27 days, by comparison. For subyearling Chinook the timing was much later than the ten year average and likely reflected low flows in 2007 through the Columbia River. The 10% passage date for subyearling Chinook was June 23 compared to the ten year average of June 16, and the 90% passage date in 2007 was July 28 compared to the ten year average of July 24.

At Bonneville Dam the yearling chinook run was similar to 2005 and 2006, while steelhead showed a later timing distribution compared to other recent years.

Table 22. Migration timing of salmonids at Lower Granite, Rock Island, McNary, and John Day dams in 2007 compared to 2006 and 2005.

Dam	Species	2007			2006			2005		
		10%	50%	90%	10%	50%	90%	10%	50%	90%
Lower Granite	Chinook Age 0	6/3	6/10	7/11	5/23	6/6	7/5	5/29	6/3	6/19
	Chinook Age 1	4/18	5/3	5/13	4/21	5/6	5/18	4/24	5/5	5/11
	Coho	5/4	5/15	5/24	5/7	6/3	6/26	4/30	5/10	5/19
	Steelhead	4/26	5/7	5/21	4/21	5/4	5/20	4/27	5/9	5/19
	Sockeye and kokanee	5/10	5/16	5/21	4/12	5/14	5/27	5/10	5/20	6/1
Rock Island	Chinook Age 0	6/3	7/15	8/6	5/20	7/15	7/27	5/27	6/29	7/25
	Chinook Age 1	4/20	5/16	6/10	4/29	5/5	6/3	4/19	5/10	5/27
	Coho	5/17	5/24	6/5	5/11	5/20	6/4	5/10	5/15	5/26
	Steelhead	5/10	5/21	6/5	5/8	5/19	6/5	5/2	5/12	5/26
	Sockeye	4/21	5/20	5/25	5/1	5/21	5/26	4/28	5/12	7/8
McNary ^a	Chinook Age 0	6/22 (6/23)	7/6 (7/7)	7/26 (7/26)	6/3 (6/10)	7/1 (7/6)	7/14 (7/20)	6/14 (6/16)	6/24 (6/27)	7/5 (7/9)
	Chinook Age 1	4/30	5/10	5/24	4/21	5/9	5/21	5/4	5/15	5/29
	Coho	5/3	5/21	6/9	5/11	5/26	6/3	5/5	5/21	6/6
	Steelhead	4/29	5/10	5/24	4/22	5/2	5/25	4/23	5/17	5/27
	Sockeye	5/12	5/21	6/1	5/4	5/17	5/30	5/11	5/19	5/31
Bonneville PH 2	Chinook Age 0 “upriver brights”	6/20 ^b	7/7 ^b	7/20 ^b	6/16 ^c	6/29 ^c	7/15 ^x	6/14 ^d	6/28 ^d	7/16 ^d
	Chinook Age 1	4/20	5/11	5/23	4/16	5/9	5/21	4/19	5/7	5/25
	Coho	4/26	5/13	5/31	4/27	5/17	5/28	4/22	5/9	5/27
	Steelhead	5/6	5/16	6/4	4/26	5/8	5/29	4/25	5/13	5/30
	Sockeye	5/16	5/25	6/7	5/10	5/19	5/31	5/15	5/23	6/1

^a Because there was every other day sampling for extended periods at McNary passage indices were adjusted by interpolating the non-sampled days total with the average of preceding and following days' total. This adjustment made a relatively little difference for subyearling chinook in 2007 (the dates in parentheses are the unadjusted values).

^b Upper brights annual values are summed commencing June 1 in 2007, since tule chinook releases from Spring Creek Hatchery occurred on March 3, March 9, April 12 and May 1).

^c Upper brights annual values are summed commencing June 1 in 2006, since tule chinook releases from Spring Creek Hatchery occurred on March 2, April 17 and May 5).

^d Upper brights annual values are summed commencing May 20 in 2005, since tule chinook releases from Spring Creek Hatchery occurred on March 2, April 15 and May 4).

F. Travel Time and Survival Analyses

1. Results for Hatchery and Trap Release Travel Time and Survivals Estimates

Snake River

Travel time of yearling chinook and steelhead from hatcheries in the Snake River basin to Lower Granite are presented in Table 23. Median travel times were similar to other recent years. For Dworshak Hatchery releases of yearling chinook median travel times were shorter than other years, while that for steelhead was longer than other recent years. Other releases appeared to have intermediate travel times to Lower Granite in 2007.

Table 23. Median travel time from release to Lower Granite Dam for Snake River basin hatchery yearling chinook and steelhead in 2007 compared to the past several years.

Hatchery	Species	Median travel time release site to Lower Granite Dam				
		2007	2006	2005	2004	2003
Dworshak Hatchery	Chinook	26.1	35.6	30.2	32.2	49.4
Imnaha Acclimation Pond	Chinook	35.0 ^a	31.5 ^a	36.1 ^a	38.5 ^a	34.6 ^a
McCall Hatchery	Chinook	47.0	46.14	49.4	43.4	42.0
Rapid River Hatchery	Chinook	50.3 ^b	48.9 ^b	50.9 ^b	46.7 ^b	49.4 ^b
Dworshak Hatchery	Steelhead	14.6	10.6	11.2	8.8	7.2

^a Midpoint of volitional release period used in calculation.

^b Uncorrected first date of volitional release period used in calculation.

Travel times for yearling chinook and steelhead were generally average to shorter than average for PIT-tagged fish marked at Smolt Monitoring Traps in 2007 (Table 24). For steelhead releases, flow is usually the most important factor, in determining their travel time but for the 2007 marks it is apparent that the lower flows resulted in average to shorter than average travel times for all locations monitored. The flows in 2001 and 2004 were similar to those experienced by steelhead PIT tag releases in 2007 but steelhead tended to have faster travel times from most sites to Lower Granite Dam. For yearling chinook temperature as well as flow can affect the travel times. In 2007 travel times for yearling chinook were longer than 2001 and 2004 for the Salmon River releases, while releases at other traps had travel times similar to those seen in 2001 and 2004.

The 2007 seasonal survival estimate for PIT tagged wild and hatchery chinook released from the four traps to Lower Monumental Dam tailrace ranged between 65% and

90% (Table 25), and that of wild and hatchery steelhead was between 63% and 85% (Table 26). Survivals for yearling Chinook PIT-tag releases from the traps varied from basin to basin when compared to those seen in recent years. Estimates were higher than other recent years for Chinook released from the Grande Ronde and Imnaha traps as well as for hatchery yearling Chinook released from the Snake River Trap. Survivals for Chinook released from the Salmon River Traps were similar to estimates for other recent years, and mostly lower than 2006. Estimates for steelhead releases were similar compared to other recent years for most releases.

Table 24. Median travel time and flow for yearling chinook and steelhead released from traps on the Salmon, Imnaha, Grande Ronde, and Snake rivers to Lower Granite Dam in 2007 compared to other recent years.

Year	Average ¹ Flow (kcfs)	Average Travel time (days) ²							
		Salmon River Trap		Imnaha River Trap		Grande Ronde River Trap		Snake River Trap	
Yearling Chinook		H	W	H	W	H	W	H	W
2000	88.5	15.9	11.4	20.7	10.6	11.4	6.8	6.7	5.3
2001	55.4	14.4	11.6	12.4	11.1	13.3	10.4	7.8	5.5
2002	67.8	13.6	17.7	19.6	12.1	25.3	9.1	10.0	7.3
2003	73.4	17.5	21.5	NA	18.9	23.7	8.9	6.4	6.0
2004	60.2	13.6	13.6	NA	9.3	15.3	8.1	5.2	4.4
2005	71.1	13.2	12.2	NA	10.5	4.6	6.9	6.9	6.5
2006	129.1	13.3	12.4	NA	9.3	12.0	5.2	5.4	4.3
2007	59.5	15.6	19.8	NA	8.9	9.0	7.1	5.0	4.4
Steelhead		H	W	H	W	H	W	H	W
2000	88.5	4.7	N/A	9.6	4.7	3.5	3.0	2.1	2.1
2001	55.4	9.1	6.5	10.1	8.0	6.5	4.2	5.2	3.9
2002	67.8	5.8	6.1	8.6	7.2	4.2	4.4	2.3	2.7
2003	73.4	5.7	5.2	8.5	7.9	3.0	3.5	2.6	2.8
2004	60.2	8.7	5.7	10.0	5.3	5.9	3.7	4.7	3.4
2005	71.1	6.4	5.4	8.1	5.1	4.3	4.4	3.7	2.4
2006	129.1	4.6	3.4	7.1	3.6	2.6	2.2	1.6	1.4
2007	59.5	5.7	5.8	7.1	3.8	3.8	3.2	2.0	2.4

¹ Flow averaged from April 20 to May 20 at Lower Granite Dam.

² Seasonal median travel time estimates from releases between April 10 and May 10.

Table 25. Annual reach survival estimates of Snake River basin PIT tagged yearling chinook from trap release sites to Lower Monumental Dam tailrace for years 2003 – 2007.

Tag Site	Species	Rearing type	Year	Date Range	No. of Blocks	Average Survival	Lower Limit	Upper Limit
Salmon River trap								
	Chinook	Wild	2003	3/14-5/07	7	0.645	0.587	0.702
		Wild	2004	3/14-5/26	1	0.556	0.594	0.518
		Wild	2005	3/12-5/17	1	0.610	0.583	0.638
		Wild	2006	3/6-5/14	1	0.777	0.746	0.808
		Wild	2007	3/10-5/11	1	0.666	0.685	0.750
		Hatchery	2003	3/18-5/1	4	0.554	0.458	0.650
		Hatchery	2004	3/17-5/8	1	0.629	0.706	0.551
		Hatchery	2005	3/12-5/18	1	0.652	0.609	0.694
		Hatchery	2006	4/30-5/14	1	0.811	0.643	0.978
		Hatchery	2007	3/17-5/11	1	0.645	0.587	0.704
Snake River trap								
	Chinook	Wild	2006	4/5-5/17	1	0.819	0.764	0.873
		Wild	2007	3/10-5/11	1	0.726	0.555	0.898
		Hatchery	2003	4/15-5/27	2	0.786	0.620	0.952
		Hatchery	2004	3/25-5/20	1	0.724	0.823	0.625
		Hatchery	2005	3/30-5/16	1	0.606	0.703	0.800
		Hatchery	2006	4/5-5/17	1	0.785	0.748	0.822
		Hatchery	2007	3/23-5/15	1	0.901	0.789	1.014
Imnaha River trap								
	Chinook	Wild	2003	3/15-4/26	5	0.660	0.583	0.737
		Wild	2004	2/26-5/31	1	0.556	0.587	0.525
		Wild	2005	3/4-5/18	1	0.645	0.592	0.697
		Wild	2006	3/25-4/21	1	0.699	0.615	0.783
		Wild	2007	3/8-5/20	1	0.771	0.712	0.831
Grande Ronde River trap								
	Chinook	Wild	2004	3/9-5/29	1	0.744	0.808	0.681
		Wild	2005	3/8-5/24	1	0.737	0.669	0.810
		Wild	2006	3/4-5/26	1	0.811	0.762	0.860
		Wild	2007	3/23-5/15	1	0.827	0.724	0.929
		Hatchery	2003	3/17-4/1	2	0.695	0.504	0.885
		Hatchery	2004	3/18-4/17	1	0.533	0.625	0.441
		Hatchery	2005	3/15-5/22	1	0.590	0.516	0.664
		Hatchery	2006	3/20-5/17	1	0.643	0.566	0.721
		Hatchery	2007	3/8-5/17	1	0.877	0.720	1.033

From 2004 to present, a single estimate of survival was calculated for the releases that year. In past years releases were divided into roughly equal groups of 500 fish and estimates grouped according to chi-square tests of homogeneity.

Table 26. Annual reach survival estimate of Snake River basin PIT tagged steelhead from trap release sites to Lower Monumental Dam tailrace in the years 2003 to 2007.

Tag Site	Species	Rearing Type	Year	Date Range	No. of Blocks	Average Survival	Lower Limit	Upper Limit
Salmon River trap								
	Steelhead	Wild	2005	3/31-5/16	1	0.711	0.526	0.897
		Wild	2007	3/17-5/23	1	0.750	0.344	1.157
		Hatchery	2003	4/28-5/12	2	0.725	0.618	0.832
		Hatchery	2004	4/10-5/21	1	0.609	0.699	0.519
		Hatchery	2005	3/21-5/17	1	0.646	0.600	0.691
		Hatchery	2006	4/29-5/14	1	0.786	0.658	0.915
		Hatchery	2007	3/31-5/11	1	0.685	0.584	0.786
Snake River trap								
	Steelhead	Wild	2003	4/18-5/27	3	0.795	0.597	0.992
		Wild	2004	3/25-6/2	1	0.646	0.741	0.551
		Wild	2005	3/29-6/1	1	0.765	0.684	0.847
		Wild	2006	4/13-5/17	1	0.715	0.619	0.810
		Wild	2007	3/23-5/25	1	0.851	0.612	1.090
		Hatchery	2003	4/12-5/20	5	0.898	0.796	1.000
		Hatchery	2004	3/26-6/3	1	0.767	0.834	0.700
		Hatchery	2005	3/29-6/2	1	0.799	0.755	0.842
		Hatchery	2006	4/14-5/17	1	0.724	0.681	0.766
		Hatchery	2007	4/13-5/25	1	0.777	0.660	0.894
Imnaha River trap								
	Steelhead	Wild	2003	4/21-5/23	5	0.710	0.644	0.775
		Wild	2004	2/21-5/31	1	0.670	0.767	0.572
		Wild	2005	3/20-5/18	1	0.588	0.548	0.627
		Wild	2006	3/10-5/14	1	0.727	0.660	0.795
		Wild	2007	3/11-5/25	1	0.671	0.574	0.768
		Hatchery	2003	4/12-5/22	5	0.834	0.770	0.899
		Hatchery	2004	4/14-5/12	1	0.685	0.758	0.612
		Hatchery	2005	4/12-5/31	1	0.604	0.572	0.637
		Hatchery	2006	4/13-5/14	1	0.722	0.661	0.783
		Hatchery	2007	4/12-5/19	1	0.813	0.615	1.012
Grande Ronde River trap								
	Steelhead	Wild	2003	5/24-6/02	1	0.655	0.493	0.817
		Wild	2005	3/29-5/24	1	0.735	0.631	0.838
		Wild	2006	3/9-5/26	1	0.739	0.674	0.804
		Wild	2007	3/10-5/24	1	0.633	0.357	0.908
		Hatchery	2003	4/14-6/04	4	0.788	0.693	0.883
		Hatchery	2004	3/20-5/21	1	0.527	0.594	0.460
		Hatchery	2005	3/30-5/24	1	0.666	0.591	0.740
		Hatchery	2006	4/1-5/6	1	0.824	0.791	0.857
		Hatchery	2007	4/5-5/22	1	0.704	0.595	0.814

From 2004 to present, a single estimate of survival was calculated for the releases that year. In past years releases were divided into roughly equal groups of 500 fish and estimates grouped according to chi-square tests of homogeneity.

Mid-Columbia

Travel times of yearling and subyearling chinook from hatcheries in the Mid-Columbia River basin to McNary Dam are presented in Table 27. Travel times were longer in 2007 than in other recent years. Median travel time to McNary Dam was 30.8 for yearling spring chinook from Leavenworth Hatchery. That estimate was longer than other recent years for Leavenworth. For Wells subyearling summer releases the median travel time was 46.9 days while for subyearling fall chinook released from Priest Rapids hatchery the travel time was 12.2 days in 2007, which was longer than other recent years. Survivals for chinook released from all three Mid-Columbia hatcheries were intermediate to low compared to other recent years (Table 28).

Table 27. Median travel time for Mid-Columbia River hatchery chinook from hatchery site to McNary Dam in 2007 compared to 2003 to 2006.

Hatchery	Age	Migration Year									
		2007		2006		2005		2004		2003	
		TT	Flow	TT	Flow	TT	Flow	TT	Flow	TT	Flow
Leavenworth	1	30.8	171.7	23.0	237	29.8	110.5	25.2	104	27.6	73
Wells ¹	0	46.9	166.8	na		37.1		40.5		23.9	
Priest Rapids ²	0	12.2	156.6	10.9	231	6.7	130.6	6.3	151	10.5	69.7

¹ Wells Hatchery's median travel time and flow is computed as average of two releases separated about 1 month mid-May and mid-June.

² 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 of each annual report).

Table 28. 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 the years 2002 to 2007.

Tag Site	Species	Age	Year	Release Date Range	Survival	Lower Limit	Upper Limit
Leavenworth NFH ^a							
	Chinook	1	2002	4/22	0.518	0.505	0.531
			2003	4/21	0.662	0.655	0.669
			2004	4/19	0.483	0.473	0.494
			2005	4/15	0.526	0.500	0.553
			2006	4/17	0.491	0.432	0.550
			2007	4/18	0.593	0.571	0.656
Wells SFH							
	Chinook	0	2002	6/17	0.449	0.395	0.503
			2003	6/17	0.456	0.406	0.506
			2004	5/12	0.251	0.205	0.296
			2004	6/15	0.160	0.106	0.215
			2005	5/18	0.323	0.230	0.416
			2006	5/12	0.446	0.193	0.698
				6/14	0.230	0.045	0.415
			2007	5/17	0.260	0.185	0.346
				6/15	0.281	0.128	0.433
Priest Rapids SFH							
	Chinook	0	2001	6/11-6/19	0.746	0.670	0.794
			2002	6/11-6/19	0.697	0.627	0.767
			2003	6/12-6/20	0.633	0.590	0.677
			2004	6/14-6/22	0.775	0.689	0.861
			2005	6/9-6/18	0.655	0.573	0.729
			2006	6/12-6/20	0.651	0.335	0.493
			2007	6/13-6/21	0.686	0.564	0.807

^a Includes releases of SMP and NMFS research PIT-tagged fish in the years 2002 to 2005.

Results for Reach Survival Estimates

Tables 29-34 summarize the reach survival estimates for the Lower Granite to McNary Dam index reach and for the McNary Dam to Bonneville Dam index reach over several years.

Lower Granite Dam to McNary Dam reach

Table 29. Reach survival estimates of Snake River basin PIT tagged steelhead from Lower Granite Dam to McNary Dam in the years 2000 to 2007.

migr_yr	dates	n	WTT	avg Spill	temp. C	survival	variance
2000	4/17-4/23	2791	8.4	43.3	10.7	0.715	0.00400
2000	4/24-4/30	2447	9.2	38.8	11.3	0.595	0.00692
2000	5/1-5/7	6297	10.5	45.6	11.8	0.549	0.00446
2000	5/8-5/14	3427	10.7	44.6	13.5	0.559	0.01635
2000	5/15-5/21	2913	10.1	40.2	14.3	0.534	0.01963
2001	4/24-4/30	6035	16.2	0.0	12.3	0.159	0.00016
2001	5/1-5/7	9229	14.5	0.4	12.4	0.177	0.00014
2001	5/8-5/14	4533	13.1	1.2	13.4	0.187	0.00092
2001	5/15-5/21	8217	14.2	1.3	13.7	0.143	0.00085
2001	5/22-5/28	2211	18.2	0.4	15.5	0.079	0.00078
2002	4/24-4/30	1112	12.3	36.2	10.3	0.461	0.00171
2002	5/1-5/7	1055	13.4	36.9	11.1	0.466	0.00761
2002	5/8-5/14	629	10.6	35.5	11.5	0.390	0.00828
2002	5/15-5/21	1485	9.2	33.2	12.1	0.516	0.00415
2002	5/22-5/28	1711	7.4	35.9	12.6	0.724	0.02399
2003	4/17-4/23	3003	11.7	42.9	9.8	0.740	0.00994
2003	5/8-5/14	3491	11.2	40.2	11.2	0.591	0.00722
2003	5/15-5/21	6547	9.9	39.2	12.0	0.619	0.00580
2003	5/22-5/28	12331	6.5	36.6	12.6	0.633	0.00227
2004	4/17-4/23	2539	14.9	38.4	11.9	0.616	0.01790
2004	4/24-4/30	5531	12.2	37.6	12.6	0.427	0.00290
2004	5/1-5/7	11493	11.5	37.8	12.9	0.439	0.00190
2004	5/8-5/14	8552	11.7	27.7	12.7	0.353	0.00370
2004	5/15-5/21	8706	9.7	25.5	13.1	0.307	0.00280
2004	5/22-5/28	8335	8.2	27.2	13.2	0.357	0.00490
2005	4/17-4/23	2836	15.4	26.0	11.5	0.469	0.00197
2005	4/24-4/30	7565	12.8	23.4	12.1	0.604	0.00125
2005	5/1-5/7	10606	10.3	26.8	12.1	0.618	0.00081
2005	5/8-5/14	15449	8.8	30.0	12.2	0.664	0.00052
2005	5/15-5/21	6713	8.0	31.9	12.4	0.541	0.00127
2005	5/22-5/28	3319	10.5	25.6	13.8	0.267	0.00146
2006	4/17-4/23	4743	7.1	31.9	10.1	0.776	0.00134
2006	4/24-4/30	8707	6.8	33.1	11.1	0.766	0.00106
2006	5/1-5/7	10137	7.7	32.5	11.7	0.670	0.00102
2006	5/8-5/14	7541	7.3	36.5	12.9	0.606	0.00141
2006	5/15-5/21	5436	5.3	44.5	13.3	0.668	0.00133
2006	5/22-5/28	2932	6.5	39.2	12.8	0.511	0.00134
2007	4/17-4/23	2793	12.9	38.0	10.9	0.689	0.00355
2007	4/24-4/30	4709	10.5	37.6	11.6	0.733	0.00658
2007	5/1-5/7	8035	10.3	35.6	12.2	0.765	0.00361
2007	5/8-5/14	6642	9.5	35.6	12.8	0.602	0.00349
2007	5/15-5/21	5306	10.8	37.0	13.5	0.587	0.00263
2007	5/22-5/28	3245	14.0	43.7	14.3	0.526	0.01317

Table 30. Reach survival estimates of Snake River basin PIT tagged Hatchery yearling Chinook from Lower Granite Dam to McNary Dam in the years 2000 to 2007.

migr_yr	dates	n	WTT	avg Spill	temp. C	survival	variance
2000	4/15-4/21	125	8.7	41.9	10.9	0.936	0.01405
2000	4/22-4/28	392	9.2	38.6	11.4	0.764	0.00469
2000	4/29-5/5	838	10.1	44.3	11.7	0.717	0.00175
2000	5/6-5/12	582	11.7	51.7	12.4	0.749	0.00286
2000	5/20-5/26	190	10.0	41.2	14.3	0.729	0.01312
2001	4/8-4/14	48	19.1	0.0	10.9	0.573	0.00095
2001	4/15-4/21	301	18.4	0.0	11.1	0.605	0.00028
2001	4/22-4/28	2934	16.1	0.0	12.3	0.593	0.00016
2001	4/29-5/5	7456	13.7	0.6	12.8	0.578	0.00016
2001	5/6-5/12	2214	13.4	1.0	13.5	0.552	0.00026
2001	5/13-5/19	5016	14.1	1.4	13.5	0.470	0.00268
2001	5/20-5/26	180	16.9	1.3	15.3	0.276	0.00066
2002	4/22-4/28	630	12.2	35.7	10.4	0.586	0.00078
2002	4/29-5/5	3079	13.3	35.9	10.9	0.733	0.00024
2002	5/6-5/12	1820	11.6	36.4	11.3	0.638	0.00074
2002	5/13-5/19	1202	9.5	33.8	11.9	0.732	0.00115
2002	5/20-5/26	350	8.0	33.4	12.2	0.755	0.00368
2003	4/15-4/21	285	11.5	41.2	9.9	0.748	0.00359
2003	4/22-4/28	1193	12.3	42.7	10.4	0.733	0.00078
2003	4/29-5/5	762	12.6	42.9	10.5	0.821	0.00341
2003	5/6-5/12	1068	11.3	40.3	11.2	0.717	0.00186
2003	5/13-5/19	1332	10.7	40.0	11.9	0.751	0.00135
2003	5/20-5/26	209	6.6	36.1	12.6	0.861	0.00261
2004	4/15-4/21	487	16.6	35.5	11.7	0.627	0.00379
2004	4/22-4/28	1561	12.9	36.6	12.3	0.633	0.00153
2004	4/29-5/5	4159	12.3	30.3	12.8	0.863	0.00204
2004	5/6-5/12	1244	12.0	29.5	12.7	0.673	0.00360
2004	5/13-5/19	161	10.0	25.4	13.0	0.583	0.00521
2005	4/15-4/21	187	11.7	25.9	11.7	0.724	0.00652
2005	4/22-4/28	1044	11.0	24.8	12.2	0.803	0.00173
2005	4/29-5/5	5190	8.5	24.6	12.1	0.763	0.00051
2005	5/6-5/12	10412	7.4	29.2	12.2	0.750	0.00026
2005	5/13-5/19	2976	6.4	31.0	12.4	0.769	0.00182
2005	5/20-5/26	112	8.2	25.7	13.7	0.647	0.01055
2006	4/1-4/7	165	6.9	33.1	10.3	0.664	0.00288
2006	4/8-4/14	247	7.0	32.4	10.2	0.699	0.00212
2006	4/15-4/21	299	7.0	32.5	10.4	0.478	0.00100
2006	4/22-4/28	8244	6.9	32.2	11.1	0.742	0.00008
2006	4/29-5/5	15563	7.6	32.0	11.6	0.754	0.00047
2006	5/6-5/12	10309	7.5	36.0	12.8	0.769	0.00085
2006	5/13-5/19	1425	5.4	43.9	13.4	0.651	0.00221
2007	4/1-4/7	31	12.9	36.8	10.9	0.618	0.00189
2007	4/8-4/14	369	13.1	38.0	10.9	0.760	0.00028
2007	4/15-4/21	926	13.0	38.9	10.9	0.727	0.00015
2007	4/22-4/28	4940	10.9	37.6	11.1	0.781	0.00023
2007	4/29-5/5	10597	10.8	36.5	12.1	0.799	0.00034
2007	5/6-5/12	8636	9.5	33.0	12.4	0.742	0.00022
2007	5/13-5/19	3088	10.1	38.3	13.4	0.745	0.00024
2007	5/20-5/26	76	12.3	36.5	13.8	0.786	0.00384

Table 31. Reach survival estimates of Snake River basin PIT-tagged wild yearling Chinook from Lower Granite Dam to McNary Dam in the years 2000 to 2007.

migr_yr	dates	n	WTT	avg Spill	temp. C	survival	variance
2000	4/15-4/21	125	8.7	41.9	10.9	0.936	0.01405
2000	4/22-4/28	392	9.2	38.6	11.4	0.764	0.00469
2000	4/29-5/5	838	10.1	44.3	11.7	0.717	0.00175
2000	5/6-5/12	582	11.7	51.7	12.4	0.749	0.00286
2000	5/20-5/26	190	10.0	41.2	14.3	0.729	0.01312
2001	4/8-4/14	48	19.1	0.0	10.9	0.573	0.00095
2001	4/15-4/21	301	18.4	0.0	11.1	0.605	0.00028
2001	4/22-4/28	2934	16.1	0.0	12.3	0.593	0.00016
2001	4/29-5/5	7456	13.7	0.6	12.8	0.578	0.00016
2001	5/6-5/12	2214	13.4	1.0	13.5	0.552	0.00026
2001	5/13-5/19	5016	14.1	1.4	13.5	0.470	0.00268
2001	5/20-5/26	180	16.9	1.3	15.3	0.276	0.00066
2002	4/22-4/28	630	12.2	35.7	10.4	0.586	0.00078
2002	4/29-5/5	3079	13.3	35.9	10.9	0.733	0.00024
2002	5/6-5/12	1820	11.6	36.4	11.3	0.638	0.00074
2002	5/13-5/19	1202	9.5	33.8	11.9	0.732	0.00115
2002	5/20-5/26	350	8.0	33.4	12.2	0.755	0.00368
2003	4/15-4/21	285	11.5	41.2	9.9	0.748	0.00359
2003	4/22-4/28	1193	12.3	42.7	10.4	0.733	0.00078
2003	4/29-5/5	762	12.6	42.9	10.5	0.821	0.00341
2003	5/6-5/12	1068	11.3	40.3	11.2	0.717	0.00186
2003	5/13-5/19	1332	10.7	40.0	11.9	0.751	0.00135
2003	5/20-5/26	209	6.6	36.1	12.6	0.861	0.00261
2004	4/15-4/21	487	16.6	35.5	11.7	0.627	0.00379
2004	4/22-4/28	1561	12.9	36.6	12.3	0.633	0.00153
2004	4/29-5/5	4159	12.3	30.3	12.8	0.863	0.00204
2004	5/6-5/12	1244	12.0	29.5	12.7	0.673	0.00360
2004	5/13-5/19	161	10.0	25.4	13.0	0.583	0.00521
2005	4/15-4/21	187	11.7	25.9	11.7	0.724	0.00652
2005	4/22-4/28	1044	11.0	24.8	12.2	0.803	0.00173
2005	4/29-5/5	5190	8.5	24.6	12.1	0.763	0.00051
2005	5/6-5/12	10412	7.4	29.2	12.2	0.750	0.00026
2005	5/13-5/19	2976	6.4	31.0	12.4	0.769	0.00182
2005	5/20-5/26	112	8.2	25.7	13.7	0.647	0.01055
2006	4/1-4/7	165	6.9	33.1	10.3	0.664	0.00288
2006	4/8-4/14	247	7.0	32.4	10.2	0.699	0.00212
2006	4/15-4/21	299	7.0	32.5	10.4	0.478	0.00100
2006	4/22-4/28	8244	6.9	32.2	11.1	0.742	0.00008
2006	4/29-5/5	15563	7.6	32.0	11.6	0.754	0.00047
2006	5/6-5/12	10309	7.5	36.0	12.8	0.769	0.00085
2006	5/13-5/19	1425	5.4	43.9	13.4	0.651	0.00221
2007	4/1-4/7	31	12.9	36.8	10.9	0.618	0.00189
2007	4/8-4/14	369	13.1	38.0	10.9	0.760	0.00028
2007	4/15-4/21	926	13.0	38.9	10.9	0.727	0.00015
2007	4/22-4/28	4940	10.9	37.6	11.1	0.781	0.00023
2007	4/29-5/5	10597	10.8	36.5	12.1	0.799	0.00034
2007	5/6-5/12	8636	9.5	33.0	12.4	0.742	0.00022
2007	5/13-5/19	3088	10.1	38.3	13.4	0.745	0.00024
2007	5/20-5/26	76	12.3	36.5	13.8	0.786	0.00384

Table 32. Reach survival estimates of Snake River basin PIT-tagged Hatchery subyearling Chinook from Lower Granite Dam to McNary Dam in the years 1998 to 2007.

migr_yr	dates	FTT	WTT	avg Spill	temp. C	survival	variance
1998	5/20-6/2	28.7	8.5	35.4	16.0	0.728	0.04113
1998	6/3-6/16	24.6	9.9	24.0	16.8	0.750	0.07361
1998	6/17-6/30	15.9	11.3	23.2	18.3	0.513	0.00993
1998	7/1-7/14	11.4	13.5	23.2	20.6	0.531	0.00165
1999	6/3-6/16	24.8	8.7	31.3	15.5	0.633	0.01193
1999	6/17-6/30	15.8	10.8	29.6	16.1	0.577	0.01109
1999	7/1-7/14	21.9	15.2	29.8	19.5	0.361	0.01646
2000	6/17-6/30	16.0	19.3	22.3	18.3	0.516	0.00743
2000	7/1-7/14	24.9	22.6	19.8	20.6	0.338	0.00140
2001	6/3-6/16	42.4	32.3	0.0	20.0	0.247	0.00142
2001	6/17-6/30	34.7	32.1	0.0	20.5	0.341	0.00150
2001	7/1-7/14	32.5	30.9	0.0	20.9	0.293	0.00149
2002	6/17-6/30	31.7	11.0	30.3	15.6	0.791	0.02850
2002	7/1-7/14	16.8	13.2	31.9	16.7	0.508	0.00469
2002	5/20-6/2	15.2	20.8	28.5	19.4	0.593	0.00539
2003	6/3-6/16	14.9	8.0	35.5	14.3	0.754	0.00479
2003	6/17-6/30	10.9	10.5	33.0	15.6	0.656	0.00055
2003	7/1-7/14	17.4	21.1	11.2	18.2	0.501	0.00074
2003	5/20-6/2	25.9	26.3	10.8	20.9	0.443	0.00686
2004	6/3-6/16	13.2	12.9	23.6	15.3	0.708	0.00227
2004	6/17-6/30	13.9	19.5	19.8	18.9	0.445	0.00145
2004	7/1-7/14	17.0	23.8	19.1	20.9	0.396	0.01566
2005	5/20-6/2	11.7	11.5	25.3	14.5	0.555	0.00172
2005	6/3-6/16	17.3	16.3	31.6	15.9	0.585	0.00903
2006	5/20-6/2	10.1	7.4	39.7	14.1	0.776	0.01269
2006	6/3-6/16	10.0	9.7	42.5	15.8	0.720	0.00533
2006	6/17-6/30	9.0	15.4	39.8	18.5	0.650	0.00707
2007	5/20-6/2	22.2	14.7	43.3	15.2	0.543	0.00768
2007	6/3-6/16	21.9	18.3	46.8	16.4	0.607	0.00530

McNary Dam to Bonneville Dam Index Reach

Table 33. Reach survival estimates of PIT-tagged steelhead from McNary Dam to Bonneville Dam in the years 1999 to 2007.

migr_yr	dates	n	WTT	avg Spill	temp. C	survival	variance
1999	4/27-5/17	2241	5.9	36.4	11.2	0.727	0.00544
1999	5/18-6/7	1593	4.9	37.8	14.0	0.561	0.00775
2000	4/27-5/17	1329	6.2	34.2	12.3	0.656	0.00872
2000	5/18-6/7	137	7.3	37.8	15.1	0.329	0.01186
2001	4/27-5/17	157	12.8	11.9	13.9	0.255	0.00357
2001	5/18-6/7	431	12.0	24.6	16.3	0.232	0.00193
2002	4/27-5/17	712	7.5	38.8	11.4	0.809	0.04129
2002	5/18-6/7	630	5.4	39.7	14.1	0.474	0.01293
2003	4/27-5/17	905	7.4	37.9	11.9	0.528	0.01725
2003	5/18-6/7	3169	5.8	33.2	14.5	0.733	0.00470
2004	5/18-6/7	129	6.7	34.3	14.8	0.397	0.03474
2005	4/27-5/17	412	7.3	31.0	13.3	0.476	0.12519
2005	5/18-6/7	435	7.6	36.0	15.0	0.445	0.10774
2006	4/27-5/17	937	5.3	36.6	12.4	0.816	0.03340
2007	4/27-5/17	5479	6.3	33.6	12.4	0.571	0.00576
2007	5/18-6/7	2910	6.9	34.9	15.2	0.439	0.00912

Table 34. Reach survival estimates of PIT-tagged yearling Chinook from McNary Dam to Bonneville Dam in the years 1999 to 2007.

migr_yr	dates	n	WTT	avg Spill	temp. C	survival	variance
1999	4/25-5/8	22795	5.7	0.4	10.8	0.672	0.018301
1999	5/9-5/22	33148	6.0	0.4	12.3	0.756	0.002577
1999	5/23-6/5	13804	4.6	0.4	14.3	0.660	0.009825
2000	4/25-5/8	12794	5.9	0.3	11.8	0.661	0.007978
2000	5/9-5/22	19374	6.5	0.4	13.7	0.669	0.005186
2001	4/25-5/8	8587	6.4	0.4	12.8	0.452	0.010977
2001	5/9-5/22	52602	6.7	0.4	14.4	0.516	0.003165
2001	5/23-6/5	66279	7.7	0.4	15.2	0.593	0.001052
2002	4/25-5/8	18715	5.9	0.3	11.8	0.694	0.004894
2002	5/9-5/22	67698	6.4	0.4	13.5	0.819	0.003407
2002	5/23-6/5	26988	7.4	0.4	15.1	0.671	0.018124
2003	4/25-5/8	37682	5.9	0.3	11.9	0.738	0.002955
2003	5/9-5/22	55424	6.5	0.4	13.7	0.805	0.002895
2004	4/25-5/8	24937	5.9	0.3	11.8	0.664	0.010644
2004	5/9-5/22	33030	6.5	0.4	13.6	0.515	0.003202
2004	5/23-6/5	12824	7.4	0.4	15.1	0.787	0.020057
2005	4/25-5/8	6950	5.9	0.3	11.9	0.577	0.014375
2005	5/9-5/22	29467	6.4	0.4	13.5	0.713	0.00629
2005	5/23-6/5	8546	7.4	0.4	15.1	0.676	0.028956
2006	5/9-5/22	24396	6.4	0.4	13.5	0.801	0.00868
2007	4/25-5/8	26841	6.3	0.3	11.7	1.041	0.008219
2007	5/9-5/22	40640	6.3	0.3	13.4	0.841	0.003069
2007	5/23-6/5	5715	7.1	0.3	15.4	0.622	0.021711

D. Conclusions

- The 2007 out-migrant survival, timing and travel time from the Snake River basin reflected the court ordered spill operations that took effect in what was otherwise a low flow year.
- The delayed start to transportation and relatively high spill resulted in a significant reduction in the proportion of fish transported (see appendix H).
- Survival of spring migrants was relatively high in 2007, despite lower flows. This high survival was likely due in large part to 24-hour spill at all projects in the Snake River.
- Migrant subyearling fall Chinook also had relatively high reach survivals from Lower Granite Dam-McNary Dam in 2007, likely due-the continued implementation of summer spill. Again flows in May-July of 2007 were similar to 2001 for the Snake River and yet the reach survivals in 2007 were much higher. In 2001 the survival estimates (LGR-MCN) ranged from 0.25-0.34, while those for 2007 ranged between 0.54 and 0.60. Over-wintering fish in the reservoirs of

the Snake River would not be included in those survival comparisons.

- In addition-high survivals, travel time estimates showed that summer migrants traveled much more rapidly in 2007 than in 2001. The median travel time estimates from Lower Granite Dam to McNary Dam in 2007 of 22 days for both groups were much lower than that seen for 2001 when reach travel times ranged between 32 and 42 days. That improvement in travel time was likely due to decreased delay associated with spill during the summer period.

IV. 2007 Adult Fish Passage

A. Introduction

Salmon are an important part of the ecosystem, economy, and culture of the Pacific Northwest both today and in the past. Prior to settlement, millions of adult salmon and steelhead returned to the streams and rivers within the Columbia River Basin. Declining salmon runs in the Columbia Basin coincide with (among other things) the construction of dams. In 1933 the first hydroelectric dam, Rock Island Dam, was built near Wenatchee, Washington. Bonneville Dam was built in 1938, while most of the construction of the major hydroelectric dams built on the Columbia and Snake rivers occurred between 1950 and 1970. Some dams were built without fishway facilities including Grand Coulee Dam and Hells Canyon Complex. The construction of Grand Coulee Dam without fishways resulted in the loss of approximately a thousand miles of Columbia River habitat for returning adults. The construction of Brownlee, Oxbow, and Hells Canyon dams blocked many more miles of habitat in the Snake River basin (STR, 1998; COE, 1994). The remaining nine main stem Columbia River dams and four Snake River dams were built with fish passage facilities. These include Wells Dam, Rocky Reach Dam, Rock Island Dam, Wanapum Dam, Priest Rapids Dam, McNary Dam, John Day Dam, The Dalles Dam, and Bonneville Dam. The development of the Federal Columbia River Power System (FCRPS) has been recognized as one of the major factors in the decline of Columbia River salmon and steelhead stocks to their present status as threatened and endangered under the Endangered Species Act (ESA).

Each of the fish passage facilities on the mainstem Columbia and Snake Rivers projects has a fish counting station that reports daily fish counts by species. The historic counting schedule for each project is presented in Table 35. In addition, it lists the dates at each dam when Chinook cross a dam and are considered to be spring, summer or fall Chinook.

Table 35. Historic adult dam count reporting dates

Dam	Spring Chinook (SP)	Summer Chinook (SU)	Fall Chinook (FA)	Historic reporting dates for Coho, Steelhead, Sockeye, Chum and Pink
BON	03/15 - 05/31	06/01 - 07/31	08/01-11/15	03/15 - 11/15
TDA	04/01 - 06/03	06/04 - 08/03	08/04 - 10/31	04/01 - 10/31
JDA	04/01 - 06/05	06/06 - 08/05	08/06 - 10/31	04/01 - 10/31
MCN	04/01 - 06/08	06/09 - 08/08	08/09 - 10/31	04/01 - 10/31
IHR	04/01 - 06/11	06/12 - 08/11	08/12 - 10/31	04/01 - 10/31
LMN	04/01 - 06/13	06/14 - 08/13	08/14 - 10/31	04/01 - 10/31
LGS	04/01 - 06/15	06/16 - 08/15	08/16 - 10/31	04/01 - 10/31
LGR	03/01 - 06/17	06/18 - 08/17	08/18 - 12/15	03/01 - 12/15
PRD	04/15 - 06/13	06/14 - 08/13	08/14 - 11/15	04/15 - 11/15
WAN	04/15 - 06/13	06/14 - 08/13	08/14 - 11/15	04/15 - 11/15 (began posting data in 2007)
RIS	04/15 - 06/17	06/18 - 08/17	08/18 - 11/15	04/15 - 11/15
RRH	04/15 - 06/19	06/20 - 08/19	08/20 - 11/15	04/15 - 11/15
WEL	05/01 - 06/28	06/29 - 08/28	08/29 - 11/15	04/15 - 11/15
WFA	01/01 - 08/15	None	08/16 - 12/31	01/01 - 12/31

Fish passage counts at dams provide a valuable tool for state, federal and tribal fishery managers. The fishery managers evaluate survival of salmon migrating upstream through the Columbia system by calculating conversion rates in part based upon dam counts. However, dam counts reflect the interaction of many factors which should be considered, particularly over the time series of available data. Passage conditions such as operation of fishway facilities, water temperature, project operations and flow can affect adult fish passage. Harvest and predation affect dam counts. Over the historic time series, changes in natural and hatchery production have affected resulting adult returns and dam counts. Adult passage was affected by all of these factors in 2007.

B. 2007 Passage Conditions and Management

This section of the report describes some of the 2007 in-river passage conditions adult salmon faced as they migrated through the Columbia River Basin. These conditions include pinniped activity at Bonneville Dam, river levels and water temperatures, major fisheries within the Columbia River system, and the operation of fish passage facilities at the dams. It also presents some of the management tools used by salmon managers in 2006 including run size forecasts and actual run size.

Run size forecasts can affect salmon harvest management. A federal court oversees Columbia River harvest management through the United States v. Oregon proceedings. There is a United States v Oregon Technical Advisory Committee (TAC). TAC was created by the Federal court and has representatives from all the parties of United States v Oregon: WDFW, ODFW, the treaty tribes and CRITFC, NMFS and USFWS, and IDFG. TAC is tasked to provide technical advice to the policy staff involved with implementing the harvest sharing between the treaty tribes and non-Indians. The types of advice include, run size updates, harvest models and expected harvest rates (Yuen, 2006 *email communication*). The following describes the methods TAC uses to develop preseason and in season run forecasts.

TAC preseason run size forecasts are typically based on previous year returns of younger fish from the same cohort (brood) and correlations between respective cohort sizes. Where among-cohort relationships are not significant, forecasts are based on recent-year average returns. In season TAC run size updates are based on historic run timing curves at Bonneville Dam applied to fish passage data for the current year (LeFleur, 2006 *email communication*).

C. Predicted Run Sizes

Both historical and current Bonneville Dam counts assist TAC in developing run size forecasts for the following year. The preseason forecasts are an essential tool for salmon managers when making decisions about potential salmon seasons and the associated salmon harvest. In addition to the preseason forecasts, the TAC utilizes current and historical Bonneville Dam counts in-season to track the progress of various salmon and steelhead runs and salmon managers use the information and adjust fisheries according. Table 36 lists some of the 2007 TAC run size predictions and actual returns. (LeFleur, 2008 *email communication*)

Table 36. TAC 2007 run size forecast and actual returns

Salmon species or race	2007 Forecast	2007 Return	Location description
Upriver Spring Chinook ^{1/}	78,500	86,200	Columbia River mouth forecast – end at hatcheries and natural spawning areas above Bonneville Dam
Snake River Spring/ Summer Chinook ^{2/}	38,500	46,200	Columbia River mouth forecast – end at hatcheries and natural spawning areas in the Snake River
Snake River Wild Spring/Summer Chinook ^{3/}	13,100	10,600	
Upper Columbia Spring Chinook ^{2/}	9,200	8,600	Columbia River mouth forecast – end at hatcheries and natural spawning areas in the Upper Columbia River (above Priest Rapids Dam)
Upper Columbia Wild Spring Chinook ^{4/}	1,200	900	
Upper Columbia Summer Chinook	45,600	37,200	Columbia River mouth forecast – end at hatcheries and natural spawning areas in the Upper Columbia River (above Priest Rapids Dam)
Willamette Spring Chinook	52,000	40,500	Columbia River mouth forecast – end at Willamette River
Cowlitz, Kalama, Lewis River Spring Chinook ⁶	15,900	17,700	Tributary return forecasts – start and end at tributaries
Yakima Spring Chinook ⁶	4,100	3,000	
Klickitat Spring Chinook ⁶	1,200	1,100	
Wind ⁶	2,100	4,300	
Little White Salmon ⁶	6,000	6,500	

Salmon species or race	2007 Forecast	2007 Return	Location description
Sockeye ^{5/}	27,300	26,700	Columbia River mouth forecast – end at natural spawning areas above Bonneville Dam
Wenatchee Stock	6,600	4,400	Columbia River mouth forecast – end at Wenatchee River
Okanogan Stock	20,700	23,300	Columbia River mouth forecast – end at Okanogan River
Snake River Sockeye	300	57	Columbia River mouth forecast – end at Snake River
Steelhead			
Wild Winter Steelhead	16,200	15,000	Columbia River mouth forecast – end at tributaries below and above Bonneville Dam
Upriver Summer Steelhead			
Skamania Hatchery	12,300	7,700	Bonneville Dam forecast – end at hatcheries and natural spawning areas above Bonneville Dam
Skamania Wild	4,400	1,700	
A-Index Hatchery	199,900	181,600	
A-Index Wild	41,600	77,300	
B-Index Hatchery	45,600	42,100	
B Index Wild	10,800	9,000	
Total Summer Steelhead	314,600	319,400	
Fall Chinook			
Upriver Bright Fall Chinook	185,200	114,500	Columbia River mouth forecast – end at hatchery and natural spawning areas above Bonneville Dam
Mid-Columbia Bright Fall Chinook	69,100	47,750	
Bonneville pool Fall Chinook	21,300	14,600	

1/ Includes Snake River Summer Chinook.

2/ Included in Upriver Spring Chinook number.

3/ Included in Snake River Spring/Summer Chinook number.

4/ Included in Upper Columbia Spring Chinook number.

5/ Includes Wenatchee, Okanogan, and Snake River stocks.

6/ To mouth of tributary

D. Pinnipeds at Bonneville Dam

One of the passage conditions that affect the Bonneville Dam counts is sea lion predation. Robert Stansell, COE, studied pinniped predation between 2002 and 2005 at Bonneville Dam. He found that in 2005 approximately 3,000 fish were consumed, about 3.6% of the run observed at Bonneville Dam. He found that the animals arrived earlier and stayed longer over the study years. They also entered fishways and hauled out in the spill bay (Stansell, 2005). In 2005-2007, the Oregon and Washington fish and wildlife departments used various hazing methods to deter the sea lions at Bonneville Dam including acoustic and percussive devices, flares, and rubber bullets. These hazing activities began in early April at Bonneville Dam (FPC, 2006; ODFW and WDFW, 2006; ODFW and WDFW, 2007).

Various hazing methods used in 2005 through 2007 were studied and evaluated for effectiveness in deterring sea lions from preying on salmonids at Bonneville Dam. In 2005 two 2 day tests in May were conducted and evaluated. These tests involved acoustic and tactile deterrents and vessel chases. The partners involved in these tests were COE, NMFS, and the State Fish and Wildlife Agencies. In 2005, they found localized but temporary decline in sea lion abundance. Sea lion predation shifted and increased in areas where there were no deterrents. In 2006, dam-based deterrent methods included sea lion exclusion devices (SLEDs) and acoustic deterrent devices (ADDs). The partners involved in these tests were COE, NMFS, CRITFC and the State Fish and Wildlife Agencies. These deterrents were used from March 5th through May 27th with 2 days of hazing followed by 2 days without hazing. Boat based deterrents were also used. These deterrents included about 1,000 vessel trips using cracker shells, seal bombs, rubber bullets, and screamers. These began on April 2nd and ended on May 27th. The boat based deterrents were scheduled with 4 days of hazing followed by 4 days of non-hazing. The partners involved in these tests were COE, NMFS, CRITFC and the State Fish and Wildlife Agencies. In 2006, they found that hazing had no effect on sea lion salmonid predation. In addition, the sea lions again found refugia in locations where hazing did not occur including near the base of the dam and in the spillway.

In 2007, the hazing was scheduled to occur from March 1st to May 30th. Daily dam-based and boat-based deterrents were used. In addition, sea lions were trapped and transferred to Astoria. The partners involved in these tests were ACOE, NMFS, CRITFC and the States. Nineteen sea lions were caught of which 16 were California sea lions and 3 were Steller sea lions. Of these, 14 were transferred to the coast and 7 were satellite tagged. All of the sea lions that were transferred returned to the dam within 1 to 2 weeks. The 2007 hazing efforts had no apparent effect on sea lion salmonid predation.

Over the three years, non-lethal hazing deterrents were used with increasing intensity. It was found that hazing efforts proved to be ineffective in reducing the sea lion abundance at the dam and that hazing efforts were ineffective in reducing salmonid predation. Additionally, sea lions that were successfully trapped in 2007 and transferred to the coast, returned to the dam within weeks (Brown, et al., 2007).

E. River Levels and Temperatures

The Snake and Columbia rivers ended the water year with below normal water supply. The January to July runoff volume at The Dalles Dam was approximately 95.7 million acre-feet or 89 percent of normal and the April to August runoff volume at Lower Granite Dam was approximately 13.5 million acre-feet or 59 percent of normal (FPC, 2008). Water temperatures were below 20° C through the early summer but rose to 20° C at times in July through September. Hence, warm water temperatures were a potential problem for salmon survival during the mid to late summer season in the Columbia and Snake Rivers.

F. Harvest

As the adult salmon move through the Columbia River basin, they pass through many established fisheries. These include commercial non-Indian fisheries, commercial Treaty Indian fisheries, and sport fisheries. Table 37 lists the fisheries, type of fisheries, the species associated with each fishery, and the dates of the fisheries in 2007 (LeFleur, 2008 email communication).

Table 37. 2007 Major CRB salmonid fisheries

Fishery	Fishery type	Species	2007 Management Periods
Buoy 10	Estuary sport fishery	Fall Chinook, hatchery coho	Fall Season (Aug 1 – Dec 31)
Columbia mouth to Bonneville Dam	Mainstem sport fishery	Hatchery Spring Chinook, summer Chinook, fall Chinook, hatchery coho, hatchery steelhead (winter and summer)	Winter-Spring Season (January 1 – June 15) Summer Season (June 16 – July 31)
Above Bonneville to Priest Rapids Dam	Mainstem sport fishery	Hatchery Spring Chinook, summer Chinook, fall Chinook, coho, hatchery steelhead (winter and summer)	
Columbia mouth to Bonneville Dam	Commercial fishery	Hatchery Spring Chinook, summer Chinook, fall Chinook, coho	
*Select Area fisheries (SAFE) Zone 1	Commercial fishery	Spring Chinook, fall Chinook, coho	Fall Season (Aug 1 – Dec 31)
All mainstem Columbia River fisheries between Bonneville Dam and McNary Dam (commonly known as Zone 6)	Treaty Indian fishery	Spring Chinook, summer Chinook, fall Chinook, coho, sockeye, steelhead (winter and summer)	January 1 through December 31

*SAFE fish return to terminal areas. They are released from net pens and return to areas downstream of Bonneville Dam, near the river mouth.

Map 1 in Appendix J shows the spatial distribution of the fishery zones in the Columbia River. Since there are many salmon fisheries throughout the Columbia River Basin, this illustrates some of the interest in the salmon both economically and recreationally (JCMS, 2006; IEAB 2005). In a report delivered to the Northwest Power

Planning Council by an Independent Economic Analysis Board in January of 2005, it was found that the Columbia River Basin anadromous salmonid production contributed about \$142 million total personal income annually to communities on the West Coast during the early 2000s. It was estimated, by using a full-time position annually earning \$30,000, that in Washington, Oregon, and Idaho about \$109 million dollars were generated. At that rate of annual pay, it represented about 3,633 jobs. In some communities with many citizens employed by the fishing industry, this may be a significant economic impact. It was also found that about 63% of the total economic contribution was generated by the Columbia in-river fishery (IEAB, 2005).

Salmonid harvest affects the Northwest economy, culture, and also affects dam counts. The 2000 NOAA BiOp analysis found that the FCRPS jeopardized the existence of the listed fish in the Columbia Basin. The BiOp identified actions that the federal action agencies could undertake to mitigate for the hydrosystem. One of the actions taken in the implementation of the BiOp was the restriction of harvest. The following paragraph describes the 2007 harvest of Spring Chinook, Summer Chinook, Fall Chinook, and Coho.

During the Winter/Spring season, recreational fisheries kept 7,500 hatchery spring Chinook, commercial fisheries landed 2,900 hatchery spring Chinook. Tribal fisheries harvested 6,100 spring Chinook for commercial or ceremonial/subsistence purposes. During the summer season, recreational fisheries downstream of Bonneville Dam caught 2,400 summer Chinook, commercial fisheries landed 1,100 summer Chinook and tribal fisheries harvested 5,400 summer Chinook for commercial or ceremonial/subsistence purposes. During the fall season, recreational fisheries below Bonneville Dam caught 12,500 fall Chinook and commercial fisheries caught 12,100 fall Chinook. Tribal fisheries harvested 44,750 fall Chinook. Coho harvest during 2007 non-Indian fisheries totaled 38,200 fish (LeFleur, 2008 *email communication*).

G. Fishways

Adult fish passage is affected by the condition of the fishways at the dams. An annual report by the FPC titled “2007 Annual Fishway Inspection Report” summarizes inspections of the adult fishways completed at the COE and PUD projects during the 2007 fish passage season. This fishway inspection program is overseen by the FPC and 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. The FPC coordinates the inspections and prepares the annual report. In addition, the FPC coordinates operations that would affect passage of adult salmon at the mainstem dams (FPC, 2008).

Specific monthly inspection reports can be found in the “2007 Annual Fishways Inspection Report”. Minor problems were observed as a result of the 2007 monthly inspections. The dams along the lower Columbia River had differential readings out of criteria, debris was found in fishway exits, and gate depths were found outside of criteria. The dams along the Snake River had the same minor problems as the dams along the lower Columbia River. In addition, at one of the dams the system was not balanced properly between head differential and gate depth. Some fish pumps were not working during the season. The dams along the mid-Columbia had the same minor problems as the lower Columbia dams. Additionally, some staff gauges were in need of cleaning, a fish counting station was found to have moisture problems and head differentials were found out of criteria. The fishway inspectors made the following recommendations in 2007 for future facility operations:

- The COE can do a better job of balancing gate depth and head differential.
- All water measuring devices should be easy to read. Utilize staff gauges that are easily cleaned or have benchmarks available which allow sensor readings to be taken.
- To prepare for a situation when main water supplies fail, evaluate backup water supply sources, assuring an adequate supply of water will be available.
- Prior to the passage season, a meeting should be held to discuss the previous year’s inspections and assess any maintenance that needs to occur to assure the readiness for the upcoming season.
- During the season, fishway passage issues should be discussed at FPOM monthly meetings and individual meetings set with Douglas, Chelan, and Grant County PUDs.
- Projects should assure that diffuser gratings are intact and clear of debris before the season begins. Additionally, they should be inspected during the season.
- A plan of action should be created detailing how to deal with removal of debris from dam forebays. This would help to assure that fish turbines/pumps, exits from the dams, picketed leads, or other areas would have less of a chance of plugging or causing damage to mechanical systems of the fishways or to the adults or juveniles passing the dams.
- Remove any sharp projections or other obstacles located in the fish ladders, collection, or transportation channels.
- Purchase spare parts of any critical operating equipment to allow for more rapid repairs during the passage season.
- Dewatering plans or other fish handling tasks should be reviewed and annually updated.

H. Adult Fish Counts

One of the management tools used by salmon managers is adult salmon counts at the dams. Adult dam counts are used in the calculation of conversion rates and in the prediction of adult returns. To assess passage of adult fish at Bonneville and other mainstem dams, the dam operating agencies fund fish counting programs at the COE and PUD projects. Map 1 Appendix J shows the adult count reporting dams, as well as, the number of fish ladders at each dam. These counting programs normally run from early spring through late fall to encompass most of the fish passage that occurs throughout the year. Fish counts may be assessed by directly counting fish as they swim through the counting slot or video-taped through the slot. Fish counts from each dam are updated daily on the FPC website during the normal fish passage season. The FPC Weekly Report incorporates adult fish counts for the current season compared to the previous year's data and the 10 year average data.

Adult dam counts are comprised of returning hatchery and wild salmon. They are the count of fish that pass through a dam's fishway. Fish may move back downstream at times. This is recorded as a negative number in the adult dam count. The number of fish recorded at each dam are those fish that have survived to move past this dam on their way to their spawning grounds. Harvest, fall back, hatchery entry, and adult mortality are some of the causes of reduction in the number salmon between dams.

Throughout this report, the 2007, 2006, and 10-year average adult dam counts are listed. The 2007 counts are compared with both the 2006 and 10-year average counts. Ten year average counts include a change in the management of salmon fisheries. This was due to a Biological Opinion (BiOp) issued by NOAA fisheries in 2000 on the operation of the Federal Columbia River Power System (FCRPS) for salmon and steelhead. The analysis in the BiOp found that the FCRPS did jeopardize the existence of the listed fish in the Columbia Basin. The BiOp identified actions that the federal action agencies could undertake to mitigate for the hydrosystem. One of the actions taken in the implementation of the BiOp was the restriction of harvest. The changes in harvests affected dam counts. Hence, it is important to use caution when evaluating 10-year average counts.

I. 2007 Adult Fish Count

In 2007, 274,321 adult Chinook salmon, 91,994 adult coho salmon, 24,376 sockeye salmon and 320,931 steelhead were counted at Bonneville Dam. In 2006, a total of 493,136 Chinook were counted at Bonneville Dam. The 2007 Chinook count was only about 55.6% of the 2006 count and the 2007 adult sockeye count was only 65.7%

of the 2006 count. The 2007 adult coho and adult steelhead counts also decreased when compared to 2006, however, it was by a much smaller amount. The 2007 adult coho count was 91% of the 2006 count and the 2007 steelhead count was about 96.3% of the 2006 count at Bonneville Dam. Table 38 has the adult counts at the mainstem dams for 2007, 2006, and the 10-year average adult count (1997-2006).

Table 38. Cumulative Adult Passage at Mainstem Dams

Cumulative 2007 Adult Passage at Mainstem Dams

River Zone	Dam	Spring Chinook					
		2007		2006		10-Yr Avg.	
		Adult	Jack	Adult	Jack	Adult	Jack
LCOL	BON	67,482	16,860	96,456	2,908	156,175	8,234
LCOL	TDA	53,524	15,567	61,827	2,176	108,412	6,003
LCOL	JDA	44,005	13,864	50,313	2,093	90,974	4,767
LCOL	MCN	39,497	12,393	45,887	2,475	83,968	5,029
SNAKE	IHR	28,380	7,371	25,434	875	56,277	3,172
SNAKE	LMN	28,397	7,102	23,589	548	53,700	2,904
SNAKE	LGS	23,960	7,227	20,836	733	51,418	2,974
SNAKE	LGR	22,905	9,085	22,530	973	51,737	3,293
MCOL	PRD	6,708	489	8,535	81	17,371	512
MCOL	WAN	7,250	484	NA	NA	NA	NA
MCOL	RIS	5,572	2,066	9,643	483	14,040	762
MCOL	RRH	2,424	920	5,376	274	5,343	306
MCOL	WEL	2,041	752	4,159	217	3,869	205
BBON	WEA	22,818	280	36,851	190	NA	NA

River Zone	Dam	Summer Chinook					
		2007		2006		10-Yr Avg.	
		Adult	Jack	Adult	Jack	Adult	Jack
LCOL	BON	47,412	13,539	97,519	4,355	69,317	7,971
LCOL	TDA	40,123	11,318	81,219	3,620	59,863	5,873
LCOL	JDA	35,773	11,582	73,814	4,150	55,712	5,893
LCOL	MCN	32,393	9,386	62,571	3,389	54,019	5,480
SNAKE	IHR	7,714	2,523	8,540	545	11,570	1,861
SNAKE	LMN	11,452	1,419	9,926	523	11,188	1,521
SNAKE	LGS	7,898	2,861	8,156	596	9,645	1,792
SNAKE	LGR	7,312	3,285	7,058	662	9,688	1,964
MCOL	PRD	30,644	1,088	57,236	556	48,735	2,050
MCOL	WAN	36,210	816	NA	NA	NA	NA
MCOL	RIS	28,222	6,200	61,821	2,086	45,655	4,765
MCOL	RRH	21,657	5,110	41,234	1,744	33,778	3,271
MCOL	WEL	13,244	3,573	25,671	1,944	24,782	1,610
BBON	WEA	NA	NA	NA	NA	NA	NA

Fall Chinook							
River Zone	Dam	2007		2006		10-Yr Avg.	
		Adult	Jack	Adult	Jack	Adult	Jack
LCOL	BON	159,427	52,655	299,161	25,549	362,571	37,819
LCOL	TDA	93,368	38,315	169,056	21,308	191,268	28,651
LCOL	JDA	73,228	35,867	135,831	22,233	140,814	24,751
LCOL	MCN	57,172	27,961	89,081	13,782	110,010	20,028
SNAKE	IHR	13,376	9,741	10,272	6,835	11,546	6,767
SNAKE	LMN	16,039	8,832	11,127	8,769	10,214	5,868
SNAKE	LGS	10,420	8,032	9,274	5,100	8,716	4,242
SNAKE	LGR	10,167	9,776	8,048	6,721	7,717	5,161
MCOL	PRD	22,650	4,383	18,851	1,827	28,211	3,180
MCOL	WAN	18,181	5,054	NA	NA	NA	NA
MCOL	RIS	3,889	1,708	6,136	1,607	10,832	2,143
MCOL	RRH	3,050	1,420	4,821	1,151	6,732	1,747
MCOL	WEL	1,633	1,037	3,321	3,236	3,744	983
BBON	WEA	162	18	1,937	329	NA	NA

Coho							
River Zone	Dam	2007		2006		10-Yr Avg.	
		Adult	Jack	Adult	Jack	Adult	Jack
LCOL	BON	91,994	4,064	101,087	7,920	96,895	6,215
LCOL	TDA	30,664	2,087	29,728	2,468	26,577	2,185
LCOL	JDA	33,019	6,209	28,868	4,910	22,656	2,438
LCOL	MCN	20,217	2,370	12,183	1,150	11,672	950
SNAKE	IHR	1,994	153	897	74	974	32
SNAKE	LMN	2,092	139	1,102	79	890	45
SNAKE	LGS	1,963	178	938	34	727	16
SNAKE	LGR	2,532	266	1,141	293	1,025	64
MCOL	PRD	11,488	822	3,205	608	2,526	298
MCOL	WAN	9,428	747	NA	NA	NA	NA
MCOL	RIS	16,604	548	5,597	0	3,747	0
MCOL	RRH	4,634	104	1,523	0	674	0
MCOL	WEL	2,432	0	409	0	190	0
BBON	WEA	1,050	164	6,186	1,614	NA	NA

Sockeye				
River Zone	Dam	2007 Adult	2006 Adult	10-Yr Avg. Adult
LCOL	BON	24,376	37,066	60,817
LCOL	TDA	19,124	30,026	50,789
LCOL	JDA	24,277	35,387	55,214
LCOL	MCN	18,175	29,295	46,987
SNAKE	IHR	55	48	30
SNAKE	LMN	44	17	31
SNAKE	LGS	37	26	34
SNAKE	LGR	52	17	36
MCOL	PRD	24,645	26,710	58,348
MCOL	WAN	24,097	NA	NA
MCOL	RIS	25,122	35,132	54,210
MCOL	RRH	20,683	25,377	37,840
MCOL	WEL	22,273	22,075	37,175
BBON	WEA	NA	NA	NA

Steelhead							
River Zone	Dam	2007		2006		10-Yr Avg.	
		Adult	Wild	Adult	Wild	Adult	Wild
LCOL	BON	320,931	80,953	333,250	83,890	335,652	87,471
LCOL	TDA	241,898	60,034	235,623	56,947	252,128	66,522
LCOL	JDA	227,112	60,142	217,122	52,009	252,769	64,277
LCOL	MCN	208,788	50,958	184,024	42,213	195,796	47,898
SNAKE	IHR	153,619	31,527	123,631	27,322	146,440	30,271
SNAKE	LMN	154,104	33,236	135,566	27,338	141,318	29,600
SNAKE	LGS	135,414	23,905	124,440	24,681	131,070	27,152
SNAKE	LGR	157,214	32,998	145,991	29,836	146,214	29,940
MCOL	PRD	15,183	NA	10,408	NA	13,820	4
MCOL	WAN	17,348	NA	NA	NA	NA	NA
MCOL	RIS	13,293	5,628	9,379	4,087	13,139	6,791
MCOL	RRH	10,143	3,915	8,122	3,003	10,317	4,521
MCOL	WEL	7,500	3,410	6,674	2,573	7,688	3,296
BBON	WEA	19,698	NA	25,930	NA	NA	NA

*This report uses traditional or historical date ranges

The following sections of the report describe salmon biology, adult migration and spawning distribution, temporal patterns in adult migration seasons, and adult dam counts for each salmon species. In addition, 2007 FPC data requests regarding adult migration issues and returns are summarized in this section by species.

1. Spring Chinook

Biology and Watershed Distribution

Chinook salmon are the largest of the Pacific salmon. Spring Chinook return to the Columbia River Basin fresh water streams anywhere from the ages of 4 to 5 years old. While the adults move through the CRB to their natal streams, their bodies change in preparation for reproduction. Spring Chinook re-enter fresh water in the spring (LCFRB, 2004). Because of their size, Chinook salmon are able to spawn in larger gravel. They often utilize streams with higher water flows (LCFRB, 2004; PSMFC, 1996).

Spring Chinook spawn within several large basins or watersheds of the Columbia River Basin (CRB) (see Map 2 Appendix J). The watersheds where Spring Chinook spawn within the CRB are portions of larger basins. Geographically, the United States can be divided and sub-divided into successively smaller hydrologic units or HUCs. Throughout this report 3rd field HUCs (the smaller the field number of HUC the larger the watershed) will be referred to as basins. Spring Chinook spawn in the Clearwater, Deschutes, John Day, Lower Columbia, Lower Snake, Middle Columbia, Salmon, Upper Columbia, Willamette, and Yakima basins. Together these basins can be considered the regional spatial distribution of migration and spawning grounds of spring Chinook in the CRB (Map 2, Appendix J).

Temporal Patterns in Adult Migration Season

In addition to the regional spatial distribution, there are temporal patterns in adult migration seasons that are evident from year to year. Two figures and a table are used in this section to describe the temporal patterns of the spring Chinook adult migration season for 2007. Within the two figures, the last three years' runs are graphed (2005, 2006, and 2007) to show recent trends, the 10-year average run is graphed to illustrate decadal trends, and the 1997 run is graphed to illustrate adult returns during a high flow year within the last decade. Figure 23 illustrates that the 2006 adult migration season began much later than the 2005 season. The 2007 adult migration season began earlier than the 2006 and 2005 seasons; however, it began later than the 10 year average and the high flow year of 1997. Figure 23 also shows that the peaks of the run were lower than 2006 and that the duration of the run was longer than 2006. Figure 24 shows that in 2007, 1% of the cumulative proportion of the adults passing Bonneville Dam arrived just prior to mid April, while in 2006 1% of the run passed Bonneville in late April and 1% of the 10-year average run passed Bonneville Dam earlier, in late March. The 2007 duration between the 1% and 90% passage dates for adult spring Chinook passing Bonneville Dam was 1.5 times longer than in 2006, while being about $\frac{3}{4}$ of the length of time for the 10 year average (Table 39).

Figure 23. Spring Chinook Dam Count by Date at Bonneville Dam

Figure 24. Spring Chinook Cumulative Proportion Dam Count by Date at Bonneville Dam

Table 39. Spring Chinook cumulative proportion dates and run duration

Spring Chinook 1% and 90% Passage Dates			
Year	1%	90%	Duration (days)
2007	10-Apr	22-May	42
2006	23-Apr	20-May	27
2005	15-Apr	26-May	41
2004	4-Apr	19-May	45
2003	16-Mar	19-May	64
2002	28-Mar	17-May	50
2001	23-Mar	12-May	50
10-Year Average	23-Mar	17-May	55

Despite the longer duration of the 2007 spring Chinook adult migration window, the total spring Chinook count at Bonneville for 2007 was 67,482 adults which was about 69.9% of the 2006 run. The 2007 adult spring Chinook count at Bonneville Dam was only 43.2% of the 10 year average.

Although the 2007 adult spring Chinook count was low, the 2007 spring Chinook jack count of 16,860 was about 5.79 times greater than the 2006 spring Chinook jack count of 2,908 and about 2.04 times larger than the 10 year average at Bonneville Dam. Since there was such a high count of spring Chinook jacks in 2007, the TAC forecasted that 269,300 upriver spring Chinook adults would return in 2008.

Counts at other dams and tributary turnoffs

This section of the report lists some of the major tributary turn offs and the change in 2007 count size between some of the dams within the CRB of spring Chinook. This section compares the 2007 and 2006 count at some of the dams. At times, it also compares the 2007 count with the 10-year average, giving a decadal perspective to the 2007 count. It is important to use caution when using 10-year averages because the counts that are a part of the average include the BiOp implementation that incorporated harvest reductions, affecting dam counts.

Map 2, Appendix J shows the spatial distribution of the 2007, 2006, and 10-year average dam counts and the streams where spring Chinook are known to occur. By evaluating Map 2 or Table 38, it can be seen that 9 of 13 Spring Chinook dam counts decreased in 2007 when compared to the 2006 count. At the four Snake River projects, Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam counts increased between 2006 and 2007.

Going upriver past Bonneville Dam, The Dalles Dam is the next dam the salmon cross. The count in 2007 of spring Chinook at The Dalles Dam was 53,524 which was 86.5% of the 2006 count and only half of the 10-year average count.

In 2006, the count at The Dalles Dam was 79.3% of the total count at Bonneville. Tributary turnoffs, harvest, fall back, and adult mortality are some of the causes of reduction in the number of fish seen at each successive dam upstream. Between Bonneville and The Dalles Dam there are several spring Chinook turn offs including, to the north, Wind River, White Salmon River, and the Klickitat River and to the south Hood River and several tributaries.

After The Dalles Dam the spring Chinook cross John Day Dam and continue upstream to the mid-Columbia and cross McNary Dam. The 2006 Spring Chinook count at McNary Dam was 39,497. The 2007 count declined by 13.9% or 6,390 fish when compared to the 2006 count. In 2007, the count at McNary Dam was about 58.5% of the total count at Bonneville. There are several spring Chinook turn offs prior to McNary Dam. These include, to the south, Fifteen Mile Creek, Deschutes River, John Day River, and the Umatilla River.

A portion of the salmon crossing McNary Dam continue upstream into the Snake River. The first dam they cross in the Snake River is Ice Harbor Dam (IHR). The 2006 IHR Dam count was 42% of the 2006 Bonneville Dam count. The Spring Chinook count at IHR of 28,380 increased 1.1 times or 2,946 fish in 2007 when compared to the 2006 count. After crossing IHR, the Spring Chinook move through the Snake River and its tributaries. Some fish turn off into the Tucannon River to the south after crossing Lower Monumental Dam (LMN), and others continue over Lower Granite Dam (LGR) to the Clearwater River, Grande Ronde River, Lower Snake, Salmon River, or the Imnaha River and their tributaries (see Map 2, Appendix J). The 2007 counts at LMN, Little Goose Dam (LGS), and LGR increased when compared to the 2006 counts by 1.2, 1.14, 1.01 times, respectively.

While some fish turned upstream into the Snake River, others continued up the Columbia River passing McNary Dam to the upper Columbia. The first dam they cross is Priest Rapids (PRD) Dam. The 2007 count at PRD was 9.9% of the total 2007 Bonneville count. Continuing upstream, the salmon also cross Wanapum (WAN), Rock Island (RIS), Rocky Reach (PRD), and Wells (WEL) dams. The 2007 count at RIS is about 8.2% of the total 2007 Bonneville count. At Rock Island Dam the 2007 count of 5,572 was only about 57.7% of the 2006 count of 9,643. Some of the upper Columbia spring Chinook turn offs include the Wenatchee River, Entiat River, Chelan River, Yakima River and Methow River (see Map 2, Appendix J).

Data Requests regarding adult spring/summer Chinook migration and returns

This section of the report summarizes data requests regarding adult passage and return issues by species type.

In response to data requests, FPC staff examined information relating to the origin of the large number of jack spring Chinook count at Bonneville Dam in 2007.

FPC summarized PIT-tag detections of Chinook adults at Bonneville Dam for the period April 1 to May 29, 2007. Jacks were identified based on their year of out-migration; in this case, 2006 migration year fish were considered jacks. It was found that the 2006 juvenile migration year clearly showed the effects of flow and spill on downstream juvenile migrants. The high in-river survivals resulting from relatively high flow and spill provide support for flow and spill measures to enhance in-river survival. At the time this memorandum was written it was too early to determine the combined effect of 2006 out-migration conditions, including the effects of ocean conditions and delayed transportation measures. The complete result of passage strategy implemented in 2006 will not be determined until all of the adult return data is available. However, a review of past data showed that the highest smolt to adult return rates for both in-river migrants and transported migrants occurs from out-migration years with higher flow and spill levels. Indications from PIT-tag data suggested that early migrants that were returned to river prior to initiation of transportation returned at rates similar to later bypassed fish from CSS study groups. However, at the time this memorandum was written the effect of the 2006 implemented passage strategy of delayed transportation of smolts could not be determined (FPC 93-07, 2007).

FPC received a data request to evaluate whether there was higher adult mortality for Upper Columbia (UCOL) spring Chinook and steelhead (BON-MCN) compared to Snake River (SR) spring/summer Chinook and steelhead (BON-LGR), as reported in the 2007 Draft BiOp. FPC found that UCOL spring Chinook had lower adult mortality from BON to MCN than did SR spring/summer Chinook from BON to LGR, however, this was not significant. It was found that adult mortality of UCOL Chinook from BON to MCN was slightly higher than that for SR spring/summer Chinook from BON to LGR, however, this difference was not significant. Increased adult mortality of UCOL Chinook (with the addition of summer Chinook) may be the result of increased passage and higher adult mortality in July. FPC found the UCOL steelhead had higher adult mortality from BON to MCN than did SR steelhead from BON to LGR, although this difference was not significant. The mortalities reported in the 2007 Draft BiOp were adjusted for harvest and straying. FPC did not know what harvest and stray rates were used so the result reported in the memorandum were not adjusted for harvest and stray rates (FPC 11-08, 2008).

2. Summer Chinook

Biology and Watershed Distribution

Adult Summer Chinook return to freshwater in the early summer and spawn in late summer or early fall. Spawners can be two to six years old (some males mature as one-year-olds) (Fitzpatrick, 1999). Like spring Chinook, summer Chinook tend to spawn in the headwaters of streams and rivers (LCFRB, 2004; PSMFC, 1996). Table 29 lists the dates at each dam when the Chinook pass over the dam and are considered to be summer Chinook. Within the CRB, summer Chinook spawn in the Lower Columbia, Middle Columbia, Upper Columbia, Lower Snake, and Salmon basins (Map 3 Appendix J).

Temporal Patterns in Adult migration season

In addition to the regional watershed distribution, there are temporal patterns in adult migration seasons for summer Chinook. Figures 25 and 26 and Table 34 are used in this section to describe the temporal patterns of the summer Chinook adult migration season for years graphed at Bonneville Dam. Figure 25 shows that the 2006 summer Chinook count distribution curve had two peaks of salmon crossing Bonneville Dam in early June and late June. The 2007 adult migration was similar in shape to the 10 year average; however, the magnitude of the curve was lower than the 10 year average, 2006, and 2005 curves. Despite the smaller magnitude of the 2007 adult migration differing from recent years, the duration between the 1% and 90% adult passage dates at Bonneville Dam was similar to that seen in recent years (see Table 40). Furthermore, passage timing distribution in 2007 was similar to recent years (Figure 26).

Figure 25. Summer Chinook Dam Count by Date at Bonneville Dam

Figure 26. Summer Chinook Cumulative Proportion Dam Count by Date at Bonneville Dam

Table 40. Summer Chinook cumulative proportion dates and run duration

Summer Chinook 1% and 90% Passage Dates			
Year	1%	90%	Duration (days)
2007	2-Jun	19-Jul	47
2006	1-Jun	14-Jul	43
2005	1-Jun	17-Jul	46
2004	1-Jun	15-Jul	44
2003	1-Jun	17-Jul	46
2002	1-Jun	16-Jul	45
2001	1-Jun	21-Jul	50
10 Year Avg	1-Jun	18-Jul	47

In 2007, a total of 47,412 summer Chinook passed Bonneville Dam which was 48.6% of the 2006 count and 68.3% of the 10 year average. Although the adult count decreased between 2006 and 2007, the jack count increased, as it did for the spring Chinook. The 2007 summer Chinook jack count at Bonneville Dam of 13,539 increased by 3.1 times when compared to the 2006 count and increased by about 1.6 times when compared to the 10 year average.

Counts at other dams and tributary turnoffs

The Summer Chinook counts decreased at all dams between 2006 and 2007 except at two of the Snake River projects, Lower Monumental Dam and Lower Granite Dam. While the adult counts decreased between the years, the jack counts increased at all projects (see Table 36).

The last dam that the salmon cross in the lower Columbia river zone is McNary Dam. The 2007 summer Chinook dam count at McNary Dam of 32,393 was only 51.7% of the 2006 count and 59.9% of the 10 year average. The 2007 summer Chinook jack count of 9,386 at McNary Dam increased 2.76 times over the 2006 count and 1.71 times over the 10 year average count.

The adult count at McNary Dam in 2007 was 68.3% of the count at Bonneville Dam. The reduction in the count between dams is due to many causes including harvest, hatchery entry, tributary turn off, fall back, and adult mortality.

Priest Rapids Dam is the first dam in the mid-Columbia river zone (Table 36) that summer Chinook encounter after McNary Dam. The 2007 count at PRD was 64.6% of the count at Bonneville Dam. Interestingly, the count at Priest Rapids Dam in 2007 was about 84.6% of the count at McNary Dam, indicating that a majority of the summer Chinook crossing McNary Dam proceed upstream to the mid-Columbia River (Map 3 Appendix J).

As the fish proceed up the Columbia River the next dam they cross is Wanapum Dam then Rock Island Dam. In 2007, the count at Rock Island of 28,222 was only 45.6% of the 2006 count and 61.8% of the 10 year average. The 2007 summer Chinook jack count of 6,200 increased 2.97 times when compared to the 2006 count and increased 1.3 times when compared to the 10 year average. Between Rock Island and Rocky Reach Dams some the summer Chinook turn off into the Wenatchee River while others continue up the Columbia. The next dam the salmon cross in the upper-Columbia river is Wells Dam. Once they cross Wells Dam, some turn off into the Methow River or the Okanogan River (Map 3 Appendix J).

3. Fall Chinook

Biology and Watershed Distribution

Adult fall Chinook return to freshwater from late summer to early fall. Spawners can be of mixed age. Fall Chinook tend to spawn in the downstream portions of streams, however, some populations migrate long distances (Fitzpatrick, 1999). Fall Chinook, unlike other races, are mainstem spawners.

Fall Chinook spawn within the Willamette, Deschutes, Lower Columbia, Middle Columbia, Upper Columbia, Lower Snake, Clearwater and Salmon basins (Map 4 Appendix J) within the CRB. Bright fall Chinook spawn within the Lower Columbia at Ives Island. Most fall Chinook spawn within Hanford reach, below John Day Dam, above Lower Granite Dam and in the Snake River below Hells Canyon Dam.

Temporal Patterns in Adult migration season

The general shape of the 2007 fall Chinook count curve at Bonneville Dam was similar to the 10 year average curve; however, the magnitude and peak numbers of returning adults were much lower than the 2006, 2005, and the 10 year average curves. Table 35 shows the 1% and 90% passage dates for adult fall Chinook passing Bonneville Dam. It also shows the number of days or run duration between the two cumulative proportions. In 2007, the run duration for adult fall Chinook was similar to the 2006 duration. The 2007 run duration was 1.22 times or 8 days longer than that seen in the 10 year average. This can also be seen by the passage timing distribution in Figure 28.

Figure 27. Fall Chinook Dam Count by Date at Bonneville Dam

Figure 28. Fall Chinook Cumulative Proportion Dam Count by Date at Bonneville Dam

Table 41. Fall Chinook cumulative proportion dates and run duration

Fall Chinook 1% and 90% Passage Dates			
Year	1%	90%	Duration (days)
2007	3-Aug	29-Sep	60
2006	3-Aug	30-Sep	58
2005	7-Aug	25-Sep	49
2004	4-Aug	25-Sep	52
2003	6-Aug	22-Sep	47
2002	4-Aug	19-Sep	46
2001	4-Aug	20-Sep	47
10 Year Avg	5-Aug	23-Sep	49

The 2007 fall Chinook count at Bonneville Dam was 159,427, a decrease of 139,734 or 46.7% when compared to the 2006 count. The 2006 fall Chinook count was a 56.0% decrease over the 10-year average. The 2007 fall Chinook jack count of 52,655 was higher than the 2006 count of 25,549 by 2.06 times and it increased 1.39 times when compared to the 10 year average.

In the lower Columbia River, the estimated number of adult “tule” fall Chinook at Bonneville Dam in 2007 was 25,322 (Figure 29) with 6,384 “tules” arriving at Spring Creek NFH, located in the Bonneville Dam pool (Errands, 2008). The 2007 tule estimated numbers were significantly lower than the 2006 estimated numbers of adult “tule” fall Chinook at 31,491 with 10,745 arriving at Spring Creek NFH that year. The 2007 tule

fall Chinook at Bonneville was 80.4% of the 2006 total and it was 59.4% of the total at Spring Creek NFH. However, the total number of jacks at the hatchery in 2007 was very high at 7,787.

Tule fall Chinook do not make the lengthy migration journeys of the upriver bright stocks with most spawning in the Bonneville pool area and below Bonneville Dam. The bright fall Chinook component of the fall Chinook run are bound for Little White Salmon, Klickitat, Deschutes, John Day, and Umatilla Rivers in the lower Columbia River reach, as well as mainstem and tributaries of the Mid-Columbia and Snake River reaches. The 2007 count of adult fall Chinook (Bright component) of 57,172 in 2007 that arrived at McNary Dam was (Figure 30), which is about 64.1% of the 2006 of 89,081 count and 51.9% of the 10-year average.

Figure 29. Historical Spring Creek National Fish Hatchery tule fall Chinook counts

Figure 30. Historical upriver bright counts at McNary dam

Counts at other dams and tributary turnoffs

Map 4 Appendix J shows the spatial distribution of the 2007, 2006, and 10-year average dam counts and the streams where fall Chinook are known to occur. By evaluating Map 4 or Table 30, it can be seen that the 2007 fall Chinook dam counts decreased at most Columbia River dams, except Priest Rapids Dam, while increasing at the Snake River dams, when compared to 2006. At all of the dams along the Columbia, the 2007 counts were also lower than the 10-year average counts. At the Snake River dams, the 2007 counts were higher than the 10 year average count.

Prior to Bonneville Dam, some fall Chinook move into the Willamette basin to spawn. Some of the tributary turn offs along the Willamette include Clackamas, Mollala, South Santiam River and the tributaries associated with these systems. After Bonneville Dam, some of Fall Chinook continue to move upstream crossing The Dalles, John Day, and McNary dams. The count at McNary Dam in 2007 was 35.8% of that seen at Bonneville Dam. Mainstem spawning, harvest, fall back, hatchery entry and adult mortality are some of the causes of reduction in the number of fall Chinook seen at each successive dam upstream. Between Bonneville Dam and McNary Dam there are numerous turn offs including Hood River, Klickitat River, Deschutes River, Rock Creek, Umatilla River, and the tributaries associated with these rivers and streams (Map 4 Appendix J). The 2007 count at McNary Dam of 57,172 was only 64.1% of the 2006 count of 89,081. When compared with the 10-year average count of 110,010, the count decreased by 52,838 fish or 48%. Many fall Chinook passing McNary Dam are of “wild” origin and are destined for the Hanford Reach to spawn.

Some of the fall Chinook continue upstream along the Columbia, crossing Priest Rapids Dam. In 2007, the count of 22,650 at Priest Rapids Dam was increased 1.2 times when compared to the 2006 count. However, the 2007 Priest Rapids count was only 80.2% of the 10 year average. In addition to the 2007 adult count increasing at Priest Rapids Dam, the jack fall Chinook count of 4,383 increased 2.4 times compared to the 2006 count and increased 1.37 times compared to the 10 year average. The 2007 Priest Rapids Dam count of adult fall Chinook was 14.2% of the count at Bonneville Dam.

A small portion of fall Chinook migrated up the Snake River. The 2007 Ice Harbor count was about 8.4% of the 2007 Bonneville Dam count. At Ice Harbor Dam the 2007 count increased 1.3 times compared to the 2006 IHR count and 1.15 times compared to the 10 year average.

Of the salmon that crossed Ice Harbor, about 76% migrated over Lower Granite Dam to the Snake River, Grande Ronde River, Salmon, Clearwater, and Imnaha River systems. In 2007, the count at Lower Granite Dam of 10,167 increased 1.26 times compared to the 2006 count. The 2007 LGR fall Chinook count increased by 1.31 times when compared to the 10-year average count. In addition to the higher adult counts, the 2007 LGR jack count of 9,776 was 1.45 times higher than the 2006 count and 1.89 times higher than the 10 year average at LGR.

Data Requests regarding adult fall Chinook migration and returns

This section of the report summarizes data requests regarding adult passage and return issues by species type. In July of 2007, FPAC requested that the FPC update a portion of a 2004 memo entitled, “Transportation of fall Chinook smolts and related fall Chinook migration and tag data concerning summer spill for fish passage”. Specifically, it was requested that the figures in the memo that presented juvenile passage timing at

McNary Dam for in-river and transported Snake River subyearling Chinook that survived to adulthood. It was found that from most migration years (6 out of 8), the majority of returning adults that were transported as juveniles from McNary Dam were transported after August 1st. Seven of 10 years that were analyzed showed that the majority of the returning adults that migrated in-river as juveniles and were detected later in the season (August to December) (FPC 120-07, 2007).

In November, FPC received a data request about the 2007 low returns of fall Chinook at Bonneville Dam and McNary and the above average returns of adult fall Chinook at Lower Granite Dam. FPC staff summarized historical passage data, passage management and production data for this request and found that the majority of fall Chinook adults returning in 2007 would have migrated in 2003 and 2004 for Hanford Reach stocks and 2004 and 2005 for Snake River stock. The Spring Creek Hatchery stock would have primarily migrated during 2004 and 2005. It was found that a significant portion of the migration in 2005 in the Snake River migrated under spill conditions. Additionally, spill for Snake River fall Chinook juvenile migrants has increased significantly over the years, with the addition of voluntary summer spill in 2005. A higher proportion of Snake River subyearling fall Chinook pass LGR during times of spill. A smaller proportion of fall Chinook originating above LGR have been transported since 2005. Recent analyses showed an improvement in survival for subyearling Chinook passing in spill. The combination of these factors (increased spill, increased in-river population and improved survival) would increase the in-river population surviving to below Bonneville Dam. Hatchery releases of Snake River fall Chinook were at their highest in 2005. However, in 2004 hatchery release was significantly less than observed in recent past years. These are the two years which comprise most of the adult return to LGR in 2007, hence, it was difficult to assess the affect that these differences would have.

Fall Chinook originating in the Hanford reach experienced poor downstream flow conditions during the summer period for the two primary migration groups that may have contributed to the 2007 adult return. Hatchery releases of fall Chinook in the Mid-Columbia in 2003 and 2004 were comparable to past years. Other factors, such as entrapments due to operation of the hydrosystem, may have affected the juvenile migrants during 2003 and 2004. These outmigration years were prior to the Hanford Reach agreement for the operation of the hydrosystem. Despite increased releases of tule fall Chinook from Spring Creek Hatchery in recent years, a smaller proportion of juveniles are passing Bonneville during periods of spill, which may have contributed to lower adult returns in recent years.

4. Coho

Biology and Watershed Distribution

Coho adults return to their natal stream and spawn at around 3 years old. Some 2 year old males or jacks also return to spawn. Coho salmon like to spawn in small streams with stable gravel beds (LCFRB, 2004). Within the CRB, coho spawn within the Willamette, Lower Columbia, Yakima, Middle Columbia, Upper Columbia, Lower Snake, and Clearwater basins (Map 5, Appendix J).

Temporal Patterns in Adult migration season

In addition to the regional spatial distribution of coho salmon, there are temporal patterns in their adult migration seasons that are evident from year to year. Figure 32 shows that the 2007 coho dam count curve at Bonneville Dam was similar to the 2006 curve. However, the first rise and first peak in adult coho counts began later than in 2006. Table 42 shows the 1% and 90% passage dates of adult coho passing Bonneville Dam. It also shows the duration between the two passage dates. In 2007, the number of days (60) between the 1% and 90% passage dates for adult Coho was only 1 day different than the 2006 duration of 61 days, although the 1% cumulative proportion date was 4 days than 2006. The length of time between the 1% and 90% cumulative proportions in 2007 was the second longest span of days since 2001. The 2007 run duration was 1.07 times, or 4 days longer than the 10 year average run duration. The slower nature of the adult migration to Bonneville in 2007 can also be seen in the passage distribution curves (Figure 31).

Figure 31. Coho Dam Count by Date at Bonneville Dam

Figure 32. Coho Cumulative Proportion Dam Count by Date at Bonneville Dam

Table 42. Coho cumulative proportion dates and run duration

Coho 1% and 90% Passage Dates			
Year	1%	90%	Duration (days)
2007	22-Aug	21-Oct	60
2006	18-Aug	18-Oct	61
2005	22-Aug	12-Oct	51
2004	28-Aug	16-Oct	49
2003	18-Aug	15-Oct	58
2002	24-Aug	20-Oct	57
2001	22-Aug	6-Oct	45
10 Year Avg	21-Aug	16-Oct	56

The 2007 coho count at Bonneville Dam of 91,994 decreased 5% compared to the 10 year average count and decreased about 9% compared to the 2006 count. The 2007 coho jack count of 4,064 was 51.3% of the 2006 count and 65.3% to the 10-year average.

Counts at other dams and tributary turnoffs

Map 5 Appendix J illustrates the many small rivers and streams in the Lower Columbia and Willamette basins where coho turn off to spawn. Some of these rivers and streams include Clatskanie River, Kalama River, Lewis River, and Multnomah Channel.

Within the Willamette basin, some of the turn offs include the Tualatin River, Yamhill River, Willamette River, and Clackamas River. The coho count at Willamette Falls Dam in 2007 of 1,050 was only 16.97% of the 2006 count of 6,186. In 2007, the coho counts increased at all of the dams with the exception of Bonneville Dam which decreased about 9% when compared to the 2006 counts. In addition the 2007 counts increased at all dams when compared to the 10 year average counts.

The 2007 count at The Dalles Dam was only about 33.3% of the 2007 Bonneville coho count, illustrating that a large proportion of Coho remain below Bonneville Dam. The 2007 Coho count at The Dalles Dam of 30,664 increased 1.03 times compared to the 2006 count. In addition to the many tributary turn offs prior to Bonneville, there are also several turn offs between Bonneville Dam and The Dalles Dam including Herman Creek, Hood River and its tributaries, Chenoweth Creek, and Mill Creek on the Oregon side. Some of the coho turn offs on the Washington side of the Columbia include Wind River, White Salmon River, and the Klickitat River.

Continuing upstream, the coho pass over John Day and then McNary Dam. The count at McNary Dam in 2007 of 20,217 increased 1.66 times when compared to the 2006 count. Additionally, the count increased by 1.73 times when compared to the 10-year average. The count at McNary Dam was 21.9% of the count at Bonneville Dam. Prior to crossing McNary Dam some coho turn off into the Umatilla River and its tributaries.

After crossing McNary Dam some coho move into the Yakima River and its tributaries. These fish are from a Yakama tribal release program to reintroduce coho into the Yakima, Methow, and Wenatchee river basins (see Hatchery chapter). Some coho cross Priest Rapids Dam where the 2007 count of 11,488 was about 3.58 times larger than the 2006 count. These coho are bound for the Wenatchee or Methow rivers (see Hatchery chapter). The 2007 coho count at Rock Island of 16,604 increased by 2.97 times compared to the 2006 count. The 2007 Rocky Reach Dam count of 4,634 increased 3.04 times when compared to the 2006 count.

Along the Snake River, the coho count at Ice Harbor of 1,994 increased by 2.22 times when compared to the 2006 count. Further upstream, the 2007 count at Lower Granite Dam of 2,532 also increased by 2.21 times compared to the 2006 count. Migrating coho move through the Lower Snake basin with fish some turning off into the Potlach River, Clearwater River, or Selway River systems within the Clearwater River Basin.

5. Sockeye

Biology and Watershed Distribution

Sockeye spend 1 to 2 years at sea and return to spend about 1 year within freshwater, usually within a lake prior to spawning. Sockeye usually spawn in streams headed by lakes (WCSBRT, 2003; PSMFC 2007). Sockeye are distributed in the Lower Columbia, Middle Columbia, Upper Columbia, Lower Snake and Salmon basins (Map 6 Appendix J).

Temporal Patterns in Adult migration season

Along with the regional spatial distribution, there are temporal patterns in adult migration seasons that are evident from year to year. For instance, Figure 33 shows that the peak of the 2007 sockeye count at Bonneville Dam is much lower than 2006, 2005, and the 10-year average. The passage timing of adult sockeye at Bonneville in 2007 appears to start just a bit earlier than recent years and the 10-year average timing (Figure 32). Table 43 shows the 1% and 90% passage dates adult sockeye passing Bonneville. It also shows the number of days between the two cumulative proportions. The duration between the cumulative proportions of the adult sockeye run at Bonneville was 3 days longer than the 2006 duration and 1 day longer than the 10 year average.

Figure 33. Sockeye Dam Count by Date at Bonneville Dam

Figure 34. Sockeye Cumulative Proportion Dam Count by Date at Bonneville Dam

Table 43. Sockeye cumulative proportion dates and run duration

Year	Sockeye 1% and 90% Passage Dates		Duration (days)
	1%	90%	
2007	3-Jun	6-Jul	33
2006	6-Jun	6-Jul	30
2005	7-Jun	9-Jul	32
2004	4-Jun	5-Jul	31
2003	7-Jun	9-Jul	32
2002	11-Jun	8-Jul	27
2001	6-Jun	2-Jul	26
10 Year Avg	5-Jun	7-Jul	32

The 2007 adult sockeye count at Bonneville Dam of 24,376 decreased by 34.2% when compared to the 2006 count of 37,066 and it decreased by 59.9% when compared to the 10 year average of 60,817.

Counts at other dams and tributary turnoffs

Map 6 and Table 38 show that the 2007 adult sockeye count decreased throughout the lower and mid-Columbia river zones when compared to both the 2006 and 10-year average counts.

Continuing upstream past Bonneville, The Dalles, and John Day dams, many sockeye cross McNary Dam. The 2007 McNary sockeye count was 74.5% of the

Bonneville count. In addition, the 2007 count at Priest Rapids Dam had 269 more salmon than the Bonneville count. This illustrates that most of the sockeye migrate through the upper Columbia River and that sockeye spend about 1 year in fresh water prior to spawning. After Priest Rapids Dam, the sockeye cross Rock Island Dam. The 2007 count at Rock Island Dam of 25,122 was about 71.5% of the 2006 count and 46.3% of the 10-year average. The 2007 Rock Island count had 746 more salmon than the Bonneville count and 477 more salmon than the Priest Rapids count. This dam is further upstream than Priest Rapids Dam, illustrating that many sockeye stayed in the Upper Columbia watershed. Before passing Rock Island Dam, sockeye turn off the Upper Columbia into the Wenatchee River, destined for Lake Wenatchee. Those that do not turn off continue upstream on the Columbia and cross Rocky Reach Dam. The count at Rocky Reach Dam in 2007 of 20,683 is 82.3% of the count at Rock Island Dam. Many of these sockeye are headed upstream through the Okanogan River basin to Lake Osoyoos. Some sockeye also turn off into the Methow River basin.

There is a very small population of sockeye that crosses Ice Harbor Dam into the Snake River system. In 2007, the Ice Harbor Dam count was only 0.22% of the count at Bonneville Dam. In 2007, the sockeye count of 55 at Ice Harbor Dam was 1.14 times larger than the 2006 count of 48 and 1.83 times larger than the 10-year average count of 30. The small population of sockeye within the Snake River are most likely adults that are part of recovery efforts taking place in the upper Salmon River basin in Red Fish, Alturas, and Pettit Lakes (WCSBRT, 2003).

6. Steelhead

Biology and Watershed Distribution

There are two types of steelhead, summer and winter. Adult summer steelhead migrate into freshwater from late spring to early fall and spawn in winter or early spring. Spawners can be a variety of ages. Adult winter steelhead return to freshwater from late fall to late winter and spawn in late winter or early spring. Spawners can be of mixed age (Fitzpatrick, 1999). Steelhead do not necessarily die after spawning and are able to spawn more than once (PSMFC, 2007). They are distributed throughout the Lower Columbia, Willamette, Yakima, Deschutes, John Day, Middle Columbia, Upper Columbia, Lower Snake, Clearwater, and Salmon basins (Map 7 Appendix J). Steelhead tend to spawn in the headwaters of streams and rivers.

The summer steelhead run is made up of two components. A-run steelhead pass Bonneville Dam from the first of June through August 25 and B-run steelhead pass Bonneville from August 26 through October. These fish spawn the following spring, so they over winter in the rivers in various points along their migration route. Summer

migrate upstream during the time of year when water temperatures are increasing and reaching their highest point. Steelhead traveling upstream seek out cooler water refuges, such as the Deschutes River, the White Salmon, the Klickitat, the John Day and the Wind rivers. Studies have shown that 61% of steelhead passing Bonneville will stage one or more times in these cooler water refuges as they migrate upstream to their spawning areas, resulting in long upstream migration timing.

Temporal Patterns in Adult migration season

In addition to the regional steelhead distribution, there are temporal patterns in adult migration seasons that are evident from year to year. The 2007 steelhead adult migration at Bonneville had two major peaks during the season which differed from the 2005, 2006, and 10 year average migrations (Figure 33). The 60% to 90% cumulative proportion passage dates of the 2007 adult migration run occurred much earlier in the summer than other years, including the 10 year average (Figure 34). Table 38 provides the 1% and 90% passage dates of the steelhead passing Bonneville Dam in 2007. It also provides an estimate of the duration of the adult migration. Table 38 shows that the run duration in 2007 (149) was longer than in 2006 by 7 days and was longer than in 2005 by 14 days. However, the 2007 run duration was shorter than the 10 year average (156 days) by 7 days.

Figure 35. Steelhead Dam Count by Date at Bonneville Dam

Figure 36. Steelhead Cumulative Proportion Dam Count by Date at Bonneville Dam

Table 44. Steelhead cumulative proportion dates and run duration

Steelhead 1% and 90% Passage Dates			
Year	1%	90%	Duration (days)
2007	20-Apr	16-Sep	149
2006	2-May	21-Sep	142
2005	15-May	27-Sep	135
2004	7-Apr	21-Sep	167
2003	9-Apr	17-Sep	161
2002	13-Apr	22-Sep	162
2001	5-May	18-Sep	136
10 Year Avg	18-Apr	21-Sep	156

In 2007 the steelhead count at Bonneville Dam of 320,931 was 96.3% of the 2006 count and 95.6% 10 year average count. Wild steelhead declined by 3.5% or 2,937 fish between 2007 (80,953) and 2006 (83,890). The 2007 wild steelhead count 92.5% of the 10 year average count.

At most of the dams, except Bonneville Dam and Willamette Falls Dam, the adult steelhead counts increased when compared to the 2006 counts. Additionally, at most of the dams in the Snake River and Mid-Columbia River zones, the 2007 counts were higher than the 10 year average counts, with the exception of Wells Dam.

Summer Steelhead A and B Runs 2007 counts

The 2007 count of A run summer steelhead was 227,398 at Bonneville Dam. It increased 1.30 times when compared to the 2006 count of 174,730. The 2007 count of B run summer steelhead at Bonneville Dam of 89,311 was 58.6% of the 2006 count of 151,738.

Counts at other dams and tributary turnoffs

By evaluating Map 7 in Appendix J, one can see that steelhead move throughout many rivers and streams in the CRB. The 2007 count of 241,898 at The Dalles Dam was 75.3% of the Bonneville Dam count. Tributary turn offs, harvest, fall back, and adult mortality are some of the causes of reduction in the number of fish seen at each successive dam upstream. Some of the turn offs between Bonneville Dam and The Dalles Dam include the Hood River, White Salmon River, Klickitat River, Mill Creek and Fifteen Mile Creek.

Some steelhead stay in the Lower Columbia basin to spawn. Steelhead distribution in the Lower Columbia basin includes Grays River, Elochoman River, Lewis and Clark River, Youngs River, Clatskanie River, Lewis River, Multnomah Channel, and Salmon Creek. Steelhead are also distributed in the Willamette River basin. Steelhead distribution in the Willamette basin includes the Willamette River, Tualatin River, Yamhill River, Pudding River, Molalla River, Clackamas River, and the tributaries of these rivers (Map 7, Appendix J).

Between The Dalles Dam and John Day Dam some steelhead turn off into the Deschutes River. There are also many turn offs between John Day Dam and McNary Dam including John Day River, Rock Creek, Wood Creek, Umatilla River, and the tributaries of these waters. The count at John Day in 2007 was 227,112, 70.7% of the Bonneville count. The count at McNary Dam in 2007 was 208,788, an increase of 1.13 times when compared to the 2006 count. After McNary Dam some steelhead turn off into the Walla Walla or Yakima rivers and their tributaries. Some steelhead continue up the Columbia over Priest Rapids Dam. The 2007 count of 15,183 at Priest Rapids Dam was only 7.2% of the 2007 McNary Dam count. The 2007 Priest Rapids steelhead count increased 1.45 times when compared to the 2006 count and increased 1.09 times when compared to the 10 year average.

Many steelhead cross Ice Harbor Dam into the Snake River basin. The 2007 Ice Harbor Dam count was 47.8% of the count at Bonneville Dam. The 2007 count at Ice Harbor Dam of 153,619 increased 1.24 times compared to the 2006 count and increased 1.05 times when compared to the 10 year average. Between Ice Harbor and Lower Granite Dam some steelhead turn off into the Tucannon River system. The 2007 count at Lower Granite Dam of 157,214 increased 1.07 times when compared to the 2006 count and increased 1.07 when compared to the 10-year average count of 146,214. The Lower

Granite count was 48.9% of the Bonneville Dam count, illustrating that a large population of Steelhead spawns in the Lower Snake, Clearwater, and Salmon basins. Some of the rivers the steelhead are distributed in these basins are the Snake, Clearwater, Salmon, Potlach, Grand Ronde and the many tributaries of these rivers.

Data Requests regarding adult steelhead migration and returns

This section of the report summarizes data requests regarding adult passage and return issues by species type. In January of 2007 FPC received a data request to analyze the associations between upstream migration success and smolt outmigration history for returning adult Snake River origin hatchery and wild summer steelhead. It was found that returning adults that were transported as juveniles were significantly less successful at homing to their natal basin (i.e., above LGR) than those with inriver outmigration histories. This differential included losses due to straying, harvest and other agents of mortality. Transported adult steelhead returned to BON slightly later and took a significantly longer time to complete their migration from BON to LGR than did inriver fish. Although the analysis demonstrated a clear effect of juvenile outmigration history on the homing success of both hatchery and wild adult summer steelhead, some limitations/caveats are worth noting: i) because adult detection capabilities are absent from most tributaries receiving strays, our stray estimate likely underestimates the actual stray; ii) too few above LGR tags were available for a race-level (A vs B) delineation of transportation effects.

7. Pink and Chum Salmon

Pink and chum salmon also return to the Columbia River Basin. In 2007, 27 pink salmon crossed Bonneville Dam an increase of 21 fish compared to the 2006 count of 6 pink salmon. In 2007, 95 chum crossed Bonneville Dam which was 26 fewer fish than the 2006 count of 121.

Historically, chum had the widest distribution of all Pacific Salmon species (Uusitalo, 2002). Today, chum are found in the CRB primarily in tributaries downstream of Bonneville Dam. Chum spawning occurs in Grays River, Hamilton Springs, Hardy Creek, Pierce/Ives Island Complex and at Wood's Landing (located just upstream of the Interstate 205 bridge on the Washington shore of the Columbia River) (USFWS, ODGW, WDFW, 2000; Uusitalo, 2002). The Ives Island complex is one of the few remaining mainstem spawning areas for chum. In March 2000, a joint study by U.S. Fish and Wildlife, Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife looked at the effects of flow on Chinook spawning below Bonneville Dam. It was found that Bonneville Dam flow level determines the amount of spawning habitat available to these fish at the Ives Island site and that flow level and fluctuating flow can eliminate spawning habitat, dewater redds and strand emerging juvenile salmon (USFWS, ODGW, WDFW, 2000).

J. Long-range Bonneville Adult Dam Counts

Adult dam counts have occurred at Bonneville Dam since 1938. Comparisons with historical Bonneville counts should be considered cautiously since in-river, ocean sports, and commercial fisheries have been seriously curtailed and upstream hatchery and natural production has significantly changed (FPC, 2004). Figure 35 shows adult dam counts at Bonneville for each salmon species, since 1977.

There was a large increase in the spring Chinook adult counts in 2001-2002. The total spring Chinook count declined in 2002, 2003, 2004 and 2005. However, the spring Chinook count increased between 2005 and 2006, but again declined between 2006 and 2007. Historically, for summer Chinook at Bonneville Dam, there was a large increase in the counts between 2001 and 2002. Between 2003 and 2005 the summer Chinook counts declined, in 2006 the adult summer Chinook count at Bonneville Dam increased, and in 2007 the summer Chinook count again declined. There was a large increase in fall Chinook counts between 2002 and 2003. Between 2005 and 2007 fall Chinook counts steadily decreased. In 2001, there was a large increase in the coho dam count at Bonneville Dam. In 2002 the coho count decreased, followed by similar counts from 2003 to 2007. There was a slight decline in the 2005 coho count with a rebound in 2006 and another small decline in 2007. The sockeye count at Bonneville Dam peaked in 2004 and declined in 2005, 2006, and 2007. Steelhead counts at Bonneville Dam reached a peak in 2001, declined through 2004, and increased in 2005 and 2006. In 2007 there was a slight decline in the steelhead count at Bonneville Dam (Figure 35).

Figure 37. Historic Bonneville counts graph

Figure 37. Historic Bonneville counts graph

Figure 37. Historic Bonneville counts graph

K. SUMMARY

- The Snake and Columbia rivers ended the water year with slightly above normal water supply. Water temperatures were below 20°C through the early summer but rose to 20°C at times in July through September.
- Various hazing methods, including boat-based and dam-based deterrents, continued to be used to discourage the sea lions at Bonneville Dam from preying on salmon. In addition, sea lions were transported to the coast and released. The hazing efforts proved to be unsuccessful and the transported sea lions all returned to the dam within 2 weeks.
- All fishways were found to be in satisfactory condition in 2007.

SPRING CHINOOK:

- The total spring Chinook count at Bonneville for 2007 was 67,482 adults which was about 69.9% of the 2006 run. The 2007 adult spring Chinook count at Bonneville Dam was only 43.2% of the 10-year average. The 2007 adult migration season began earlier than the 2006 and 2005 seasons; however, it began later than the 10-year average. Although the 2007 adult spring Chinook count was low, the 2007 spring Chinook jack count at Bonneville Dam of 16,860 was about 5.79 times greater than the 2006 spring Chinook jack count of 2,908 and about 2.04 times larger than the 10-year average at Bonneville Dam. In the Snake River, the spring Chinook adult count at Lower Granite Dam in 2007 was 22,905. The 2007 count had 375 more salmon than the 2006 count and was only 44.3% of the 10-year average. The 2007 spring Chinook jack count at Lower Granite Dam of 9,085 was 9.33 times greater than the 2006 count and 2.76 times greater than the 10-year average. Since there was such a high count of spring Chinook jacks in 2007, the TAC forecasted that 269,300 upriver spring Chinook adults would return in 2008.

SUMMER CHINOOK:

- In 2007, a total of 47,412 summer Chinook passed Bonneville Dam which was 48.6% of the 2006 count and 68.3% of the 10-year average. Although the adult count decreased between 2006 and 2007, the jack count increased, as it did for the spring Chinook. The 2007 summer Chinook jack count at Bonneville Dam of 13,539 increased by 3.1 times when compared to the 2006 count and increased by about 1.7 times when compared to the 10 year average. The Summer Chinook counts decreased at all dams between 2006 and 2007 except at two of the Snake River projects, Lower Monumental Dam and Lower Granite Dam. The jack counts increased at all projects between 2006 and 2007. At Lower Granite Dam, the 2007 count of adult summer Chinook of 7,312 increased by 254 salmon when compared to the 2006 count and was about 75.5% of the 10-year average count. The 2007 jack summer Chinook count at LGR of 3,285 was 4.96 times greater than the 2006 count and was 1.67 times greater than the 10-year average.

FALL CHINOOK:

- In 2007, the run duration for adult fall Chinook was similar to the 2006 duration. The 2007 run duration was 1.22 times or 8 days longer than that seen in the 10-year average. The 2007 fall Chinook count at Bonneville Dam of 159,427 was only 53.3% of the 2006 count and about 44% of the 10-year average. The 2007 fall Chinook jack count of 52,655 was higher than the 2006 count of 25,549 by 2.06 times and it increased 1.39 times when compared to the 10-year average. In 2007, the count at Lower Granite Dam of 10,167 increased 1.26 times compared to the 2006 count. The 2007 LGR fall Chinook count increased by 1.31 times when compared to the 10-year average count. In addition to the higher adult counts, the 2007 LGR jack count of 9,776 was 1.45 times higher than the 2006 count and 1.89 times higher than the 10 year average at LGR.

COHO:

- The 2007 coho count at Bonneville Dam of 91,994 decreased about 5% compared to the 10-year average count and decreased about 9% compared to the 2006 count. The 2007 Bonneville coho jack count of 4,064 was 51.3% of the 2006 count and 65.3% to the 10-year average. The adult coho count at McNary Dam in 2007 of 20,217 increased 1.66 times when compared to the 2006 count. Additionally, the count increased by 1.73 times when compared to the 10-year average. The 2007 count at Lower Granite Dam of 2,532 increased by 2.21 times compared to the 2006 count and increased by 2.47 times compared to the 10 year average.

SOCKEYE:

- The 2007 adult sockeye count at Bonneville Dam of 24,376 decreased by 34.2% when compared to the 2006 count of 37,066 and it decreased by 59.9% when compared to the 10-year average of 60,817. The 2007 adult sockeye count at Lower Granite Dam of 52 increased 3.06 times when compared to the 2006 count and increased 1.44 times compared to the 10-year average.

STEELHEAD:

- In 2007, the steelhead count at Bonneville Dam of 320,931 was 96.3% of the 2006 count and 95.6% 10-year average count. Wild steelhead declined by 3.5% or 2,937 fish between 2007 (80,953) and 2006 (83,890). The 2007 count of A run summer steelhead was 227,398 at Bonneville Dam. It increased 1.30 times when compared to the 2006 count of 174,730. The 2007 count of B run summer steelhead at Bonneville Dam of 89,311 was 58.8% of the 2006 count of 151,738. The 2007 adult steelhead count at Lower Granite Dam of 157,214 increased 1.07 times when compared to the 2006 count and increased 1.07 when compared to the 10-year average count of 146,214.

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V. 2007 Columbia River Basin Hatchery Releases

A. General Overview

The Fish Passage Center (FPC) maintains a hatchery database of anadromous salmon species released from State, Federal, and Tribal hatcheries in the Columbia River Basin. This database contains numbers of hatchery fish released above Bonneville Dam since 1979 and released below Bonneville Dam since 1987. The FPC database was upgraded to also facilitate its use for Artificial Production Review and Evaluation (APRE) and Hatchery Genetic Management Plan (HGMP) purposes. For hatcheries releasing fish into the Columbia River Basin, 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 initially entered in the FPC database and 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.

Hatchery release schedules are available on the FPC website (http://www.fpc.org/hatchery/Hatchery_Queries.html) and are used for various purposes throughout the Columbia River Basin. Explanation of the fields/columns in this database can be found in the FPC hatchery Metadata website. These schedules provide Salmon Managers with hatchery release information for assessing that year's migration of juvenile hatchery fish through the hydrosystem. Salmon Managers may use these data to inform in-season passage management decisions. Furthermore, from March to November, FPC staff use these data to compile a portion of their weekly reports, which provide a list of all hatchery releases (above Bonneville Dam) two weeks prior and two weeks after the date of the report. FPC staff also use these data to fill more specific data requests regarding present and historical production releases, timing and magnitude of runs, in-season population estimates, proportion of hatchery fish that are tagged or clipped, etc. Projects that are currently under the Smolt Monitoring Project (SMP) also rely on these data in the preparation of their weekly and annual reports, particularly when it comes to identifying potential sources of Coded Wire Tagged (CWT) or Elastomer Tagged fish that are released above and collected by the project

This report focuses primarily on releases of yearling and sub-yearling anadromous salmonids in the Lower Columbia, Mid-Columbia, and Snake River zones. These release schedules do not include eggs that might be placed in egg boxes or planted in the gravel of Columbia River streams, fry releases, or releases of mature adults back to their natal streams. However, a brief overview of these types of releases for migration year 2007 will be discussed at the end of this report. Also fish that fall in the category of "non-

anadromous” by the fish managers are not included in the FPC hatchery release schedule (e.g., subyearling summer Chinook released in Lake Chelan, since these fish normally do not migrate from the lake).

In 2007, about 81.2 million juvenile salmon were released from Federal, State, Tribal or private hatcheries into the Columbia River Basin above Bonneville Dam. Table 45 provides hatchery release totals for three river zones: Snake River, Mid-Columbia River, and Lower Columbia River. Although the 2007 hatchery release total was about 840,000 above what was seen in 2006, it is still the second lowest release total since 2001. In 2007, about 55.3 million juvenile salmon were released into the Columbia River Basin below Bonneville Dam. An additional 1.15 million anadromous salmonid fry (38,940 summer steelhead, 198,841 winter steelhead, and 911,000 Coho) were released into the Columbia River Basin below Bonneville Dam in 2006. Since they were released as fry in 2006, they were expected to out-migrate in 2007. The majority of these fry releases were conducted by Washington Department of Fish and Wildlife (WDFW), as part of their COOP program. Since these hatchery salmonids do not pass through the Columbia River Basin hydrosystem, we do not discuss their release schedules in this report.

Table 45. Hatchery release totals by River Zone: Snake River, Mid-Columbia River (above McNary Dam) and Lower Columbia River (Bonneville Dam to McNary Dam) for migration year 2007.

Race/Species	2007 Hatchery Releases by Zone			
	Snake River	Mid-Columbia	Lower Columbia	Total Release
Fall Chinook	3,416,839	11,991,364	22,934,581	38,342,784
Spring Chinook	8,396,059	4,220,133	4,665,095	17,281,287
Summer Chinook	2,195,135	3,007,264	---	5,202,399
Coho	1,182,208	2,461,981	4,984,904	8,629,093
Sockeye	208,968	140,542	---	349,510
Summer Steelhead	9,414,395	1,403,489	541,193	11,359,077
Winter Steelhead	---	---	62,358	62,358
Total	24,813,604	23,224,773	33,188,131	81,226,508

The 2007 Hatchery Release Schedule (Appendix G) lists the agency, hatchery, and release numbers along with other pertinent data such as mark groups, number per pound, date of release, release site, and river zone. The 2007 Release Schedule and prior years (as far back as 1979) can also be accessed at the FPC Website (http://www.fpc.org/hatchery/Hatchery_Queries.html). Table 45 to Table 49 list the hatchery release totals from 1979 through 2007 for the Lower Columbia, Mid-Columbia, and Snake River zones, respectively.

Results of hatchery releases for migration year 2007 are presented in each River

Zone section with some highlights listed below. Figure 36 provides a time series (1979 to 2007) of release totals for each of the six species that have been released above Bonneville Dam.

1. There was an overall increase in hatchery fall Chinook production in 2007 compared to 2006. However, this increase is due to higher release totals in the Mid and Lower Columbia Zones, compared to 2006. Fall Chinook releases to the Snake River Zone decreased in 2007 by approximately 1.27 million, compared to 2006. This is mostly due to insufficient adult returns and egg take in 2006.
2. Hatchery spring Chinook production continued to decrease in 2007. The spring Chinook production in 2007 represented a 10.5% decrease over that seen in 2006. The majority of the decrease in spring Chinook production occurred in the Snake River Zone.
3. There was a slight decrease in hatchery summer Chinook production in 2007 compared to 2006. However, hatchery summer Chinook production levels have remained consistent over the past 6 years.
4. Hatchery coho production levels continued to increase in 2007. In fact, all three release zones above Bonneville Dam experienced increases in coho production in 2007, compared to 2006. Although coho production has been increasing over the past three years, these production levels are not quite where they were prior to 2004.
5. There was a slight increase in sockeye production levels in 2007 compared to 2006. This overall increase in sockeye production is due to a 32% increase in sockeye production in the Snake River Zone over than seen in 2006. There was an 18% decrease in sockeye production in the Mid-Columbia Zone compared to 2006.
6. Due to increased production of summer steelhead in the Snake and Lower Columbia Zones and winter steelhead in the Lower Columbia Zone, 2007 hatchery steelhead releases increased by 71,429 over that seen in 2006 (Figure 38). The Snake River Zone continued to account for over 80% of the total Columbia River basin-wide steelhead production (above Bonneville Dam).

Figure 38. Total production releases in Columbia River Basin (above Bonneville Dam) for migration years 1979 to 2007.

B. Lower Columbia River Zone

In the FPC database, the Lower Columbia River Zone is designated as the area from Bonneville Dam to McNary Dam. This zone had a total of 33.2 million juvenile salmonids released from the different hatcheries for migration year 2007, which accounts for approximately 41% of all hatchery fish released above Bonneville Dam (Table 46). Approximately 69.1% of the total release in the Lower Columbia River Zone (22.9 million fish) were fall Chinook consisting of upriver Bright and Tule stocks.

In all, over 22.9 million fall Chinook juveniles were released in this zone in migration year 2007. Of these, about 15.5 million were subyearling fall Chinook Tules that were released from Spring Creek NFH in March, April, and May. There were two releases in March which accounted for over 50% of the total release from Spring Creek NFH. Both of these releases took place prior to spring spill operations at Bonneville Dam and, thus, the only non-powerhouse route of passage for these releases was through the corner collector. However, spill was provided at Bonneville Dam during the April and May releases from Spring Creek NFH. In addition, nearly 4.36 million subyearling fall Chinook juveniles were released into the Klickitat River. Of these, approximately 86% were unmarked. Approximately, 2.06 million fall Chinook subyearlings were released into the Little White Salmon River in June. All of these releases took place in tributaries that empty into the Columbia River below The Dalles Dam. The only releases of fall Chinook juveniles to this zone that took place above The Dalles Dam were releases to the Umatilla River, which empties into the Columbia River below McNary Dam. In all, just over 1.04 million fall Chinook juveniles were released on the Umatilla River in

migration year 2007. Of these, approximately 41% were yearling fall Chinook that were released in March and April. The remaining 59% were subyearling fall Chinook that were released in mid-May.

The 2007 hatchery releases of subyearling and yearling spring Chinook in the Lower Columbia River Zone totaled about 4.7 million fish. The total release in 2007 is approximately 4.5% lower than that seen in 2006, which was the lowest total release of spring Chinook in this zone since 1997 (Table 46). This production level was 10.5% larger than that seen in the Mid-Columbia River Zone; however, it was only 55.6% of the Snake River Zone release total. Approximately 81% of all the spring Chinook juveniles released into the Lower Columbia Zone were released into Columbia River tributaries that meet the Columbia River between John Day and Bonneville Dams. These tributaries include the Deschutes, Hood, Wind, Little White Salmon, and Klickitat rivers. The remaining 19% were released from the Imeques acclimation ponds on the Umatilla River, which empties into the Columbia River below McNary Dam. Of the total release of spring Chinook, 20,830 were subyearling spring Chinook that were released from the Klickitat Hatchery into the upper Klickitat River in July 2007.

Nearly 5 million coho juveniles were released into the Lower Columbia River Zone in migration year 2007. The vast majority (75.8%) of these coho juveniles were unmarked. This release total continues to be lower than what has typically taken place over the past twenty years. In fact, with exception to 2006, 2007 coho releases to this zone were the lowest seen since 1985. Approximately 30% of the coho released into this zone were acclimated at the Pendleton acclimation ponds on the Umatilla River. However, all of these coho were reared at hatcheries near Bonneville Dam and transferred to these sites for acclimation and release. The remaining 70% were type-N coho that were released into the Klickitat River. A large portion (69%) of the coho released into the Klickitat River were reared at Washougal Hatchery, below Bonneville Dam, and transferred to this zone for release.

Releases of both summer and winter steelhead are conducted in this zone. In 2007, 603,551 steelhead juveniles were released into this zone. This release total is larger than that seen in 2006 and more comparable to the releases in more recent years. Approximately 90% of the steelhead released to this zone were summer steelhead. Most (67%) of the summer steelhead released to this zone are released into Columbia River tributaries that meet the Columbia River between Bonneville and John Day dams. However, about 33% of the summer steelhead were released into the Umatilla River, which meets the Columbia River below McNary Dam but above John Day Dam. Summer steelhead releases to this zone continue to remain steady over the past decade. A total of 62,358 winter steelhead were released into this zone in 2007. Of these, approximately 62% were released into Hood River, while the remaining 38% were released into the White Salmon River. This was the second lowest release of winter-run steelhead in this zone since 1992.

Table 46. Lower Columbia River Zone hatchery releases, 1979 – 2007.

Year	2007 Lower Columbia Hatchery Releases						
	Spr Chinook	Sum Chinook	Fall Chinook	Steelhead	Coho	Sockeye	Totals
1979	3,491,456	110,500	40,975,000	462,722	3,288,000	0	48,327,678
1980	5,828,561	0	31,896,000	816,084	5,495,500	0	44,036,145
1981	6,044,500	0	35,936,500	609,500	4,391,500	0	46,982,000
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
2002	5,748,143	0	26,343,158	620,529	6,069,435	0	38,781,265
2003	5,441,505	0	25,531,102	585,608	5,732,260	0	37,290,475
2004	5,272,710	0	21,996,183	580,439	6,017,123	0	33,866,455
2005	5,150,955	0	21,568,089	642,562	5,149,621	0	32,511,227
2006	4,882,521	0	22,687,698	536,123	4,840,612	0	32,946,954
2007	4,665,095	0	22,934,581	603,551	4,984,904	0	33,188,131

C. Mid-Columbia River Zone

The Mid-Columbia River Zone encompasses the area from above McNary Dam to Chief Joseph Dam. In 2007, just over 23.2 million juvenile salmonids were released in this zone (Table 47). Hatchery releases of juvenile summer and fall Chinook, steelhead, and coho continue to remain relatively stable since 1996. For the third year in a row, the total release of spring Chinook in 2007 was above 4 million juveniles.

Production releases of juvenile fall Chinook (up-river Bright stock) totaled nearly 12.0 million juveniles. Fall Chinook released in this zone are released as subyearlings to the Yakima and Mid-Columbia rivers. In all, just over 10.1 million subyearling fall Chinook were released into the Mid-Columbia River by WDFW from Priest Rapids (66%) and Ringold (34%) hatcheries. Unlike 2006, there were no outbreaks of disease at Ringold hatchery, which allowed for release goals to be met in 2007. The Yakama Tribe

released about 1.85 million subyearling fall Chinook juveniles into the Yakima River in 2007. Nearly all of the subyearling fall Chinook released into this zone in 2007 were unmarked and untagged. Hatchery fall Chinook comprised about 51.6% of the total fish released in this zone.

Just over 3.0 million summer Chinook salmon were released from hatcheries, acclimation ponds, or directly into streams and tributaries located in the Mid-Columbia Zone. Of the summer Chinook released into the Mid-Columbia Zone, approximately 52% were reared until yearling age (about 18 months) and released during the spring. These yearling summer Chinook juveniles were released into the Wenatchee (37%), Mid-Columbia (31%), Okanogan (16%), and Methow (15%) rivers. The “wild” summer Chinook from this zone migrate as subyearlings. Nearly 1.28 million of the summer Chinook juveniles released in this zone were released as subyearlings in May through July. A fairly large portion (39.5%) of the subyearling summer Chinook were released unmarked and untagged. All of the subyearlings released in this zone were released into the Mid-Columbia River. This year’s release of summer Chinook is comparable to that seen over the previous 27 years.

In 2007, Mid-Columbia hatcheries released just over 4.22 million yearling spring Chinook, a slight increase over that seen in 2006. Normal production of spring Chinook continued in the Methow, Entiat, and Wenatchee rivers and their tributaries this season. Cumulatively, releases to these three rivers accounted for approximately 74% of the total yearling spring Chinook released into the Mid-Columbia River Zone. The Yakama Tribe released approximately 860,000 juvenile spring Chinook from their acclimation facilities located in the Yakima River basin. All of these juveniles were marked with red, green, or yellow Elastomer tags prior to release. As with 2006, releases of hatchery spring Chinook continued in the Walla Walla River basin, with a release of 249,186 juveniles in April.

Production releases of coho salmon from Mid-Columbia acclimation ponds and hatcheries were approximately 2.46 million fish in 2007. This was the highest level of production of coho in this zone ever (Table 47). However, there have been a few recent years of production that were close to this level (e.g., 2001, 2004, and 2006). Approximately 83% of all the juvenile coho salmon released in this zone were originally transferred from hatcheries located below or slightly above Bonneville Dam. The coho releases in the Mid-Columbia River Zone are part of the Yakama Tribal Program to re-establish coho runs in the Yakima, Methow and Wenatchee River basins. Of the 2.46 million coho released into the Mid-Columbia zone in 2007, approximately 44% were released in the Wenatchee River Basin, 36% were released in the Yakima River Basin, and 14% were released into the Methow River Basin. The remaining 16% of the coho released in this zone were released directly into the Mid-Columbia River at Wells Hatchery.

A total of 140,542 juvenile sockeye salmon were released from net pens located in Lake Wenatchee in late October 2006. The majority of these fish were expected to reside in the lake through the winter and migrate from the lake in spring of 2007. The Wenatchee sockeye were 100% adipose clipped and coded-wire tagged.

Hatchery production of juvenile steelhead in this zone had remained stable over the past 15 years, averaging around 1.4 million per year. The 2007 release was the second largest release of summer steelhead to this zone since 1999. Of the 2007 release total for steelhead, 31.8% were released into the Methow River, with the remainder being released in the Okanogan (11.0%), Walla Walla (7.0%), Wenatchee (21.4%), Mid-Columbia Rivers (18.4%), and Touchet (10.4%) rivers. There continued to be no hatchery-produced steelhead released into the Yakima River.

Table 47 Mid-Columbia River Zone hatchery releases, 1979 – 2007.

Year	2007 Mid-Columbia Hatchery Releases						
	Spr Chinook	Sum 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	4,954,855	2,977,364	11,870,800	1,726,741	1,486,500	210,591	23,226,851
2000	3,926,812	2,853,950	12,293,934	1,396,898	1,662,994	142,901	22,277,489
2001	3,351,699	4,324,169	11,976,344	1,291,813	2,151,318	241,216	23,336,559
2002	3,815,814	3,520,683	10,913,482	1,312,693	1,911,684	308,042	21,782,398
2003	3,538,365	3,001,618	12,255,089	1,289,063	1,876,158	208,986	22,169,279
2004	3,973,904	3,331,738	12,183,684	1,184,775	2,387,222	315,790	23,377,113
2005	5,158,795	3,363,640	11,749,112	1,209,657	1,868,096	592,459	23,941,759
2006	4,196,800	2,948,297	8,880,693	1,556,020	2,382,403	172,923	20,137,136
2007	4,220,133	3,007,264	11,991,364	1,403,489	2,461,981	140,542	23,224,773

D. Snake River Zone

The Snake River Zone encompasses the Snake River and its tributaries from its confluence with the Columbia River to Hells Canyon Dam. The total release of salmon species in the Snake River basin was approximately 24.8 million for the 2007 migration season (Table 49). This is the lowest total release of anadromous salmon species to this zone since 2001. Most of this reduction was due to lower release totals for both spring and fall runs of Snake River Chinook. Release totals for summer Chinook, steelhead, and sockeye remained similar to recent years, while the total release for coho was the higher than the most recent years.

In migration year 2007, the production of hatchery spring Chinook in the Snake River Zone totaled nearly 8.4 million. This was the lowest total release of spring Chinook for this zone since 2001. Approximately 39% of the spring Chinook that were released into the Snake River Zone were released into the Clearwater River or its tributaries. Of these, approximately 51% were reared at IDFG's Clearwater Hatchery and 46% were reared at Kooskia and Dworshak NFH. The remaining 3% were reared at the Nez Perce Tribal Hatchery. Approximately 43% of the total spring Chinook release were released into Little Salmon or Salmon Rivers. The remaining 17% of the spring Chinook releases in this zone were released in the Snake (Hells Canyon area), Grande Ronde, Tucannon, Imnaha, and Wallowa rivers. The majority of the spring Chinook released into the Snake River zone were released as yearlings in 2007. However, a very small portion (1%) of the spring Chinook released into the Snake River Zone for migration year 2007 were released as parr or pre-smolts in the summer and fall of 2006. As in prior years, most hatchery spring Chinook were distinguishable in 2007 based on an adipose fin clip and/or a coded-wire tag. A portion of the hatchery production of spring Chinook from IDFG, ODFW and WDFW hatcheries remain listed as "threatened" under the ESA. Captive brood stock releases of juvenile salmon continued at some of these State hatcheries.

Nearly 2.2 million juvenile summer Chinook were released from McCall and Pahsimeroi hatcheries in March and April 2007. This production level was slightly lower than recent years but consistent with levels since 2003. The McCall Hatchery releases made up about 55% of the total summer Chinook release for 2007. Both of the releases of McCall summer Chinook took place on the South Fork of the Salmon River. The remaining 45% of the summer Chinook were reared at the Pahsimeroi Hatchery and released into the Pahsimeroi River. All summer Chinook released in this zone were adipose clipped and/or marked with a coded-wire tag or Elastomer tag.

Only 3.4 million hatchery fall Chinook were released to the Snake River Zone in 2007. This represents a 27.1% decrease over that seen in migration year 2006. Approximately 28% of the fall Chinook released in the Snake River Zone were released as yearlings from Lyons Ferry Hatchery and acclimation facilities at Pittsburg Landing

and Captain John Rapids in the Snake River, and Big Canyon Creek in the Clearwater River. The release total of yearling fall Chinook in 2007 was similar to that seen in 2006. All yearling fall Chinook releases were completed in early to mid-April. The remaining 72% of the hatchery fall Chinook released in the Snake River Zone were released as subyearlings. In all, nearly 2.5 million subyearling fall Chinook were released into the Snake River Zone in 2007. This release total represents a 35.6% decrease over that seen in 2006 and is due, in large part, to the low adult returns and low egg take in 2006. Subyearling fall Chinook releases to the Snake River zone, above Lower Granite Dam, continued from the Captain John Rapids, Big Canyon Creek, and Pittsburg Landing acclimation ponds, as well as direct stream releases below Hells Canyon Dam, and Nez Perce Tribal Hatchery releases into the Clearwater River. Approximately 8.2% of the subyearling fall Chinook released in this zone were released from Lyons Ferry Hatchery, below Lower Granite Dam. Due to the low egg count, there were no releases of subyearling fall Chinook to the Grande Ronde River. Furthermore, there were no releases of fall Chinook surrogates in 2007.

The migration year 2007 releases of subyearling fall Chinook to the Snake River above Lower Granite Dam continue to follow the trend of occurring earlier than past years (Table 48). For example 1995 and 1996 had releases ending well into July and August. However, over the last 4 years all releases have ended by June 21. In addition to earlier releases, there has also been a decrease in the time span of releases. This indicates that long volitional hatchery releases have become less common, while shorter release spans are the norm in more recent years. As with Snake River releases of subyearling Chinook, releases into the Clearwater River have changed from longer volitional releases (1996-1998) to shorter releases (1999-2007; Table 48).

Table 48. Snake and Clearwater River subyearling Chinook release dates and release time spans from 1995-2007.

Migration Year	Snake River Releases				Clearwater River Releases			
	PLAP	CJRAP	HCD	GRR	BCCAP	NPTH	CLWR	LAPW
1995	5/18-8/17							
1996	6/6-7/10						6/6-7/10	
1997	5/28-7/8				6/3-7/8 6/10-6/13			
1998	5/14-7/7				6/2-7/8			
1999		5/30-6/5			6/2-6/3			
2000	5/24-5/26	5/20-5/31 6/15-6/23			5/30-6/1 6/20-6/26			
2001	5/28 6/1-7/6	5/26	5/16-6/19		5/29 5/29-7/4 6/13			
2002	5/27-5/29	5/28 6/20	5/21		5/27-5/28 6/18-6/19			
2003	6/4	5/28 6/9-6/16 6/12	5/1-5/16 5/22		6/3 6/19-6/21	6/3-6/5		5/28-5/31
2004	5/24 5/31	5/26-6/1	5/28		5/31-6/3	6/4-6/11		
2005	5/23-5/24	5/16-5/30 5/23 5/23-5/27 5/26	4/28 5/13	5/24-5/25	5/30-5/31 6/21-7/8	5/7		
2006	5/24	5/15-6/2 5/26-5/29 5/30	5/2 5/8-5/10	6/19-6/21	5/25-5/26 6/19-7/9	6/8-6/15	6/13 6/13	5/17
2007	5/26	5/29	5/8		5/28-5/29	6/11-6/15	6/4 6/11	5/22-5/23

PLAP – Pittsburg Landing Acclimation Pond

CJRAP – Captain Johns Rapids Acclimation Pond

HCD – Hells Canyon Dam

GRR – Grande Ronde River

BCCAP – Big Canyon Creek Acclimation Pond

NPTH – Nez Perce Tribal Hatchery

CLWR – Clearwater River

LAPW – Lapwai River

Approximately 33% of the subyearling and yearling fall Chinook released in the Snake River Zone in 2007 were unmarked and unclipped. Distinguishing hatchery from wild fall Chinook will remain a challenge with both the juvenile migrants and returning adult fish in future years. Finally, even though 2007 was considered a low flow year, summer spill (June 21 to August 31) was provided at all Snake River projects below Hells Canyon Dam in 2007. This is the third year that releases of subyearling fall Chinook coincided with spill operations at these projects.

Production of juvenile sockeye salmon for the 2007 migration totaled 208,968. This release total is the second largest since 1998 and represents a 32.1% increase over that seen in 2006. Approximately 51% of these sockeye juveniles were released as pre-smolts in Redfish Lake, Pettit Lake, and Lake Alturas in October 2006. These pre-smolts were expected to remain in the lake over the winter and out-migrate in the spring of 2007. The remaining 49% of the sockeye juveniles were released directly into the Salmon River or into Redfish Lake as smolts in May 2007. All of these releases were conducted by Idaho Department of Fish and Game and all released juveniles were marked with adipose fin clips. To complement the hatchery-reared sockeye released each year, efforts continue to allow some adult sockeye to spawn naturally in these lake systems. In addition, egg boxes were used to supplement the production releases. Releases of sockeye eggs and adults in 2007 are further discussed at the end of this chapter.

Nearly 1.2 million juvenile coho salmon were released in the Clearwater River basin in 2007. This release total was the third largest since coho production in the Snake River Zone was initiated in 1998. These coho releases are part of the Nez Perce Tribe's program to re-introduce coho into the Clearwater River basin and are expected to continue in upcoming years. Approximately 27% of these coho were released in August 2006 as presmolts. The remaining 73% were released as smolts in March and April of 2007. Finally, approximately 73% of the coho released to the Snake River Zone for the 2007 migration were unmarked and/or untagged.

Juvenile hatchery steelhead released in the Snake River basin totaled approximately 9.4 million in 2007. Steelhead production levels in the Snake River Zone have been relatively stable over the past 27 years (range: 8.1 to 12.1 million). Steelhead represented approximately 38% of the anadromous salmonids released into the Snake River Zone for migration year 2007. Of the total steelhead released in this zone in 2007, approximately 70% were released into the Clearwater and Salmon River Basins. Of these, approximately 61% were known to be of B-run stock. Several other releases of summer steelhead were conducted either directly into the Snake River or into Snake River tributaries above Lower Granite Dam. These releases include: 1) a release into

the Snake River below Hells Canyon Dam (6%), 2) several releases into the Pahsimeroi River (9%), 3) many releases into the Grande Ronde and Wallowa rivers (10%), and 4) a couple of releases into the Imnaha River (3%). Finally, approximately 3% of the steelhead released in 2007 were released below Lower Granite Dam. These releases took place at the Lyons Ferry Hatchery and into the Tucannon River.

Table 49. Snake River Zone hatchery releases, 1979 – 2007.

Year	2007 Snake River Hatchery Releases						
	Spr Chinook	Sum Chinook	Fall Chinook	Steelhead	Coho	Sockeye	Totals
1979	5,641,235	236,500	0	4,064,095	0	0	9,941,830
1980	5,123,988	0	0	6,328,000	0	0	11,451,988
1981	6,757,307	249,500	0	8,409,500	0	0	15,416,307
1982	3,068,233	122,000	0	9,664,109	209,500	0	13,063,842
1983	5,393,623	198,500	79,000	8,279,500	0	0	13,950,623
1984	7,076,708	356,673	427,191	10,882,598	0	0	18,743,170
1985	8,084,943	781,405	1,317,921	9,437,250	0	210,000	19,831,519
1986	6,314,421	982,443	2,453,010	8,085,953	0	0	17,852,565
1987	10,743,364	1,217,000	1,060,971	8,242,200	0	0	21,263,535
1988	11,230,300	1,777,500	4,981,287	11,726,776	0	0	29,715,863
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	4,248,422	11,149,502	0	0	31,587,073
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	374,982	10,109,372	0	30,973	21,167,858
1996	1,541,127	676,894	629,911	10,461,986	0	84,599	13,394,517
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	335,803	14,837,940
1999	9,310,024	1,574,369	1,835,896	9,841,543	788,358	151,899	23,502,089
2000	5,968,537	1,172,717	3,233,860	9,775,735	797,474	40,419	20,988,742
2001	2,801,460	1,343,943	2,536,218	9,796,039	597,192	86,029	17,160,881
2002	10,206,719	1,676,957	3,665,801	9,509,463	1,089,672	144,838	26,293,450
2003	10,473,825	2,332,578	4,091,468	9,687,941	1,277,246	140,410	28,003,468
2004	10,482,986	2,374,050	2,579,347	9,225,386	1,367,111	76,927	26,105,807
2005	9,440,350	2,348,012	4,907,703	8,887,794	816,300	209,046	26,609,205
2006	10,239,030	2,260,706	4,687,236	9,257,863	698,522	158,160	27,301,517
2007	8,396,059	2,195,135	3,416,839	9,414,395	1,182,208	208,968	24,813,604

E. Egg, Fry, and Adult Releases

1. Lower Columbia Zone:

There were no egg, fry, or adult releases into the Lower Columbia River Zone for migration year 2007.

2. Mid-Columbia Zone:

There were no releases of anadromous salmonid eggs or adults into the Mid-Columbia River Zone in 2007. However, nearly 1.4 million sockeye fry were released by Fisheries and Oceans Canada into Lake Skaha, a tributary of the Okanogan River basin, in May 2006. These fry were released at 302 fish per pound and were expected to rear to smolt size and migrate through Lake Osoyoos and the Okanogan River to the Columbia River in spring of 2007. This group of fish was unclipped but did have otolith and Calcin marks.

3. Snake River Zone:

In November 2007, 51,008 sockeye eyed-eggs were released into Pettit Lake by the Idaho Department of Fish and Game (IDFG). Any juveniles from these eyed-egg releases that survive to the smolt stage are expected to out-migrate in 2009.

In April 2007, Potlatch Pulp and Paperworks released approximately 25,000 coho fry into Orofino Creek, a tributary of the Clearwater River. This release was in partnership with the Nez Perce Tribe. All of these fry were unmarked and were expected to out-migrate as smolts in the spring of 2008.

In September 2007, IDFG released 494 adult sockeye into Redfish Lake. Approximately 73% of these adult sockeye were sourced from a captive broodstock (BY 2004) and raised to maturity at NOAA's Manchester Facility. The remaining 27% were sourced from Eagle Hatchery (BY 2002 and 2003) and transferred to NOAA's Manchester Facility where they were raised to maturity. Adults were released into their natal lakes and allowed to spawn naturally. All adults were PIT-tagged and adipose clipped.

In addition to releasing sockeye adults, IDFG also released 575 adult spring Chinook in July 2007. These adults were all reared at Sawtooth/Eagle Hatcheries and transferred as smolts to NOAA's Manchester Facility where they were raised to maturity in captivity. Only about 3% of these adults were from brood year 2002, where as 42%, 30%, and 25% were from brood years 2003, 2004, and 2005, respectively. Of the 575 adults, 316 were released into the East Fork of the Salmon River (ID), while the remaining 259 were released into the Yankee Fork of the Salmon River (ID). All adults were adipose clipped and PIT-tagged. Furthermore, those adults that were released into the East Fork received green Elastomer tags while those that were released into the Yankee Fork received orange Elastomer tags. Finally, as with the adult sockeye, these adults were allowed to spawn naturally in their natal streams.

APPENDIX A

Memorandums & Other Documents

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MEMORANDUM

TO: Ron Boyce, ODFW
Tony Nigro, ODFW

Michele DeHart

FROM: Michele DeHart

DATE: December 10, 2007

RE: NOAA proposal for Snake River summer spill for fish passage

In response to your request the Fish Passage Center staff reviewed the NOAA proposal for managing summer spill for juvenile fall Chinook passage against the historical fish passage and operations data. We developed the following points from our review of passage and operations data for your consideration. The NOAA proposal is presented without any biological basis. Our overall conclusion is that **the NOAA proposed operation which greatly limits summer spill for fall Chinook is premature until additional data on the benefits of spill to adult returns and wild/natural fish passage is developed. The data collected thus far indicates that spill is beneficial to adult returns.** It is too soon to have a full life cycle return on the first year of spill for fish passage implemented in 2005. However the incomplete results presently available indicate that spill for fall Chinook may be the most beneficial measure implemented in recent years. The NOAA proposal does not capture the full range of actions that has affected fall Chinook and therefore does not address the full range of mitigation measures that that may be required. The NOAA proposal does not recognize the limitations associated with the use of present PIT tag groups to determine timing and survival of wild /natural fall Chinook in particular. A coordinated fall Chinook PIT tagging effort to mark proportionally over hatchery and natural groups that are representative of the population as a whole has not been implemented. The implementation of spill for juvenile fall Chinook passage is only one of many factors have changed in recent years, which has impacted fall Chinook. Changes in reservoir operations, hatchery programs, passage operations and project operations have occurred in recent years which have impacted fall Chinook. Determining the best passage operation for the future requires a decision framework which addresses all of these factors and concludes in the best suite

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of operations to benefit adult returns of both Snake River and Clearwater components of the population.

- The NOAA proposal is not related to a biological basis, or decision framework that is related to adult return information or impact on wild/natural components of the migration. It is difficult to assess the impact of the NOAA proposal on wild/natural fall Chinook because of limited data.
- The available data, although limited, indicates that fall Chinook that are bypassed in August contribute to adult returns. Fish that return as adults from in-river migration in spill or through turbines in August are not detected and could contribute significantly to adult returns. At the present time smolt to adult return data for in-river migrants passing the projects in spill or through turbines is not available.
- Historic data indicates that the 90% point of passage for wild fall Chinook occurred on August 31 and sometimes extended into September. Increased releases in the hatchery production supplementation program in particular after 2000 has, because of its magnitude, shifted the average passage timing of the run-at-large to an earlier period. The magnitude of the hatchery releases could mask the wild/natural migration timing.
- The available data, although limited, indicates that since 2000 when hatchery releases increased dramatically Snake River natural fall Chinook juvenile migrants have outmigrated at a smaller size and at earlier dates, and that marking of juveniles has also been earlier. This could introduce a bias in the PIT tag data towards the earlier portion of the outmigration.
- The first spill for fish passage provided for Snake River fall Chinook was implemented in 2005. Prior to 2005 fall Chinook only received excess hydraulic capacity spill and those fall Chinook that migrated in June received spill planned for spring migrants.
- For actively migrating subyearling Chinook, increased spill and decreased water transit time (higher flows) appear to improve survival, while higher temperatures decrease survival.
- In 2007 Lower Granite adult fall Chinook returns were notable because while fall Chinook adult returns to Bonneville Dam and to McNary Dam were well below their ten year average and the 2006 return, returns to Lower Granite were above the 2006 return and the ten year average for Lower Granite. The adults returning in 2007 are comprised of juvenile out migrants primarily from 2004 and the first year of spill in 2005 giving an indication that summer spill for fish passage and reduction in proportion of fish transported is beneficial.
- The fall Chinook population above Lower Granite Dam is comprised of two components, Snake River and Clearwater groups, which have different passage timing characteristics. The recent operation of Dworshak Reservoir may be changing passage timing of this group to later in the fall. Provision of spill for this later timing has not been considered by NOAA and may be beneficial.
- Whether or not to continue spill for fish passage in August should be based upon a decision framework which is based upon 1) the benefits of smolt transportation relative to in-river survival during August 2) the contribution of August in-river migrating fall Chinook to adult returns 3) migration timing, adult contribution and

other characteristics of wild/natural produced fall Chinook. The decision framework should include consideration of spill for the later component of juvenile passage.

Available historic data indicates that juvenile wild/natural fall Chinook that outmigrated in August were a significant part of the outmigration and made a significant contribution to adult returns.

This data portrays the subyearling emigration timing of natural/wild fall Chinook that later returned as adults. The long term PIT tag data on natural fall Chinook spans 16 years for Snake River operations and 14 years in the Clearwater River. Adult returns for the fall Chinook outmigrating in 2005, 2006 and 2007 are not complete. We did not utilize adult return data from 2006 for this reason and there is no adult return information for 2007 out-migrants. Although adult return data from the 2005 out-migration are not complete, historic age class returns indicate that at least half of the expected adult return from the 2005 out-migration has occurred by 2007. Returning adults were defined as fish that were detected at Lower Granite Dam (LGR).

Of the 7,727 PIT natural/wild PIT tagged fish in the Clearwater River from 1993 to 2005, 19 returned as adults. In the Snake River, 126 fish returned from 37,998 natural/wild PIT tagged fish.

To express historic timing information “bypassed” fish from all years were grouped for the Snake River and the Clearwater River. There were 68 adult wild/natural fall Chinook from the Snake River and 10 from the Clearwater River that had been bypassed as juveniles. Passage detection information was grouped by dam and month (e.g. June LGR passage includes subyearling detections from all years at LGR during June for a particular river origin). Figure 1 shows histograms for these data shown in one “year” post tagging for the Snake River. In each panel, there are two distributions of fish suggesting that there is a population of fish that outmigrate as juveniles and a smaller population that holdover either within or above the hydrosystem. However, these observations do not include all outmigrating PIT tagged fish. Fish that pass through the system undetected, either because they passed the projects through spill or through the turbines or during the November to March period when PIT tag detection is not operational.

Figure 1. Monthly percentage of juveniles for PIT tagged natural/wild fall Chinook adults that returned to Lower Granite Dam from Snake River releases from 1994 - 2005.¹

1. No PIT tag adults that were detected as juveniles returned from 1991 and 1993

June, July, and August had the three highest numbers of detections at the first 5 dams within the hydrosystem. The month of August ranged from 14% to 36% of the detections at each of these five dams. This suggests that historically, fish that returned as adults emigrated through the hydrosystem over the entire summer.

The Clearwater River data contains few fish, in part because so few fish returned. Of the 10 fish in the “bypassed” category, there were two or fewer detections at all the dams below LGR and

Little Goose (LGS). Of the 13 detections at LGR and LGS, 5 were during July and August suggesting a later summer passage than for Snake River subyearlings (Figure 2).

Figure 2. Monthly percentage of juveniles detected for the PIT tagged natural/wild fall Chinook that returned to Lower Granite Dam from releases in the Clearwater River¹.

1. Clearwater River PIT tag releases of natural/wild fall Chinook juveniles occurred in 1993, 1998, 2001, 2003-2005. No PIT tagged adults that returned in 1994-1996 and 2002 were detected as juveniles.

Historically juvenile outmigration PIT tag timing data indicates that fall Chinook which were bypassed through the hydrosystem in August contributed to adult returns. FPC staff considered the PIT tag data to determine whether subyearling fall Chinook passing Lower Granite Dam (LGR) in August contribute to adult returns to the Columbia River Basin. The observations included hatchery and wild subyearling fall Chinook that were detected at Lower Granite as juveniles (in the year of their out-migration) and later detected at Bonneville, McNary, and/or Lower Granite dams as adults for migration years 1995-2005. This analysis does not include fall Chinook that returned as jacks or mini-jacks because coincident with the recent increases in supplementation hatchery releases the proportion of jacks in the adult return has increased greatly compared with historic years and wild production. The observations are divided into juveniles that were bypassed versus those that were transported (from LGR, LGS, LMN, or MCN). Finally individual fish that may have held over below LGR after passing LGR in the year of their out-migration were included.

From the PIT tag observations, it is clear that historically subyearling fall Chinook juveniles that pass Lower Granite Dam in August contribute to adult returns in the Columbia Basin (Table 2; Figures 3 and 4). This is true for both bypassed and transported juveniles. It appears that, in recent years (MY 2003-2005), subyearling juveniles passing Lower Granite in August represent a smaller proportion of the adult returns (Table 1). However, the majority of PIT-tagged subyearling fall Chinook are production fish, which have been released earlier and over a shorter time period in recent years. It is likely that the decline in the proportion of adult returns represented by August passing juveniles is due to these earlier release schedules and thus, lower numbers of juveniles passing in August. What is still unclear is what proportion of the wild subyearling Chinook juveniles pass Lower Granite in August and return as adults. Although this analysis included PIT-tagged wild subyearling Chinook, tagging of these wild subyearlings has also occurred earlier and at smaller sizes in recent years compared to past years.

Table 1. Percent of adults (jacks not included) returning that had juvenile detections at Lower Granite Dam in August (MY 1995-2005).

Migration Year	Percent of Adults that Passed LGR in August as Juveniles	
	Bypassed	Transported
1995	45.8	20.0
1996	46.7	66.7
1997	14.3	N/A
1998	25.0	0.0
1999	22.6	85.7
2000	16.7	40.0
2001	30.0	34.1
2002	18.2	29.1
2003*	6.7	13.8
2004**	0.0	0.0
2005***	11.1	16.7

* 5-year ocean fish from MY 2003 have not yet returned

** 4 and 5-year ocean fish from MY 2004 have not yet returned

*** 3, 4, and 5-year ocean fish from MY 2005 and not yet returned

Figure 3. Juvenile passage timing at Lower Granite Dam for bypassed subyearling fall Chinook that survived to adulthood (jacks not included) for migration years 1995-2005. Numbers of PIT-tagged adults returning for each migration year are shown in the figure legend in parentheses. Larger circles reflect larger number of PIT-tags passing on a particular date. This figure may include any holdovers that held over below LGR and were detected the following year as yearlings, below LGR.

* 5-year ocean fish from MY 2003 have not yet returned

** 4 and 5-year ocean fish from MY 2004 have not yet returned

*** 3, 4, and 5-year ocean fish from MY 2005 and not yet returned

Figure 4. Juvenile passage timing at Lower Granite Dam for transported subyearling fall Chinook that survived to adulthood (jacks not included) for migration years 1995-2006. Numbers of PIT-tagged adults returning for each migration year are shown in the figure legend in parentheses. Larger circles reflect larger number of PIT-tags passing on a particular date. This figure may include any holdovers that held over below LGR and were detected the following year as yearlings, below LGR.

* 5-year ocean fish from MY 2003 have not yet returned

** 4 and 5-year ocean fish from MY 2004 have not yet returned

*** 3, 4, and 5-year ocean fish from MY 2005 and not yet returned

Fish that return as adults from in-river migration in spill in August are not detected and could contribute significantly to adult returns. At the present time smolt to adult return data for in-river migrants passing the projects in spill is not available.

For subyearling fall Chinook released above Lower Granite Dam (LGR) as juveniles, the proportion of the adult returns (including jacks) that out-migrated through the hydrosystem undetected was estimated. Both hatchery and wild subyearling fall Chinook that were detected as adults at Bonneville, McNary, and/or Lower Granite dams for migration years 1995-2006 were included. This analysis does not include fall Chinook that returned as jacks or mini-jacks. Juvenile detections in the adult facilities were also removed from this analysis.

On average, approximately 28.6% of PIT-tagged Snake River fall Chinook adults returning out-migrated through the hydrosystem undetected as juveniles (Table 2). This is of importance because it is impossible to determine when these juveniles migrated through the hydrosystem. It is worth noting that a portion of these undetected individuals may have passed the hydrosystem later in the season when PIT-tag detectors are no longer running. However, a portion of these undetected individuals could have passed the hydrosystem when spill may have been occurring or through turbine units.

Table 2. Percent of PIT tagged adult fall Chinook (jacks not included) that were released above LGR as juveniles and out-migrated undetected through the hydrosystem (MY 1995-2005).

Migration Year	Number Returned	Number of Returned Who Were Undetected as Juveniles	Percent Returned Who Were Undetected as Juveniles
1995	108	52	48.1
1996	78	28	35.9
1997	59	13	22.0
1998	93	20	21.5
1999	286	178	62.2
2000	63	7	11.1
2001	254	78	30.7
2002	426	112	26.3
2003*	81	6	7.4
2004**	19	1	5.3
2005***	102	45	44.1
Average	142.6	49.1	28.6

* 5-year ocean fish from MY 2003 have not yet returned

** 4 and 5-year ocean fish from MY 2004 have not yet returned

*** 3, 4, and 5-year ocean fish from MY 2005 have not yet returned

Increased releases in the hatchery production supplementation program in particular after 2000 has, because of its magnitude, shifted the average passage timing to an earlier period. The magnitude of the hatchery releases could mask the wild/natural timing.

As part of the hatchery production supplementation program, there has been a marked increase in the number of hatchery subyearling fall Chinook released into the Snake River above Lower Granite Dam since 2000 (Figure 5). Releases of supplementation fish to the Snake River have begun to occur earlier in recent years (Table 3). For example 1995 and 1996 had releases ending well into July and August, whereas releases from more recent years have ended by June 21. The schedule for supplementation releases on the Clearwater River have not changed as dramatically as those to the Snake River (Table 3). However, both Clearwater and Snake river supplementation releases have been decreasing in their time span. Long volitional releases have become less common, while shorter release spans are the norm in more recent years.

The combination of larger releases of hatchery subyearling Chinook and those releases occurring earlier in the season (late May – early June in recent years) could have shifted the overall passage timing of subyearling fall Chinook to an earlier period, thus masking the timing of wild/natural Snake River fall Chinook. It is still unknown whether this shift in timing has affected the passage timing of wild/natural Snake River fall Chinook.

Figure 5. Hatchery releases of subyearling fall Chinook above Lower Granite Dam (MY 1995-2006).

Table 3. Snake and Clearwater River hatchery sub-yearling Chinook release dates and release time spans from 1995-2006.

Migration Year	Snake River Hatcheries				Clearwater River Hatcheries			
	PLAP	CJRAP	HCD	GRR	BCCAP	NPTH	CLWR	LAPW
1995	5/18-8/17							
1996	6/6-7/10						6/6-7/10	
1997	5/28-7/8				6/3-7/8 6/10-6/13			
1998	5/14-7/7				6/2-7/8			
1999		5/30-6/5			6/2-6/3			
2000	5/24-5/26	5/20-5/31 6/15-6/23			5/30-6/1 6/20-6/26			
2001	5/28 6/1-7/6	5/26	5/16-6/19		5/29 5/29-7/4 6/13			
2002	5/27-5/29	5/28 6/20	5/21		5/27-5/28 6/18-6/19			
2003	6/4	5/28 6/9-6/16 6/12	5/1-5/16 5/22		6/3	6/3-6/5 6/19-6/21		5/28-5/31
2004	5/24 5/31	5/26-6/1	5/28		5/31-6/3	6/4-6/11		
2005	5/23-5/24	5/16-5/30 5/23 5/23-5/27 5/26	4/28 5/13	5/24-5/25	5/30-5/31 6/21-7/8	5/7		
2006	5/24	5/15-6/2 5/26-5/29 5/30	5/2 5/8-5/10	6/19-6/21	5/25-5/26 6/19-7/9	6/8-6/15	5/17	6/13 6/13

Natural/wild fall Chinook juvenile migrants have migrated at a smaller size and at earlier dates since 2000, when hatchery releases increased dramatically in the Snake River. Coincidentally, the mean date of PIT tag marking of natural/wild fall Chinook juveniles has also been earlier.

The PIT tag groups for natural/wild juvenile fall Chinook in the Snake River shows a shift in mean tagging date after 1999 (Figure 6) concurrent with the large increase in the subyearling hatchery releases in the Snake River after 1999 (Figure 5 above). When data for 1991-1999 is pooled and compared with 2000-2007 the mean tagging date is 11.5 days earlier (May 23rd versus June 4th) The mean fork length of fish tagged has also decreased from 74 mm +/- 0.10 SE (1991-1999) to 69 mm +/- 0.04 SE (2000-2007).

Figure 6. Date of PIT tagging for sub-yearling natural/wild fall Chinook in the Snake River (1991-2007). The mean date for each year is shown +/- 1 standard deviation.

In addition to the changes in the mean date of tagging and size at tagging, the mean date of arrival at LGR for bypassed fish is approximately 19 days earlier for the 2000-2007 group (June 26th versus July 16th). This earlier arrival time at LGR for bypassed fish was not expected given that smaller sized fish should take longer to develop and start their outmigration.

The travel time for bypassed fish from their release to granite also appears to be decreasing. Fish travel time is often expressed as a median value instead of a mean. These data show a decreasing trend in the median fish travel time from release to LGR (Figure 7).

Figure 7. PIT tagged Snake River natural/wild median fish travel time from tagging date to LGR (1991-2007). Each filled circle is the median value for fish bypassed at LGR in a particular year.

The driving factors for these changes in fish size at marking, arrival time at LGR, and travel time to LGR in the Snake River across the historic data are unknown. However, with the concurrent increase in subyearling hatchery releases it is possible that population density factors and/or competition for resources may play a role. It also could be possible that a portion of the untagged subyearling Chinook hatchery releases are being marked as natural/wild Chinook and confounding the monitored natural/wild population.

Recent improvements to river operations for fall Chinook including improved flow and spill for fish passage has improved survival.

In order to characterize the migration characteristics of subyearling fall Chinook the PIT-tag data from hatchery/production subyearling fall Chinook releases above Lower Granite Dam were analyzed to estimate survival and travel time in the reach Lower Granite Dam to McNary Dam. Fish were grouped into two-week blocks based on their detection date at Lower Granite Dam. Survival and travel time were estimated, as well as downstream timing past Little Goose, Lower Monumental, Ice Harbor, and McNary dams. Timing data was used to estimate the average in-river conditions the fish experienced passing through the river reach; such as water transit time, discharge, spill percentage and water temperatures at the dams and reservoirs. The relationship between survival through the reach Lower Granite Dam tailwater to McNary Dam tailwater was compared to in-river conditions in a series of bi-variate weighted regressions. Generally, survival was highest during periods of high flow and spill and cooler temperatures (Figures 8 to 10). Court ordered summer spill appeared to improve survival in recent years when flows were lower and temperatures warmed, compared to prior years when spill ended June 20. For actively

migrating subyearling Chinook, increased spill and decreased water transit time (higher flows) appear to improve survival, while higher temperatures decrease survival.

Figure 8. Subyearling Chinook survival LGR to McN plotted against average spill proportion at LGS, LMN, IHR and McNary dams from 1998 to 2007. Data points for 2007 are in red.

Figure 9. Subyearling Chinook survival LGR to McN plotted against water transit time from LGR tailwater to McNary Dams from 1998 to 2007. Data points for 2007 are in red.

Figure 10. Subyearling Chinook survival LGR to McN plotted against average temperature (degrees C) measured at tailwater TDG monitors at LGR, LGS, LMN, and IHR dams from 1998 to 2007. Data points for 2007 are in red.

In 2007 Lower Granite adult fall Chinook returns were notable because while fall Chinook adult returns to Bonneville Dam and to McNary Dam were well below their ten year average and the 2006 return, returns to Lower Granite were above the 2006 return and the ten year average for Lower Granite. The adults returning in 2007 are comprised of juvenile out migrants primarily from 2004 and the first year of spill in 2005 giving an indication that summer spill for fish passage and reduction in proportion of fish transported is beneficial.

Reservoir operation changes such as shifting flow augmentation from August to September, decreasing water temperature of flow augmentation from Dworshak reservoir, implementing a spill for fish passage operation at transportation collector projects and large increases in the fall Chinook hatchery production releases above Lower Granite Dam have all had an impact on fall Chinook. The fall Chinook adult return is an indicator that these changes or some combination of these changes, are providing a significant benefit to fall Chinook adult returns. The full affect of implementation of spill for fall Chinook and reduction of transportation has not yet been observed. It is clear that implementing the NOAA proposed trigger will eliminate spill for fall Chinook migrating in August and it is clear that eliminating spill will be detrimental to those migrants. The following graphs show that fall Chinook adults have returned at levels higher than their ten year average and higher than 2006 while Bonneville and McNary returns are depressed.

Lower Granite

McNary

Bonneville

Figure 11. The 2007 adult returns of fall Chinook at Lower Granite, McNary and Bonneville dams compared to the 2006 returns and the 10 year average returns.

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MEMORANDUM

TO: Ed Bowles, ODFW

Michele DeHart

FROM: Michele DeHart

DATE: December 10, 2007

RE: Review of the 2007 Draft Biological Opinion

In response to your request, the FPC staff has reviewed the 2007 Draft Biological Opinion relative to the 2000 Biological Opinion and the 2006-2007 Operations Agreement. Overall this Opinion reduces spill for fish passage, increases smolt transportation and reduces flow compared to the 2006 & 2007 operations agreement and the 2000 Biological Opinion. The Opinion also includes modification of regional management and collaboration framework that affects the state, and tribal fishery managers. The FPC did not provide comments on these or tributary and habitat sections of the Opinion. The following are our comments by section relating to mainstem passage.

1. Hydropower Strategy 1- Hydro Actions.

Dworshak Dam

The primary difference relative to the 2000 BiOp is the summer draft to 1535 feet by the end of August. The 2000 Biological Opinion contained a draft to 1520 feet by the end of August. The 2007 Draft BiOp will result in approximately 200 Kcf less flow Augmentation from Dworshak Dam between June 21 and August 31st (72 days). This loss of 200 Kcf over the 72 days between June 21st and August 31st will equate to an average daily loss of 1.4 Kcfs of flow over the summer flow period. Not included is any language regarding the potential to reduce winter drafts to assure the best possibility of reaching the April 10th rule curve. The Biological Opinion does not include any language regarding the Action Agencies consideration of trends in water supply when operating reservoir for flood control. For example, it would not seem logical to continue to draft to the end of month flood control elevations based on a moderate water supply forecast when month long conditions had been very dry causing the next month forecast to be drastically less causing flood control elevations to be drastically increased.

Libby and Hungry Horse

In dry water years (lowest 20%) the 2000 BiOp drafts Hungry Horse and Libby to 3540 feet and 2439 feet by the end of August. In comparison, in dry water years, the 2007 Draft BiOp drafts to the same elevations by the end of September. Assuming a linear summer draft, the 2007 Draft BiOp would draft Hungry Horse

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and Libby to elevation 3547 feet and 2446 feet by the end of August. Overall, the 2007 Draft BiOp would result in approximately 440 Kaf less flow augmentation water over the summer period, this volume of water equates to a daily flow augmentation loss of 3.6 Kcfs (3,600 cfs) from Hungry Horse and Libby in dry water years over the 62 days of summer (July 1 to August 31).

In normal and wet water years (upper 80%) the 2000 BiOp also drafts Hungry Horse and Libby to 3540 feet and 2439 feet by the end of August. In comparison, in normal and wet water years, the 2007 Draft BiOp drafts to only 3550 and 2449 feet by the end of September. Assuming a linear summer draft, the 2007 Draft BiOp would draft Hungry Horse and Libby to elevation 3553 feet and 2452 feet by the end of August. The 2007 Draft BiOp would result in approximately 900 Kaf less flow augmentation water over the summer period in normal and wet water years, this volume of water equates to a daily flow augmentation loss of 7.3 Kcfs (7,300 cfs) from Hungry Horse and Libby over the 62 days of summer (July 1 to August 31).

The Opinion does not include language regarding the potential to reduce excessive winter drafts to assure the best possibility of reaching the April 10th rule curve. The Opinion language referring to “the 75% chance of meeting the URC” language is weak and could be strengthened by modifying the language such as “.... Operate to achieve the best possible chance of reaching the URC elevation on April 10th based on all available information...” Although this was discussed with NOAA and the agencies and tribes the Opinion does not address the variable end of December draft at Libby and the potential to modify this draft to affect the Libby late winter/early spring reservoir elevation. NOAA could have included language requiring that the COE reanalyze this draft operation by 2009, and work with the agencies and tribes to explore an agreement for potential modifications of this draft.

Grand Coulee

Some language also should be added about reducing excessive winter drafts to assure the best possibility of reaching the April 10th rule curve. Again the language regarding winter drafts is weak, the 85% chance of meeting the URC language could be strengthened by directing the action agencies to “.... Operate to achieve the best possible chance of reaching the URC elevation on April 10th based on all available information...”

The 2007 Draft Biological Opinion indicates that Grand Coulee must be drafted for drum gate maintenance, in a minimum of three times over seven years. This draft for drum gate maintenance will negatively impact spring flows especially in dry water years. The action agencies could explore other schedules for maintenance or options for less frequent maintenance to reduce the impact on salmon and steelhead migration conditions. Drum gate maintenance has impacted provision of flow augmentation for fish in three of seven years, the Opinion does not address the consideration of maintenance to avoid impacts on provision of fish protection measures.

Chum Spawning Flows

Bullet #1 under chum flows states that tailwater elevations below Bonneville of approximately 11.5 feet will be maintained beginning in November when chum are present and ending by December 31st. Previous BIOPS included flows for chum salmon through emergence in the spring.

Flow Objectives

There are no flow objectives that can be found in the 2007 Draft Biological Opinion. Previous Biological Opinions had flow objectives or flow targets for both spring and summer at McNary and Lower Granite Dam and spring flow objectives at Priest Rapids. Flow objectives were managed in terms of weekly averages in the past. This Opinion provides more flexibility to operators and regulators to manage flows for hydropower operations, and eliminates any emphasis on provision of flows for downstream migrating salmon and steelhead.

2. Hydropower Strategy 2- Hydro Actions

RPA #28 discusses investigating adult passage at Little Goose Dam and spill operations based upon 2007 operations. However NOAA does not completely consider events that occurred in 2007. In 2007, when an adult passage delay was noticed a change in spill pattern appeared to break up an eddy by the south shore adult entrance and immediately pass many adult fish. It should be noted that unit #1 had been out of service for four days previous to the spill pattern change and in fact was turned back on at the same time the spill pattern was changed. Unit #1 is the closest unit to the south shore entrance and would likely have large impact on the eddy that formed near the south exit. It is very possible that both the unit #1 outage and the bulk spill pattern contributed to the adult delay seen at LGS in 2007. NOAA has not fully considered these issues in their description of this RPA. This potentially impacts the spill level provided at Little Goose. The RPA should encompass all of the factors which occurred in 2007 at Little Goose.

3. Hydropower Strategy 3 – Implement Spill and Juvenile Transportation Improvements at Columbia River and Snake River Dams.

This Opinion reduces spill from the 2000 Opinion and the 2006 & 2007 operations agreement.

Duration of Voluntary Spill

- **The duration of spring spill at Snake and Lower Columbia River projects is shorter under the 2007 Draft BiOp than the 2006 Court Order and 2007 Agreement.**
 - Spring spill starts later at most Snake River projects. Under the 2007 Draft BiOp, spring spill at Snake River projects will have staggered start dates; where LGR starts April 3, LGS starts April 5, and LMN and IHR start April 7. Spring spill under 2006 Court Order and 2007 Agreement started April 3 at all Snake River projects.
 - Spring spill ends earlier at all Snake River projects. Under 2007 Draft BiOp, spring spill at Snake River transportation projects will end on May 15, when transportation is maximized with no spill will begin. Furthermore, the last day of spring spill at IHR is June 15 under the 2007 Draft BiOp. In 2006 and 2007, spring spill ran through June 20 at all Snake River projects.
 - Spring spill ends earlier at all Lower Columbia River projects. Under 2007 Draft BiOp, spring spill at Lower Columbia River projects will end on June 15. In 2006 and 2007, spring spill ran through June 30 at all Lower Columbia River projects.

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- **The duration of summer spill at Snake River projects will likely be shorter under the 2007 Draft BiOp than the 2006 Court Order and 2007 Agreement.**
 - Although summer spill volumes will be initiated earlier at all projects (10-15 days on average), summer spill will be terminated much earlier than the August 31 date that was identified in the 2006 Court Order and 2007 Agreement. Based on data from recent years (2005-2007), the criteria for terminating summer spill would have been met by August 3 at all three Snake River collector projects. If spill were terminated on August 4, effectively 28 days of spill would be eliminated in August. This would result in a net loss of approximately 13-18 days of summer spill at these projects.
 - Summer spill at IHR will begin on June 15 under the 2007 Draft BiOp, which is 6 days earlier than the 2006 Court Order and 2007 Agreement. However, summer spill will terminate 2 days after LMN (early August), which results in a net loss of approximately 20 days of summer spill.
 - **The duration of summer spill at Lower Columbia River projects is longer under the 2007 Draft BiOp than under the 2006 Court Order and 2007 Agreement.**
 - Under the 2007 Draft BiOp, summer spill volumes will be initiated on June 16 at all Lower Columbia Projects. The initiation of summer spill volumes was July 1 under the 2006 Court Order and 2007 Agreement.

Transportation:

- **Transportation at all Snake River projects initiated earlier under the 2007 Draft BiOp than the 2007 Agreement.**
 - Under the 2007 Draft BiOp, transportation at LGR, LGS, and LMN will begin on April 21. The 2007 Agreement allowed for transportation to be initiated at LGR as late as May 1 and staggered the initiation of transportation at LGS and LMN after LGR. In 2007, LGR initiated transportation on May 1, LGS on May 9, and LMN on May 12.
- **Proportion transported likely higher under 2007 Draft BiOp than 2006 Court Order and 2007 Agreement, for all species**
 - Combination of earlier initiation date and no spill/max transport operation at the end of May will result in a higher proportion of yearling Chinook, steelhead, Coho, and sockeye juveniles transported from Snake River projects.
 - Max transport/no spill operation in late May/early June and “Adaptive” operation in August (i.e., termination of spill and max transport) will result in higher proportion of subyearling Chinook transported from Snake River projects.

Spill Volumes:

- **Little Goose spring spill volume is lower under 2007 Draft BiOp than under 2007 Agreement.**
 - 2007 Agreement allowed for 14 nights of gas cap spill at LGS during tentative window of April 22 to May 15. 2007 Draft BiOp does not allow for any gas cap spill at LGS in the spring. Also, the project is restricted to 30% spill because of adult passage concerns. Spill amount has not been shown to be the primary culprit for the adult passage delay and definitive studies of spill levels must be included in RPA #28.

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- **Changes in spill duration at Snake River projects will lead to less overall spill under 2007 Draft BiOp than what was provided under the 2006 Court Order and 2007 Agreement.**
 - Staggered start to implementation of spring spill, elimination of spill from mid-May to early-June (max transport operation), and elimination of spill in early August will all result in lower spill volumes at Snake River projects.
 - Overall spill volumes at LGR and LMN will be further reduced due to earlier implementation of summer spill volumes. Spring and summer spill at these projects are set amounts (Kcfs), which are reduced upon the implementation of summer spill (LGR: 20 Kcfs in spring vs. 18 Kcfs in summer; LMN: gas cap in spring vs. 17 Kcfs in summer). The spill volumes at Lower Monumental are based on data collected in the hydrosystem where forebay monitors are limited to 115% and tailrace to 120%. The forebay monitors often limit spill because the 115% limit is exceeded before the 120% is met. This is presently under discussion in the Adaptive Management Team process established under the State of Washington and Oregon's water quality agencies. The BIOP should recognize this process by using gas cap as limits, rather than the present Kcfs amounts.

 - **Changes in spill duration at Lower Columbia projects will have variable effect on total spill volume under 2007 Draft BiOp compared to 2006 Court Order and 2007 Agreement.**
 - Instantaneous spill volumes at MCN are same between 2007 Draft BiOp and 2007 Agreement. If summer spill volume at MCN continues to be 40%/40% vs. 60%/60%, than total spill volume at MCN may be higher under 2007 Draft BiOp, given that summer spill is longer duration. However, if summer spill at MCN changes to 40%/40% after testing is completed, than there will be less spill under 2007 Draft BiOp.
 - Instantaneous spill volumes at TDA are same between 2007 Draft BiOp and 2007 Agreement. Furthermore, spring and summer volumes at TDA are the same. Therefore, longer duration of summer spill will have no effect on total spill volume at TDA.
 - Instantaneous spill volumes at JDA are same between 2007 Draft BiOp and 2007 Agreement. 2007 Draft BiOp mentions the possibility of 24-hour spill at JDA in the spring. However, there is no mention of what the instantaneous spill level would be if this were to occur. Without this information, it is difficult to determine whether there will be any change in total spill volume at JDA over what has occurred in the past.
 - The 2007 Draft BiOp calls for spring spill of 100Kcfs/100Kcfs. There is some concern for daytime passage at higher spill levels so the daytime restriction to 100 Kcfs maybe justified. However, there is no biological reason to limit nighttime spill to 100 Kcfs. This was most likely related to the spill level near where the 115% was exceeded at Camas/Washougal. Camas/Washougal is no longer a point of compliance so all nighttime spill at Bonneville Dam should be to the gas cap. The 2007 Draft BiOp calls for 85 Kcfs/Gas Cap spill at BON from June 16 to July 31 and 75 Kcfs/Gas Cap from August 1 to August 31. This likely will result in an increase in the overall spill volume at BON over what has been provided in the past. However, the 85 Kcfs is the minimum spill level needed for good project conditions and there is no justification for reducing daytime spill after July 31.

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MEMORANDUM

TO: Ron Boyce, ODFW
Tony Nigro, ODFW

Michele DeHart

FROM: Michele DeHart

DATE: December 3, 2007

RE: Proposed maximum transportation, no voluntary spill for fish passage operation, May 15 to May 31, Snake River when flows are above 65 kcfs.

In response to your request, the Fish Passage Center staff reviewed the proposed no spill, maximum transportation operation and considered potential alternative operations to benefit steelhead. We reviewed and analyzed passage data, juvenile survival and smolt-to-adult return data for Snake River steelhead. Our review of the proposed operations, historical operations, historical fish passage data and analysis resulted in the following points for your consideration. A detailed discussion of each of these points is attached. **Our review and conclusions do not support the implementation of the proposed elimination of spill from May 15 through May 31.** Our review indicates that an alternative to improve steelhead survival and adult return could include decreases in water travel time in the Columbia River reach from McNary to Bonneville dams, and 24 hour spill for fish passage at John Day Dam within gas cap and adult passage constraints.

- The concept of maximizing transportation is not new and has been extensively tested through implementation for many years. Maximizing transportation of steelhead juveniles at Lower Granite, Little Goose and McNary dams occurred in 1978 through 1993. With the completion of transportation and collection facilities in 1993 at Lower Monumental Dam, maximization of transportation of steelhead was increased and a larger proportion

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of Snake River steelhead were transported. Maximizing transportation over all of these years did not preclude ESA listing of A-run and B-run steelhead in 1997.

- The Court ordered passage and spill operations implemented in 2006, including spill for fish passage throughout May and June, in a relatively high flow year, resulted in the transportation of an estimated 76% of the hatchery and 79 % of the wild steelhead originating above Lower Granite Dam. Survival of juvenile steelhead in 2006 between Lower Granite and McNary dams was 70%. In 2006, as in previous years the majority of steelhead were transported.
- The proposal to eliminate spill from May 15 – May 31 is based primarily on COMPASS model results and limited empirical data. The state, tribal and federal fishery agencies have documented their concerns regarding the use of COMPASS to determine passage operations. Those documents are available at www.fpc.org/documents . Other data analyses were not considered.
- The model is only as good as its data and assumptions. Limitations in data can certainly affect model outcome. The COMPASS basis, time of arrival at Bonneville versus SAR, is based on just a few years when most steelhead have been bypassed multiple times. The fact that there is a significant relation between the number of times bypassed and survival to adulthood limits the application of the COMPASS data set to describe the relation for steelhead in river migrants. The potential bias in the survival of in-river steelhead migrants to adult return raises significant concern regarding the application of the COMPASS model runs to fish passage management decisions.
- Data collected during the court ordered agreed upon spill operations in 2006 and 2007 indicates that spill is the most beneficial mitigation action implemented in recent years. We compared in-river juvenile steelhead survival rates calculated by NOAA Fisheries which occurred in 2006 a high flow high spill year with 2007 a low flow year when the 2007 operation agreement included spill. Steelhead survival from Lower Granite to McNary was 70% in 2006 the high flow year (seasonal average flow of 125 kcfs) and 69.5% in 2007 (seasonal average flow of 63 kcfs) indicating that spill was very important to survival in the Snake River. This indicates that eliminating spill would likely reduce the survival of steelhead remaining in-river.
- In 2006, a high flow year (spring season average of 326.5 kcfs), outages at John Day Dam resulted in spill of approximately 40% of instantaneous flow 24 hours per day. Juvenile steelhead survival from John Day to Bonneville Dam was 81% in that year. In 2007, a low flow year (spring season average of 245 kcfs) spill for fish passage at John Day was limited to 52% of instantaneous flow for nighttime hours. Juvenile steelhead survival from John Day to Bonneville was 61%.
- SAR data for steelhead indicate that spill increases smolt-to-adult survival. In an analysis examining the relationship between spill and smolt-to-adult survival, average spill for Lower Snake and Lower Columbia River dams, explained the greatest portion of variation in steelhead SARs from LGR to LGR for migration years 1998 to 2005. Using information criteria to examine the degree of fit for the best models to steelhead SAR data, average spill was the best single variable model and average spill was in all models with lowest AICc and BIC scores.
- The CSS ten year retrospective report (Report) summarized ten years of juvenile passage data. The Report showed that the two most influential variables on juvenile survival for steelhead in the Snake River were water travel time (flow) and spill.
- The CSS Report, which summarized juvenile data from 1996 through 2006, did not include adult return data from the implementation of the 2006-2007 operations

agreement. The CSS Report results indicate that overall transported steelhead SARs were higher than in-river migrating, bypassed SAR. However the SARs of transported steelhead were not sufficiently high to recover ESA listed stocks and were lower than historic SARs for steelhead.

- The CSS Report found that transportation to in river ratios (TIR) were generally less than 1.0 for wild Chinook and greater than 1.0 for wild steelhead. The CSS report found that in river survival rates for wild Chinook were higher than in-river survival rates for wild steelhead. The higher TIR for steelhead appears to be the result of low in-river survival for steelhead in the years summarized prior to 2006. The CSS report also indicates that in-river survival for steelhead can be improved by reducing water travel time and increasing spill.
- In-river survival estimates for steelhead in recent years have increased with higher spill passage in recent years, which may affect future analyses given the relationship between TIR and in-river survival.
- The CSS Report indicates that steelhead experience significant mortality in the middle Columbia River reach between McNary and Bonneville dams.
- The CSS Report findings do not support the proposed elimination of spill from May 15 to May 31 to maximize transportation of steelhead operation in the Snake River.
- Eliminating spill from May 15 to May 31 will only increase the proportion of steelhead transported by approximately 20%. The majority of steelhead are presently being transported with the present court ordered operation as occurred in 2006.
- A significant portion of the coho, sockeye, fall Chinook, spring Chinook, and steelhead juvenile migrants remaining in-river could be adversely impacted by the proposal to eliminate spill in the last two weeks of May. On average, the majority of Snake River sockeye and coho (63% to 76% for sockeye, 65%-79% for coho) juveniles pass Snake River collector projects during the times of the proposed maximum transport/no spill operation. On average, 20% of the sub-yearling Chinook migration and 15% of the spring Chinook migration (Table 6) would be adversely impacted by increased transportation, increased turbine passage, and increased passage delay by the elimination of spill.

Alternative operations to benefit steelhead could be considered

- **Data and analyses indicate that increasing spill and reducing water travel time (increasing flow) will increase steelhead juvenile survival and SARs.**
- **Data indicates that juvenile steelhead experience high mortality rates in the mid Columbia River reach from McNary Dam to Bonneville Dam.**
- **Survival estimates calculated by NOAA fisheries from 2006 and 2007 were similar although flow conditions were not, indicating that providing spill provided benefits to juvenile survival of in-river migrating steelhead even under low flow conditions.**
- **The survival of juvenile steelhead from John Day to Bonneville dams was significantly higher when 24 hour spill and high flows were provided in 2006 compared to night time spill only and low flows in 2007.**
- **An alternative operation, which could provide more benefit to juvenile steelhead survival and steelhead SARs, would be to spill 24 hours per day, within the gas cap and adult passage constraints at John Day Dam, to decrease passage delay and increase survival. In addition data indicates that decreasing water travel time will decrease steelhead travel time and arrival time to below Bonneville Dam.**

The concept of maximizing transportation of steelhead is not new and has been extensively tested through implementation for many years. The maximization and expansion of transportation of juvenile steelhead did not preclude the listing of Snake River A-run and B-run steelhead stocks as threatened.

Transportation of juvenile steelhead has been maximized at Lower Granite Dam and Little Goose Dam since 1978. The long term strategy for steelhead has been to maximize transportation at these two projects. There was no planned spill for fish passage provided until 1994. Planned spill began at Lower Monumental in 1988 and maximization of transportation began in 1993. Maximization of transportation began at McNary Dam in 1978 and planned spill for fish passage began in 1994.

The following table shows that the majority of the juvenile steelhead have been transported even with the planned spill program implementation in recent years (1999-2006).

Comparison of the 2006 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 1999 to 2005. For yearling chinook and steelhead, the results exclude transport at McNary Dam.

Species-age group	Transport Proportion ¹							
	2006	2005	2004	2003	2002	2001	2000	1999
Yearling Chinook	0.611 (H) 0.579 (W)	0.92	0.870	0.629	0.683	0.980	0.71	0.777 (H) 0.862 (W)
Steelhead	0.76 (H) 0.793(W)	0.94	0.964	0.670	0.677	0.986	0.81	0.825
Subyearling Chinook	0.521 (H) 0.562(W)	0.809	0.972	0.895	0.929	0.962	0.93	0.870

¹ In years 2000-2006, estimates of collection efficiency based on PIT tag data was used to generate a single annual estimate of proportion transported, while in 1999 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.

Although the majority of steelhead have been transported, as juveniles even with a planned spill program, their adult returns from the following run reconstruction and PIT tag SARs are not improving and steelhead SARs are not reaching the level needed for recovery. B-run steelhead in particular are at low levels as illustrated by the following run reconstruction plot.

Average spill for Lower Snake and Lower Columbia River dams explained the greatest portion of variation in steelhead smolt -to-adult return from Lower Granite to Lower Granite for migration years 1998 to 2005.

Recent analyses have shown a strong correlation between ocean indices and adult returns of Snake River spring/summer Chinook (Scheuerell and Williams 2005, Schaller and Petrosky 2007). Other analyses by NOAA have examined the relationship between in-river survival (Lower Granite Dam to Bonneville Dam) and SARs and reported no statistically significant relationship. Based on this conclusion, it has been suggested that it would be difficult to develop a hydrosystem reach survival standard.

To further examine these issues, we used ocean indices of upwelling and sea surface temperatures identified by Scheuerell and Williams 2005, and Schaller and Petrosky (2007) to characterize the ocean environment that juvenile fish would experience in their first year in the ocean. We also used in-river conditions during juvenile out-migration to characterize the freshwater water environment each cohort would have experienced, including average spill proportion and water transit time through the hydro-system.

Methods

Reach survival estimates were produced for steelhead that migrated during the years 1998 to 2005 between Lower Granite Dam and Bonneville Dam. Passage date at Lower Granite Dam and travel time to Little Goose Dam was used to group juvenile migrants into five discrete, two-week cohorts for each year. For each two-week interval of passage at Lower Granite Dam, survival was estimated using Cormack-Jolly-Seber methods. The overall population of juvenile migrants destined to migrate in-river was expressed in Lower Granite Dam equivalents by tracking fish removed for transportation, and expressing those removals in equivalents at LGR based on survival to the downstream dam. In effect, fish removed for transportation or other purposes, reduced the starting population at Lower Granite Dam that would be used to calculate the in-river SAR back to that site.

Once the population at Lower Granite Dam destined to migrate in river was determined, PIT-tag adult returns to Lower Granite Dam were summarized, based on ocean age (e.g. minijacks, jacks, 2-ocean, 3-ocean). SAR's were calculated based on the number of adult returns divided by the in-river population. For yearling chinook, minijacks and jacks (0-ocean and 1-ocean) were not included in the adult return numbers, while for steelhead 1-ocean and older returns were considered adults.

Ocean indices were used to characterize the ocean productivity that juvenile fish would experience the year of ocean entry. For example, out-migrants in migration year 1995 would be assigned ocean indices from that calendar year. Several ocean indices were used in the analysis based on their correlations to SAR's, S/R, residuals, and first year ocean survival (S3) as shown by Hare and Mantua (2000) Scheuerell and Williams 2005, Schaller and Petrosky (2007): April and October Upwelling at transect Latitude 122 W, Longitude 45 N; May and September Pacific Decadal Oscillation (PDO) for the north Pacific Ocean. River conditions during juvenile out-migration were assigned based upon median travel time for the two-week cohorts. Spill

proportion and water transit time was calculated for each cohort passing through the entire reach. Spill proportion was averaged for all 8 dams in the juvenile migration corridor, while water transit time through 7 dams (from Little Goose pool to Bonneville Pool) was summed.

Results and Discussion

Models were fitted to the natural log (SAR) using ocean indices as well as in-river conditions as covariates. The results are summarized in Table 1. The best fitting model was a two-variable model that included Average spill proportion (AV_SPIL_PROP) and date group (DATE_GRP). The other top models all included AV_SPIL_PROP, as well as DATE_GRP and then ocean indices such as May PDO (MAY_PDO). Water Transit time (WTT) was also present in several of the top models. While the top 3 models were not distinguishable based on AICc, the rule of parsimony would suggest that the two variable model including AV_SPIL_PROP and DATE_GRP was the best model for predicting SAR's. Models that did not include AV_SPIL_PROP resulted in substantially poorer fits with AICc scores 11.6-48.4 points above the best two variable model. Similarly, models that only included the ocean indices performed poorly compared to models that included indices characterizing the in-river environment.

Table 1. Models fitted to Ln SAR with resulting AICc and BIC scores. Models are sorted by AICc scores.

Variables in Models	P value	AICc	BIC	Variables
AV_SPIL_PROP+DATE_GRP	0	59.9	62.2	2
AV_SPIL_PROP+DATE_GRP+MAY_PDO	0	60.4	62.5	3
AV_SPIL_PROP+WTT+DATE_GRP+MAY_PDO	0	61.3	62.9	4
AV_SPIL_PROP+WTT+DATE_GRP+SEP_PDO+MAY_PDO	0	62.8	63.3	5
AV_SPIL_PROP+WTT+APR_UPWELL+DATE_GRP	0	63.1	64.7	4
AV_SPIL_PROP+DATE_GRP+SEP_PDO	0	63.2	65.3	3
AV_SPIL_PROP+APR_UPWELL+WTT+DATE_GRP+MAY_PDO	0	65.1	65.6	5
AV_SPIL_PROP+WTT+DATE_GRP+SEP_PDO+OCT_UPWELL+MAY_PDO	0	65.9	64.7	6
AV_SPIL_PROP	0	67.4	69.6	1
AV_SPIL_PROP+WTT+DATE_GRP+APR_UPWELL+SEP_PDO+OCT_UPWELL	0	69.4	68.2	6
AV_SPIL_PROP+WTT	0	70.1	72.5	2
DATE_GRP+APR_UPWELL+MAY_PDO+SEP_PDO+OCT_UPWELL+WTT+AV_SPIL_PROP	0	71.5	67.8	7
DATE_GRP+WTT	0	81.9	84.3	2
WTT+DATE_GRP+MAY_PDO	0	84.0	86.1	3
APR_UPWELL+WTT+DATE_GRP+MAY_PDO	0	85.0	86.6	4
WTT	0.001	93.1	95.3	1
MAY_PDO+APR_UPWELL+SEP_PDO+OCT_UPWELL	0.044	103.0	104.6	4
DATE_GRP	0.212	103.2	105.3	1
APR_UPWELL	0.292	103.7	105.8	1
MAY_PDO	0.594	104.6	106.7	1
SEP_PDO	0.664	104.7	106.8	1
DATE_GRP+MAY_PDO	0.393	105.7	108.0	2
APR_UPWELL+SEP_PDO	0.428	105.9	108.2	2
DATE_GRP+SEP_PDO+MAY_PDO	0.484	108.3	110.4	3

Analyses by Budy et al, (2002) and Zabel (unpublished) have suggested that detection at multiple bypasses is correlated with decreased survival post-Bonneville Dam. Our results for steelhead are consistent with those findings. Analyses have shown a high correlation between steelhead reach survival and spill proportion (Schaller et al 2007). This analysis of SAR's and in-river conditions at out-migration suggests that some of the benefits of spill are realized beyond the in-river environment. This may be why linear regression analyses between in-river survival and SAR have not previously identified strong statistical relationships. Indices of in-river conditions, such as average spill proportion and water transit time, are likely to provide benefits that are not fully explained by reach survival estimates alone. While a good relation was shown to exist between juvenile survival and adult return rate, within at various categories of ocean indices, this analysis shows that the impacts of hydro-system passage conditions are likely to have impacts on ocean survival as well as juvenile hydro-system survival. In particular, water transit time, date of entry into hydrosystem, and average spill proportion were all important variables in describing SARs for Snake River steelhead.

The CSS study results do not support the proposed elimination of spill in order to maximize the transportation of steelhead.

NOAA has stated in public forums that the CSS data on wild steelhead supports their proposal to eliminate spill from May 15 to May 31 and into June each year. This claim is not supported by the CSS data, because CSS analyses have not addressed the benefits of spill versus no spill in comparison with transportation in weekly or bi-weekly time periods such as the NOAA proposed May 15 to May 31 time block. The CSS has shown that wild steelhead had transport-to-inriver ratios (TIRs) significantly greater than 1.0 in four out of the seven migration years (1997 to 2003) analyzed in the 10-year retrospective summary report (Table 3.14 in Schaller et al 2007). These results are based on *annual* estimates of transport SAR to inriver SAR ratios being statistically significantly greater than 1.0. Additional analyses of project-specific transport SARs show that most of the benefit of transportation occurs from transporting wild steelhead from Lower Granite Dam, the first dam encountered in the hydrosystem, while benefits from Little Goose and Lower Monumental dams are much more variable and intermediate in level between transport from Lower Granite Dam and simply passing inriver undetected (non-bypass route) past the three Snake River dams with transport facilities (Figure 4.2 in Schaller et al 2007). But these results only address the full migration season, and are not directly applicable to the question of whether spill should be terminated from May 15 to May 31 in order to maximize transportation.

The CSS has conducted analyses in which the full season has been partitioned into three temporal blocks – early (before April 26), middle (April 26-May 10), and late (after May 10). These analyses showed mean SARs for wild steelhead transported at Lower Granite Dam of 2.72% for early period, 3.21% for middle period, and 3.50% for late period. However, when looking at the shape of the SAR distributions (PDFs – probability density functions) for wild steelhead transported from Lower Granite Dam during each of these time periods (Figure 4.20 in Schaller et al 2007), the extreme variability exhibited in the late period PDF makes it unreliable for assessing any transport benefit during that late period (note that the distribution mode for the late period was only around 1% compared to 3% exhibited in the early and middle periods). Wild steelhead bypassed at Lower Granite Dam and continuing to migrate through the hydrosystem inriver had higher SARs during the early period than in the late period. However, these results do not address the expected SAR of wild steelhead passing the three Snake River collector dams undetected, which is primarily through spill when it is provided. Weekly or bi-weekly SARs can only be estimated on bypassed fish, not fish passing in spill. **In summary, these CSS results do not support the termination of spill from May 15 to May 31 in order to maximize transportation and should not be construed as supporting this proposed operation.**

In Chapter 2 of the CSS 10-year retrospective summary report (Schaller et al 2007), there are a series of analyses comparing fish travel time and survival rates to environmental and project-operational conditions that ultimately lead to predictive models. These models generally found that, for steelhead (wild and hatchery combined) the duration of time required to migrate through the hydrosystem (i.e. fish travel time) decreased with increasing flows, decreased with increasing spill proportion at a given flow and that these patterns occur for steelhead regardless of the time period of the migration. For a given flow level, steelhead survival is predicted to be higher early in the migration season than later in the season. These model prediction trends match observed data for steelhead shown in Table 2.9 for the flow effects and Table 2.10 for the spill effects in Schaller et al (2007). These findings are consistent with the comment made earlier that bypass

wild steelhead SARs are higher earlier in the migration season. The results of the Chapter 2 analyses in Schaller et al (2007) clearly indicate that the provision of flow and spill are two management actions that will improve wild steelhead survival for those fish that remain inriver through the hydrosystem.

Review of data from 2001, a year with very low flows, no spill at Snake River collector dams, and maximum transportation through the season provides additional insight into this issue. The CSS 10-year retrospective summary report (Schaller et al 2007) estimated that 99.2% of the wild steelhead population arriving Lower Granite Dam forebay in 2001 were transported (Appendix E Table E-16). Review of the adult returns of PIT-tagged **wild steelhead smolts from 2001 that were transported and of those that remained in-river provides an indication of whether the full transportation occurring between May 15 and 31 was even beneficial in 2001** a year of extremely low flow. As stated earlier, steelhead travel time (duration) through the hydrosystem decreases and survival increases as flows and spill proportion levels increase. In a year like 2001 with extremely low flows, steelhead smolts encountered extremely poor migration conditions.

There were a total of 21 returning adults of wild steelhead PIT-tagged in Clearwater, Grande Ronde, Salmon, and Imnaha River drainages as well as mainstem Snake River trap at Lewiston, Idaho for the 2001 migration year (Table 1). **Ten of these returning wild steelhead adults were from smolts that were transported, while the other eleven returning adults were of smolts that had migrated in-river.** Of those that had migrated in-river, three were never detected at any site, and the remaining eight were all detected first at Lower Granite Dam in 2001. As stated in Appendix A of Schaller et al (2007) and the 2005 and 2006 CSS annual reports (Berggren et al 2005, 2006), it was more likely the non-detected wild steelhead either completed their smolt migration in 2002 or passed undetected into the raceways during a computer outage in mid-May at Lower Granite Dam rather than traversed the entire hydrosystem undetected in 2001. Of the eight PIT-tagged wild steelhead adults whose juvenile migration was in-river following their detection at Lower Granite Dam in 2001, a total of six were confirmed to have residualized since they were subsequently detected at a downstream site in 2002. However, it is highly probable that even the other two smolts which were only detected in 2001, likewise held over and completed their migration in 2002. One of these smolts was only seen at Lower Granite Dam on May 4, 2001, while the other was detected again at Little Goose Dam on August 12, 2001, a total of 79 days after first being detected at Lower Granite Dam. Based on these adult returns, it appears likely that most wild steelhead that started migrating in-river in 2001, stopped and overwintered within the hydrosystem, and those surviving then completed their migration in 2002 under more favorable in-river conditions.

Table 1. Date of detections at PIT-tag monitoring sites of wild steelhead smolts from the 2001 migration year that subsequently have returning adult detections at Lower Granite Dam.

Tag Location ¹	Capture History	LGR	LGS	LMN	MCN	JDA	BON	TWX	GRA
In-River Migrants									
CLW	10000000								9/25/03
SAL	10000000								9/20/03
SAL	10000000								9/5/04
SNK	11000001	9/23/01						5/11/02	10/11/03
SAL	11000000	5/4/01							7/1/04
IMN	11000010	5/19/01					5/11/02		10/1/03
SNK	11001000	5/20/01			4/24/02				9/27/03
IMN	11100000	5/18/01	4/22/02						10/12/03
IMN	11100000	5/27/01	8/14/01						11/14/03
GRN	11100100	5/28/01	6/5/01			4/27/02			9/12/03
IMN	11101010	5/14/01	5/17/01		5/4/02		5/11/02		9/22/03
Transported Migrants									
GRN	11120000	4/29/01	5/2/01	5/5/01					9/2/02
SAL	11200000	4/24/01	4/28/01						9/14/02
IMN	11200000	5/3/01	5/8/01						4/22/03
IMN	11200000	5/16/01	4/5/02						10/7/03
CLW	11200000	5/1/01	5/5/01						10/29/03
SAL	12000000	5/7/01							9/11/02
SAL	12000000	5/2/01							10/1/02
IMN	12000000	4/25/01							9/25/03
IMN	12000000	4/25/01							10/27/03
CLW	12000000	4/29/01							3/28/04

¹ SNK=Snake River trap; SAL=Salmon R. basin; IMN=Imnaha R. basin; GRN=Grande Ronde R. basin; CLW=Clearwater R. basin.

Of the ten PIT-tagged wild steelhead adults that were transported as juveniles, all were first detected at Lower Granite Dam in 2001. Five of the returning adults were transported from Lower Granite Dam as smolts, four were transported from Little Goose Dam, and one was transported from Lower Monumental Dam. **Regardless of which dam these juvenile wild steelhead had been transported, all were transported before May 9, except for one fish.** This PIT-tagged smolt had been detected and bypassed at Lower Granite Dam on May 16, 2001, and was transported from Little Goose Dam on April 5, 2002, after having overwintered in the pool below Lower Granite Dam.

Under the extremely low flow conditions experienced in 2001, the PIT-tagged wild steelhead adult return data illustrate that smolts collected and transported before mid-May had documented survivors, as well as those smolts that overwintered and migrated inriver or with transportation in 2002. Likewise, wild steelhead smolts passing Lower Granite Dam throughout May and then overwintering at some downstream location before continuing their migration in 2002 had documented survivors. Even a smolt detected at Lower Granite Dam and bypassed there on September 23, 2001, survived to adulthood by overwintering and completing their in-river migration in 2002.

Based on the PIT-tagged wild steelhead adult returns of juveniles that began their smolt migrations in 2001, the NOAA proposal, in which spill is stopped to maximize transportation between May 15 and 31, would effectively not have benefited wild steelhead in that year. It appears wild steelhead were beginning the process of residualizing prior to May 15, and so transportation after that date may have had limited benefit.

In summary, results from the CSS do not support the NOAA proposal to eliminate spilling May 15 to 31 in order to maximize transportation of listed wild steelhead smolts. On the contrary, data on PIT-tagged wild steelhead in the CSS supports the provisions of adequate flows and spill proportion levels to keep the wild steelhead migration moving quickly through the hydrosystem in addition to transportation of collected wild steelhead. The annual spring freshet occurs around the May 15 to 31 period, with flows generally exceeding the Snake River dam's hydraulic capacity with uncontrolled spill occurring for some interval of time. This freshet helps push the remaining steelhead through the hydrosystem, and hydrosystem operational actions aimed at reducing the spill at the collector dams in order to maximize transportation of wild steelhead could be detrimental to the same wild steelhead population that the NOAA proposal is trying to benefit.

Relationships between in-river survival and transport to in-river ratio (*TIR*) indicate that steelhead transportation benefits are directly related to poor in-river conditions. In river conditions can be improved by decreasing water travel time and increasing spill for fish passage. Improved in-river survival will change the *TIR*.

The CSS (Schaller et al. 2007) found that transportation-to-in-river ratios (*TIRs*) were generally less than 1.0 for wild Chinook and greater than 1.0 for wild steelhead, which suggested that transported steelhead had higher smolt-to-adult survival rates (*SARs*) than steelhead that migrated in-river. However, the CSS also found that juvenile in-river survival rates were lower for wild steelhead than wild Chinook. One potential explanation for the higher *TIRs* for steelhead is that poor juvenile in-river migration conditions have resulted in poor in-river survival rates for steelhead. Under this hypothesis, improvements in in-river survival could result in *TIRs* less than 1.0 for steelhead along with providing higher *SARs* for steelhead that migrate in-river. To investigate this hypothesis, we examined the relationships between in-river survival rates and *TIRs* for each species. We also examined whether the relationship between in-river survival (S_R) and *TIR* was similar across species.

Methods and Results

Schaller et al. (2007) provides estimates of S_R and *TIR* for wild Chinook and wild steelhead. We used linear regression to assess the relationships between S_R and *TIR* for both species (Figure 1). The dependent variable (*TIR*) was log-transformed to better approximate normality in the error terms and to reduce heteroscedasticity. Table 3 below, contains the resulting parameter estimates and summary statistics from the fitted relationships. Both regressions demonstrated statistically significant slopes ($P = 0.03$ for Chinook and $P = 0.05$ for steelhead). For wild Chinook, the mean *TIR* is predicted to decline below 1.0 when in-river survival rates are greater than 0.52. For wild steelhead, the mean *TIR* is predicted to decline below 1.0 when in-river survival rates are greater than 0.55. Historically for wild Chinook, S_R has been greater than 0.52 in four years and in two of those years, *TIRs* were less than 1.0 (Appendix 1). Historically for wild steelhead, S_R has not been greater than 0.55, but the highest S_R (0.54) was associated with a *TIR* of 0.20 (Appendix 1).

Table 3. Equation parameter estimates, R^2 -values, and P -values for regressions between S_R and $\text{Log}(TIR)$ for wild Chinook and wild steelhead.

Species	Equation parameter estimates	R^2 -values	P -value
wild Chinook	$\text{Log}(TIR) = 1.78 - 3.45S_R$	0.44	0.03
wild steelhead	$\text{Log}(TIR) = 3.51 - 6.46S_R$	0.55	0.05

Figure 1. Regression relationships between in-river survival (S_R) and $\text{Log}(TIR)$ for wild Chinook (left panel) and wild steelhead (right panel).

Next, we examined whether there were differences in the relationships between S_R and TIR by species. We fit four models (Table 4) to examine whether a common model could apply to both species or whether each species had different intercept and/or slope parameters describing the relationships between S_R and TIR . We used Akaike's Information Criterion (AIC) to determine the best-fitting model, with lower values of AIC indicating a better fit to the data.

The resulting AIC values indicate that a common (across-species) model can be used to characterize the relationship between S_R and TIR for both species (Table 4). Species-specific intercepts and/or slopes resulted in higher AIC-values than the model that used one intercept parameter and one slope parameter to characterize the relationship. The best-fit regression was: $\text{Log}(TIR) = 2.75 - 5.20S_R$, which had an R^2 of 0.50 and a highly significant slope ($P < 0.001$, Figure 2). The common model parameter estimates indicate that mean TIR will be less than 1.0 when S_R is greater than 0.53. Historically, five of the S_R estimates have been greater than 0.53, and three of the five estimates of TIR were less than 1.0 (Appendix 1).

Table 4. AIC values for the four models examined for describing the relationship between S_R and TIR .

Model	AIC
one intercept, one slope	48.74
species-specific intercept, one slope	49.40
one intercept, species-specific slope	50.31
species-specific intercept and slope	49.76

Figure 2. Lowest-AIC regression of the relationship between S_R and $\text{Log}(TIR)$ for wild Chinook and wild steelhead combined.

Discussion

These results support the hypothesis that the higher TIR s observed for wild steelhead is a result of low in-river survival rates for wild steelhead. Over the time series examined, in-river survival rates have been considerably lower for steelhead compared to Chinook (average $S_R = 0.46$ for wild Chinook and 0.39 for wild steelhead). Using the common (across-species) model, mean TIR is predicted to be 2.06 when the in-river survival rate is 0.39. However, if in-river survival rates increased to values greater than 0.53, the mean TIR for both species is predicted to decline below 1.0. The S_R for steelhead was greater than 0.53 in only one year (1998, $S_R = 0.54$, Appendix 1), but steelhead demonstrated a TIR much less than 1.0 ($TIR = 0.20$, Appendix 1). Because in-river survival rates are so much lower for steelhead compared to Chinook, it is not surprising that the TIR s for steelhead are higher compared to Chinook. If the S_R for steelhead were similar to Chinook, these results suggest that TIR s would also be similar.

The results in Schaller et al. (2007) demonstrate that improvements in in-river survival for steelhead can be achieved through reductions in water travel time and increases in the percentage of spill. The highest weekly survival rate observed in the LGR-MCN reach (0.84) occurred during the last week in May 1999 when water travel time was 5.8 days (flow = 211 kcfs) and the average percent spill was 42%. The models developed in Schaller et al. (2007) also suggest that reduction or elimination of spill would dramatically reduce in-river survival rates for steelhead. For example, under conditions of 120 kcfs flow and 50% spill in the LGR-MCN reach during late May, steelhead survival is predicted to be 0.49 versus 0.27 under conditions of the same flow and 0% spill.

The expected result of management decisions to terminate or reduce spill based on TIR s becomes a self-fulfilling prophecy: the termination of spill would reduce the in-river survival rates of juvenile migrants (both steelhead and Chinook) resulting in TIR s greater than one. However, if juvenile migration conditions are improved through reductions in water travel time and increases in the percent spill, in-river survival rates would increase and TIR s would be less than one. An

additional consideration is the overlap between other species (e.g., juvenile sockeye and fall Chinook) that would be experiencing the same migration conditions.

The information presented here on S_R and $TIRs$ indicates that $TIRs$ are largely a function of the conditions that are provided to in-river migrants. An important point to remember is that TIR is the *ratio* of the SAR of transported fish versus the SAR of fish that migrate in-river. Management decisions have limited ability to affect the SAR of fish that are transported as transport $SARs$ are primarily a function of the environmental conditions experienced during the estuarine/early-ocean period. In contrast, management decisions have much greater ability to affect the $SARs$ of fish that migrate in-river. Decisions to reduce water travel time or increase the percentage of spill functionally decrease the TIR by increasing the SAR of in-river migrants. These same decisions can increase the proportion of fish migrating in-river under improved migration conditions. As a consequence, increasing the proportion of fish migrating in-river under improved migration conditions is the *only* way to increase the population-level $SARs$ of anadromous salmonids by increasing the $SARs$ of fish that migrate in-river and reducing the number of fish that are transported.

Appendix 1. Data from Schaller et al. (2007) used in the analysis.

Year	S_R	Species	TIR	$\ln(TIR)$
1994	0.20	CHW	1.62	0.48
1995	0.41	CHW	0.95	-0.05
1996	0.44	CHW	1.92	0.65
1997	0.51	CHW	0.74	-0.30
1998	0.61	CHW	0.87	-0.14
1999	0.59	CHW	1.14	0.13
2000	0.48	CHW	0.60	-0.51
2001	0.23	CHW	8.96	2.19
2002	0.61	CHW	0.65	-0.43
2003	0.60	CHW	1.05	0.05
2004	0.40	CHW	0.97	-0.03
1997	0.52	STW	2.20	0.79
1998	0.54	STW	0.20	-1.61
1999	0.45	STW	2.28	0.82
2000	0.30	STW	1.45	0.37
2001	0.04	STW	37.00	3.61
2002	0.52	STW	4.25	1.45
2003	0.37	STW	4.13	1.42

Survival estimates calculated by NOAA fisheries from 2006 and 2007 were similar although flow conditions were not, indicating that spill provided benefits to juvenile survival of in-river migrating steelhead, even under low-flow conditions. Additionally, in river survival for steelhead has increased in recent years, which have not been included in transport benefit analyses because adult returns are not complete.

The following table (Table 5) was developed from an August 31, 2007 NOAA National Marine Fisheries Service memo from John Ferguson on “Preliminary survival estimates for passage during the spring migration of juvenile salmonids through Snake and Columbia River reservoirs and dams, 2007”. Juvenile steelhead survival (hatchery and wild combined) in 2007 was 0.695. This contrasts to the 2006 estimate, which was 0.702 and the 2001 estimate of 0.168. However, 2006 was a high flow year in the Snake River (125 Kcfs spring flow average), while 2007 was an extremely low flow year (63 Kcfs spring flow average). Given the relation between flow and survival for steelhead it was anticipated that juvenile survival would have been more like that observed in 2001 a drought year when average spring flow was about 48 Kcfs. The operational difference between the two years in the Snake River was that no spill occurred at Snake River collector projects in 2001, while spill occurred all through the spring migration period in 2007. At John Day Dam the difference in operations was high flow and spill of approximately 40% instantaneous flow 24 hour per day in 2006, compared to lower flow and spill of 52% instantaneous only during nighttime hours in 2007. As NOAA notes in their memo “The 2007 water year differed, and from the other low-flow year of 2001, in the amount (and percentage) of the flow volume that passed Snake River dams via spillways. The mean volume spilled at Lower Granite, Little Goose, and Lower Monumental dams was near constant throughout April and May of 2007. With the low flow of April, this represented the highest percentage of spill of the last 7 years.” NOAA does make reference to the possibility that tern predation was lower this year, but no data have been analyzed to suggest this change.

Table 5. Mean estimated survival and standard error (s.e.) through various reaches of the Snake and Columbia River power system for steelhead originating in the Snake River 2001, 2007. (Hatchery and wild fish combined) Data from John Ferguson, August 31, 2007 memo.

Year	LGR –MCN	MCN -JDA	JDA-BVL
2001	0.168 (0.006)	0.337 (0.025)	0.753 (0.063)
2002	0.536 (0.025)	0.844 (0.063)	0.612 (0.098)
2003	0.597 (0.013)	0.879 (0.032)	0.630 (0.066)
2004	0.379 (0.023)	0.465 (0.078)	No estimate
2005	0.593 (0.018)	0.595 (0.040)	No estimate
2006	0.702 (0.016)	0.795 (0.045)	0.813 (0.083)
2007	0.695 (0.020)	0.947 (0.087)	0.614 (0.076)

The COMPASS model does not provide an adequate basis for eliminating spill the last two weeks of May to improve Snake River steelhead survival.

The Draft Biological Opinion states that terminating spill during the last two weeks of May and maximizing transportation provides a benefit for migrating steelhead. This conclusion is reached based on COMPASS model simulations. The foundation for the improvements predicted by the COMPASS model is based on a hypothesis that links salmonid survival to adulthood (SAR) based on the arrival time of juvenile migrants below Bonneville Dam (Scheuerell and Zabel, 2007 *draft manuscript*). With the exception of very early in the season, the earlier a migrant arrives below Bonneville Dam the higher the subsequent survival to adulthood.

While there is likely a biological basis for the relation between arrival below Bonneville and SARs, there are several shortcomings with the present COMPASS relation between arrival timing and SARs for steelhead. These shortcomings affect the ability to predict actual changes in adult survival from this information. Included in those shortcomings are:

- The relation between arrival timing and SARs for steelhead is based on limited data. The analysis used only four years of data available for steelhead (1999, 2000, 2002 and 2003).
- The SARs for steelhead used in the model are based on data collected mostly from years when overall in-river survival was low. The in-river survival in those years was likely affected by the river and project operations and the absolute number of migrating in-river steelhead juveniles. This bias inherently favors transported fish over in-river migrants.
- There is a clear relation between the number of times a juvenile migrant is bypassed and the subsequent survival to adulthood post juvenile hydrosystem passage. The relation can be developed for chinook because of sufficient data, and bypass can be used as a factor for explaining variability in SARs. However, the relation is not developed for steelhead because of the limited data. In response to the data limitations, all in-river migrants have been combined in the NOAA analyses (i.e. 0-bypass, 1-bypass, 2-bypass etc.) in characterizing the relation to SARs potentially biasing in-river migrant SARs too low.
- The COMPASS model uses two relations for describing arrival date below Bonneville and SARs. One is for in-river juveniles and the other is for transported juveniles. The SARs for in-river steelhead are generally lower than for transported steelhead. Consequently, in the model it is more likely that higher transported SARs were derived when the proportion of in-river migrants was low and the proportion of transported fish was high. This would favor a higher transportation SAR by increasing the proportion transported.
- It should be no surprise that the maximization of transport would yield a higher modeled survival given the model mechanics and assumptions that arrival timing at Bonneville determines survival. The model uses a two day transport for barged fish and therefore, transported fish will always arrive at Bonneville sooner than it would have as an in-river migrant. The maximization of transport modeled scenario gets more migrants to below Bonneville Dam on an earlier date than in- river migrants yielding a higher SAR.

The COMPASS model should be one tool for evaluating the efficacy of a measure under consideration in the Biological Opinion not the only tool. The model is only as good as its data and assumptions. Limitations in data can certainly affect model outcome. In this case, we see a relation that is based on just a few years when most steelhead were bypassed multiple times. The knowledge that there is a significant relation between the number of times bypassed and survival to adulthood should give pause regarding the use of a composite data set to describe the relation for steelhead in river migrants. Given this knowledge of the potential bias in the survival of in-river migrants to adulthood, it would be prudent to use extreme caution when making management changes to the way steelhead are handled in the system.

In conclusion, the COMPASS analysis does not provide an adequate basis for eliminating spill the last two weeks of May. There is too little data describing juvenile steelhead survival to adulthood, based on whether they migrated in-river or on the barge, to make actual management recommendations based on the COMPASS model.

The proposed operation eliminating spill from May 15 to May 31 will adversely affect other species passing during this time period by increasing turbine passage, increasing transportation and increasing passage delay at the projects.

In years where seasonal average flows exceed 65 Kcfs, the Draft 2007 Biological Opinion (2007 BiOP) calls for the termination of spring spill and implementation of maximum transportation at Snake River collector projects (LGR, LGS, and LMN), beginning May 15th. This operation would continue until the initiation of summer spill, which would begin when subyearling Chinook exceed 50% of the collection at each Snake River project for a 3 day period after June 1. If subyearling Chinook do not exceed 50% of the collection for a 3 day period in June, summer spill at these projects would begin on July 1.

The primary rationale for eliminating voluntary spill and implementing maximum transport is to increase the proportion of the steelhead run that is transported. This is based in large part on studies that indicate higher SARs for transported steelhead versus those that migrated in-river or were bypassed. Although transported steelhead have had higher SARs than those migrating in-river or bypassed, this is not the case for wild Snake River spring/summer Chinook. Furthermore, it is unclear whether there is a benefit to transporting Snake River subyearling Chinook. Finally, it is unknown what kind of impact transportation has on Snake River sockeye and coho juveniles. Switching to maximum transportation with no spill, beginning May 15, will inevitably increase the proportion of yearling Chinook, subyearling Chinook, sockeye, and coho that are transported, which could lead to a negative impact on these species, given the lack of data showing a benefit from transportation.

To investigate the potential impact of operating at maximum transportation with no spill (from May 15 through the initiation of summer spill), FPC staff estimated the proportion of the population of yearling Chinook, steelhead, sockeye, coho, and subyearling Chinook passing Lower Granite, Little Goose, and Lower Monumental dams during this time, over the past ten years (1998-2007). These estimates are based on the daily passage index for each species at LGR, LGS, and LMN. For each year, we determined the start date for summer spill at each project, based on the 50% subyearling Chinook criteria indicated in the 2007 BiOP. Results from this analysis can be found in Table 6.

On average, the vast majority of Snake River sockeye and coho (63.4 to 75.9% for sockeye, 64.9-78.6% for coho) juveniles pass Snake River collector projects during the times of the proposed maximum transport/no spill operation (Table 6). Given that such a high proportion of sockeye and coho populations are passing Snake River collection projects during this time, it is highly likely that eliminating spring spill from May 15 until the initiation of summer spill would significantly increase the proportion transported. This is a particularly risky strategy, given that there is no evidence of transportation providing a benefit to these species.

Table 6. Annual percentage of yearling Chinook, steelhead, sockeye, coho, and subyearling Chinook passing Lower Granite Dam during proposed period of no spill/maximized transportation operation (May 15 to Initiation of summer spill).

Project	Year	Last Day of Max. Transport	Percent Passing During Max. Transport Operation (May 15 to Last Day of Max. Transport Operation)				
			Yearling Chinook	Steelhead	Sockeye	Coho	Subyearling Chinook
LGR	1998	30-Jun	5.7	19.7	41.0	55.4	16.3
	1999	11-Jun	26.6	38.3	67.0	89.5	21.2
	2000	12-Jun	9.9	22.1	57.2	85.1	8.1
	2001	12-Jun	27.8	39.7	73.4	59.4	12.5
	2002	25-Jun	26.7	47.1	65.3	94.1	17.4
	2003	6-Jun	22.7	50.0	86.9	82.4	18.4
	2004	8-Jun	7.2	33.1	57.1	60.1	12.8
	2005	3-Jun	4.2	15.2	71.4	14.3	47.9
	2006	3-Jun	12.3	24.6	43.7	59.8	36.1
	2007	4-Jun	6.7	24.7	71.4	49.0	16.9
Average		11-Jun	15.0	31.4	63.4	64.9	20.8
LGS	1998	30-Jun	15.1	29.8	78.3	84.7	8.9
	1999	23-Jun	37.9	46.8	67.4	86.6	28.4
	2000	17-Jun	18.2	12.1	62.6	76.1	16.7
	2001	26-Jun	55.3	54.9	15.4	26.8	7.9
	2002	18-Jun	37.1	54.9	35.7	95.7	15.5
	2003	16-Jun	42.6	61.2	89.8	94.8	38.5
	2004	11-Jun	14.5	35.9	65.9	78.0	27.0
	2005	3-Jun	19.9	28.8	74.4	47.7	20.9
	2006	3-Jun	23.8	29.2	62.4	91.2	28.1
	2007	8-Jun	43.9	53.6	83.6	72.7	16.7
Average		15-Jun	30.8	40.7	63.6	75.4	20.9
LMN	1998	30-Jun	16.5	37.2	93.1	85.1	29.1
	1999	25-Jun	40.1	55.8	75.3	95.2	20.2
	2000	12-Jun	18.2	32.5	83.4	78.1	27.0
	2001	30-Jun	40.4	54.2	61.3	26.4	17.1
	2002	28-Jun	41.2	73.8	69.6	95.4	16.4
	2003	6-Jun	35.0	69.8	68.3	84.0	18.4
	2004	10-Jun	15.1	42.8	86.4	86.4	20.6
	2005	5-Jun	21.7	36.0	67.6	66.7	20.0
	2006	3-Jun	35.1	43.8	75.7	84.2	32.4
	2007	9-Jun	51.2	63.6	88.8	84.2	27.0
Average		15-Jun	31.5	50.9	76.9	78.6	22.8

Implementing the proposed operation will only slightly increase the proportion of steelhead transported.

To assess the affect of the proposed elimination of spill on May 15, we estimated the proportion of steelhead which would have been transported in 2007 and 2006 if the proposed May 15 to May 31 elimination of spill was implemented in 2007 and 2006.

- The probability of steelhead originating above Lower Granite Dam being transported in 2007 under the operations agreement was estimated by FPC to be 47% for hatchery steelhead and 43% for wild steelhead. Ending spill in mid-May, as proposed by NOAA would have increased the proportion transported to approximately 65%. Implementing the NOAA proposal to eliminate spill the last two week of May in 2006 would have increase the proportion of steelhead transported by approximately 13%, from 78% to 90%.
- The estimated transport probabilities in 2007 were the lowest since FPC began calculating those numbers in 1999
- The lower portion transported in 2007 was due to higher than average spill proportions at Snake River collector dams and the delayed transport schedule. However, in-river survival of steelhead calculated by NOAA fisheries indicated a 69.5% survival of in-river migrating steelhead in 2007 which was similar to the 70% in-river survival which occurred in the high flow high spill year of 2006.

Methods

Daily passage indices were used to estimate steelhead passage timing over the season at Lower Granite Dam. This approach was compared to population indices based on estimated daily detection efficiencies of PIT-tagged steelhead and found to be very similar for the years 2003 to 2007. Detection efficiency estimates were generated from CJS reach survival estimates for Lower Granite, Little Goose and Lower Monumental dams, for both hatchery and wild PIT-tagged steelhead released above Lower Granite Dam. From the Lower Granite timing data (which was combined for hatchery and wild steelhead), and the detection efficiency estimates, the probability of steelhead being transported at Snake River collector dams was calculated.

The projected proportion of steelhead that would have been transported at Lower Granite Dam in 2007, had the new BiOp transport program been implemented, was also calculated. The new BiOp calls for maximum transport (by stopping spill) beginning May 15 at Snake collector dams. Spill would be begun anew in June, when 50% or more of the collection was subyearling chinook. Estimates of detection efficiency from 2001 were used to simulate what proportion of steelhead would have been collected at those sites in 2007 under the no spill scenario. Steelhead travel time, in 2007, was just under 3 days between LGR and LGS, and just under 6 days LGR and LMN. Therefore, fish arriving at Lower Granite Dam between May 9 and May 11 were assumed to pass LMN dam after spill had ended on May 15. Similarly, fish that passed LGR between May 12 and 14 were assumed to pass LGS and LMN after spill ended at those sites on May 15. Because it is difficult to determine what impact no spill would have had on collection at Little Goose and Lower Monumental dams, it was assumed in our estimate that those dams

would have completed no spill operation in such a way that steelhead passing Lower Granite Dam after June 4 (the last date the no spill operation would have occurred in 2007 based on collection at LGR) would not be subject to transport at downstream sites.

Results

Detection probabilities used in the 2007 calculations are shown in Table 7. The CE values were derived from survival estimates, while the transport proportion of collection was derived from SMP data. The detection probabilities in 2007 were much lower at Lower Granite Dam and especially at Little Goose Dam, such that overall detection probability for 2007 was markedly lower than other years. Table 8, summarizes the transport probabilities for steelhead originating above Lower Granite Dam in 2007. As can be seen the 2007 values of 47% for hatchery and 43% for wild fish were much lower than any other recent year. The next closest year, 2003 at 67%, was a relatively high flow year.

Table 7. Estimated detection probabilities, transport proportions and resulting overall proportion of steelhead transported at transport dam.

Species/Rear Type	Dam	CE estimated detection probability	P(t) Proportion of collection transported ¹	P(j) overall proportion transported
Hatchery Steelhead	LGR	0.24	0.995	0.244
	LGS	0.35	0.993	0.346
	LMN	0.18	0.990	0.181
Wild Steelhead	LGR	0.22	0.995	0.219
	LGS	0.39	0.993	0.388
	LMN	0.25	0.990	0.249

¹ Proportion of collection transported was calculated as (total fish transported/total collection) during the time period when transport was occurring at each dam.

If the NOAA proposal had been implemented in 2007, based on actual collection at Lower Granite Dam, there would have been no spill between May 15 and June 4 at that project. Our estimate of the resulting transport proportion under the new BiOp scenario was 65%. This represents a 20 percentage point increase in the proportion of steelhead that would have been transported in 2007.

Table 8. Estimated proportion of steelhead arriving Lower Granite Dam “destined” to the transportation strategy.

Species	Migration Year								
	1999	2000	2001	2002	2003	2004	2005	2006	2007
Steelhead	0.83	0.81	0.99	0.68	0.67	0.96	0.94	0.76(H) 0.79(W)	0.47(H) 0.43(W)

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MEMORANDUM

TO: Scott Harden, All Sports LLC

Michele DeHart

FROM: Michele DeHart

DATE: November 21, 2007

RE: Data Request

In response to your data request regarding the 2007 low returns of fall Chinook at Bonneville Dam and McNary and the above average returns of adult fall Chinook at Lower Granite Dam, the FPC staff summarized historical passage data, passage management and production data for your review. The following summary is not a comprehensive life cycle analysis of these populations of fall Chinook, but simply a summary of juvenile migration factors that could have affected the current adult returns. We have compared passage data and passage conditions, as well as hatchery production and the differences that have occurred from year to year for Bonneville Pool (Spring Creek Hatchery), Hanford Reach and Snake River fall Chinook. We have not addressed harvest because we do not maintain harvest data.

Adult returns in any given year are the result of several cohorts of returning adults and their survival represents the cumulative effect of a myriad of factors throughout the life cycle of these populations. As previously stated we have not attempted a complete life cycle analysis, nor have we attempted to single out the importance of individual variables. We have, however, summarized the juvenile hydrosystem passage and return data to display the differences in conditions that occurred without offering a definitive conclusion regarding a single most important factor that resulted in the disparity between fall Chinook returns to Lower Granite Dam relative to McNary and Bonneville dams. We have documented that changes have occurred in juvenile fish passage and hatchery production in recent years. The following summary is separated into categories that data and analysis have shown to affect adult returns:

- Flow conditions for juvenile migrants
- Spill for juvenile fish passage at Columbia and Snake rivers hydroelectric projects

- Hatchery production releases

Columbia and Snake River Fall Chinook returns in 2007

Fall Chinook migrating past Bonneville Dam continued to exhibit a downward trend in abundance that began after adult returns peaked in 2003. The 2007 Fall Chinook returns to Bonneville Dam were 157,443 as of November 14, 2007. This return is 53% of the 2006 return and 43.5% of the ten year average. The Fall Chinook returns at McNary Dam showed a similar pattern with 2007 equaling 64% of the 2006 return, and 52 % of the ten year average.

On the other hand, fall Chinook returns to Lower Granite Dam on the Snake River showed a different trend. Prior to 2007 the trend in abundance to the Snake River was similar to that observed for the return to the Columbia River. However, in 2007 counts at Lower Granite Dam did not decrease and were 127% of the 2006 counts and 132% of the ten year average.

The following graphs of adult fall Chinook returns show the trends since 2000.

Figure 1. Adult Fall Chinook ladder counts at (a) Bonneville, (b) McNary and (c) Lower Granite dams for 2000 to 2007.

The majority of fall Chinook adults returning in 2007 would have primarily migrated in 2003 and 2004 for Hanford Reach stocks and 2004 and 2005 for Snake River stocks, with 2003 contributing a small percentage. The Spring Creek Hatchery stock would have primarily migrated primarily in 2004 and 2005, similar to the Snake River stocks. The intent of this memo is to characterize the migration conditions that had occurred in these years and compare them to the recent historic conditions in an attempt to identify factors that might have been different for Hanford reach, Snake River and Spring Creek Hatchery migrants.

Summary

Based on the attached analyses and compilation of information, it is difficult to identify one factor as the cause for the decline of Hanford Reach and Spring Creek Hatchery stocks while Snake River stocks increased. Although recognizing that this is not the definitive answer to your question, we have summarized what we do know about the groups comprising the 2007 adult fall Chinook return.

- The first year of a planned summer spill program in the Snake River occurred in 2005. In 2005, there was no planned spring spill program because of low river flows. A short period of unplanned spill occurred during a peak flow period. Hatchery releases of fall Chinook occurred early in 2005 and coincidentally benefited from the peak flows and spill period. However, early hatchery releases migrated coincident with unplanned Snake River spill events due to peak flows. Consequently, a significant portion of the migration in 2005 in the Snake River migrated under spill conditions.
- Spill for Snake River fall Chinook juvenile migrants has increased significantly over the past few years, with the addition of voluntary summer spill since 2005. Furthermore, with the addition of voluntary summer spill, a higher proportion of Snake River subyearling fall Chinook pass LGR during times of spill.
- A smaller proportion of the fall Chinook originating above Lower Granite Dam have been transported since 2005 compared to previous years. Recent analyses (FPC Annual Report 2005) showed the improvement in survival for subyearling Chinook passing in spill. These two facts together result from increased spill; increased in-river population (lower transport proportion), and improved survival. The combination of these would increase the in-river population surviving to below Bonneville Dam, and could provide one source of the increased adult returns seen in 2007.
- Hatchery releases of Snake River fall Chinook were at their highest in 2005. However, the 2004 hatchery release was significantly less than observed in recent past years. Since these two out migration years comprise most of the adult return to Lower Granite in 2007, it is difficult to assess the affect that differences in numbers of fall Chinook released from hatcheries above Lower Granite in 2004 and 2005 had on the 2007 adult return.

- Fall Chinook originating in the Hanford reach experienced poor downstream flow conditions during the summer period for the two primary migration groups (2003 and 2004), which may have contributed to the 2007 adult return.
- Hatchery releases of fall Chinook in the Mid-Columbia in 2003 and 2004 were comparable to past years.
- Other factors, such as entrapments due to the operation of the hydrosystem, may have affected the juvenile migrants during 2003 and 2004. These outmigration years were prior to the Hanford Reach agreement for the operation of the hydrosystem.
- Despite increased releases of tule fall Chinook from Spring Creek Hatchery in recent years, a smaller proportion of juveniles are passing Bonneville Dam during periods of spill, which may be contributing to the lower adult returns seen in recent years.

A. Snake River Juvenile Fall Chinook Migration conditions

1. Flow

The development of the Columbia and Snake rivers hydrosystem changed a free flowing river system into a series of slow moving reservoirs with dams as obstacles to fish passage. Flow objectives are a measure contained in the Biological Opinion to aid the juvenile migration in passing through the hydrosystem. Increases in river flow decrease the amount of time that juvenile salmonids spend in the hydrosystem and improves their overall survival to adulthood.

The majority of the 2007 adult PIT tags were recovered from juveniles that migrated downstream in 2004 and 2005. The following table (Table 1) shows the spring and summer flows that occurred in the Snake River over the past 13 years. Both spring and summer flows in the Snake River were below the Biological Opinion flow objectives for 2004 and 2005.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Spring Objective	95.0	100.0	100	90.0	100.0	96.3	85.0	97.0	89.1	85.0	85.0	100.0	85.0
Spring Average	101.1	138.3	162.5	115.6	117.0	85.1	47.5	83.4	90.0	70.1	66.3	125.3	61.5
Summer Objective	52.0	53.5	55.0	50.6	54.0	51.3	50.0	51.0	50.7	50.0	50.0	54.5	50.0
Summer Average	55.3	52.7	66.3	53.2	56.0	39.6	25.4	41.2	32.3	33.2	33.4	37.6	28.8

Table 1. Spring and Summer Biological Opinion flow objectives at Lower Granite Dam from 1995 to 2007 as well as actual average seasonal flows at each project. Values in bold indicate that the seasonal flow objective was met.

2. Spill

Spill is provided as a mechanism to get fish past a hydroelectric project via the route associated with the least project mortality. In addition, spill decreases the amount of time that fish spend in

the hydrosystem by decreasing the delay associated with hydroproject passage. Early indications of transportation studies for fall Chinook in the Snake River suggest that transportation neither harms nor enhances juvenile survival of fall Chinook. Consequently, spill in the Snake River is provided to enhance in-river migration conditions for fall Chinook. Analyses of spill effects on juvenile fall Chinook (FPC, Subyearling Chinook Survival in Lower Granite Dam to McNary Dam reach 1998 to 2006) have shown the benefit of spill to in-river survival of subyearling Chinook, especially fish originating in the Snake River above Lower Granite Dam.

A summer spill program for fall Chinook was not implemented until the Court order of 2005. The following figure (Figure 2) show the total spill that has occurred during the Biological Opinion summer spill period of June 21 to August 31 in the Snake River since 2001. As you can see from the graph, very little summer spill occurred at the transport projects prior to the Court Ordered spill program in 2005. Spill that did occur prior to 2005 at the transport collector projects was a function of “involuntary spill”, which is water that is spilled because the flow exceeds the hydraulic capacity of a project or because there is a lack of market for the energy produced.

Figure 2. Total summer (June 21-August 31) spill volumes (MAF) at Bonneville (BON), McNary (MCN), Priest Rapids (PRD), Ice Harbor (IHR), Lower Monumental (LMN), Little Goose (LGS), and Lower Granite (LGR) dams from 2001 to 2007.

However, the amount of spill that occurred during the summer spill program does not by itself tell the whole picture. Since the initiation of the fall Chinook supplementation Program in the late 1990's the hatchery releases have overwhelmed the natural fish and display a different pattern of migration. The following figure (Figure 3) shows the passage distribution of fall Chinook at Lower Granite Dam since 2001. The cumulative distribution appears to occur earlier throughout the time period as more and earlier supplementation hatchery releases have occurred above Lower Granite Dam.

Figure 3. Subyearling fall Chinook passage index distribution timing at Lower Granite Dam (2001-2007).

Because of this shift in timing it is important to also consider the spill that occurred prior to the start of the summer spill period. The following figure (Figure 4) shows the spill that occurred in the system between June 1 and June 21. This spill would have occurred as a result of the spring spill program or involuntary spill.

Figure 4. Total spill volume (MAF) at Bonneville (BON), McNary (MCN), Priest Rapids (PRD), Ice Harbor (IHR), Lower Monumental (LMN), Little Goose (LGS), and Lower Granite (LGR) dams from June 1 to June 21 (2001 to 2007).

An important factor to consider is that in 2005 there was no planned spill at the fish transportation projects, however, involuntary spill did occur during May. This, coupled with the fact that hatcheries released fish approximately two weeks early because of decreasing river flows, resulted in a relatively high proportion of juvenile migrants passing in-river during periods of spill. Given the variability in involuntary spill at Snake River projects over the years, the proportion of the subyearling fall Chinook population that would have migrated past LGR during spill for migration years 2001 to 2007 (Table 2) was estimated. These estimates are based on the daily passage indices and the daily average spill volumes at LGR. Of the migration years that would be returning to LGR in 2007 (MY 2002-2007), migration years 2005, 2006, and 2007 had the highest percent of subyearling Chinook passing LGR during spill and the highest average percent spill during times of fish passage (Table 2). This is mostly due to the addition of voluntary summer spill during these years. It is worth noting that the percent of subyearling Chinook juveniles passing LGR during spill in 2005 may have been more similar to that seen in 2001, had there not been involuntary spill in May and early June and voluntary spill in the summer.

Table 2. Percent of subyearling Chinook passing Lower Granite Dam during spill and average percent spill when fish are passing during spill (2001-2007).

Migration Year	Percent Passing LGR During Spill	Average Percent Spill When Fish Passing LGR Through Spill
2001	0.45	11.65
2002	48.75	32.68
2003	53.89	28.47
2004	16.65	20.58
2005	66.62	43.91
2006	99.17	42.91
2007	96.87	42.63

As a result of summer spill, a smaller proportion of subyearling Chinook were transported in recent years (Table 3). In 2006 the lowest proportion of subyearlings were transported in any of the recent years. While 2005 was lower than other years, it was still a relatively high proportion transported, due to the lack of planned spring spill in that year. As stated earlier with the increase in spill there has been an increase in reach survival in subyearling Chinook. So the combination of decreased transportation, and increased in-river survival could yield overall increases in the numbers of juvenile subyearling Chinook surviving to ocean entry. This is one possible source of increased adult returns in 2007.

Table 3. Comparison of the 2006 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 1999 to 2005.

Species-age group	Transport Proportion							
	2006	2005	2004	2003	2002	2001	2000	1999
Subyearling Chinook	0.521 (H) 0.562 (W)	0.809	0.972	0.895	0.929	0.962	0.93	0.870

3. Hatchery production releases

Over the past seven years, production releases of Snake River fall Chinook (above LGR) have ranged from 1.93 to 4.25 million (Figure 5). Migration years 2005 and 2006 had the highest production releases of Snake River fall Chinook (above LGR) over the past 7 years, with 4.25 million released in 2005 and 3.83 million released in 2006, while 2004 had one of the lowest hatchery releases. Juveniles from the 2004 and 2005 releases would be making the largest contribution to the adult returns. However, without smolt to adult return rates for each cohort it is impossible to assess at this time what contribution the increased hatchery release may be making to the 2007 return.

Figure 5. Production releases of fall Chinook to the Snake above LGR.

B. Hanford Reach juvenile fall Chinook migration conditions

A summary of the Hanford Reach fall Chinook population by age from 1997 through 2006 is provided in Table 4. From this table it can be seen that between the years 1997 and 2006, the majority of returning URB fall Chinook adults in the Hanford reach are age 4 and age 5. Although the 2007 age class breakdown is not yet available, it can be assumed based on Table 4, that the majority of Hanford URB adults returning in 2007 were age 4 and age 5. Returning age 4 and age 5 adults in 2007 would have spawned in 2002 and 2003 and would have out-migrated in 2003 and 2004.

Table 4. Annual Hanford Reach URB fall Chinook escapement by age (%), 1997 - 2006¹.

Year	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
2006	6.0	7.4	34.3	51.0	1.1	0.2
2005	0.9	10.9	55.2	31.9	1.1	
2004	1.3	13.6	20.7	61.8	2.2	
2003	1.4	5.1	54.8	38.6	0.1	
2002	1.2	16.2	60.5	22.1	0.1	
2001	5.8	21.0	50.9	21.0	1.3	
2000	3.2	7.4	36.1	53.3	0.0	
1999	3.2	12.3	65.8	17.5	1.3	
1998	1.8	18.6	13.1	65.6	1.0	
1997	1.1	2.9	64.0	31.8	0.2	
Mean	2.2	12.0	46.8	38.2	0.8	

1. Flow

Mid and Lower Columbia flow conditions during the 2003 and 2004 out-migration are presented in Table 5. From Table 5, the 2003 out-migration year appeared to be a slightly better flow year than 2004 during the spring Biological Opinion flow period. At McNary Dam and Priest Rapids Dam, flows just exceeded the Spring Biological Opinion targets in 2003. In 2004, flows averaged just under the Spring Biological Opinion targets. In both 2003 and 2004, summer flows were significantly below the Summer Biological Opinion objectives. In fact, the summer flows during 2003 and 2004 were the lowest in the 13 years presented, with the exception of the 2001 drought year.

It appears that average spring flows were not exceptionally low during either the 2003 or 2004 out-migration years. Average spring flows in 2004 were less than the Biological Opinion flow targets in both the middle and lower Columbia River, however average spring flows in 2004 were not excessively below the flow spring target. Summer flows during both the 2003 and 2004 out-migration years were significantly below the Summer Biological Opinion objectives and the lowest in the 13 years presented, with the exception of the 2001 drought year. Based on all of this information, it appears that excessively low summer flows below the Hanford Reach during the out-migration years of 2003 and 2004 may have contributed to low adult returns seen in 2007.

¹ Table from Assessment of Losses of Juvenile Fall Chinook in the Hanford Reach of the Columbia River in relation to Flow Fluctuations, Hoffarth, P., et.al. June 30, 2007.

Table 5. Spring and Summer Biological Opinion flow objectives at McNary Dam, and Priest Rapids Dam (spring only) from 1995 to 2007 as well as actual average seasonal flows at each project. Values in bold indicate that the seasonal flow objective was met.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
McNary													
Spring Objective	249.0	260.0	260.0	228.0	260.0	260.0	220.0	246.0	220.0	220.0	220.0	260.0	237.0
Spring Average	253.0	357.1	463.5	287.8	303.6	243.4	123.9	269.3	231.4	203.2	195.7	325.4	239.2
Summer Objective	200.0	200.0	200.0	200.0	200.0	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	135.5	133.7	165.1	166.5	166.3
Priest Rapids													
Spring Objective	<i>Na</i>	<i>Na</i>	<i>Na</i>	<i>Na</i>	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0
Spring Average	<i>Na</i>	<i>Na</i>	<i>Na</i>	<i>Na</i>	169.6	158.1	76.7	180.6	141.4	126.7	122.7	191.3	168.6

2. Spill

Figure 6 displays the percentage of Hanford Wild Chinook passing McNary during McNary spill and the average percentage spill at McNary experienced by fish passing McNary during spill. Figure 6 shows that over the years of 2003 and 2004 at least 70% of Hanford Wild Chinook passed McNary Dam during periods of spill between April 1 and August 31; in 2005, all (100%) of Wild Hanford Chinook passing McNary Dam by August 31st passed during spill at McNary. Figure 6 also shows that the percentage of spill experienced by fish passing McNary Dam during period of spill has increased in the latest years.

Figure 6. Percentage of Hanford Wild Chinook passing McNary Dam during spill and the average percentage spill at McNary experienced by fish passing McNary during Spill, between April 1 and August 31. Note: No passage data were available during 2002 and 2006.

During the years of 2003 and 2004 at least 70% of Hanford Wild Chinook passed McNary Dam during periods of spill between April 1 and August 31. From this information, it does not appear that spill conditions below the Hanford Reach can easily explain why the Hanford fall Chinook that out-migrated during the years of 2003 and 2004 did not return well in 2007.

3. Hatchery production Releases

The majority of fall Chinook released into the Mid-Columbia (McNary Dam to Chief Joseph Dam) are released from Priest Rapids Hatchery, Ringold Hatchery, and several hatcheries on the Yakima River. Over the past seven years, releases of fall Chinook from these hatcheries have been fairly consistent, ranging from 10.91 to 12.2 million, with the exception of 2006 (Figure 7). Due to disease, Ringold Hatchery was only able to release a small fraction of their fall Chinook juveniles in 2006. This resulted in the smallest total release (8.88 million) of fall Chinook to the Mid-Columbia since 1993.

Figure 7. Production releases of fall Chinook to the Mid-Columbia (Priest Rapids Hatchery, Ringold Hatchery, and Yakima River Releases) (2001 to 2007).

4. Other Factors for Hanford Reach Fall Chinook

Table 6 shows fall Chinook escapement in the Hanford Reach from 1964 through 2006. Table 6 shows that adult fall Chinook escapement in the Hanford Reach in 2002 and 2003 was very good. In fact, adult fall Chinook escapement in the Hanford Reach in 2003 was the highest recorded between 1964 and 2006. Table 7 shows a calculation of the 2002-2007 fall Chinook salmon fry production estimate for the Hanford Reach of the Columbia River by year of emergence. Again, both the emergence years of 2003 and 2004 (spawning years of 2002 and 2003) appear to be good fry years, with emergence year 2004 (spawning year 2003) especially high.

Table 6. Escapement estimates for fall Chinook in the Hanford Reach, 1964 - 2006².

Year	Adult	Jack	Total	Year	Adult	Year	Adult
2006	47,095	4,606	51,701	1990	40,117	1974	25,847
2005	64,355	7,612	71,967	1989	65,913	1973	33,044
2004	79,464	8,231	87,695	1988	74,034	1972	26,749
2003	89,322	11,533	100,855	1987	88,762	1971	31,398
2002	69,342	15,167	84,509	1986	72,559	1970	26,730
2001	44,140	15,708	59,848	1985	65,796	1969	34,939
2000	36,027	11,993	48,020	1984	41,982	1968	24,067
1999	27,012	2,800	29,812	1983	36,022	1967	23,188
1998	29,410	5,983	35,393	1982	20,543	1966	28,079
1997	34,007	9,486	43,493	1981	15,115	1965	24,360
1996	37,548	5,701	43,249	1980	21,861	1964	24,048
1995	38,381	16,827	55,208	1979	23,558		
1994	48,857	14,246	63,103	1978	20,578		
1993	30,650	6,697	37,347	1977	31,527		
1992	29,449	12,503	41,952	1976	21,140		
1991	31,971	20,225	52,196	1975	22,242		

Table 7. Calculation of the 2002-2007 fall Chinook salmon fry production estimate for the Hanford Reach of the Columbia River by year of emergence.

	2007	2006	2005	2004	2003	2002
Fall Chinook Salmon fry Production (Mean of two estimates in Table 3 ³)	19,407,569	28,509,720	30,358,531	38,971,487	23,580,149	16,538,513

The following discussion addresses the river conditions that Hanford fall Chinook returning in 2007 experienced while rearing and out-migrating in 2003 and 2004.

In 1999, an Interim Protection Program was developed and implemented on a trial basis in an attempt to safeguard rearing juvenile fall Chinook salmon in the Hanford Reach. In 1999, the program set operational constraints on flow fluctuations in the Hanford Reach during the fall Chinook salmon emergence and rearing period. From 1999 to 2003 the Hanford Reach Stranding Policy Group met annually to develop and refine an interim protection plan to protect emergent and rearing juvenile fall Chinook salmon in the Hanford Reach. In 2004, a comprehensive plan to enhance fall Chinook survival was established by Grant County PUD and approved by WDFW and NOAA Fisheries. The Hanford Reach Fall Chinook Protection

² Table from Assessment of Losses of Juvenile Fall Chinook in the Hanford Reach of the Columbia River in relation to Flow Fluctuations, Hoffarth, P., et.al. June 30, 2007.

³ Table derived from Table 3 in Assessment of Losses of Juvenile Fall Chinook in the Hanford Reach of the Columbia River in relation to Flow Fluctuations, Hoffarth, P., et.al. June 30, 2007.

Program Agreement (HRFCPP) included all protection measures covered under the Vernita Bar Agreement and included additional provisions to improve survival of juvenile fall Chinook after emergence. Parties to the agreement included GCPUD, BPA, NOAA Fisheries, WDFW, USFWS, Confederated Tribes of the Yakama Indian Nation, and the Colville Confederated Tribes. It is also important to note that out-migration year 2003 was before the 2004 comprehensive plan to enhance fall Chinook survival.

According to “Assessment of Losses of Juvenile Fall Chinook in the Hanford Reach of the Columbia River in Relation to Flow Fluctuations” by Hoffarth, P., et.al June 30, 2007, escapement data (Table 8) suggests that the effects of flow fluctuations on the population of fall Chinook fry inhabiting the Hanford Reach over the past several years was greatest in 2003, with a high percentage of entrapments having Chinook present during emergence and a high number of Chinook per entrapment. It should be pointed out that entrapment monitoring did not begin until well after the estimated emergence in all years and this was especially true for the 2004 field season.

Table 8. Comparison of overall entrapments with Chinook and mean number of Chinook per entrapment in the Hanford reach, 2003-2007. Weekly time periods varied from year to year⁴.

Entrapments w/ Chinook (%)				Chinook per Entrapment			
2007	2005	2004	2003	2007	2005	2004	2003
5%	18%	12%	18%	2.3	13.4	7.1	35.5

From the above information (Table 8), it appears that the fall Chinook salmon fry that emerged in 2003 had a high percentage of entrapments having Chinook present during emergence and a high number of Chinook per entrapment. Compared to 2003, fall Chinook emerging in 2004 had a smaller percentage of entrapments with Chinook and far fewer Chinook per entrapment.

From this simple analysis, it does appear to be a possibility that increased entrapments in the Hanford Reach containing Chinook and increased numbers of Chinook per entrapment in migration year 2003 may have contributed to a reduced adult return in 2007. Also, out-migration year 2003 was before the 2004 comprehensive plan to enhance fall Chinook survival. The out-migrants from 2003 would be age-5 Chinook; it will be interesting to compare the 2007 age-class breakdown to other years when this information is available.

C. Spring Creek hatchery Juvenile Fall Chinook migration conditions

The Spring Creek Hatchery returns (Figure 8) show the same pattern as the adult return as a whole presented previously in Figure 1. Based on past years' data the Spring Creek Hatchery return in 2007 would come primarily from juveniles that migrated in 2004 and 2005.

⁴ Table derived from Table 32 in Assessment of Losses of Juvenile Fall Chinook in the Hanford Reach of the Columbia River in relation to Flow Fluctuations, Hoffarth, P., et.al. June 30, 2007.

Figure 8. Spring Creek Hatchery returns by year.

1. Flow

The flow experienced by the Spring Creek Hatchery release at Bonneville Dam would be similar to the spring flows observed for spring of 2004 and 2005. The spring flows did not achieve the Biological Opinion flow objectives in either year, but the average flows were not that much less than the objectives.

2. Spill

Spring Creek hatchery releases millions of tule fall Chinook juveniles into the Bonneville Pool, typically in March, April, and May of each year. The March release typically represents approximately 50% of the overall release from Spring Creek Hatchery and accounts for approximately 46% of the adult returns. Prior to 2004, spill was provided at Bonneville Dam for the March release from the hatchery. In March 2004, the U.S. Fish and Wildlife Service (FWS) released over 220,000 subyearling fall Chinook from Spring Creek NFH with coded wire tags (CWT) to evaluate smolt-to-adult return rates (SAR) back to the hatchery under two operations at Bonneville Dam. Tagged fish were released in two groups: one group released during four days of spill operation at Bonneville Dam and one group released during four days of corner collector operation at Bonneville Dam.

In past years (2002-2004), the vast majority (75-94%) of Spring Creek fall Chinook migrated past Bonneville Dam during periods of full spill (Table 9). However, in more recent years (2005-2007), spill has not been provided for the March release (Figure 8). During these years, only corner collector operation has been provided for the March releases. It is worth noting that, even though there was a higher total spill volume in March 2007 (Figure 8), the higher spill volume occurred well after the March Spring Creek releases passed Bonneville Dam.

Table 9. Percent of tule fall Chinook from Spring Creek Hatchery that passed Bonneville Dam during times of full spill (2001-2007).

Migration Year	Total Spring Creek Release	Percent Passing Bonneville Dam During Spill
2001	10,569,810	50.3
2002	16,117,906	94.7
2003	15,079,904	100.0
2004	14,653,529	75.1
2005	14,533,488	49.4
2006	15,239,054	50.2
2007	15,472,563	49.8

Figure 8. Monthly (March, April, and May) spill volume at Bonneville Dam during months of Spring Creek Hatchery releases of fall Chinook (2000-2007).

3. Production

A significant portion of the total fall Chinook production releases into the Columbia River Basin occurs from Spring Creek Hatchery in the Bonneville Dam pool. Spring Creek Hatchery releases fall Chinook tules in March, April, and May of each year. Over the past seven years, these releases have ranged from 10.57 million in 2001 to 16.12 million in 2002 (Figure 8). Recent years (2005-2007) have seen a slight increase in the total fall Chinook released from Spring Creek Hatchery

Figure 9. Production releases of fall Chinook to the Bonneville Pool (Spring Creek Hatchery) (2001 to 2007).

In summary, we cannot positively identify any one factor that at this time can explain the 2007 trends in the return of adult fall Chinook to the Columbia Basin. We have tempted to identify the factors that characterized the juvenile migration conditions for these years to determine if any particular differences in migration conditions could be established. As more information becomes available for the cohorts identified and as more adult data becomes available under varying migration conditions, better explanations may be possible.

To end on a positive note, the 2007 fall Chinook jack return to Bonneville Dam and to Lower Granite Dam have far exceeded the ten year averages. In fact, the jack count at Lower Granite Dam is almost double the ten year average. The higher jack return from the 2006 juvenile fall Chinook migration may be an early indication of good out-migration conditions occurring in 2006, particularly in the Snake River.

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MEMORANDUM

TO: FPAC

FROM: Michele DeHart

DATE: November 7, 2007

RE: Summer spill volumes and estimated proportion of subyearling Chinook passing in spill at Bonneville Dam under three operational scenarios

The Fish Operations Plan called in 2007 for summer spill volumes of 75 Kcfs during the daytime and spill to the gas cap at night, from July 1 to August 31 at Bonneville Dam. However, it was determined that 75 Kcfs spill during the daytime hours was creating poor tailrace egress conditions potentially contributing to lower project passage survival. To investigate this further, the Action Agencies proposed to conduct research at BON under a different daytime spill volume, which was expected to improve tailrace egress conditions and, thus, survival of subyearling Chinook. There was some initial discussion among the parties as to what the summer spill operations should be. Among the operational scenarios discussed were: 1) 85 Kcfs during daytime hours and 100 Kcfs at night (herein referred to as the '85/100 Plan'), and 2) 85 Kcfs during daytime hours and gas cap spill (assumed to be 120 Kcfs) at night (herein referred to as the '85/120 Plan'). Both of these plans would have run from June 21 to August 31. However, there was disagreement between the Action Agencies and the Salmon Managers regarding these two scenarios as one clearly limited night-time spill, while the other called for more daytime spill than what was outlined in the 2007 FOP. Ultimately, an agreement was reached and the decision was made to operate BON at 85 Kcfs during daytime hours and spill to the gas cap at night from June 21 to July 15, followed by 75 Kcfs spill during daytime hours and spill to the gas cap at night through August 31 (herein referred to as the 2007 Operation).

FPAC requested that FPC staff review 2007 summer spill operations at Bonneville Dam (BON). Specifically, FPAC requested that FPC staff compare the actual 2007 Operation summer

spill volume to what might have occurred under the two different proposed operational scenarios, one with 85 Kcfs spill during daytime hours and 100 Kcfs during nighttime hours (85/100) and one with 85 Kcfs during daytime hours and gas cap (assumed to equal 120 Kcfs) during nighttime hours (85/120). FPAC also requested that FPC staff estimate the proportion of subyearling Chinook passing through spill at BON in 2007, versus the proportion that might have passed under the two alternative operational scenarios.

Below is a brief synopsis of our findings.

- The 2007 operations passed a greater proportion of fish over the spillway than would have occurred under the 85/100 scenario, but less than the 85/120.
- It is likely that the 2007 Operation resulted in less spill than anticipated, due to limitations with the total dissolved gas (TDG) gauge at Camas/Washougal (CAMWAS). If TDG did not limit the 2007 operations a higher proportion of the subyearling Chinook population would have passed through the spillway
- Without dissolved gas limitations, the 85/120 Plan would have resulted in the highest overall volume of spill (13,588 KAF). This spill volume was approximately 572 KAF greater than what was experienced under the actual 2007 Operation.
- Without dissolved gas limitations, the 85/120 Kcfs Plan would have also resulted in the highest proportion of subyearling Chinook passing through spill (59.3%) due to the higher volume of spill under this plan.

Spill Volumes:

FPC staff calculated the total volume of spill (KAF) at BON under the 2007 Operation (June 21-August 31). In order to estimate the spill volumes under the 85/100 and 85/120 Plans, we relied on an assumed spill cap of 120 Kcfs. Under this assumption, these two plans were not limited in their spill volumes by TDG and, thus, were assumed to spill the full night-time volumes, except when low flows and powerhouse minimums did not permit.

Assuming a gas cap of 120 Kcfs, the 85/120 Plan resulted in the highest spill volume (13,588 KAF), followed by the 2007 Operation (13,016 KAF) and the 85/100 Plan (12,782 KAF) (Table 1). The volume of spill attained under the 2007 Operation was limited by the 115% TDG at the Camas/Washougal gauge. From June 21 to August 31 there were 16 days where TDG waivers were exceeded at CAMWAS, whereas there were no exceedences at the Cascade Island gauge (CCIS) during that period. Table 1 contains estimates of the daily average spill (Kcfs) under the three operational scenarios, as well as estimates of daily average percent spill.

Table 1: Estimates of total spill volume (KAF), daily average spill (Kcfs), and daily average percent spill under the three operational scenarios (June 21-August 31).

Operation	Total Spill Volume (KAF)	Average Spill Volume (Kcfs)	Daily Average Percent Spill
2007 Operation	13,016	91.3	56.9
85/100 Plan	12,782	89.7	56.1
85/120 Plan	13,588	95.3	59.6

Percent of Subyearling Chinook Passing Through Spill:

The COMPASS model includes Bonneville powerhouse 2 (PH2) and spill efficiency curves for spring Chinook and steelhead, but because there is limited data for fall Chinook efficiency curves have not been developed. The FPC reviewed several studies (see detailed list at the end of the memo) for all of the available radio tag and acoustic tag data and tried to apply the same methodology employed by NOAA Fisheries in the development of the spring Chinook and steelhead curves. The limited available data analyzed with the NOAA methodology suggested a relation close to a 1:1 PH2 and spill efficiency curve. At this time sufficient data does not exist to justify deviating from a 1:1 efficiency curves so the 1:1 PH2 and spill efficiency was adopted for this analysis.

Since all three of the operational scenarios involved different daytime (0500-2059) and nighttime (2100-0459) spill volumes, we estimated a diel passage distribution for subyearling Chinook from previously published hourly passage distribution data (Evans et al. 2001, Evans et al. 2006a, and Evans et al. 2006b). From these data, we determined that 58.2% of the daily collection of subyearlings would pass during daytime hours (0500-2059), while 41.8% passed at night (2100-0459).

The total daily population of subyearling Chinook was estimated using the 1:1 PH2 and spill efficiency, the average FGE for PH2 (0.35 based on sources listed below) and the estimates of the river flow through PH2. Under the 85/100 and 85/120 Plans, flow through PH2 was estimated as the difference between total flow and the sum of the estimated spill, powerhouse 1 (PH1) flow, and miscellaneous flow (i.e., adult ladders, juvenile fish facility, etc.). Under these plans, we assumed the same levels of PH1 flow and miscellaneous flow as was seen under the 2007 Operations. With estimates of daytime and nighttime %PH2, we were able to expand the daytime and nighttime PH2 collection counts to estimate the subyearling Chinook population at BON. We then estimated the percent passing through spill by using the daytime and nighttime average percent spill, the estimates for spillway passage efficiency, and the estimates of the subyearling Chinook population at BON.

Results from this analysis can be found below in Table 1.

Table 1: Estimates of percent of subyearling Chinook passing through the spillway under three operational scenarios.

Operation	Estimated CH0 population	Estimated CH0 passing through spill	Percent CH0 passing through spill
2007 Operation	6,170,785	3,436,247	55.7
85/100 Plan	5,886,060	3,166,958	53.8
85/120 Plan	6,856,757	4,068,851	59.3

In summary, the 2007 operation passed a greater proportion of fish over the spillway than would have occurred if nighttime spill was limited to 100 Kcfs. However, if the 115% TDG level at Camas/Washougal were not limiting spill, then the proportion of fish passing in spill would have been greater. Lastly, as expected, the 85/120 Plan, with the highest spill volume would have passed the greatest proportion of subyearling migrants over the spillway.

Data Sources:

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- Evans, S.D., C.D. Smith, N.S. Adams, D.W. Rondorf. 2001. Passage behavior of radio-tagged Chinook salmon at Bonneville Dam, 2001. Report of U.S. Geological Survey (Contract W66QKX10442576) to U.S. Army Corps of Engineers, Portland, Oregon.
- Evans, S.D., L.S. Wright, R.E. Wardell, N.S. Adams, D.W. Rondorf. 2006a. Passage behavior of radio-tagged subyearling Chinook salmon at Bonneville Dam, 2002: revised for corrected spill. Report of U.S. Geological Survey (Contract W66QKZ20303685) to U.S. Army Corps of Engineers, Portland, Oregon.
- Evans, S.D., L.S. Wright, R.E. Reagan, N.S. Adams, and D.W. Rondorf. 2006b. Passage behavior of radio-tagged subyearling Chinook salmon at Bonneville Dam, 2004: Revised for corrected spill. Report of U.S. Geological Survey (Contract W66QKZ40238289 to U.S. Army Corps of Engineers, Portland, Oregon.
- Ploskey, G.R., M.A. Weiland, S.A. Zimmerman, J.S. Hughes, K. Bouchard, E.S. Fischer, C.R. Schilt, M.E. Hanks, J. Kim, J.R. Skalski, J. Hedgepeth, and W.T. Nagy. 2006. Hydroacoustic evaluation of fish passage through Bonneville Dam in 2005. Report to U.S. Army Corps of Engineers (Contract DE-AC05-76RLO1830).

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MEMORANDUM

TO: Rob Lothrop

Michele DeHart

FROM: Michele DeHart, FPC

DATE: October 30, 2007

RE: 2007 Upper Snake Biological Opinion Operation

In response to your request, the FPC staff has evaluated the Upper Snake Flow Augmentation changes outlined in the 2007 Proposed Action. The 2007 Proposed Action for the Upper Snake River has proposed shifting annual flow augmentation from the upper snake from predominantly the summer period (July-August) to the Spring/Early Summer period (May-July).

Following are the summary conclusions from this exercise:

- The 2007 Proposed Action, calls for a shift in Brownlee **Inflows**, there is no known agreement with Idaho Power (IPC) that the shifted inflows will be translated to flows downstream of Brownlee Dam.
- In an average water years, **inflows** to Brownlee Dam will be increased under the 2007 Proposed Action in the months of May and June (1.7 and 1.3 Kcfs) and decreased over the months of July and August (1.5 Kcfs).
- If the increased inflows seen at Brownlee Dam under the 2007 Proposed Action are translated down stream during the months of May and June, these flows will only increase average flows seen at Lower Granite by 1.6% and 1.4% in May and June, respectively. Conversely, if decreases in Brownlee inflow are translated down stream during the months of July and August, these flows will decrease average flows seen at Lower Granite between 3.0-5.6%.
- If an agreement with Idaho Power were not reinforced to be on the April 10th Flood Control Rule Curve, it would be possible for Idaho Power to pre-draft water from Brownlee prior to April and be below their April 10th flood control elevation. A situation where Idaho Power were allowed to pre-drafted water prior to April in anticipation of using increased inflows to Brownlee in May and June to refill, would result in increased flows below Brownlee prior to April, not during May and June

- Without an agreement with Idaho Power, there is no guarantee that outflows from Brownlee will be any less in July or August under the 2007 Proposed Action relative to the 2004 proposed Action. It is likely that drafts over the summer at Brownlee have more to do with the demand for electricity than for pass through of summer flow augmentation water. If the impact of July/August outflows at Brownlee Dam on lower Snake River temperatures were intended to be reduced, the 2007 proposed Action should have called for the construction of selector gates at Brownlee Dam, similar to those at Dworshak Dam.
- It is likely that when summer reductions in flow augmentation from the Upper Snake are coupled with reductions seen in the last several years at Dworshak (200 Kaf of summer water released into September), at least two of the four years when summer flow objectives were actually met at Lower Granite would not have occurred.

The volume of flow augmentation that is released from the upper snake depends largely on the water year and previous year's carryover in upper snake reservoirs; however, the Bureau of Reclamation (BOR) typically attempts to release 487 Kaf of flow augmentation annually. The BOR has conducted modeling exercises comparing flow augmentation amount and timing from the the 2004 and 2007 Proposed Actions¹. Table 1 is a modified version of Figure 3-5 in the BORs assessment document. Figure 3-5 in the BOR document compared monthly flow augmentation volumes between April and August of an average water year between the 2004 and 2007 Proposed Action. Because the 2004 proposed Action data used in this table were not presented in the BOR document, each volume had to be estimated from the presented graph. The following table uses the monthly flow augmentation volumes presented in figure 3-5 and divides each monthly volume into a flow over each month.

Table 1. Volumes of flow augmentation under the 2004 Proposed Action and the 2007 Proposed Action estimated from the 2007 BOR Biological Assessment (Figure 3-5) over average water years between 1928 and 2000 and the resulting average monthly inflow to Brownlee over each month.

	2004 Proposed Action* US Flow Aug. Kaf	2007 Proposed Action* US Flow Aug. Kaf	2004 Proposed Action BRN Inflow (Kcfs)	2007 Proposed Action BRN Inflow (Kcfs)	Difference 2007-2004 Proposed Actions (Kcfs)
May	15	120	0.2	2.0	1.7
June	35	115	0.6	1.9	1.3
July	200	110	3.3	1.8	-1.5
August	165	70	2.7	1.1	-1.5

* Indicates that the monthly volumes were estimated from Figure 3-5 in the 2007 BOR Biological Assessment.

¹ Reclamation managing Water in the West: Assessment for Bureau of Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir, August 2007.

From Table 1, it is clear that in an average water year, inflows to Brownlee Dam will be increased under the 2007 Proposed Action in the months of May and June and decreased over the months of July and August, relative to the 2004 Proposed Action. Concerning the proposed shift of Upper Snake River Augmentation Water, there are several unknowns that need to be addressed.

The 2007 Proposed Action, calls for a shift in Brownlee *Inflows*, there is no known agreement with Idaho Power that the shifted inflows will be translated to flows downstream of Brownlee Dam. In terms of the increase in May and June flows, an agreement made with Idaho Power to be at their flood control rule curve by April 10th of each year would ensure a high probability of increased flows in May and June being translated downstream to the lower Snake River. If an agreement were not reinforced to be on the April 10th Flood Control Rule Curve, it would be possible for Idaho Power to pre-draft water from Brownlee prior to April and be below their April 10th flood control elevation. Idaho Power could then use the extra inflows to Brownlee in May and June to refill to their flood control elevations. By proposing this seasonal shift in Upper Snake Flow Augmentation, it was NOAA Fisheries intent to increase flows for spring migrants during the May/June freshet.² A situation where Idaho Power were allowed to pre-drafted water prior to April in anticipation of using increased inflows to Brownlee in May and June to refill, would result in increased flows below Brownlee prior to April, not during May and June.

In NOAA's staff recommendation referenced above, it was pointed out that releases from Brownlee Dam in August are generally very warm and often exacerbate problems with controlling temperatures in the lower Snake River. This was part of the NOAA justification provided for shifting Upper Snake flow augmentation from the summer period to the spring/early summer period. Again, it should be pointed out that by reducing inflows to Brownlee over July and August, there is no guarantee that outflows from Brownlee Dam would be reduced without an agreement with Idaho Power. It is likely that drafts over the summer at Brownlee have more to do with the demand for electricity than for pass through of summer flow augmentation water. The following figures show historical July and August drafts at Brownlee Dam from 1975 through 2007.

² Staff Recommendation to Relax the Priority on Summer Flow Augmentation for the Upcoming FCRPS Biological Opinion and Request NWFSC Review this Recommendation. June 12, 2007.

Figure 1. July drafts in Kaf at Brownlee Dam from 1975 through 2007.

Figure 2. August drafts in Kaf at Brownlee Dam from 1975 through 2007.

Summer drafts at Brownlee in July and August are often variable and are most likely dependent on the demand for power. By reducing inflows to Brownlee Dam over the summer months as proposed in the 2007 Proposed Action, there is no guarantee that either Idaho Power will draft deeper during July or August to satisfy their power market or begin to consolidate summer drafts over periods with the greatest power demand. In either case, if there is a demand for power it is likely that Idaho Power will draft what will suit its needs, and the proposed shift of Upper Snake flow augmentation will not likely be important. Without an agreement with Idaho Power, there is no guarantee that outflows from Brownlee will be any less in July or August under the 2007 Proposed Action relative to the 2004 proposed Action. If the impact of July/August outflows at Brownlee Dam on lower Snake River temperatures were intended to be reduced, the 2007 proposed Action should have called for the construction of selector gates at Brownlee Dam, similar to those at Dworshak Dam. Using selector gates, Idaho Power could pull water from depths that satisfy temperature needs downstream.

Concerning volumes of flow augmentation, it is important to consider the relative impact that monthly volumes will have on river flows typically seen during those months. Table 2 displays average May through August flows at Lower Granite Dam over the entire 50-year record of the GENYSIS Hydromodel (under the 2000 Biological Opinion Scenario) along with changes to Brownlee inflow over the same months (from Table 1). Table 2 also displays the percentage of monthly changes in Brownlee inflows under the 2007 Proposed Action to the monthly average flows seen at Lower Granite.

Table 2. Comparison of Average Monthly Flows at Lower Granite over the 50-year record of the GENYSIS Program under 2000 BiOp conditions to the anticipated changes of inflows to Brownlee Dam under the 2007 Proposed Action.

	Ave Monthly flow at LGR over GENYSIS 50-yr record 2000 BiOp (Kcfs)	Change in BRN inflow due to 2007 PA (Table 1) Kcfs	Ave Monthly flow at LGR over GENYSIS 50-yr record if 2007 PA Changes in BRN Inflow translated to LGR (Kcfs)	Percent of 2007 PA Monthly Gain/Loss of Ave Monthly Flow at LGR GENYSIS 50-yr Record (%)
MAY	105.1	1.7	106.8	1.6
JUN	98.6	1.3	100.0	1.4
JUL	49.3	-1.5	47.9	3.0
AG1	33.7	-1.5	32.2	4.6
AG2	26.6	-1.5	25.1	5.6

From Table 2, it can be seen that if the increased inflows seen at Brownlee Dam under the 2007 Proposed Action are translated down stream during the months of May and June, these flows will only increase average flows seen at Lower Granite by 1.6% and 1.4% in May and June, respectively. Conversely, if decreases in Brownlee inflow are translated down stream during the months of July and August, these flows will decrease average flows seen at Lower Granite between 3.0-5.6%.

It is important to note that the 2000 Biological Opinion has designated flow objectives at Lower Granite Dam over the spring and summer periods. The 2000 Biological Opinion spring flow objective ranges between 85 and 100 Kcfs, where as, the summer flow objective ranges between 50 and 55 Kcfs. Table 2 shows that the 50-year average GENYSIS flows in May and June at Lower Granite are near the upper end of the spring flow objective range. On the other hand, July and August average flows at Lower Granite Dam never reach the lower end of the summer flow objective and in late August are approximately one-half of the flow objective. If summer flows at Lower Granite are reduced further, as is proposed, the likelihood of achieving summer flow objectives at Lower Granite Dam will be even less likely.

Table 3 displays the actual spring and summer Biological Opinion flow objectives at Lower Granite and McNary Dams from 1995 through 2007 as well as the actual average seasonal flow at each location. From Table 3, flow objectives were met during the spring season at Lower Granite Dam in 46% of years since 1995; however, summer flow objectives were only met in 31% of the same years at Lower Granite. At McNary Dam, flow objectives were met during the spring season at in 54% of years since 1995 and summer flow objectives were only met in 23% of the same years.

From Table 3, there were no years when spring flow objectives were not met that the added flow during May and June in the 2007 Proposed Action (1.3 and 1.7 Kcfs, respectively) would have been enough extra water for Lower Granite spring flow objectives to have been met. Concerning summer flows at Lower Granite, there were only four of thirteen years when flow objectives were met, in those years, a reduction of 1.5 Kcfs in July and August would not have caused summer flows to be reduced to the point where summer flow objectives were not met at Lower Granite. However, it is likely that when summer reductions in flow augmentation from the Upper Snake are coupled with reductions seen in the last several years at Dworshak (200 Kaf of summer water released into September), at least two of the four years when summer flow objectives were actually met at Lower Granite would not have occurred³.

³ 200 Kaf of flow augmentation over the 62 days of the July and August period equated to a loss of flow of 1.6 Kcfs per day at Lower Granite; when added to the loss in flow of 1.5 Kcfs per day in July and August due to the 2007 Proposed Action, the total daily loss in flow over July and August would be 3.1 Kcfs. If 3.1 Kcfs were deducted from the actual summer flow average at Lower Granite Dam during the four years when summer flow objectives were met at Lower Granite between 1995 and 2007, the resulting flow averages would be less than the BiOp objective in two of the original four years.

Table 3. Spring and Summer Biological Opinion flow objectives at Lower Granite Dam and McNary Dam from 1995 to 2007 as well as actual average seasonal flows at each project. Values in bold indicate that the seasonal flow objective was met.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Lower Granite													
Spring Objective	95.0	100.0	100	90.0	100.0	96.3	85.0	97.0	89.1	85.0	85.0	100.0	85.0
Spring Average	101.1	138.3	162.5	115.6	117.0	85.1	47.5	83.4	90.0	70.1	66.3	125.3	61.5
Summer Objective	52.0	53.5	55.0	50.6	54.0	51.3	50.0	51.0	50.7	50.0	50.0	54.5	50.0
Summer Average	55.3	52.7	66.3	53.2	56.0	39.6	25.4	41.2	32.3	33.2	33.4	37.6	28.8
McNary													
Spring Objective	249.0	260.0	260.0	228.0	260.0	260.0	220.0	246.0	220.0	220.0	220.0	260.0	237.0
Spring Average	253.0	357.1	463.5	287.8	303.6	243.4	123.9	269.3	231.4	203.2	195.7	325.4	239.2
Summer Objective	200.0	200.0	200.0	200.0	200.0	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	135.5	133.7	165.1	166.5	166.3

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MEMORANDUM

TO: Rod Sando

FROM: Michele DeHart

DATE: October 29, 2007

RE: Historic Sockeye PIT-Tag releases at Alturas and Redfish Lakes

Per your request, FPC staff has reviewed historic releases of PIT-tagged sockeye juveniles in Alturas and Redfish Lakes and attempted to identify what types of information may be available from these tagged releases. FPC staff focused on specific release sites for each of these lakes, as they are identified in PTAGiS. There were two release sites for Alturas Lake: 1) Alturas Lake and 2) Alturas Lake Creek. Redfish Lake had a total of three release sites: 1) Redfish Lake, 2) Redfish Lake Creek, and 3) Redfish Lake Creek Trap. Historically, hatchery sockeye have been released into Alturas and Redfish Lakes both as pre-smolts and smolts. The pre-smolts are typically released in the fall prior to the year of their out-migration while the smolts are released in the spring of their migration year (April through June). Finally, wild sockeye are typically tagged and released as smolts in the spring and summer of their migration year.

PIT-Tagged Juvenile Sockeye Releases:

FPC staff tallied the total numbers of hatchery and wild sockeye tagged and released at the above listed sites over the past seventeen years (1991-2007). These data can be found in Table 1. As you can see, there are relatively few tags released each year at these sites. With so few tags being released each year, the amount of information that may be available with these tags is limited.

Table 1. Hatchery and wild sockeye tagged and released at Alturas and Redfish Lakes (1991-2007)

Migration Year	Alturas Lake			Alturas Lake Total	Redfish Lake			Redfish Lake Total
	Pre-Smolt	Smolt			Pre-Smolt	Smolt		
	Hatchery	Hatchery	Wild		Hatchery	Hatchery	Wild	
1991				0			37	37
1992				0			79	79
1993				0			48	48
1994				0			717	717
1995				0	2,728	1,371	109	4,208
1996				0	5,977	1,988	90	8,055
1997				0	1,930		67	1,997
1998	3,890	80		3,970	6,732	2,046	390	9,168
1999	1,246	181	87	1,514	4,179	401	392	4,972
2000	1,554	181	422	2,157	1,557	534	107	2,198
2001 ^A		385	174	559		2,389	36	2,425
2002		249	158	407		2,808	627	3,435
2003	3,479	5	1	3,485	2,022	1,331	935	4,288
2004		1		1	1,519	1,915	843	4,277
2005	1,009	246	160	1,415	1,020	3,081	767	4,868
2006	1,011	79	224	1,314	1,008	1,329	368	2,705
2007	1,016	180	265	1,461	1,016	1,971	440	3,422

^A In 2001 there were 2 sockeye smolts of unknown rearing type tagged and released at Alturas Lake Creek

Release Timing:

One piece of information that can be gathered from these releases of PIT-tags is migration timing to Lower Granite Dam (LGR). This relies on detections at LGR which, prior to 1995, were rare occurrences with so few tags being released. Timing to LGR for each migration year is provided in the figures below (Figures 1-3). For ease of presentation, we have broken the migration years apart. These timing plots combine releases of hatchery and wild sockeye smolts and pre-smolts to Alturas and Redfish Lakes for each migration year.

Figure 1. Migration timing to Lower Granite Dam for combined wild and hatchery sockeye smolts and pre-smolts (migration years 1991-1997). During these migration years, sockeye juveniles were released only from Redfish Lake.

Figure 2. Migration timing to Lower Granite Dam for combined wild and hatchery sockeye smolts and pre-smolts (migration years 1998-2002). During these migration years, sockeye juveniles were released from both Alturas and Redfish Lakes.

Figure 3. Migration timing to Lower Granite Dam for combined wild and hatchery sockeye smolts and pre-smolts (migration years 2003-2007). During these migration years, sockeye juveniles were released from both Alturas and Redfish Lakes. Of the juvenile sockeye released in migration year 2003, 103 were detected at LGR in 2004 and 1 was detected in 2005.

Juvenile Survival:

Estimations of juvenile survival were also possible with these PIT-tag releases. FPC staff analyzed juvenile survival from release (Alturas and Redfish Lake combined) to Lower Granite Dam for each migration year. Where applicable, juvenile survival from release to McNary Dam was also estimated. Due to difference in their life-histories, these survival analyses were conducted for sockeye smolts (hatchery and wild combined) and pre-smolts separately.

Survival estimates for sockeye smolts (hatchery and wild combined) were not possible for migration years 1991-1993 and 1997, due to the small number of tags released in these years. For all other years, it was at least possible to estimate survival from release to LGR for sockeye smolts (Table 2). Due to higher sample sizes, FPC staff was able to estimate survival from release to McNary Dam (MCN) for migration years 1998, 1999, 2002, 2003, 2006, and 2007. Even though sample sizes were relatively high, estimates of sockeye smolt survival from release to MCN were not possible for migration years 2004 and 2005 since approximately 96% and 86% of the juvenile sockeye that were detected after their release were transported at Lower Granite, Little Goose, or Lower Monumental Dam prior to making it to McNary Dam, respectively.

Table 2. Survival of wild and hatchery sockeye smolts from release to Lower Granite Dam and release to McNary Dam (migration years 1991-2007)

Migration Year	Number Released	Number Recovered	Release to Lower Granite Dam (95% CI)			Release to McNary Dam (95% CI)		
			Survival	Lower Limit	Upper Limit	Survival	Lower Limit	Upper Limit
1991	37	21	N/A	N/A	N/A	N/A	N/A	N/A
1992	79	19	N/A	N/A	N/A	N/A	N/A	N/A
1993	48	21	N/A	N/A	N/A	N/A	N/A	N/A
1994	717	157	0.545	0.295	0.774	N/A	N/A	N/A
1995	1,480	136	0.127	0.100	0.154	N/A	N/A	N/A
1996	2,078	496	0.480	0.401	0.558	N/A	N/A	N/A
1997	67	28	N/A	N/A	N/A	N/A	N/A	N/A
1998	2,516	1264	0.780	0.719	0.830	0.430	0.195	0.664
1999	1,061	345	0.467	0.393	0.543	0.318	0.142	0.494
2000	1,244	271	0.427	0.330	0.531	N/A	N/A	N/A
2001 ^A	2,987	701	0.266	0.247	0.285	N/A	N/A	N/A
2002	3,842	829	0.351	0.310	0.395	0.175	0.118	0.232
2003	2,272	639	0.368	0.334	0.403	0.293	0.185	0.401
2004	2,759	1,085	0.407	0.382	0.432	N/A	N/A	N/A
2005	4,254	1,353	0.501	0.445	0.557	N/A	N/A	N/A
2006	2,000	646	0.549	0.463	0.632	0.279	0.133	0.425
2007	2,856	738	0.427	0.381	0.474	0.283	0.158	0.408

^A In 2001 there were 2 sockeye smolts of unknown rearing type tagged and released at Alturas Lake Creek

Since there were no releases of PIT-tagged sockeye pre-smolts prior to 1995, survival estimates were not possible for migration years 1991 through 1994. Also, there were no releases of PIT-tagged sockeye pre-smolts in 2001 and 2002, so survival estimates are not possible for these migration years. For all other years, it was at least possible to estimate survival from release to LGR for sockeye pre-smolts (Table 3). Estimates of survival from release to MCN for sockeye pre-smolts were only possible for migration years 1998, 1999, 2003, and 2007.

Table 3. Survival of hatchery sockeye pre-smolts from release to Lower Granite Dam and release to McNary Dam (migration years 1991-2007)

Migration Year	Number Released	Number Recovered	Release to Lower Granite Dam (95% CI)			Release to McNary Dam (95% CI)		
			Survival	Lower Limit	Upper Limit	Survival	Lower Limit	Upper Limit
1995	2,728	38	0.017	0.012	0.024	N/A	N/A	N/A
1996	5,977	397	0.111	0.093	0.128	N/A	N/A	N/A
1997	1,930	119	0.097	0.070	0.124	N/A	N/A	N/A
1998	10,622	773	0.109	0.099	0.121	0.044	0.020	0.069
1999	5,425	574	0.131	0.118	0.145	0.096	0.059	0.133
2000	3,111	372	0.195	0.166	0.227	N/A	N/A	N/A
2003	5,522	345	0.076	0.066	0.086	0.032	0.015	0.050
2004	1,519	140	0.097	0.080	0.117	N/A	N/A	N/A
2005	2,029	328	0.241	0.195	0.293	N/A	N/A	N/A
2006	2,019	294	0.236	0.183	0.299	N/A	N/A	N/A
2007	2,032	270	0.190	0.161	0.223	0.140	0.070	0.211

Travel Time:

Estimates of median travel time are also possible for sockeye smolts or pre-smolts. Travel time of pre-smolts is problematic, due to their beginning their out-migration until several months after being released. Also, releases of smolts were generally conducted over relatively long periods of time (1-2 months), which makes median travel time difficult to estimate, given that different releases would be subject to different operations.

We hope that this memo helps to answer some of your questions regarding the tagging and release of sockeye juveniles in Alturas and Redfish Lakes. If we can provide any additional information on this matter, please let us know.

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MEMORANDUM

TO: Gary Fredricks, NOAA

FROM: Tom Berggren and Jerry McCann

DATE: October 23, 2007

RE: Simulations of the effects of increased detection probabilities at Bonneville Dam on the variability in reach survival estimates

Introduction

As you requested simulations were used to evaluate the effects of increased detection probability at Bonneville Dam, on the variance of PIT-tag reach survival estimates. In an effort to better quantify the possible effects of increased detection probability of proposed spillway PIT-detection systems at Bonneville Dam, we simulated the reach survival of PIT-tag juvenile salmon populations migrating from Lower Granite Dam to below Bonneville Dam. The results suggest that relatively large increases in precision can be achieved by increasing detection probability, when the starting population of PIT-tagged fish at Lower Granite Dam is relatively small (12,500). However, with large starting populations at Lower Granite Dam, in the range of 100,000 tags, the benefit of increasing detection probability is not as dramatic. Increased starting population at Lower Granite had a larger effect on relative precision than increased detection probability. It may be that using the same technological breakthroughs applied to developing the Bonneville spillway detector array, could be used to better effect at the Lower Granite Dam RSW. Some discussion of possible management implications of using an alternate installation site such as the Lower Granite Dam RSW instead of the Bonneville Dam spillway is included for your consideration.

Methods

Simulated populations of PIT-tagged fish were generated using software developed within the Comparative Survival Study (Schaller et al 2007). The starting point for each simulated PIT-tag population is a common timing distribution at Lower Granite Dam (LGR) as illustrated in Figure 1. The simulated populations then migrate from dam to dam following the default travel time distributions used in Schaller et al 2007, and then arrive at Bonneville Dam (BON) approximately two weeks later (Figure 1). Each simulated inter-dam survival rate is constant over time in daily binomial draws that produce the number of surviving smolts to the reach's downstream dam. The collection probability of these PIT-tagged fish at each dam is also constant over time in daily binomial draws that produce the number of detected smolts. Input values for the reach survival and collection probabilities are shown in Table 1. Across the simulated populations created, a common set of reach survival and collection probabilities are used as shown in Table 1, except at BON where 5 separate levels of collection probability are run (*i.e.*, 0.125, 0.1875, 0.250, 0.375, and 0.500). Finally, there are four levels of starting population numbers at LGR in the various runs (*i.e.*, 12,500; 25,000; 50,000; 100,000). In order to account for the potential of some PIT-tagged fish detected and re-released at LGR being transported at LGS or LMN, we added a removal probability of 0.15 on the collected fish at those two sites.

Figure 1. Arrival distribution of simulated PIT-tag population at Lower Granite and Bonneville dams.

Table 1. Probability inputs for parameters in binomial draws used in generating simulated data sets.

Inter-dam survival rate		Dam collection probability	
Parameter	Input value	Parameter	Input value
Release to LGR (S_1)	0.999 (maximum)	LGR (P_2)	1.000 (maximum)
LGR-to-LGS (S_2)	0.90	LGS (P_3)	0.45
LGS-to-LMN (S_3)	0.88	LMN (P_4)	0.30
LMN-to-MCN (S_4)	0.90	MCN (P_5)	0.35
MCN-to-JDA (S_5)	0.85	JDA (P_6)	0.15
JDA-to-BON (S_6)	0.85	BON (P_7)	Varies across runs: 0.125 0.1875 0.250 0.375 0.500
BON-to-TWX	0.03 (joint survival and collection probability)		
Removals at LGS	0.15 of collected fish		
Removals at LMN	0.15 of collected fish		

Results

Twenty simulated data sets were created based on the four levels of starting populations at LGR and five levels of collection probability at BON. The total LGR-to-BON reach survival rate ($S_R = S_2 \cdot S_3 \cdot S_4 \cdot S_5 \cdot S_6$) is the parameter of interest in this evaluation. Table 2 shows how precision of S_R is affected by changes in PIT-tag collection at BON for different size PIT-tag populations. The relative increase in precision of S_R as BON collection probability increases is higher for smaller populations than larger populations. A doubling of BON collection probability reduces the standard deviation of average S_R by approximately one-half for the smaller populations evaluated, while reducing the standard deviation by approximately one-third for larger populations evaluated.

Table 2. Simulated populations of smolts with underlying LGR-to-BON reach survival rate of 0.515 and resulting CJS estimate and precision relative to changes in PIT-tag collection probability at Bonneville Dam and starting number of smolts entering the reach at Lower Granite Dam (average and standard deviation of 1000 bootstrap replicates).

Collection prob. Bonneville Dam	Smolts re-released at Lower Granite Dam (detected plus initial tagged fish)							
	N = 12,500		N = 25,000		N = 50,000		N = 100,000	
	Avg.	Std.dev.	Avg.	Std.dev.	Avg.	Std.dev.	Avg.	Std.dev.
0.1250	0.677	0.1732	0.507	0.0730	0.551	0.0616	0.494	0.0354
0.1875	0.517	0.0952	0.489	0.0544	0.472	0.0357	0.541	0.0310
0.2500	0.579	0.0809	0.466	0.0406	0.497	0.0306	0.504	0.0235
0.3750	0.508	0.0504	0.519	0.0349	0.539	0.0299	0.529	0.0199
0.5000	0.527	0.0424	0.504	0.0259	0.526	0.0203	0.529	0.0145

If a goal of maintaining a precision of approximately 5% or lower coefficient of variation, then a combination of having larger population sizes of PIT tags available as well as higher collection probabilities at BON would be necessary (Table 3). A larger population number of PIT-tagged smolts with known date of passage at LGR could be attained by increasing the detection probability at LGR. Table 3 shows a 4-fold increase in number of smolts at LGR tends to cut in half (approximately) the coefficient of variation of S_R .

Table 3. Coefficient of variation for CJS estimated LGR-to-BON reach survival rates for simulated datasets in Table 1 (CV of 1000 bootstrap replicates; CV of approximately 5% or lower are shown in red).

Collection prob. Bonneville Dam	Smolts re-released at Lower Granite Dam (detected plus initial tagged fish)			
	N = 12,500	N = 25,000	N = 50,000	N = 100,000
0.1250	0.256	0.144	0.112	0.072
0.1875	0.184	0.111	0.076	0.057
0.2500	0.140	0.087	0.062	0.047
0.3750	0.099	0.067	0.055	0.038
0.5000	0.080	0.051	0.039	0.027

Discussion

As demonstrated with the simulated data sets, an increase in the precision of the estimated LGR-to-BON reach survival rate (S_R) is possible by increasing the collection probability of PIT-tagged fish at BON (Figure 2). This will also improve the precision of estimated reach survival rates of PIT-tagged fish originating outside the Snake River basin from tributaries such as the Wind, Hood, Deschutes, John Day, Klickitat, Umatilla, Yakima, Wenatchee, Entiat, Methow, and Okanagon rivers, as well as mainstem tagged fish in the Hanford reach or at Columbia River dams.

However, increasing the number of PIT-tagged fish detected at LGR, which will also increase the precision of the estimated S_R , may have more utility for future evaluations of interest to fishery managers. Currently, we can only detect PIT-tagged smolts that enter the bypass channels at dams. Determination of a known number of fish passing a non-bypass/collector route, particularly through spill, would be very beneficial. This would allow direct comparisons between bypassed and spilled fish at LGR relative to their corresponding LGR-to-BON reach survival rate on a temporal basis, and potentially smolt-to-adult survival rates (SAR) if the number of PIT-tagged smolts available is large enough. Therefore, it may be prudent to consider installation and evaluation of the spillway PIT-tag detection system at LGR rather than BON. Also, it may prove more feasible for installation and operation at LGR within a spillway that contains a removable-spillbay-weir (RSW) rather than at BON in a convention spillway. If and when the technologies to monitor PIT-tags passing through spill bays is perfected to a high enough detection capability to warrant the expense of future installations, then the addition of spillway PIT-tag monitors at other dams would be useful for future evaluations of spillway passage benefits.

Figure 2. Trend in precision of LGR-to-BON reach survival rates (S_R) as PIT-tag detection probability increases at BON for various PIT-tag population sizes (upper plot is coefficient of variation of S_R and lower plot is standard deviation of 1000 bootstrap estimates of S_R).

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MEMORANDUM

TO: Ron Boyce, ODFW

FROM: Michele DeHart

DATE: September 21, 2007

RE: Data request to estimate spill volumes under different project spill/transport operations

You requested that the FPC conduct an analysis of the spill that would result under different project operational scenarios for spill and transportation. Specifically, you asked for a comparison of spill volumes if the hydrosystem was operated to the 2000 Biological Opinion, the Proposed Action, the 2007 Agreement and the Oregon Plan under low, medium and high flows.

In order to conduct the analysis the FPC elected to use the hourly flow and spill data collected since 2000, and to stratify the data into low, medium and high flow years based on the pre-season estimated flow for each year. The low, medium and high years were as follows:

- Low Years: 2001, 2005
- Medium Years: 2004, 2007
- High Years: 2000, 2002, 2003, 2006

The table below summarizes the operations that were modeled. A summary of all the assumptions used in the analysis is attached to this document. The four modeled scenarios differ in both the amount of spill provided at a project, and in the duration of the spill implementation. The analysis assumes gas caps for the Biological Opinion that were historically consistent with operations under those years when the BIOP was implemented, whereas the more recently proposed scenarios use average spill caps as determined and established by the COE.

Operations Modeled:

Project	2000 BIOP	Proposed Action	2007 Operations	Oregon Plan
LGR	0/60Kcfs	20Kcfs/20Kcfs	20Kcfs/20Kcfs	40%/40%
LGS	0/Gas Cap (GC=45 Kcfs)	30%/30% (GC=30 Kcfs)	30%/30% (+ 14 nights Gas Cap) ^A (GC = 30 Kcfs)	40%/Gas Cap (GC = 30 Kcfs)
LMN	40 Kcfs/40 Kcfs	27 Kcfs/27 Kcfs	27 Kcfs/27 Kcfs	27 Kcfs/27 Kcfs
IHR	45 Kcfs/Gas Cap (GC=95 Kcfs)	30%/30% vs 45 Kcfs/ Gas Cap ^B (GC=95 Kcfs)	30%/30% vs 45 Kcfs/Gas Cap ^B (GC=95 Kcfs)	64 Kcfs/64 Kcfs
MCN	0/Gas Cap (GC=175 Kcfs)	40%/40% (GC=175 Kcfs)	40%/40% (GC=175 Kcfs)	161 Kcfs/161 Kcfs (GC=175 Kcfs)
JDA	0/60% ^C (GC=140 Kcfs)	0/60% ^C (GC=140 Kcfs)	0/60% ^C (GC=140 Kcfs)	Gas Cap/Gas Cap (GC=140 Kcfs)
TDA	40%/40% (GC=140 Kcfs)	40%/40% (GC=140 Kcfs)	40%/40% (GC=up to 126 Kcfs)	126 Kcfs/126 Kcfs (GC=140)
BON	75 Kcfs/Gas Cap (GC=120 Kcfs)	100 Kcfs/100 Kcfs	100 Kcfs/100 Kcfs	100 Kcfs/100 Kcfs

^A For 14 nights Gas Cap spill, assumed same nights as in 2007 (Apr 29-May 12)

^B Assumed 2007 schedule for 30%/30% vs 45 Kcfs/ Gas Cap treatments

^C Night time spill 18:00-06:00 Apr. 10-May 14; 19:00-06:00 May 15-June 30

The table below describes a summary of the volume of spill that occurs each year under the various scenarios.

All Projects

Year	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	79,491	82,774	64,859	77,884	106,608
2001	6,569	37,575	26,948	32,325	57,597
2002	86,415	85,722	68,409	80,869	106,995
2003	74,357	80,510	63,386	76,396	105,919
2004	57,082	59,485	52,962	69,518	98,632
2005	52,179	56,045	46,382	55,977	82,373
2006	116,695 ^A	98,281	79,497	92,039	113,030
2007	73,134	63,205	56,973	73,029	103,006

^A Actual spill in 2006 appears much greater than any of the modeled operation. This is because the powerhouse capacity in 2006 was restricted with one unit out of operation, whereas the modeled scenarios assume full powerhouse capacity.

The following tables partition the All Projects Table to the two river reaches: Snake - Lower Granite to Ice Harbor dams; and, Lower Columbia – McNary to Bonneville dams. From these tables you can see that most of the difference in the scenarios occurs in the Lower Columbia (individual project results are also attached).

Snake River Projects (LGR, LGS, LMN, IHR)

Year	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	21,404	24,238	14,926	18,780	23,654
2001	19	5,584	3,906	4,348	6,013
2002	18,028	23,499	14,312	18,351	23,220
2003	20,644	24,634	15,865	19,615	24,265
2004	10,393	8,053	9,508	16,998	21,068
2005	8,113	7,369	5,312	5,794	7,616
2006	27,830	26,928	17,777	22,036	27,512
2007	15,015	7,123	8,914	15,807	19,481

Lower Columbia Projects (MCN, JDA, TDA, BON)

Year	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	58,087	58,536	49,933	59,103	82,954
2001	6,549	31,991	23,042	27,977	51,585
2002	68,387	62,223	54,097	62,518	83,774
2003	53,714	55,876	47,521	56,781	81,653
2004	46,688	51,433	43,454	52,519	77,564
2005	44,066	48,676	41,070	50,183	74,757
2006	88,865	71,353	61,721	70,003	85,518
2007	58,119	56,082	48,059	57,222	83,525

As stated previously, the FPC modeled the Proposed Action for spring migrants and assumed no spill occurred in June. The proposed Action does include an adaptive management clause, where spill is implemented when subyearling Chinook are present with certain criteria. In order to put this potential additional spill in perspective, the FPC assumed that subyearling Chinook met the criteria on June 1 and the summer spill would be initiated on these dates. The following table shows the maximum additional spill that would be provided by the Proposed Action in each year.

Spill at Snake River collector projects if spill occurred June 1 through June 15

Year	PA Spill Volume (KAF)		
	LGR	LGS	LMN
2000	535	637	505
2001	529	383	481
2002	505	765	472
2003	422	663	397
2004	535	812	504
2005	534	579	499
2006	534	872	502
2007	535	484	505

Assumptions used for the BiOP, PA, Agreement, OR Plan analysis:

- It was assumed that each project had a powerhouse minimum that was the same for all management scenarios (PH minimums were those reported in WMP for 2007).
- Summary of flow targets used to determine spill at the Snake River transportation projects:
 - 2000 BiOP- if average flows <85 Kcfs, no spill. Otherwise spill Apr. 3 – June 20.
 - PA
 - If average flows <65 Kcfs, no spill
 - If average flows 65-80 Kcfs, spill beginning April 3, 5, or 7 and ending on April 30, May 4, or May 9 for LGR, LGS, and LMN, respectively. No spill May 1 (LGR), May 5 (LGO), or May 9 (LMN) to May 31. Assumed no subyearlings in June, therefore no spill occurs in June (except for spill in excess of hydraulic capacity).
 - If average flows >80 Kcfs, spill April 3, 5, or 7 to May 31 for LGR, LGS, and LMN, respectively. Assumed no subyearlings in June so no spill in June (except for spill in excess of hydraulic capacity).
 - 2000 Agreement- if average flows < 70 Kcfs, no spill. Otherwise spill Apr. 3 – June 20.
 - OR Plan- if average flows <65 Kcfs, no spill. Otherwise spill Apr. 3 – June 20.
- Flow targets at McNary:
 - 2000 BiOP- Spill Apr. 10 – June 30, no minimum flows.
 - PA
 - If average flows <125 Kcfs, no spill
 - If average flows > 125 Kcfs, spill April 10-June 14. Assumed no subyearlings June 15-30 so no spill (except for hydraulic capacity)
 - 2000 Agreement-
 - If average flows <125 Kcfs, no spill
 - If average flows > 125 Kcfs, spill April 10-June 30.
 - OR Plan- Spill Apr. 10 – June 30, no minimum flows.
- No flow targets at non-transport projects. Spill occurs in all years.
- Categorized years as Low (<65 Kcfs), Medium (65-80 Kcfs), and High (>80 Kcfs) based on flow objectives published in Annual Reports
 - Low Years: 2001, 2005
 - Medium Years: 2004, 2007
 - High Years: 2000, 2002, 2003, 2006
- Additionally, modeled PA with spill for subyearlings (i.e., summer spill volumes June 1-15)

Lower Granite Dam

Year	Avg Daily Flow (Kcfs)	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	84.1	3,752	4,916	2,336	3,128	5,265
2001	47.5	0	0	0	0	0
2002	83.0	4,812	4,771	2,360	3,123	5,218
2003	90.0	4,340	5,181	2,843	3,512	5,631
2004	70.1	1,311	4	1,105	3,124	4,387
2005	66.3	983	14	0	0	0
2006	125.3	7,277	5,597	2,803	3,594	7,841
2007	61.2	3,110	0	1,109	3,128	3,830

Little Goose Dam

Year	Avg Daily Flow (Kcfs)	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	81.5	3,275	3,750	2,857	3,817	4,576
2001	48.4	0	0	0	0	0
2002	80.4	4,240	3,679	2,519	3,769	4,534
2003	88.1	3,500	4,105	2,902	4,009	4,686
2004	69.9	705	6	914	3,329	4,259
2005	65.7	279	9	0	0	0
2006	123.6	5,583	4,330	3,464	4,683	4,834
2007	59.5	2,832	0	920	2,906	4,069

Lower Monumental Dam

Year	Avg Daily Flow (Kcfs)	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	83.8	4,660	6,215	2,939	4,221	4,221
2001	50.7	0	0	0	0	0
2002	84.0	139	6,157	2,962	4,205	4,205
2003	87.8	4,674	6,317	3,341	4,463	4,463
2004	73.8	1,106	0	1,713	4,146	4,146
2005	67.6	667	0	0	0	0
2006	126.0	5,190	6,477	3,357	4,636	4,636
2007	59.9	3,469	0	1,740	4,139	4,139

Ice Harbor Dam

Year	Avg Daily Flow (Kcfs)	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	88.5	9,717	9,357	6,793	7,614	9,592
2001	49.9	19	5,584	3,906	4,348	6,013
2002	86.0	8,836	8,893	6,470	7,255	9,264
2003	91.6	8,130	9,032	6,780	7,630	9,485
2004	74.6	7,270	8,043	5,776	6,400	8,276
2005	68.7	6,185	7,345	5,312	5,794	7,616
2006	127.9	9,779	10,524	8,153	9,123	10,202
2007	61.3	5,605	7,123	5,146	5,633	7,443

McNary Dam

Year	Avg Daily Flow (Kcfs)	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	244.9	15,826	15,554	13,567	15,908	24,428
2001	123.9	323	4,965	0	0	12,005
2002	269.3	18,928	17,201	16,243	17,515	24,805
2003	231.4	12,253	14,439	12,743	15,027	23,602
2004	203.2	10,986	12,538	11,003	13,194	21,502
2005	195.7	11,699	11,770	10,281	12,709	21,213
2006	325.5	27,539	21,688	19,522	21,183	26,079
2007	239.6	16,987	14,812	13,089	15,560	25,279

John Day Dam

Year	Avg Daily Flow (Kcfs)	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	249.6	12,434	11,209	9,519	11,209	22,184
2001	126.7	792	4,959	4,161	4,959	12,362
2002	272.7	13,765	11,978	10,117	11,978	22,410
2003	231.4	9,229	10,627	8,937	10,627	21,839
2004	200.9	9,029	9,823	8,191	9,823	20,605
2005	192.7	8,838	8,929	7,432	8,929	19,349
2006	321.9	20,883	13,204	11,271	13,204	22,679
2007	231.0	10,060	10,685	9,135	10,685	22,047

The Dalles Dam

Year	Avg Daily Flow (Kcfs)	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	246.1	15,129	15,918	13,579	15,748	20,103
2001	126.8	2,500	8,095	6,654	8,095	12,294
2002	266.1	16,054	17,170	13,506	16,782	20,316
2003	230.9	13,744	14,980	12,558	14,892	19,976
2004	204.4	12,691	13,274	10,993	13,270	19,225
2005	190.9	10,619	12,398	10,180	12,398	18,049
2006	316.6	20,321	20,250	17,044	19,296	20,440
2007	227.3	14,797	14,758	12,570	14,742	19,963

Bonneville Dam

Year	Avg Daily Flow(Kcfs)	Actual Spill (KAF)	2000 BIOP Spill (KAF)	PA Spill (KAF)	2007 Agreement Spill (KAF)	OR Plan Spill (KAF)
2000	259.3	14,698	15,855	13,269	16,239	16,239
2001	135.5	2,934	13,972	12,227	14,923	14,923
2002	276.8	19,640	15,875	14,231	16,244	16,244
2003	250.7	18,487	15,831	13,283	16,236	16,236
2004	230.9	13,981	15,798	13,267	16,233	16,233
2005	200.1	12,910	15,579	13,177	16,147	16,147
2006	333.1	20,122	16,210	13,884	16,320	16,320
2007	241.9	16,274	15,828	13,266	16,236	16,236

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TO: Russ Kiefer, IDFG

FROM: Michele DeHart

DATE: September 11, 2007

RE: The effect of transport on reach survival for steelhead smolts in water years 1996-2006

In response to your request, the FPC staff conducted an analysis of the effects of transport on the survival of the remaining population in river for steelhead smolts. This analysis attempted to identify the presence of a density dependent population mortality effect. We concluded that although there is some evidence of a density related effect, the inherent limitations of the data do not adequately describe this effect.

Estimates of the proportion of steelhead smolts (hatchery and wild) arriving at Lower Granite Dam (LGR) that were transported were calculated for 1996 to 2006 with the probabilistic model presented in FPC Annual Reports from 1998 to 2006 (see Appendix H in 2006). This method expresses the annual proportion of fish transported from LGR, Little Goose Dam (LGS), and Lower Monumental Dam (LMN) in LGR equivalents. The LGR to LMN reach survivals were estimated using the CSJ mark-recapture model on PIT tagged steelhead smolts released from above LWG for each year from 1996 to 2006. We plotted the proportion transported versus the reach survival (Figure 1). However, with these results it may be difficult to interpret the effect of differences in population size on survival within the LGR to LMN reach because the population of in river fish may vary in accordance with removals at LGR, LGS or MCN within that reach.

Figure 1 Reach survival (LGR to LMN) for steelhead vs. proportion transported for 1996-2006 (hatchery and wild fish combined).

Since the hypothesis you present was based on population density, an estimate of steelhead smolt population size below Lower Monumental Dam was developed and compared to the LMN to MCN reach survival. The steelhead smolt population at LMN tailrace was calculated as: (number of fish collected at LMN) / (detection probability at LMN) – (number of fish transported from LMN). The detection probability at LMN and the LMN to MCN reach survival was estimated with same mark-recapture method as above. The relationship between proportion of steelhead transported and the population at the LMN tailrace appears linear and both would compare similarly to survival (Figure 2).

Figure 2. Estimated population of fish at the LMN tailrace vs. the proportion of fish transported 1996-2006 (hatchery and wild fish combined).

The size of the LMN tailrace population is plotted vs. the LMN to MCN reach survival in Figure 3. The reach survivals show a sharp increase with population size at very low population levels and “level off” at higher population numbers (because of inconsistent operation in PIT detection sampling equipment at LMN in April of 2002, the 2002 estimate here may be biased). So initially, this appears to show a consistent survival estimate at most population sizes with some density dependence at small population sizes. In the CSS 10-year retrospective summary report, the authors found, “limited evidence for density-dependent effects on the instantaneous mortality rates of steelhead” based on a comparative modeling-building exercise. However, caution should be used when relating the estimated population of fish at the LMN tailrace to the survival estimate of fish between LMN and MCN.

Figure 3. Population of steelhead at LMN tailrace vs. the subsequent reach survival 1996-2006 (hatchery and wild fish combined).

Many other factors could influence reach survival for emigrating juvenile steelhead (e.g. spill, average flow, water transit time, fish travel time, etc.). These variables are confounded with the estimate of the proportion of fish transported and subsequently the population at the LMN tailrace. For example, low spill could reduce the population in the LMN tailrace by making more fish available for transport; but, low spill conditions could also be paired with low flow and longer fish transit times that would result in a lower fish survival independent of the size of the population. In summary, while these data do not disprove a density dependent mortality hypothesis, it also is not possible to adequately describe an effect given the inherent limitations of these data.

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MEMORANDUM

TO: Don Anglin, USFWS
Howard Schaller, USFWS

Michele DeHart

FROM: Michele DeHart

DATE: September 13, 2007

RE: Historical passage timing, travel times, and juvenile survival of wild Hanford Reach sub-yearling Chinook to McNary Dam.

In response to your request, FPC staff summarized passage timing, travel time, and juvenile survival data for wild Hanford Reach subyearling Chinook from release to McNary Dam over the past several years. We approached this task in a manner similar to analyses conducted for hatcheries that release PIT-tagged juvenile salmonids for the Smolt Monitoring Program (SMP) and Comparative Survival Study (CSS).

Since 1993, wild subyearling Chinook have been captured, PIT-tagged, and released in the Hanford Reach of the Mid-Columbia River, below Priest Rapids Dam (excluding 2002 and 2006). With the release of these PIT-tags, information on the timing and migration speed of tagged individuals becomes available, along with information on survival as these juveniles migrate downstream.

Table 1 describes the median travel times for each release to McNary Dam along with the minimum and maximum travel time estimates for wild subyearling Chinook tagged and released from Hanford Reach. This table also provides the 95% confidence limits around the estimated median travel time.

Table 1. Median travel time from release to McNary Dam for wild Hanford Reach subyearling Chinook.

Release Dates	Migration Year	Travel Time (Days)			Confidence Limits (95%)	
		Min	Median	Max	Lower	Upper
6/7-6/15	1993	3.2	29.1	79.0	28.7	30.0
6/6-6/7	1994	3.1	32.5	109.1	32.0	33.7
6/6-6/8	1995	6.0	28.1	49.8	27.7	28.5
6/10-6/13	1996	1.9	31.7	57.2	30.2	33.2
6/9-6/13	1997	1.2	29.1	72.8	28.3	30.1
6/1-6/3	1998	2.3	31.6	56.9	30.9	32.3
6/3-6/10	1999	2.4	33.0	74.8	32.0	34.1
6/1-7/3	2000	3.7	31.1	80.5	30.7	31.5
5/29-7/1	2001	1.6	33.0	298.4	32.0	33.8
5/27-5/30	2003	2.1	26.3	58.9	25.6	27.1
6/2-6/4	2004	4.0	23.2	57.7	25.6	27.1
5/31-7/1	2005	2.1	14.5	154.7	14.0	14.9
6/6-6/10	2007	2.3	28.7	63.3	28.4	28.9

Table 2 contains estimates of juvenile survival from release to McNary Dam, along with upper and lower confidence limits on these estimates. The yearly estimates are for all releases of wild subyearling Chinook tagged and released at Hanford Reach over that migration year.

Table 2. Survival (release to McNary) of Hanford Reach wild subyearling Chinook.

Release Dates	Migration Year	Survival	Confidence Limits (95%)	
			Lower	Upper
6/7-6/15	1993	N/A	N/A	N/A
6/6-6/7	1994	N/A	N/A	N/A
6/6-6/8	1995	0.414	0.096	0.733
6/10-6/13	1996	N/A	N/A	N/A
6/1-6/3	1998	0.617	0.518	0.707
6/3-6/10	1999	0.399	0.352	0.448
6/1-7/3	2000	0.416	0.386	0.446
5/29-7/1	2001	0.365	0.341	0.390
5/27-5/30	2003	0.311	0.273	0.351
6/2-6/4	2004	0.331	0.292	0.373
5/31-7/1	2005	0.286	0.262	0.310
6/6-6/10	2007	0.377	0.348	0.406

Finally, Figures 1 and 2 show the passage timing to McNary Dam of the PIT-tagged wild Hanford Reach subyearling Chinook, over the past several years. To better facilitate comparison, we have broken the years into two separate graphs.

Figure 1. Passage timing to McNary Dam of PIT-tagged wild Hanford Reach subyearling Chinook (1993-1999).

Figure 2. Passage timing to McNary Dam of PIT-tagged wild Hanford Reach subyearling Chinook (2000-2007).

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August 29, 2007

Mr. Gary Osborne
Wells Hatchery
24621 Highway 97
Pateros, WA 98846

Dear Gary-

The Fish Passage Center has been marking fish from the Wells Hatchery facility over the last several years as part of the Smolt Monitoring Program (SMP). For purposes of these studies data are collected on either juvenile life stage, or both the juvenile and adult life stages. The SMP provides information for in-season management of the hydrosystem and post-season analyses to the federal, state, and tribal fishery agencies. We would like to share with you some of the information we developed under this study for the fish used from the Wells Hatchery facility.

Under the Smolt Monitoring Program, information is collected on the timing and migration speed from the hatchery to McNary Dam.

Wells Hatchery Yearling and Subyearling Chinook Travel Times to McNary Dam

Release Age	Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Flow (kcfs)	Priest Rapids Temp (F)
			Min	Med	Max	Lower	Upper		
CH1	9-Apr	1997	16.7	29.2	56.1	28.1	30.4	172.1	45.8
CH1	4/15-5/	1998	8.8	29	111.6	28.1	30	160.5	51.1
CH0	24-Jun	1997	5.1	23	80.6	20.9	24.9	80.8	61.4
CH0	10-Jun	1998	8.1	30.8	68.4	29.8	32	148.7	61.8
CH0	19-Jun	1999	9.6	30.6	65.5	29.6	31.3	192.6	59
CH0	19-Jun	2000	12.4	35.3	67	32.5	36.5	132.7	
CH0	20-Jun	2001	14.8	37.8	309.5	36.9	39.6	69.8	63
CH0	17-Jun	2002	7.1	25.8	66.3	25.3	26.3	100.3	
CH0	17-Jun	2003	12.7	23.9	54.7	23.7	24.3	85.5	
CH0	12-May	2004	27.8	47.2	78.5	46.4	48.3	135.8	
CH0	15-Jun	2004	11.4	27.1	150.5	26.9	27.6	134.1	
CH0	18-May	2005	12.6	37.1	60.9	35.8	38.5		
CH0	13-Jun	2005	12.6	23.4	38.9	19.9	28.8	131.5	
CH0	12-May	2006	16.3	38.6	65.8	37	39.1	184.5	
CH0	14-Jun	2006	9.7	21.2	51.8	19.8	23.5		
CH0	17-May	2007	24.7	50.9	84.7	50.2	51.9	163.3	
CH0	15-June	2007	16.8	35.4	67.7	30.9	36.7	146.2	

The table above describes the median travel times from each release to McNary Dam along with the minimum and maximum travel times. It also provides the 95% confidence limits around the estimated median travel time.

**Wells Hatchery – Subyearling Chinook (1997-2003)
Passage Timing to McNary Dam**

**Wells Hatchery – Subyearling Chinook (2004-2007)
Passage Timing to McNary Dam**

Furthermore, the above graphs show passage timing of the hatchery releases to McNary Dam for the past eleven years. To better facilitate comparison, we have broken the years into two separate graphs. Please note the different scales on the x-axis.

Finally, we are providing estimates of survival from release at the hatchery to McNary Dam, along with the upper and lower confidence limits on these estimates. These survival estimates are for all releases of subyearling fall Chinook within a given migration year.

Wells Hatchery yearling and subyearling Chinook survivals (Release to McNary Dam)

Release Age	Release Date	Migration Year	Survival	Confidence Limits (95%)	
				Lower	Upper
CH1	9-Apr	1997	N/A	N/A	N/A
CH1	4/15-5/	1998	0.609	0.540	0.674
CH0	24-Jun	1997	0.254	0.170	0.338
CH0	10-Jun	1998	0.291	0.241	0.340
CH0	19-Jun	1999	0.373	0.281	0.465
CH0	19-Jun	2000	0.210	0.168	0.253
CH0	20-Jun	2001	0.211	0.166	0.257
CH0	17-Jun	2002	0.449	0.395	0.503
CH0	17-Jun	2003	0.456	0.406	0.506
CH0	12-May	2004	0.251	0.205	0.296
CH0	15-Jun	2004	0.160	0.106	0.215
CH0	18-May	2005	0.341	0.243	0.456
CH0	13-Jun	2005	N/A	N/A	N/A
CH0	12-May	2006	0.376	0.285	0.478
CH0	14-Jun	2006	0.352	0.199	0.534
CH0	17-May	2007	0.260	0.189	0.347
CH0	15-June	2007	0.281	0.155	0.454

We hope that the information we have provided regarding the use and application of information from the marked groups over the last several years is of some use to you. If you would like any additional information regarding these releases please feel free to contact us.

Sincerely,

Michele DeHart
Fish Passage Center Manager

Cc: Pete Hassemer, IDF&G
Doug DeHart, USFWS
Brian Lipscomb, CBFWA
Tony Nigro, ODFW
Ron Boyce, ODFW
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August 29, 2007

Mr. Glen Pearson
Priest Rapids Hatchery
P.O. Box 937
Mattawa, WA 99349

Dear Glen-

The Fish Passage Center has been marking fish from the Priest Rapids Hatchery facility over the last several years as part of the Smolt Monitoring Program (SMP). For purposes of these studies, data are collected on either juvenile life stage, or both the juvenile and adult life stages. The SMP provides information for in-season management of the hydrosystem and post-season analyses to the federal, state, and tribal fishery agencies. We would like to share with you some of the information we developed under this study for the fish used from the Priest Rapids Hatchery facility.

Under the Smolt Monitoring Program, information is collected on the timing, migration speed, and survival from the hatchery to McNary Dam.

The table below describes the median travel times from each release to McNary Dam along with the minimum and maximum travel time. It also provides the 95% confidence limits around the estimated median travel time.

Priest Rapids Hatchery Fall Chinook Travel Times to McNary Dam

Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Priest Rapids	
		Min	Med	Max	Lower	Upper	Flow (kcfs)	Temp (F)
16-Jun	1997	4.3	21.2	65.4	18.5	21.9	182.2	56.5
20-Jun	1997	1.3	11.9	54.4	11.4	12.6	153.7	57
24-Jun	1997	4.3	10.6	38.9	9.7	11.1	110.4	57.5
13-Jun	1998	2.6	7.4	39.1	7.03	8.01		
25-Jun	1998	2.5	9.6	27.4	9.2	9.9		
14-Jun	1999	3.8	13	39.6	12	13.6	184.7	57.6
18-Jun	1999	3.2	10.5	34.3	9.7	11.2	185.6	57.8
23-Jun	1999	2.2	11.7	57.2	11	12.2	196.3	57.8
15-Jun	2000	5.1	12.1	49.9	11.5	13.1	136.5	
19-Jun	2000	4.4	13.4	37.4	12.3	14.2	138.1	
27-Jun	2000	4.3	11.5	43	11.2	13.1	137.6	
11-Jun	2001	4.9	14	46.8	13.6	14.6	93.6	57.3
15-Jun	2001	7.2	13.2	60	12.8	14	94.2	58.2
19-Jun	2001	6.8	13.9	57.8	13.7	14.1	95.1	59.3
11-Jun	2002	5.2	14.1	41.8	13.7	14.9	222.3	13.6
15-Jun	2002	5.9	11.4	39.9	11.1	13.2	223.6	14.2
19-Jun	2002	3.9	11.3	38.9	10.2	13.1	234.2	14.6

Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Priest Rapids Flow (kcfs)	Temp (F)
		Min	Med	Max	Lower	Upper		
12-Jun	2003	3.9	11.1	41.7	10.6	11.4	148	
16-Jun	2003	4.2	9.3	34	8.9	9.8	143.3	
20-Jun	2003	4.5	11.1	35.8	10.9	11.4	138.1	
14-Jun	2004	3.9	6.2	19.6	6.1	6.6	150.3	
18-Jun	2004	3.2	6.8	21.6	6.5	7	139.1	
22-Jun	2004	2.7	5.9	27.2	5.6	6	129.8	
9-Jun	2005	3.4	7.8	28.2	7.2	8.4		
13-Jun	2005	3.2	5.5	22.9	5.4	6.1		
17-Jun	2005	0.2	7	19.4	6.7	7.3		
12-Jun	2006	3	10.8	27.5	8.3	12.3		
16-Jun	2006	3.4	12.1	25	11.1	12.4		
20-Jun	2006	3.2	9.9	22.3	9.3	10.5		
13-June	2007	5.3	15.6	35.8	13.8	17.6	157.9	
17-June	2007	3.9	11.8	31.4	11	12.8	151.7	
21-June	2007	4.8	10	23.5	9	11.1	148	

We are also providing the following graphs which show passage timing of the hatchery releases to McNary Dam for the past eleven years. Since each migration year has consisted of 3 separate release dates (except 1998 with only two release dates), each migration year is presented on a separate graph. Please note the different scales on the x-axis among the graphs.

**Priest Rapids Hatchery – Fall Chinook (1997)
Passage Timing to McNary Dam**

**Priest Rapids Hatchery – Fall Chinook (1998)
Passage Timing to McNary Dam**

Priest Rapids Hatchery – Fall Chinook (1999)
Passage Timing to McNary Dam

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Passage Timing to McNary Dam

Priest Rapids Hatchery – Fall Chinook (2006)
Passage Timing to McNary Dam

**Priest Rapids Hatchery – Fall Chinook (2007)
Passage Timing to McNary Dam**

Finally, we are providing estimates of survival from release at the hatchery to McNary Dam, along with the upper and lower confidence limits on these estimates. These yearly survival estimates are for all releases of subyearling fall Chinook within a given migration year.

Priest Rapids Hatchery fall Chinook survivals (Release to McNary Dam)

Release Dates	Migration Year	Survival	Confidence Limits (95%)	
			Lower	Upper
June 16-24	1997	0.568	0.458	0.679
June 13-25	1998	0.840	0.639	0.940
June 14-23	1999	0.757	0.679	0.836
June 15-27	2000	0.666	0.577	0.755
June 11-19	2001	0.746	0.670	0.794
June 11-19	2002	0.697	0.627	0.767
June 12-20	2003	0.633	0.590	0.677
June 14-22	2004	0.775	0.689	0.861
June 09-17	2005	0.655	0.573	0.729
June 12-20	2006	0.671	0.577	0.766
June 13-21	2007	0.698	0.556	0.809

We hope that the information we have provided regarding the use and application of information from the groups that have been marked at the hatchery over the last several years is of some use to you. If you would like any additional information regarding these releases please feel free to contact us.

Sincerely,

Michele DeHart
Fish Passage Center Manager

Cc: Pete Hassemer, IDF&G
Doug DeHart, USFWS
Brian Lipscomb, CBFWA
Tony Nigro, ODFW
Ron Boyce, ODFW
FPAC

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August 29, 2007

David Carie
Mid-Columbia River Fisheries Resource Office
7501 Icicle Road
Leavenworth, WA 98826

Dear David-

The Fish Passage Center has been marking fish from the Leavenworth National Fish Hatchery facility over the last several years as part of the Smolt Monitoring Program (SMP). For purposes of these studies data are collected on either juvenile life stage, or both the juvenile and adult life stages. The SMP provides information for in-season management of the hydrosystem and post-season analyses to the federal, state, and tribal fishery agencies. We would like to share with you some of the information we developed under this study for the fish used from the Leavenworth National Fish Hatchery facility.

Under the Smolt Monitoring Program, information is collected on the timing, migration speed, and survival of juveniles from the hatchery to McNary Dam.

Leavenworth Hatchery Spring Chinook Travel Times to McNary Dam

Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Priest Rapids	
		Min	Med	Max	Lower	Upper	Flow (kcfs)	Temp (F)
17-Apr	1997	8.6	28.7	52.2	22.7	41.8	92	44
20-Apr	1998	10.3	21.7	55.1	21.2	22.2	141.7	50.1
19-Apr	1999	6.8	27.8	55.7	27.3	28.1	171.1	47.1
18-Apr	2000	11.9	36.1	79.2	34.6	36.9	184.7	
17-Apr	2001	11.3	37	72	36.9	37.2	63.8	50.5
22-Apr, 24-Apr	2002	3.6	35.9	64.4	25.9	26	100.3	
21-Apr	2003	5.8	27.6	110.1	27.4	27.7	83.9	
19-Apr	2004	0.1	25.2	107.2	25.1	25.1	104.3	
15-Apr	2005	11.9	29.8	116.7	29.4	30.1		
17-Apr	2006	22.8	28.5	48.2	28.3	28.8	108.2	
18-Apr	2007	7.7	30.8	65.1	30.4	31.2	171.4	

The above table describes the median travel times from each release to McNary Dam along with the minimum and maximum travel times. It also provides the 95% confidence limits around the estimated median travel time.

We are also providing the following graphs which show passage timing of the hatchery releases to McNary Dam for the past eleven years. To better facilitate comparison, we have broken the years into two separate graphs. Please note the different scales on the x-axis.

Leavenworth Hatchery – Spring Chinook (1997-2002)
Passage Timing to McNary Dam

Leavenworth Hatchery – Spring Chinook (2003-2007)
Passage Timing to McNary Dam

Finally, we are providing estimates of survival from release at the hatchery to McNary Dam, along with the upper and lower confidence limits on these estimates.

Leavenworth Hatchery Spring Chinook survivals (Release to McNary Dam)

Release Date	Migration Year	Survival	Confidence Limits (95%)	
			Lower	Upper
17-Apr	1997	N/A	N/A	N/A
20-Apr	1998	0.546	0.491	0.602
19-Apr	1999	0.586	0.550	0.622
18-Apr	2000	0.593	0.520	0.667
17-Apr	2001	0.501	0.484	0.517
22-Apr, 24-Apr	2002	0.560	0.553	0.567
21-Apr	2003	0.662	0.655	0.669
19-Apr	2004	0.483	0.473	0.494
15-Apr	2005	0.526	0.500	0.553
17-Apr	2006	0.558	0.531	0.586
18-Apr	2007	0.592	0.569	0.615

We hope that the information we have provided regarding the use and application of information from the marked groups over the last several years is of some use to you. If you would like any additional information regarding these releases please feel free to contact us.

Sincerely,

Michele DeHart
Fish Passage Center Manager

Cc: Pete Hassemer, IDF&G
Doug DeHart, USFWS
Brian Lipscomb, CBFWA
Tony Nigro, ODFW
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August 29, 2007

Mr. John Hitron
Carson National Fish Hatchery
14041 Wind River Highway
Carson, WA 98610

Dear John-

The Fish Passage Center has been marking fish from the Carson National Fish Hatchery facility over the last several years as part of the Smolt Monitoring Program (SMP). For purposes of these studies data are collected on either juvenile life stage, or both the juvenile and adult life stages. The SMP provides information for in-season management of the hydrosystem and post-season analyses to the federal, state, and tribal fishery agencies. We would like to share with you some of the information we developed under this study for the fish used from the Carson National Fish Hatchery facility.

Under the Smolt Monitoring Program, information is collected on the timing and migration speed from the release at the hatchery to Bonneville Dam.

Carson National Fish Hatchery Spring Chinook Travel Times to Bonneville Dam

Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Bonneville Flow (kcfs)
		Min	Med	Max	Lower	Upper	
17-Apr	1997	0.66	16.5	33.7	14.6	17.1	
20-Apr	1998	1.7	10.0	38.5	9.6	10.7	
20-Apr	1999	0.8	8.7	94.3	7.8	9.5	198.5
20-Apr	2000	0.9	11.6	41.2	10.7	12.6	192.5
19-Apr	2001	1.6	18.5	130.3	18.3	18.7	127.8
17-Apr	2002	0.7	15.6	76.7	15.5	15.7	132.1
16-Apr	2003	1.2	12.5	42.5	11.6	13	111.8
15-Apr	2004	0.9	10.4	65.9	9.6	10.6	143.8
15-Apr	2005	1.5	11.5	29.3	10.7	11.6	146.7
10-Apr	2006	0.7	7.4	44.3	6.7	8.4	226.2
12-Apr	2007	0.9	17.6	41.6	15.7	18.6	215.7

The above table describes the median travel times from each release to Bonneville Dam along with the minimum and maximum travel times. It also provides the 95% confidence limits around the estimated median travel time.

Also, we are providing the following graphs which show passage timing of the hatchery releases to Bonneville Dam for the past eleven years. To better facilitate comparison, we have broken the years into two separate graphs. Please note the different scales on the x-axis.

Carson National Fish Hatchery – Spring Chinook (1997-2002)
Passage Timing to Bonneville Dam

Carson National Fish Hatchery – Spring Chinook (2003-2007)
Passage Timing to Bonneville Dam

We hope that the information we have provided regarding the use and application of information from the marked groups over the last several years is of some use to you. If you would like any additional information regarding these releases please feel free to contact us.

Sincerely,

A handwritten signature in black ink that reads "Michele DeHart". The signature is fluid and cursive, with the first name "Michele" and last name "DeHart" clearly distinguishable.

Michele DeHart
Fish Passage Center Manager

Cc: Pete Hassemer, IDF&G
Doug DeHart, USFWS
Brian Lipscomb, CBFWA
Tony Nigro, ODFW
Ron Boyce, ODFW
FPAC

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August 29, 2007

Mr. Bob Semple
U.S. Fish and Wildlife Service
P.O. Box 18
4147 Ahsahka Rd.
Ahsahka, ID 83520-0018

Dear Bob-

The Fish Passage Center has been marking fish from the Dworshak National Fish Hatchery facility over the last several years as part of the Smolt Monitoring Program (SMP) and the Comparative Survival Study (CSS). For purposes of these studies data are collected on either juvenile life stage, or both the juvenile and adult life stages. The SMP provides information for in-season management of the hydrosystem and post-season analyses to the federal, state, and tribal fishery agencies. The CSS is a multi-year program that estimates survival rates over different life stages for spring and summer Chinook produced in major hatcheries. We would like to share with you some of the information we developed under these studies for the fish used from the Dworshak Hatchery facility.

Under the Smolt Monitoring Program, information is collected on the timing and migration speed from the hatchery to Lower Granite Dam. In addition, as part of the CSS study, juvenile survival estimates are developed for the hydrosystem between Lower Granite and Bonneville Dams, and for the adulthood of different passage histories.

Dworshak NFH Spring Chinook Travel Times to Lower Granite Dam

Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Lower Granite	
		Min	Med	Max	Lower	Upper	Flow (kcfs)	Temp (F)
7-Apr	1997	3.2	31.9	97.6	31	32.8	156.6	52.3
3/23-3/26	1998	2.8	28.1	78.2	27.8	28.1	60.2	49.7
4/7-4/8	1999	4.6	27.7	133.7	27.4	28.2	97.4	44.7
3/23, 4/5-4/6	2000	3.9	27.3	86.8	27.2	27.3	74.8	48.8
28-Mar	2001	3.9	30.4	151.1	30.3	30.4	33.5	46.9
3/27-3/28	2002	3.4	38.1	77.6	38.1	38.2	27.4	
3/19-3/20	2003	6	49.4	121.4	49	49.7	28.4	
3/31-4/1	2004	6.2	32.2	74.9	32	32.4	23.4	
4/4-4/6	2005	5.6	30.2	76	30.2	30.2		
3/27-3/29	2006	2.7	35.6	78.7	35.4	35.9	43.3	
3/28-3/29	2007	4.4	27.8	76.9	27.4	28.4	46.4	

Dworshak NFH Steelhead Travel Times to Lower Granite Dam

Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Lower Granite Flow (kcfs)	Temp (F)
		Min	Med	Max	Lower	Upper		
28-Apr	1997	1.3	2.8	28.6	2.4	3.6	160.6	50.6
2-May	1997	1.9	6.7	30.5	5.1	11.2	156.6	52.3
29-Apr	1997	1.2	1.8	30.1	1.7	1.8	160.6	50.6
1-May	1997	1.5	6.9	64.8	5.5	8.8	150.9	52.3
4/27-4/30	1998	2.3	4.7	48.8	4.5	5	90.6	53.5
4/26-4/30	1999	1.5	6.2	60.1	5.8	6.5	115.4	50.8
5/3-5/5	2000	1.6	3.5	66.6	3.5	3.5	95.2	53.2
4/23-4/26	2001	2.5	6.8	110	6.7	7	46.6	44.9
4/22-4/25	2002	2.4	5.7	47.4	5.5	6.4	22.5	
4/24	2003	0.6	7.1	54.8	6.6	7.7	18	
4/29-4/22	2004	2.9	8.8	34	8.4	9.3	21.8	
4/18-4/22	2005	3.4	11.2	60.8	10.4	11.6		
4/17-4/21	2006	1.0	10.5	52.7	8.1	12.6	47.5	
4/16-4/19	2007	1.9	14.6	52.7	13.0	15.8	53.0	

The above tables describe the median travel times from each release site to Lower Granite Dam along with the minimum and maximum travel time estimates for both spring Chinook and steelhead. They also provide the 95% confidence limits around the estimated median travel time.

The table below contains estimates calculated in the CSS study of juvenile survival in the hydrosystem between Lower Granite and Bonneville Dams and the survival to adult of spring Chinook in several categories. Those categories are SAR(T), SAR(C₀), and Weighted SAR_{LGR-to-LGR}, where SAR(T) represents smolts transported from Lower Granite, Little Goose, or Lower Monumental Dam, SAR(C₀) represents smolts migrating in river, and SAR_{LGR-to-LGR} is a weighted estimate that is obtained by taking the proportion of the total population of smolts (tagged and untagged) at Lower Granite Dam in each study category and multiplying by the respective study category's SAR_{LGR-to-LGR}. In effect, the weighted SAR_{LGR-to-LGR} is the estimated SAR for the overall hatchery release.

Dworshak NFH Spring Chinook Survivals from CSS

Release Date	Migration Year	Juvenile Survival LGR-BON	Proportion Transported	T/C Ratio	SAR(T)	Adult Survival	
						SAR(C ₀) %	Weighted SAR _{LGR-to-LGR}
7-Apr	1997	0.49	0.48	1.75	0.83	0.47	0.62
3/23-3/26	1998	0.51	0.71	0.72	0.9	1.25	1
4/7-4/8	1999	0.54	0.74	0.99	1.18	1.2	1.19
3/23, 4/5-4/6	2000	0.48	0.66	0.99	1	1.01	1
28-Mar	2001	0.24	0.98	8.76	0.36	0.04	0.35
3/27-3/28	2002	0.62	0.57	1.24	0.62	0.5	0.57
3/19-3/20	2003	0.68	0.54	1.20	0.26	0.21	0.24
3/31-4/1	2004 ^A	0.50	0.84	0.95	0.21	0.22	0.21

^A Migration year 2004 is incomplete with Age 2-salt adult returns through 8/9/2006

The following graph shows a time series of the Weighted SAR_{LGR-to-LGR} over the eight years of available data.

Finally, we are providing the following graphs which show passage timing of the hatchery releases to Lower Granite Dam for the past several years. To better facilitate comparison, we have broken the years into two separate graphs. Please note the different scales on the x-axis among the graphs.

**Dworshak NFH – Spring Chinook (1997-2002)
Passage Timing to Lower Granite Dam**

Dworshak NFH – Spring Chinook (2003-2007)
Passage Timing to Lower Granite Dam

Dworshak NFH – Steelhead (1997-2002)
Passage Timing to Lower Granite Dam

**Dworshak NFH – Steelhead (2003-2007)
Passage Timing to Lower Granite Dam**

We hope that the information we have provided regarding the use and application of information from the marked groups over the last several years is of some use to you. If you would like any additional information regarding these releases please feel free to contact us.

Sincerely,

Michele DeHart
Fish Passage Center Manager

Cc: Pete Hassemer, IDF&G
Doug DeHart, USFWS
Brian Lipscomb, CBFWA
Tony Nigro, ODFW
Ron Boyce, ODFW
FPAC

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August 29, 2007

Mr. Gene McPherson
McCall Hatchery
Idaho Department of Fish and Game
P.O. Box 1021
McCall, ID 83638

Dear Gene-

The Fish Passage Center has been marking fish from the McCall Hatchery facility over the last several years as part of the Smolt Monitoring Program (SMP) and the Comparative Survival Study (CSS). For purposes of these studies data are collected on either juvenile life stage, or both the juvenile and adult life stages. The SMP provides information for in-season management of the hydrosystem and post-season analyses to the federal, state, and tribal fishery agencies. The CSS is a multi-year program that estimates survival rates over different life stages for spring and summer Chinook produced in major hatcheries. We would like to share with you some of the information we developed under these studies for the fish used from the McCall Hatchery facility.

Under the Smolt Monitoring Program, information is collected on the timing and migration speed from the hatchery to Lower Granite Dam. In addition, as part of the CSS study, juvenile survival estimates are developed for the hydrosystem between Lower Granite and Bonneville Dams, and for the adulthood of different passage histories.

McCall Hatchery Summer Chinook Travel Times to Lower Granite Dam

Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Lower Granite	
		Min	Med	Max	Lower	Upper	Flow (kcfs)	Temp (F)
20-Mar	1997	9.9	49.4	100.2	49.1	49.7	150.9	52.3
30-Mar	1998	14.4	36.5	109.7	36.4	36.5	71.4	51.4
6-Apr	1999	13.8	39.9	129	39.7	40.5	95.5	50.4
5-Apr	2000	11.3	34.1	114	34	34.2	94.2	51.6
26-Mar	2001	24.2	48.5	114.8	48.2	48.6	41.4	47.3
25-Mar	2002	20.2	51.3	82.5	51	51.5	27.6	
31-Mar	2003	12.4	42	101.3	41.9	42.1	28.8	
22-Mar	2004	16.4	43.5	96.1	43.4	43.6	23.9	
18-Mar	2005	24.4	49.4	93.1	49.4	49.5		
21-Mar	2006	17.5	46.1	76	45.9	46.3	44.2	
19-Mar	2007	20.0	47.0	71.8	46.8	47.2	52.9	

The above table describes the median travel time from each release site to Lower Granite Dam along with the minimum and maximum travel time estimates. It also provides the 95% confidence limits around the estimated median travel time.

The table below contains estimates calculated in the CSS study of juvenile survival in the hydrosystem between Lower Granite and Bonneville Dams and the survival to adult of juvenile salmonids in several categories. Those categories are SAR(T), SAR(C₀), and Weighted SAR_{LGR-to-LGR}, where SAR(T) represents smolts transported from Lower Granite, Little Goose, or Lower Monumental Dam, SAR(C₀) represents smolts migrating in river, and SAR_{LGR-to-LGR} is a weighted estimate that is obtained by taking the proportion of the total population of smolts (tagged and untagged) at Lower Granite Dam in each study category and multiplying by the respective study category's SAR_{LGR-to-LGR}. In effect, the weighted SAR_{LGR-to-LGR} is the estimated SAR for the overall hatchery release.

McCall Hatchery Summer Chinook Survivals from CSS

Release Date	Migration Year	Juvenile Survival LGR-BON	Proportion Transported	T/C Ratio	SAR(T)	Adult Survival SAR(C ₀) %	Weighted SAR _{LGR-to-LGR}
20-Mar	1997	0.43	0.51	1.39	1.89	1.09	1.50
30-Mar	1998	0.56	0.86	1.97	2.71	1.38	2.52
6-Apr	1999	0.52	0.73	1.5	3.61	2.4	3.28
5-Apr	2000	0.61	0.58	1.9	3.91	2.06	3.13
26-Mar	2001	0.27	0.97	31.9	1.24	0.04	1.21
25-Mar	2002	0.58	0.68	1.45	1.49	1.03	1.34
31-Mar	2003	0.70	0.54	1.46	0.79	0.54	0.68
19-Mar	2004 ^A	0.44	0.93	1.23	0.31	0.25	0.31

^A Migration year 2004 is incomplete with Age 2-salt adult returns through 8/9/2006

The following graph shows a time series of the Weighted SAR_{LGR-to-LGR} over the eight years of available data.

Finally, we are providing the following graphs which show passage timing of the hatchery releases to Lower Granite Dam for the past eleven years. To better facilitate comparison, we have broken the years into two separate graphs. . Please note the different scales on the x-axis.

McCall Hatchery – Summer Chinook (1997-2002)
Passage Timing to Lower Granite Dam

McCall Hatchery – Summer Chinook (2003-2007)
Passage Timing to Lower Granite Dam

We hope that the information we have provided regarding the use and application of information from the marked groups over the last several years is of some use to you. If you would like any additional information regarding these releases please feel free to contact us.

Sincerely,

A handwritten signature in black ink that reads "Michele DeHart". The signature is fluid and cursive, with the first name "Michele" and last name "DeHart" clearly distinguishable.

Michele DeHart
Fish Passage Center Manager

Cc: Pete Hassemer, IDF&G
Doug DeHart, USFWS
Brian Lipscomb, CBFWA
Tony Nigro, ODFW
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August 29, 2007

Mr. Bob Lund
Lookingglass Fish Hatchery
Oregon Department of Fish and Wildlife
Route 2 Box 89-D-B
Elgin, OR 97287

Dear Bob-

The Fish Passage Center has been marking fish from the Lookingglass Fish Hatchery facility over the last several years as part of the Smolt Monitoring Program (SMP) and the Comparative Survival Study (CSS). For purposes of these studies data are collected on either juvenile life stage, or both the juvenile and adult life stages. The SMP provides information for in-season management of the hydrosystem and post-season analyses to the federal, state, and tribal fishery agencies. The CSS is a multi-year program that estimates survival rates over different life stages for spring and summer Chinook produced in major hatcheries. We would like to share with you some of the information we developed under these studies for the fish used from the Lookingglass Hatchery facilities (Imnaha and Catherine Creek Acclimation Ponds).

Under the Smolt Monitoring Program, information is collected on the timing and migration speed from the hatchery to Lower Granite Dam. In addition, as part of the CSS study, juvenile survival estimates are developed for the hydrosystem between Lower Granite and Bonneville Dams, and for the adulthood of different passage histories.

Imnaha Acclimation Pond – Spring Chinook Travel Time to Lower Granite Dam

Release Date	Migration Year	Travel Time (Days)			Confidence Limits		Lower Granite Flow (kcfs)	Temp (F)
		Min	Med	Max	95% Lower	95% Upper		
Apr-7	1997	9.1	28.1	79.7	27.9	28.7	144.1	51.9
Apr-6	1998	8.3	26.2	60.8	26	26.3	70.5	51.8
3/16, 4/05	1999	5.1	54.7	175.6	54.4	54.9	98	49.4
22-Mar	2000	15.7	42.8	66.3	42.5	43.1	82.1	50
21-Mar	2001	8.8	42.1	93	41.7	42.2	36.8	47.1
21-Mar	2002	8.2	45.2	66	44.9	45.4	27.9	
1-Apr	2003	7.2	34.6	76.6	34.5	34.7	28	
26-Mar	2004	9.9	38.5	84.4	38.5	38.6	23.6	
3/26, 3/29	2005	9.3	36.1	78.7	35.9	36.3		
3/21, 3/30	2006	6.3	40.6	74.2	40.2	41	44	
3/21, 3/31	2007	17.0	41.3	103.5	41.2	41.4	49.6	

Catherine Creek Acclimation Pond – Spring Chinook Travel Time to Lower Granite Dam

Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Lower Granite Flow (kcfs)	Temp (F)
		Min	Med	Max	Lower	Upper		
4/2	2001	13.6	42.4	98.9	42.3	42.5	41.7	47.7
4/1-4/02	2002	9.3	45.6	82.9	45.4	45.9	27.7	
3/12, 3/23, 3/31	2003	3	41.2	90.9	40.9	41.9	28.8	
3/15, 3/30	2004	10.3	46.3	117.1	45.6	46.6	23.8	
3/14, 4/04	2005	15.9	43.9	85.7	43.7	44.3		
27-Mar	2006	13.6	42.4	98.9	42.3	42.5	41.7	47.7
26-Mar	2007	24.9	44.8	74.1	44.5	45.2	53.0	

The above tables describe the median travel time from each release site to Lower Granite Dam along with the minimum and maximum travel time estimates. They also provide the 95% confidence limits around the estimated median travel time.

The tables below contain estimates calculated in the CSS study of juvenile survival in the hydrosystem between Lower Granite and Bonneville Dams and the survival to adult of juvenile salmonids in several categories. Those categories are SAR(T), SAR(C₀), and Weighted SAR_{LGR-to-LGR}, where SAR(T) represents smolts transported from Lower Granite, Little Goose, or Lower Monumental Dam, SAR(C₀) represents smolts migrating in river, and SAR_{LGR-to-LGR} is a weighted estimate that is obtained by taking the proportion of the total population of smolts (tagged and untagged) at Lower Granite Dam in each study category and multiplying by the respective study category's SAR_{LGR-to-LGR}. In effect, the weighted SAR_{LGR-to-LGR} is the estimated SAR for the overall hatchery release.

Imnaha Acclimation Pond – Spring Chinook Survival

Release Date	Migration Year	Juvenile Survival LGR-BON	Proportion Transported	T/C Ratio	SAR(T)	Adult Survival	
						SAR(C ₀) %	Weighted SAR _{LGR-to-LGR}
Apr-7	1997	0.31	0.516	1.37	1.17	0.86	0.98
Apr-6	1998	0.53	0.848	1.56	0.86	0.55	0.81
3/16, 4/05	1999	0.54	0.777	1.9	2.72	1.43	2.43
22-Mar	2000	0.57	0.686	1.3	3.15	2.41	2.92
21-Mar	2001	0.37	0.976	10.8	0.62	0.06	0.61
21-Mar	2002	0.50	0.662	1.76	0.8	0.45	0.68
1-Apr	2003	0.70	0.552	1.21	0.58	0.48	0.53
26-Mar	2004 ^A	0.37	0.888	1.50	0.35	0.23	0.33

^A Migration year 2004 is incomplete with Age 2-salt adult returns through 8/9/2006

Catherine Creek Acclimation Pond – Spring Chinook Survival

Release Date	Migration Year	Juvenile Survival LGR-BON	Proportion Transported	T/C Ratio	SAR(T)	Adult Survival	
						SAR(C ₀) %	Weighted SAR _{LGR-to-LGR}
4/2	2001	0.25	0.964	5.32	0.23	0.04	0.22
4/1-4/02	2002	0.65	0.706	1.82	0.89	0.49	0.77
3/12, 3/23, 3/31	2003	0.62	0.552	1.44	0.36	0.25	0.31
3/15, 3/30	2004 ^A	0.33	0.898	1.75	0.35	0.20	0.33

^A Migration year 2004 is incomplete with Age 2-salt adult returns through 8/9/2006

The following graph shows a time series of the Weighted $SAR_{LGR-to-LGR}$ between the two acclimation ponds.

Finally, we are providing the following graphs which show timing of the Imnaha and Catherine Creek releases to Lower Granite Dam for the past several years. To better facilitate comparison, we have broken the years into two separate graphs for the Imnaha Hatchery. This was not necessary for the Catherine Creek Hatchery, as there are fewer years. Please note the different scales on the x-axis of these graphs.

**Imnaha Acclimation Pond – Spring Chinook (1997-2002)
Passage Timing to Lower Granite Dam**

**Imnaha Acclimation Pond – Spring Chinook (2003-2007)
Passage Timing to Lower Granite Dam**

**Catherine Creek Acclimation Pond – Spring Chinook (2001-2007)
Passage Timing to Lower Granite Dam**

We hope that the information we have provided regarding the use and application of information from the marked groups at the hatchery over the last several years is of some use to you. If you would like any additional information regarding these releases please feel free to contact us.

Sincerely,

A handwritten signature in black ink that reads "Michele DeHart". The signature is fluid and cursive, with the first name "Michele" being more prominent than the last name "DeHart".

Michele DeHart
Fish Passage Center Manager

Cc: Pete Hassemer, IDF&G
Doug DeHart, USFWS
Brian Lipscomb, CBFWA
Tony Nigro, ODFW
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August 29, 2007

Mr. Ralph Steiner
HC 69, Box 85
Riggins, ID 83549

Dear Ralph-

The Fish Passage Center has been marking fish from the Rapid River Hatchery facility over the last several years as part of the Smolt Monitoring Program (SMP) and the Comparative Survival Study (CSS). For purposes of these studies data are collected on either juvenile life stage, or both the juvenile and adult life stages. The SMP provides information for in-season management of the hydrosystem and post-season analyses to the federal, state, and tribal fishery agencies. The CSS is a multi-year program that estimates survival rates over different life stages for spring and summer Chinook produced in major hatcheries. We would like to share with you some of the information we developed under these studies for the fish used from the Rapid River Hatchery facility.

Under the Smolt Monitoring Program, information is collected on the timing and migration speed from the hatchery to Lower Granite Dam. In addition, as part of the CSS study, juvenile survival estimates are developed for the hydrosystem between Lower Granite and Bonneville Dams, and for the adulthood of different passage histories.

Rapid River Hatchery Spring Chinook Travel Times to Lower Granite Dam

Release Date	Migration Year	Travel Time (Days)			Confidence Limits 95%		Lower Granite	
		Min	Med	Max	Lower	Upper	Flow (kcfs)	Temp (F)
4/1	1997	1.5	34.9	115.8	34.4	35.4	143	52
4/13	1998	n/a	19.5	60	19.5	19.6	75.2	52.6
4/2, 4/20	1999	1.4	37.1	134.8	36.9	37.2	95.7	49.8
3/17	2000	19.7	49	75.9	48.9	49	79.2	49.7
3/15	2001	16.2	46.3	110.3	46.2	46.3	34.7	46.7
3/18	2002	14.9	47.4	66.8	47.4	47.5	27.5	
3/17	2003	15.1	47.4	84.1	47.2	47.7	28.6	
3/15	2004	14.4	46.7	72.6	46.6	46.9	23.9	
3/15	2005	20.9	50.9	78.2	50.8	50.9		
3/17	2006	15.1	48.9	71.1	48.7	49.1	44	
3/15	2007	11.3	50.3	82.9	50.2	50.4	52.1	

The above table describes the median travel time from each release site to Lower Granite Dam along with the minimum and maximum travel time estimates. It also provides the 95% confidence limits around the estimated median travel time.

The table below contains estimates calculated in the CSS study of juvenile survival in the hydrosystem between Lower Granite and Bonneville Dams and the survival to adult of juvenile salmonids in several categories. Those categories are SAR(T), SAR(C₀), and Weighted SAR_{LGR-10-LGR}, where SAR(T) represents smolts transported from Lower Granite, Little Goose, or Lower Monumental Dam, SAR(C₀) represents smolts migrating in river, and SAR_{LGR-10-LGR} is a weighted estimate that is obtained by taking the proportion of the total population of smolts (tagged and untagged) at Lower Granite Dam in each study category and multiplying by the respective study category's SAR_{LGR-10-LGR}. In effect, the weighted SAR_{LGR-10-LGR} is the estimated SAR for the overall hatchery release.

Rapid River Hatchery Spring Chinook Survivals from CSS

Release Date	Migration Year	Juvenile Survival LGR-BON	Proportion Transported	T/C Ratio	SAR(T)	Adult Survival SAR(C ₀) %	Weighted SAR _{LGR-10-LGR}
4/1	1997	0.33	0.54	1.73	0.79	0.46	0.65
4/13	1998	0.59	0.86	1.66	2	1.2	1.89
4/2, 4/20	1999	0.57	0.80	1.28	3.05	2.37	2.91
3/17	2000	0.58	0.68	1.32	2.1	1.59	1.94
3/15	2001	0.33	0.97	21.8	1.09	0.05	1.06
3/18	2002	0.71	0.67	1.52	1.01	0.67	0.9
3/17	2003	0.66	0.55	1.07	0.25	0.23	0.24
3/15	2004 ^A	0.35	0.89	1.79	0.26	0.14	0.24

^A Migration year 2004 is incomplete with Age 2-salt adult returns through 8/9/2006

The following graph shows a time series of the Weighted SAR_{LGR-10-LGR} over the eight years of available data.

Finally, we are providing the following graphs which show passage timing of the hatchery releases to Lower Granite Dam for the past eleven years. To better facilitate

comparison, we have broken the years into two separate graphs. Please note the different scales on the x-axis of these graphs.

**Rapid River Hatchery – Spring Chinook (1997-2002)
Passage Timing to Lower Granite Dam**

**Rapid River Hatchery – Spring Chinook (2003-2007)
Passage Timing to Lower Granite Dam**

We hope that the information we have provided regarding the use and application of information from the marked groups over the last several years is of some use to you. If you would like any additional information regarding these releases please feel free to contact us.

Sincerely,

A handwritten signature in black ink that reads "Michele DeHart". The signature is fluid and cursive, with the first name "Michele" being larger and more prominent than the last name "DeHart".

Michele DeHart
Fish Passage Center Manager

Cc: Pete Hassemer, IDF&G
Doug DeHart, USFWS
Brian Lipscomb, CBFWA
Tony Nigro, ODFW
Ron Boyce, ODFW
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MEMORANDUM

TO: Liz Hamilton, NWSFI
Ron Boyce, ODFW

Michele DeHart

FROM: Michele DeHart

DATE: August 24, 2007

RE: Response to Comments from 6/21/07 Oregon Department of
Environmental Quality Meeting

The Fish Passage Center received your data request to respond to several comments made by different presenters at the Oregon Department of Environmental Quality (DEQ) meeting on June 21, 2007. Specifically, we were asked to respond to comments made by James Buchal, representing himself, relative to the total dissolved gas program; by Shane Scott, Northwest River Partners, relative to the survival of juvenile salmonids through various routes of passage at Bonneville Dam and to an exchange between Ritchie Graves, NOAA Fisheries and Commissioner Williamson, Oregon Environmental Quality Commission, relative to the estimates of survival through turbines and spillways. In order to directly respond to the conversations that took place at the meeting, the FPC requested an audio transcript of the DEQ hearing. We have excerpted those specific conversations from the tapes and will present them here as best as possible.

I. James Buchal Testimony

"I have in my hands here a memorandum from the Fish Passage Center on their letterhead to the chairman of the Fish Passage Advisory Committee. It went to Miss Lut and it went up to Washington and it says we have a gas bubble disease problem, we have 36.6 percent of the fish have gas bubble trauma up at Little Goose and Lower Monumental dams and that is at levels of TDG that are in complete compliance like at 112 and 111 % and we've got these massive levels of gas bubble disease and I know that these GBT is not detected at such high levels downstream but elementary toxicology may tell you why – if you kill them all at the projects upstream then

the ones that are susceptible the ones downstream won't show as many symptoms. But the idea that we have in place, that there is some system that where when the fish managers see the high levels of symptoms that something is done- that's utterly false. Well what it says here is that there aren't that many fish left so let's just keep spilling. And I'll put that in the record too – here it is – it went to commission staff and every body ignores it and do you know what the number is today or yesterday, it is up to 46.9 percent of the fish are showing gas bubble trauma and the answer is, just keep on spilling.”

The Fish Passage Center Staff provided information on the incidence of gas bubble trauma (GBT) in juvenile Snake River steelhead on June 8, 2007 and again on June 11, 2007. The GBT monitoring was observing large numbers of late migrating steelhead exhibiting signs of GBT. However, the implication made in Mr. Buchal's testimony, regarding the Salmon Manager's unwillingness to consider alterations to the spill program based on data are entirely false. The following summarizes the data that was taken into consideration regarding the GBT incident.

GBT Data

The GBT data of concern was collected at both Little Goose and Lower Monumental dams. As noted in the memos, the frequency of GBT monitoring was increased at these two projects in an effort to understand the implications of the high levels of TDG. Table 1 shows the % GBT for steelhead at Little Goose Dam and Table 2 shows that data for Lower Monumental Dam. A high proportion of steelhead were observed with signs of GBT, but at the same time the total dissolved gas levels were very low. The initial observations of the high levels of GBT were at Little Goose Dam and TDG was below the waiver criteria and, in fact with the exception of 6/5/2007, the TDG levels were below the state and federal standards of 110% and were not subject to the conditions of the waiver. Additionally, very few subyearling migrants exhibited these signs of GBT, so it was clearly a steelhead issue. The Salmon Managers were managing a situation where water quality standards were not being exceeded and there was a desire to maintain protection for the subyearling population, whose numbers were increasing.

Table 1. Observation of GBT in steelhead smolts observed at Little Goose Dam in 2007.

Date	Species	FishExams	TotalNumGBT	%GBT	TDG
6/5/2007	ST	94	14	14.9%	112.8
6/8/2007	ST	93	36	38.7%	108.2
6/10/2007	ST	50	13	26.0%	110.9
6/12/2007	ST	50	11	22.0%	109.3
6/19/2007	ST	61	35	57.4%	109.6
6/26/2007	ST	2	1	50.0%	109.3
7/3/2007	ST	4	1	25.0%	110.3
7/10/2007	ST	12	8	66.7%	109.2

Table 2. Observation of GBT in steelhead smolts observed at Lower Monumental Dam in 2007.

Date	Species	FishExams	TotalNumGBT	% GBT	TDG
6/4/2007	ST	64	13	20.3%	114.3
6/7/2007	ST	18	5	27.8%	109.0
6/11/2007	ST	33	16	48.5%	110.2
6/25/2007	ST	1	0	0.0%	106.9
7/1/2007	ST	2	1	50.0%	107.0
7/22/2007	ST	3	0	0.0%	

From the data it was apparent that the late migrating juvenile steelhead were disproportionately displaying the signs of GBT. In addition, the issue began high up in the system at Little Goose Dam. The Salmon Managers did not necessarily regard this as a TDG problem, but investigated the potential causes of this occurrence from a project operations and migration conditions issue.

Passage Timing

Historically steelhead smolt passage at Lower Granite Dam peaks in early May (50% passage date) with over 90% of steelhead migrants passing by late May, which was the migration pattern exhibited in 2007(see Figure 1). As the steelhead migration is diminishing, the subyearling migration is increasing steadily in early June, and in 2007 the magnitude of the subyearling population was ten times that of the steelhead migrants.

The Snake River GBT sampling program typically ended on June 20th (or earlier) in past years since until 1995 there was no summer spill program in the Snake River. It has been observed that typically the incidence of GBT in steelhead tends to increase slightly towards the end of the season, although not to the degree that occurred in 2007. The question then arose as to why this was being observed in 2007.

Flow and Fish Travel Time Conditions in 2007

From laboratory studies that had been conducted (Mesa et al., 2000) it had been shown that up to 80% of Chinook would display minor signs of GBT at low levels of TDG if left sufficiently long in the water at that exposure. There were no mortalities in this group throughout the duration of the experiment, which lasted for 22 days. Given this information the Salmon Managers began to investigate the flow and fish travel time conditions that existed in 2007.

The graph (Figure 1) shows the 2007 flow levels at Lower Granite Dam as compared to 2006 and the average over the past ten years. From the graph it can be seen that flow at Lower Granite Dam during June was significantly less than observed in 2006, or as represented by the ten year average. Steelhead juvenile migrants are particularly sensitive to changes in flow as expressed by their fish travel time estimates. The hypothesis was that steelhead travel time was longer during June of 2007 due to extremely low flows, and the few late migrating steelhead were displaying minor signs of GBT because of the long exposure to these sub-lethal levels of TDG.

Figure 1. Daily average flows at Lower Granite Dam for 2007, 2006 and a ten year average daily flow for 1997-2006.

The hypothesis was evaluated by plotting travel time of steelhead smolts between Lower Granite and Little Goose dams as a function of their arrival timing at Little Goose Dam. From the graph (Figure 2) it can be seen that the later arriving fish in 2007 have much longer travel times in 2007, consistent with the hypothesis that a higher incidence of signs of GBT in steelhead juveniles at Snake River projects in 2007 as a result of long travel times between projects, due to low flows.

Figure 2. Travel time of steelhead juveniles migrating between Lower Granite and Little Goose Dam in 2007 as a function of arrival time at Little Goose Dam.

In conclusion, the following information was considered when the decision was made to continue Snake River spill in 2007 during the month of June:

- 1) TDG levels were below standards, not just below waiver limits;
- 2) Steelhead smolts represented a small proportion of the overall migrant population passing Lower Granite Dam, priority was instead focused on protecting subyearling migrants which predominated in the river.
- 3) Signs of GBT in steelhead were mostly minor, and few, if any, subyearling Chinook displayed signs of GBT;
- 4) The incidence of GBT signs in steelhead smolts at the low TDG concentrations were likely a function of very long travel times as flows were so low.
- 5) Laboratory studies indicated that mortality due to GBT was minimal (or nil) under the conditions that prevailed in 2007.

II. Shane Scott Testimony

“The recent improvements at Bonneville Dam include the corner collectors which is a surface bypass system (EQC then asks Scott to identify himself) Shane Scott formerly with Washington Department of Fish and Wildlife now I’m with Northwest River Partners. The COE, Bonneville and federal family have installed two real significant fish passage facilities at Bonneville Dam: one is the corner collector, it’s another surface bypass system, and the other is a juvenile bypass system. Together those are about 200 million dollars in concrete fish passage improvements at that dam to safely pass fish through that project, demonstrated with test fish to have the highest route survival through that dam. Spillway has the lowest route survival so you simply look at numbers. I would put my fish through the corner collector which has a survival of 100%, it is just a long channel you can see it when you are on the Washington side of the dam and then the juvenile bypass system you see it puts fish about two miles downstream back into the river, usually you see a lot of birds hanging around there. Those two routes of passage are much higher than the spillway and we question first the lost generation, plus just putting small fish through that spillway which is demonstrated for all species that have been adequately evaluated to have a higher mortality through that spillway. This is independent science paid for by the Bonneville Power Administration and COE through a regional independent process and the agencies don’t do this research themselves it is by independent folks outside of those agencies.”

Mr. Scott makes general statements regarding the corner collector and bypass system at Bonneville Dam. These statements primarily relate to direct survival estimates from studies conducted in 2004 and 2005. Direct survival studies measure immediate dam survival only. Direct survival estimates do not account for any delay or mortality incurred in either the tailrace or forebay as a result of the route of passage.

It is incomplete to only refer to direct project survival estimates that do not take into consideration the impact that a passage route can have on subsequent survival. In fact, in his own testimony Mr. Scott refers to the fact that many “birds hang out at the downstream outlet of the bypass pipe”. The predation caused by the birds can be a significant source of mortality, and concentrating juveniles and releasing them from one point source that drops water and fish into the tailrace does exacerbate that mortality and should be part of the accounting of mortality due to a specific passage route.

It is important to note that the spillway survival values Mr. Scott refers to were collected in 2004 and 2005 under different project operations than previously existed. The spillway survival estimate for the 1995 to 1999 studies was 98%. Specifically, for the studies conducted in 2004 and 2005 the COE states in the “Structural and Operational Changes at FCRPS Dams to Improve Fish Survival”, June 19, 2007, the addition of spillway deflectors and new spill patterns likely caused the decrease in spillway survival and evaluation of their impact on survival is underway.

Most importantly, survival to adulthood relative to the route of passage is the ultimate measure of a passage routes' benefit. It is true that a considerable amount of money was spent on the corner collector based on its being a beneficial surface route of passage. However, as with all routes of passage the use of a specific route of passage must produce adults. The Bonneville Second Powerhouse corner collector had not been tested for Spring Creek Hatchery subyearling migrants released in March nor have spillway releases been tested for these fish. Various survival studies for these routes of passage have been conducted at different times of year or for different species/stocks of fish. The Spring Creek March release is generally responsible for 46% of the returning adults from this hatchery and, while not necessary to protect these fish from an ESA perspective, the stock is of utmost importance to international and national fisheries. In 2004 (the first year of corner collector operation) the USFWS proposed to do a three year study under varying operations comparing spill to corner collector passage. Only one year of the study was implemented, and while the study was designed and conclusive results would have been drawn based on the data if the study had been implemented for all three years, the data suggests that fish that passed via the corner collector did not survive as well as those that passed the project via spill.

Given the importance of this fish stock and the role that spill may have relative to the long term survival of this stock, as well as the research data, it was important for the USFWS to procure the waiver for the March Spring Creek Hatchery release.

Also, the distribution of predators would change if spill passage were reduced. Likely concentrating more predators at the bypass and corner collector outfall locations recommended by Mr. Scott, where a little over 5 Kcfs of water would deliver most of the juvenile fish, would likely greatly reduce the survival through those routes of passage.

III. Interchange between Ritchie Graves, NOAA National Marine Fisheries Service (RG) and Commissioner Ken Williamson (CW) with input from Mark Schneider, NOAA NMFS (MS). This interchange was excerpted from testimony that occurred during hearing.

(CW) What is your read on the comparative survival rates – turbines versus spill?

(RG) It is my experience sir that that is a very dam specific question.

(CW) Well, give me a range.

(RG) A range of survival through uh?

(CW) Turbines.

(RG) Turbines, it is a result of several factors, one of which is tailrace egress conditions, if you have poor tailrace egress conditions even though the fish may survive a particular passage route, there may be predators lurking downstream, but for direct survival.

(CW) For direct survival, forget the predators.

(RG) I think your looking somewhere in the range of 4-5 % up to 10-12 % is pretty common for turbine passage routes.

(CW) Mortality?

(RG) Yes, mortality
(CW) And for spill?
(RG) For spill it can be as high as 99% and as you have heard today it can be as low as 92% or even 89%.
(CW) That's survival now?
(RG) Yes, survival.
(CW) Your talking about 1-11%, that's what your are telling me.
(RG) Yes.
(CW) So the ranges are about the same?
(RG) The ranges are overlapping, and in general.
(CW) They're not overlapping. They're about the same, isn't that what you are telling me?
(RG) Well, up to 99% survival through spillways, up to 95-96% survival through turbines units, direct survival.
(CW) So if we are talking about 4 million acre feet here, so what are talking about in terms of total spill for one season.
(RG) I have not brought those numbers with me, we do not try to calculate that as some of the other parties here are, we tend to view the success or failure of the program as the success of how well you meet the program developed in the fish passage plans.
(MS) Was you question
(CW) Well my question was you have a number here of 100 million dollars, and your telling me we are spending 100 million dollars for a 2-3% difference between spill and turbines.
(RG) I would ask you to consider that that is a cumulative effect.
(CW) Cumulative, what does that have to do with it?
(RG) If you're looking at survival through one dam, maybe it is not a big deal, but you have to remember that each of these fish are going through 7 to nine dams.
(CW) But comparing survival rates, it doesn't make a difference if it is one dam or twelve dams, it's a cumulative process so.
(RG) But it makes a difference, the survival estimates I gave you are for one dam.
(CW) I understand that...
(RG) And you multiply that by eight.
(CW) and they are roughly the same.
(MS) But, one of the calculations you saw the result of earlier today is a 4-6 % improvement in spill and that is in the ball park. And I believe that is a cumulative number that represents the system effect.
(CW) Okay, so what you are saying is 4-6 % for 100 million dollars. Is that what we are saying.
(MS) That is a lot of fish.
(CW) That is a lot of money
(MS) No one is arguing that, these numbers, we are getting into a lot of numbers here. There are reports that cover that and what I am saying is that I can get you those reports.

The conversation changes subjects here as other commissioners begin to ask questions on other topics covered.

The information that Mr. Graves gave the Commissioner was not completely incorrect and Mr. Graves did try to caution Commissioner Williamson regarding the limitations of using direct survival estimates. This interchange that took place between Mr. Graves and Commissioner Williamson again highlights the difficulty of interpreting direct juvenile project route specific survival estimates and their relation to adult productivity. The specific language that confused the interchange was when Mr. Graves referred to survivals through a passage route based on the high values obtained from studies for turbine passage. This lead Commissioner Williamson to draw a conclusion based on comparing a mortality value of 4-5 % versus 10-12%, and the impression was that the numbers overlap.

The comparison between spill and turbine survival should be done on a project by project basis. Point estimates of survival via spill or turbine passage are displayed in the table below using the data for spring Chinook to illustrate. Spill survival can be anywhere from 4.9% to 16.5% higher at a specific project and with the exception of Lower Granite Dam, are consistently higher via the spill route of passage. Numbers overlap when the range for all projects are considered – on when considering the confidence intervals or ranges of data on a project by project basis. As can be seen from the table the estimates vary widely and represent among other things, different flow, spill and temperature conditions among years and among tests.

The following table summarizes the estimates adopted by NOAA National Marine Fisheries in their COMPASS modeling efforts under the Biological Opinion Remand Program. These data are for spring Chinook.

Project	Spill Survival Estimate	Turbine Survival Estimate
LGR	93.1 (81.5–104.6) ¹	94.5 (88.1–100.9) ¹
LGO	97.2 (94.3 – 100.1) ¹	92.3 (85.8 – 97.4) ¹
LMN	96.1 (92.4 – 99.9) ¹	88.1 (78.8 - 97.3) ¹
IHR	96.5 (95.8 – 97.1) ¹	87.1 (83.2 – 91.3) ¹
MCN	96.2 (93.3 – 99.3) ²	90.3 (86.9 - 95.4) ²
JDA	96.4 (93.4 – 99.3) ²	79.9 (77.8 – 82.0) ²
TDA	92.4 (90.9 – 93.8) ²	81.8 (79.7 – 83.8) ²
BVL	83 – 100 ³	87- 98.1 ³

¹ Average and 95% Confidence Interval.

² Average of data and data range.

³ Data Range of point estimates 1995 -2005.

In summary, the particular amount of spill at a project is related to the survival via different passage routes at that project and the overall adult production that results from various passage route configurations.

Cc:

Lauri Aunan, OR-DEQ

Gene Foster, OR-DEQ

Agnes Lut, OR-DEQ

Ed Bowles, ODFW

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MEMORANDUM

TO: Ron Boyce, ODFW

Michele DeHart

FROM: Michele DeHart

DATE: August 22, 2007

RE: Proportion Transported and Spill

In response to your request we summarized the proportion transported by species from the FPC Smolt Monitoring Program Annual reports for the years you requested, 2006, 2005 and 2004. We also summarized the planned spill operation for those years. The proportion of fish transported is directly related to the amount of spill at the collector projects. We also have attached a memo which is posted on the FPC web site, which summarizes elements of the 2006 fish passage and river operations.

The following table shows the proportion of fish transported by species. In 2004 a spring spill program was in place at transportation collector projects but there was no summer spill for fish passage at collector projects. In 2004 was a below average water year, with a 77 % of average run off volume for the Columbia Basin above The Dalles. The spring spill program was limited and only occurred intermittently at collector projects. There was no summer spill in 2004. In 2005 the run off volume for the Columbia River above The Dalles was lower than 2004 at 67% of average runoff. Spring spill was limited and intermittent at collector projects. Summer spill began as a result of a federal court order in mid-June and continued throughout the summer migration period in 2005. The transportation proportion of fall Chinook is high in 2005 because fall Chinook passing the collector projects in late May and the first half of June were not afforded spill for fish passage. Biological Opinion flow and reservoir targets were not met in either 2004 or 2005. In 2006 the run off volume for the Columbia Basin above the Dalles was 113% of average. Biological Opinion flow and reservoir targets for the spring period were met. As summarized in the attached memorandum passage conditions, for spring Chinook were the best that have been seen in recent years with high spill and flow levels. During the spring court ordered spill for fish passage was actually exceeded at some projects. However, Biological Opinion flow targets were not met in the summer migration period. The Court Ordered spill levels were implemented fully in 2006, with high levels of spill occurring through the spring period. The proportion of fall Chinook transported in 2006 is lower than 2005, because spill was

continuous at the collector projects at high levels throughout the spring period and at the court ordered levels through out the summer period. Fall Chinook passing the projects in late May and early June would have the benefits of the high spill levels, and also the benefits of the summer spill, thereby reducing the proportion of fish transported to 52% and 56% for hatchery and wild fish.

TABLE 1. Comparison of the 2006 estimate of the proportion of Snake River Basin smolt population in Lower Granite Dam forebay that are "destined for transportation" and the corresponding estimates in 2004 and 2005. For yearling Chinook and steelhead, the results exclude transport at McNary Dam.

Species –age group	Transportation Proportion ¹		
	2006	2005	2004
Yearling Chinook	0.611 (H) 0.579 (W)	0.92	0.870
Steelhead	0.76 (H) 0.793 (W)	0.94	0.964
Subyearling Chinook	0.521 (H) 0.562 (W)	0.809	0.972

¹ In years 2000-2006, estimates of collection efficiency based on PIT tag data was used to generate a single annual estimate of proportion transported, while in 1999 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.

TABLE 2. Comparison of spring and summer spill at Lower Snake and Lower Columbia projects over 2004, 2005, and 2006

Site	2006	2005	2004
Lower Granite	Spring ² = 20 Kcfs Summer = 18 Kcfs	Spring = Limited (Apr 30- May 2 and when flows exceeded Hydraulic Capacity) Summer = TDG Cap	Spring = RSW plus training Spill (Apr 3-23, some spill in excess of Hydraulic capacity in late May and early June) Summer = None
Little Goose	Spring and Summer = 30%	Spring = Limited (Only when flows exceeded Hydraulic Capacity) Summer = 30% Day TDG Cap Night	Spring = TDG Cap Night (April 3-23) Summer = None
Lower Monumental	Spring = 40 Kcfs Summer = 17 Kcfs	Spring = Limited (Only when flows exceeded Hydraulic Capacity) Summer = TDG Cap	Spring = 50% when 75>Q>100 45% when 75<Q<100 (Only April 24 to Mid May) Summer = None
Ice Harbor	TDG Cap except when RSW testing occurred	TDG Cap	April 15-July 15 = 45 Kcfs July 16-August 31 = 45 Kcfs Day TDG Cap Night
McNary	Spring = 40% vs TDG Cap Night Summer = 40% vs. 60%	Spring TDG Cap Night Summer = Spill all flow above 50 Kcfs (min PH)	Spring = TDG Cap Night Summer = None
John Day	Spring = 40% Summer = 30%	Spring = 60% Night 0% Day Summer = 30%	Spring = 60% Night 0% Day Summer = 30% Night
The Dalles	Spring = 40% Summer = 40%	Spring = 40% (Often less due to failure of spillway gate ropes) Summer = 40%	Spring and Summer = 40%
Bonneville	Spring = 100 Kcfs Summer = 75 Kcfs Day 120 Kcfs Night	Spring and Summer 75 Kcfs Day TDG Cap Night	Spring and Summer 75 Kcfs Day TDG Cap Night

² Spring flows in 2006 were sufficiently high that spill often exceeded hydraulic capacity of projects and the Court's Order during April, May and most of June.

ATTACHMENT:

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TO: Rob Lothrop, CRITFC

Michele DeHart

FROM: Michele DeHart

DATE: August 13, 2007

RE: 2006 Spring Chinook survival and outmigration conditions in relation to predicted high SAR's

In response to your request, the FPC staff summarized results from the FPC 2006 Annual Report as follows.

Spring migrating Chinook experienced improved passage conditions when compared to recent years. Higher flows and twenty four hour spill resulted in relatively high survivals when compared to previous years. Improved spill and delay of the start of smolt transportation resulted in a reduction of the proportion of smolts transported.

Runoff volume was 107% of average for the Columbia River above The Dalles and 113% of average for the Snake River above Lower Granite. 2006 was the highest run off volume and flow year in the Snake River since 1999 and 2002 in the Columbia River. Biological Opinion reservoir elevations targets were met on April 10 at Hungry Horse, Libby, Dworshak, Brownlee and Grand Coulee projects. Biological Opinion flow objectives were met and exceeded for the spring migration period benefiting spring Chinook (Table 1).

Table 1. Spring and summer Biological Opinion flow objectives and average seasonal flows in 2006 at Lower Granite, McNary and Priest Rapids.

	2006			
	Spring Flow Objective	Spring Average	Summer Flow Objective	Summer Average
Lower Granite	100	125.3	54.5	37.6
McNary	260	325.4	200	166.5
Priest Rapids	135	191.3	Na	Na

Spill for fish passage was affected by the interaction of several factors. Spill for fish passage was improved in 2006 over past years as a result of a 2005 federal court order that increased spring spill at Little Goose and Bonneville Dam to 24 hours per day and continued summer spill at the same levels that occurred in 2005. At the same time hydropower project equipment problems at The Dalles caused reductions in spill while unit outages and other problems at John Day and Lower Granite limited the hydraulic capacity of the projects which resulted in increased spill as river flows increased.

Survivals in 2006 for Yearling Chinook through the hydrosystem were relatively high compared to other recent years. The FPC analyzed Snake River basin yearling Chinook released from trap sites and emigrating to Lower Monumental Dam; 2006 survival estimates for these spring Chinook were the highest documented in recent years at 61.0% (Table 2). The estimated proportion of yearling Chinook that were “destined for transportation” during 2006 (61.1% and 57.9% for hatchery and wild fish respectively) was similar to 2002 and 2003 (Table 3). In addition, the court ordered spill for summer months contributed to higher survival rates for summer migrants.

Table 2. Combined PIT-tagged hatchery and wild yearling Chinook survival in the reach Lower Granite Dam tailrace to Bonneville Dam tailrace (FPC).

	Reach Survival by year					
Migr Year	2001	2002	2003	2004	2005	2006
Survival	0.262	0.568	0.546	0.374	0.477	0.610
Std error	0.032	0.115	0.106	0.088	0.080	0.087

Table 3. Estimated probability of yearling Chinook being transported for out-migrants originating above Lower Granite Dam (from FPC 2006 Annual Report).

	Estimated Proportion Transported by year					
Migr Year	2001	2002	2003	2004	2005	2006
Transport Proportion	0.980	0.683	0.629	0.870	0.92	0.611 (H) 0.579(W)

NOAA found similar high survival estimates for 2006 stating, “Mean estimated survival for yearling Chinook salmon from Lower Granite Dam tailrace to Bonneville Dam tailrace was 61.1% in 2006, the highest since survival estimates to Bonneville Dam tailrace became possible from PIT-tag data in 1999.” (August 30, 2006 NOAA technical Memorandum, Table 4).

Table 4. Combined PIT-tagged hatchery and wild yearling Chinook survival in the reach Lower Granite Dam tailrace to Bonneville Dam tailrace (from August 30, 2006 NOAA technical Memorandum).

	Reach Survival by year					
Migr Year	2001	2002	2003	2004	2005	2006
Survival	0.279	0.578	0.532	0.395	0.577	0.611
Std error	0.016	0.06	0.023	0.05	0.069	0.018

Given the high reach survivals in 2006, it may be that increased spill volumes coupled with high flows could result in higher SAR's for in-river migrants. Figure 1 shows flow and the cumulative passage for each species in 2006. The month of May was significant for all species. Nearly 25% of subyearling Chinook passed Lower Granite during May. Coho, yearling Chinook, steelhead and sockeye were also present in large numbers during May.

Figure 1. Cumulative passage timing at Lower Granite Dam in 2006 for all species of migrant juvenile salmonids using passage indices.

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TO: Rob Lothrop, CRITFC

Michele DeHart

FROM: Michele DeHart

DATE: August 13, 2007

RE: 2006 Spring Chinook survival and outmigration conditions in relation to predicted high SAR's

In response to your request, the FPC staff summarized results from the FPC 2006 Annual Report as follows.

Spring migrating Chinook experienced improved passage conditions when compared to recent years. Higher flows and twenty four hour spill resulted in relatively high survivals when compared to previous years. Improved spill and delay of the start of smolt transportation resulted in a reduction of the proportion of smolts transported.

Runoff volume was 107% of average for the Columbia River above The Dalles and 113% of average for the Snake River above Lower Granite. 2006 was the highest run off volume and flow year in the Snake River since 1999 and 2002 in the Columbia River. Biological Opinion reservoir elevations targets were met on April 10 at Hungry Horse, Libby, Dworshak, Brownlee and Grand Coulee projects. Biological Opinion flow objectives were met and exceeded for the spring migration period benefiting spring Chinook (Table 1).

Table 1. Spring and summer Biological Opinion flow objectives and average seasonal flows in 2006 at Lower Granite, McNary and Priest Rapids.

	2006			
	Spring Flow Objective	Spring Average	Summer Flow Objective	Summer Average
Lower Granite	100	125.3	54.5	37.6
McNary	260	325.4	200	166.5
Priest Rapids	135	191.3	Na	Na

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Spill for fish passage was affected by the interaction of several factors. Spill for fish passage was improved in 2006 over past years as a result of a 2005 federal court order that increased spring spill at Little Goose and Bonneville Dam to 24 hours per day and continued summer spill at the same levels that occurred in 2005. At the same time hydropower project equipment problems at The Dalles caused reductions in spill while unit outages and other problems at John Day and Lower Granite limited the hydraulic capacity of the projects which resulted in increased spill as river flows increased.

Survivals in 2006 for Yearling Chinook through the hydrosystem were relatively high compared to other recent years. The FPC analyzed Snake River basin yearling Chinook released from trap sites and emigrating to Lower Monumental Dam; 2006 survival estimates for these spring Chinook were the highest documented in recent years at 61.0% (Table 2). The estimated proportion of yearling Chinook that were “destined for transportation” during 2006 (61.1% and 57.9% for hatchery and wild fish respectively) was similar to 2002 and 2003 (Table 3). In addition, the court ordered spill for summer months contributed to higher survival rates for summer migrants.

Table 2. Combined PIT-tagged hatchery and wild yearling Chinook survival in the reach Lower Granite Dam tailrace to Bonneville Dam tailrace (FPC).

	Reach Survival by year					
Migr Year	2001	2002	2003	2004	2005	2006
Survival	0.262	0.568	0.546	0.374	0.477	0.610
Std error	0.032	0.115	0.106	0.088	0.080	0.087

Table 3. Estimated probability of yearling Chinook being transported for out-migrants originating above Lower Granite Dam (from FPC 2006 Annual Report).

	Estimated Proportion Transported by year					
Migr Year	2001	2002	2003	2004	2005	2006
Transport Proportion	0.980	0.683	0.629	0.870	0.92	0.611 (H) 0.579(W)

NOAA found similar high survival estimates for 2006 stating, “Mean estimated survival for yearling Chinook salmon from Lower Granite Dam tailrace to Bonneville Dam tailrace was 61.1% in 2006, the highest since survival estimates to Bonneville Dam tailrace became possible from PIT-tag data in 1999.” (August 30, 2006 NOAA technical Memorandum, Table 4).

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MEMORANDUM

TO: FPAC

FROM: FPC Staff

DATE: July 18, 2007

RE: Juvenile passage timing at McNary Dam for in-river and transported Snake River subyearling Chinook that survived to adulthood

On July 3, 2007, FPAC requested that the FPC staff update a portion of a 2004 memo entitled, "Transportation of fall Chinook smolts and related fall Chinook migration and tag data concerning summer spill for fish passage". Specifically, FPAC requested that FPC staff update the figures in the memo that presented juvenile passage timing at McNary Dam for in-river and transported Snake River subyearling Chinook that survived to adulthood. Our conclusions are summarized below:

- For most migration years analyzed (6 out of 8), the majority of the returning adults that were transported as juveniles from McNary Dam were transported after August 1st (Table 1, Figure 1).
- 7 of the 10 years analyzed showed that the majority of the returning adults that migrated in-river as juveniles and were detected at McNary Dam, were detected at McNary Dam after August 1st. Only in 1998 and 2003 did the earlier detected in-river juveniles (June-July) exhibit higher returns than those that were detected later in the season (August-Dec) (Table 1, Figure 2).

Methods

This analysis relied on PIT-tag data for subyearling fall Chinook originating in the Snake River basin above Lower Granite Dam for migration years 1995 through 2004. These PIT-tagged fish consist of wild fall Chinook PIT-tagged in the mainstem Snake and Clearwater rivers above Lewiston and hatchery fall Chinook PIT-tagged for supplementation releases. These supplementation releases of subyearling fall Chinook included: 1) releases made at or near the Pittsburg Landing, Captain Johns Rapids, and Big Canyon Creek acclimation ponds, 2) surrogate releases along the Snake and Clearwater rivers, 3) releases at Hells Canyon Dam and along the

Snake River, and 4) releases from the Nez Perce Tribal Hatchery. Only juveniles who were detected at McNary Dam in the year of their release were considered in this analysis. Juveniles detected at McNary Dam were placed into two categories; those detected prior to August 1st and those detected on or after August 1st (through December 31). To determine “survival to adulthood”, adult detections at Bonneville Dam, McNary Dam, and/or Lower Granite Dam were used in this analysis. However, adult returns for migration years 2002, 2003, and 2004 are not yet complete and results for these migration years should be interpreted with caution.

Prior to the implementation of the NMFS transportation study in 2001, the goal of these PIT-tag studies required that PIT-tagged fish were kept in-river. Thus, sample sizes for transported subyearling Chinook during these earlier years are low and results should be interpreted with caution. Finally, prior to 2003, transportation at McNary Dam typically extended into November and even December. However, in migration years 2003 and 2004, transportation at McNary Dam ended on or before October 1. This further complicates comparisons between years.

Table 1. Proportion of adult returns for in-river and transported subyearling fall Chinook for early (June-July) and late (Aug.-Dec.) detections at McNary Dam.

Migration Year (Dates)	Juvenile Detection at McNary Dam	Proportion of In- River Adult Returns	Proportion of Transported Ault Returns
1995	June-July	0.11	0.00
(Jun. 22 – Dec. 8)	Aug.-Dec.	0.89	1.00
1996	June-July	0.00	N/A
(Jun. 6 – Nov. 22)	Aug.-Dec.	1.00	N/A
1997	June-July	0.38	N/A
(May 30 – Dec. 14)	Aug.-Dec.	0.62	N/A
1998	June-July	0.60	0.00
(Jun. 2 – Dec. 15)	Aug.-Dec.	0.40	1.00
1999	June-July	0.19	0.00
(Jun. 24 – Dec. 14)	Aug.-Dec.	0.81	1.00
2000	June-July	0.43	0.00
(Jun. 22 – Nov. 28)	Aug.-Dec.	0.57	1.00
2001	June-July	0.14	0.50
(May 1 – Dec. 9)	Aug.-Dec.	0.86	0.50
2002*	June-July	0.26	0.20
(Jun. 25 – Dec. 11)	Aug.-Dec.	0.74	0.80
2003**	June-July	0.88	0.67
(Jun. 28 – Oct. 1)	Aug.-Dec.	0.13	0.33
2004***	June-July	0.50	1.00
(Jun. 24 – Sep. 19)	Aug.-Dec.	0.50	0.00

* 5-year ocean fish from MY 2002 have not yet returned

** 4 and 5-year ocean fish from MY 2003 and not yet returned

*** 3, 4, and 5-year ocean fish from MY 2004 have not yet returned

Figure 1. Juvenile passage timing at McNary Dam for transported subyearling fall Chinook that survived to adulthood (MY 1995-2004). Numbers of PIT-tagged adults returning for each migration year are shown in the figure legend in parentheses. Larger circles reflect larger number of PIT-tags passing on a particular date.

* 5-year ocean fish from MY 2002 have not yet returned

** 4 and 5-year ocean fish from MY 2003 and not yet returned

*** 3, 4, and 5-year ocean fish from MY 2004 have not yet returned

Figure 2. Juvenile passage timing at McNary Dam for in-river subyearling fall Chinook that survived to adulthood (MY 1995-2004). Numbers of PIT-tagged adults returning for each migration year are shown in the figure legend in parentheses. Larger circles reflect larger number of PIT-tags passing on a particular date.

* 5-year ocean fish from MY 2002 have not yet returned

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MEMORANDUM

TO: The Files

FROM: Jerry McCann

DATE: June 6, 2007

RE: Methods for estimating a Population Index for juvenile salmon from detection probability at Lower Granite Dam

Overview

The route of passage configuration has changed significantly at Lower Granite Dam since the installation and use of the Removable Spill Weir (RSW). This change in operations made it difficult to use the traditional passage index calculation within season for management application. The FPC is exploring the use of another metric called the "population index" (PI) at this project.

Using PIT-tag detections at Little Goose Dam, it is possible to estimate daily detection probability (CE) at Lower Granite Dam. Then, using the daily estimates of detection probability a regression relationship was developed between CE and flow, spill and temperature, and then this regression was used to predict daily CE. Once daily detection efficiencies were predicted, a daily PI was calculated by dividing the daily collection (from SMP data) by the predicted CE for that date.

FPC estimated daily detection probabilities for hatchery yearling Chinook and hatchery steelhead, for four years from 2003 to 2006 at Lower Granite Dam. Then predictive models were developed for estimating CE at the dam for each species. The regression model developed performed well when used to predict past years (2003-2006). However, when the regression model was applied to 2007 data there appeared to be some differences, especially for steelhead. The model overestimates detection probability for steelhead at the low flows experienced in 2007. Consequently, the predicted population index is low. The 2007 migration conditions are different from what existed in the years used to build the model. Flows in 2007 are relatively

low, with regular spill occurring during the peak of migration. Due to this unique operation, the predicted values are outside the range of data from which the model was developed, so caution should be used in interpreting the results. The model will be repopulated with 2007 data after the season is completed, which should improve predictive capabilities under conditions similar to this year.

Estimating Daily Detection probability at Lower Granite Dam

Sandford and Smith 2002, and others have employed a method of using downstream PIT-tag detections to estimate proportions of daily detections at upstream projects. The method uses the travel time distribution data for fish detected at both sites to reconstruct their prior passage timing at the upstream dam. Applying the same passage distribution to the fish only detected at the downstream dam, allows their passage at the upstream site to be reconstructed as well, assuming the fish undetected at the upstream dam, have the same travel time distribution as the fish detected at both sites.

For each date at Little Goose Dam, the downstream site, there are a number of fish that were previously detected at Lower Granite dam. The travel time for each fish can be calculated, so that for a given day at Little Goose, the number of fish detected, n_i , the average travel time $\bar{x}_i$, and the population variance σ_i^2 can be estimated. From these statistics, using the method of moments, parameters, gamma and lambda can be calculated, for estimating gamma distributions to describe the distribution of travel times (LGR to LGS) observed at Little Goose Dam for the i th day (Lee 1980). Using the gamma distribution probability density function for a given date at Little Goose, the observed number of detections can then be distributed back through time at Lower Granite Dam, by solving $P(X_{11})_i$ for days i to i minus 20 days. Since there are daily distributions for days 1 to n , where n is the last date for which adequate detections available, then the estimated number of fish passing detected X_{11} and undetected X_{01} at Lower Granite Dam on

the j th date at Lower Granite is the trace sum $\hat{N}_{jX_{11}} = \sum_{i=1}^n \sum_{j=(I-n)}^i P(X_{11})_{ij}$ for fish detected at both sites, and similarly, $\hat{N}_{jX_{01}} = \sum_{i=1}^n \sum_{j=(I-n)}^i P(X_{01})_{ij}$ is the estimated number of undetected fish passing Lower Granite Dam on the same date.

Once the number detected and undetected is estimated for each date, an uncorrected estimate of detection probability can be calculated $\hat{N}_{X_{11}} / (\hat{N}_{X_{01}} + \hat{N}_{X_{11}})$. However, this number must be corrected by the proportion of PIT-tagged fish that were removed on the j th date at Lower Granite Dam, R_j . These are fish that are either transported or removed for research. The final estimated detection probability for each date is calculated:

$$\hat{p}_j = \hat{N}_{X_{11}} / (\hat{N}_{X_{01}} + ((1 - R_j) \bullet \hat{N}_{X_{11}}))$$

Derivation of Data Predictive Model for CE

Fish Passage Center developed estimates of daily detection probability for yearling Chinook and steelhead for the years 2003 to 2006. For each date at Lower Granite Dam, we paired the estimated detection probability with Flow, Spill and Temperature data.

Detection probability was transformed to a logistic function, and regressed against predictor variables. Four multiple regression models, using combinations of the predictor variables and interaction terms were calculated. The predicted $\hat{p}$ were compared to those $\hat{p}_j$'s estimated for each year. Of the candidate models

$$\ln\left(\frac{\hat{p}}{1-\hat{p}}\right) = \beta_0 + \beta_1 \text{Avg}Q + \beta_2 \text{AvgSpilPct} + \beta_3 \text{AvgSpill}Q + \varepsilon$$

was chosen (preliminarily) as the best predictor of the daily $\hat{p}_j$'s for those years for both yearling Chinook and steelhead data sets. All models had similar predictive capability, but the use of flow, spill and percent spill was deemed most comparable to the historic passage index, which used flow and spill to calculate the index. And, the flow data is readily available to anyone wishing to calculate the index.

Confidence Intervals

Once the model was chosen, the variance for the predicted daily detection probabilities, $V(\hat{p})$ were calculated based on the variance covariance matrix from the regression (Draper and Smith 1981) as follows;

$$V(\hat{p}) = \sigma^2 [X_0'(X'X)^{-1}X_0']$$

Confidence intervals were then calculated as

$$\hat{p} \pm 1.96 \bullet \sqrt{V(\hat{p})}$$

Population Index

The daily population index PI_j was calculated by dividing the daily collection by the estimated collection efficiency (C_j); $PI_j = C_j / \hat{p}_j$.

Confidence intervals around the estimated population index were the daily collection divided by the upper and lower daily index limits. For cumulative plots, the daily upper and lower limits were summed to provide the upper and lower bounds for the cumulative estimate.

Literature Cited

N. Draper, and H. Smith 1981. Applied Regression Analysis. New York, NY: John Wiley and Sons Publishers.

Lee, E.T. 1980. Statistical Methods for Survival Data Analysis. Belmont, CA: Lifetime Learning Publications.

Sandford, B. P., 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, 7:243-263.

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MEMORANDUM

TO: FPAC

FROM: Jerry McCann

DATE: June 20, 2007

RE: Preliminary Detection Probability Estimates for Snake River Subs in 2007

Low passage indices at Snake River projects in 2007 have led to concern that fish population is either delayed due to low flows or simply lower than other recent years (Table 1). Hatchery releases are lower than in other recent years, so the population reaching Lower Granite Dam is likely smaller (Table 2). However, due to low flows in the Snake River, spill proportion is relatively high at Lower Granite and Lower Monumental dams, so that fish collection may be lower than in other years as well.

In order to explore this question, the FPC estimated detection probability for subyearling Chinook released above Lower Granite Dam in 2007. Detection probability was estimated to be relatively low at all three Snake River collector projects (Table 1). Detection probability was estimated using downstream detections to estimate detection probability at upstream dams. Data are limited due to fewer tags in 2007 and to low detection efficiency at the dams, so that estimates should be viewed as preliminary and taken with caution.

As had occurred during the Spring migration, the index at Lower Granite is less than that at Little Goose Dam. This is due to the higher spill proportion at Lower Granite resulting in the lower detection probability at the site. Based on our detection probability estimate a "population index" at Lower Granite Dam (collection/detection probability) would be nearly 1 million fish, while at Little Goose the "population index" would be closer to 700,000, while the Lower Monumental "index" would be near 500,000.

Historic timing based on passage indices over the past 10 years, (the indices are relatively robust for timing estimation despite underestimating overall population size), suggests that approximately $38\% \pm 36\%$ of the run would have passed by this date. The wide confidence interval reflects the inter-annual variability in timing, which is due, in large part, to changes in hatchery release timing as well as the increasing proportion of hatchery fish in the last 10 years.

It should be noted that all of the scheduled hatchery releases of subyearling Chinook above Lower Granite Dam for 2007 have occurred. But, based on PIT-tag data, the fish from Nez Perce Tribal hatchery release of 500,000 subyearlings on June 15, are just beginning to reach Lower Granite Dam.

Table 1. Collection, Passage indices and estimated detection probability of subyearling Chinook PIT-tagged above LGR in 2007.

Site	Passage Index Since May 1	Collection Since May 1	Estimated Detection probability	Population Index
Lower Granite	212,607	135,386	0.15	967,043
Little Goose	251,773	175,287	0.25	701,148
Lower Monumental	54,023	30,759	0.06	512,650

Table 2. Hatchery releases of subyearling fall Chinook above Lower Granite Dam in recent years.

Migration Year	Hatchery Releases above LGR
1997	282,794
1998	86,824
1999	670,033
2000	2,184,384
2001	1,878,529
2002	2,600,985
2003	2,881,640
2004	1,517,006
2005	3,964,117
2006	4,226,183
2007	2,231,124

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MEMORANDUM

TO: Michele DeHart and FPC Files

FROM: Brandon R. Chockley

DATE: June 14, 2007

RE: FYI - Change in spring spill schedule at Ice Harbor

In preparing the daily figures for the 2007 Spill Season Update website (<http://www.fpc.org/WebForm2.0/MAINCHART.ASPX>) on May 31, 2007, I noticed that Ice Harbor Dam (IHR) did not spill to the 45 kcfs/Gas Cap level for May 30, as originally planned. Upon further investigation, I noticed that it appeared that IHR spilled approximately 30% of total flow on an hourly basis. I contacted Tim Wik (COE) to inquire whether IHR had deviated from the original spill schedule. According to Mr. Wik, BPA had requested that some days of 45 kcfs/Gas Cap spill be switched with days of 30%/30% spill. Mr. Wik sent me copy of the teletype (attached below) informing operators of a change in the spill schedule at IHR. This teletype indicates that May 30 and 31 will be operated at 30%/30% spill, while June 3 and 4 will be operated at 45 kcfs/Gas Cap spill. Furthermore, the teletype indicated that this change was originally requested by Scott Bettin (BPA). Below is a table outlining the original planned spill levels and the new spill levels for the effected days. These changes result in 6 continuous days of 30%/30% spill (May 26-May 31) followed by 6 continuous days of 45 kcfs/Gas Cap spill (June 1-June 6) at IHR.

Date	Original Schedule	New Schedule
Wednesday, May 30	45 kcfs/Gas Cap	30%/30%
Thursday, May 31	45 kcfs/Gas Cap	30%/30%
Sunday, June 3	30%/30%	45 kcfs/Gas Cap
Monday, June 4	30%/30%	45 kcfs/Gas Cap

Teletype copied from e-mail received by Brandon R. Chockley from Tim Wik on Thursday, May 31, 2007.

Sent to: SN

XX

IHR R 052907 1300 SN MCN IHR LMN LGS LWG BPA BPC NPD NPC NPW

ATTENTION: ICE HARBOR AND BPA

REPLACE TTY IHR R 040237 0900 START OF SPRING SPILL TEST

SUBJECT: NEW SCHEDULE - SEE * FOR CHANGE

1. STARTING 0500 HOURS ON 30 APRIL 2007 UNTIL 0500 HOURS ON 13 JUNE 2007,
SPILL FOR JUVENILE FISH PASSAGE AS SPECIFIED BELOW USING THE SPILL PATTERNS
PROVIDED TO THE CONTROL ROOM BY TIM WIK AND FOLLOW THE SCHEDULE BELOW.

2. TEST SPILL PATTERNS FROM 2007 FISH PASSAGE PLAN

FOR TREATMENT GAS CAP USE:

TABLE IHR-10 ICE HARBOR RSW 45 KCFS/SPILL CAP SPILL PATTERN.

FOR TREATMENT 30% USE:

TABLE IHR-9 ICE HARBOR RSW 30% SPILL PATTERN

4. STUDY SCHEDULE

DATE

START BLOCK	TREATMENT
30-APR 0500 HR	1 GAS CAP
1-MAY 0500 HR	1 GAS CAP
2-MAY 0500 HR	1 30%
3-MAY 0500 HR	1 30%
4-MAY 0500 HR	2 GAS CAP
5-MAY 0500 HR	2 GAS CAP
6-MAY 0500 HR	2 30%
7-MAY 0500 HR	2 30%
8-MAY 0500 HR	3 GAS CAP
9-MAY 0500 HR	3 GAS CAP
10-MAY 0500 HR	3 30%
11-MAY 0500 HR	3 30%
12-MAY 0500 HR	4 30%
13-MAY 0500 HR	4 30%
14-MAY 0500 HR	4 GAS CAP
15-MAY 0500 HR	4 GAS CAP
16-MAY 0500 HR	5 30%
17-MAY 0500 HR	5 30%
18-MAY 0500 HR	5 GAS CAP
19-MAY 0500 HR	5 GAS CAP
20-MAY 0500 HR	6 GAS CAP
21-MAY 0500 HR	6 GAS CAP
22-MAY 0500 HR	6 30%
23-MAY 0500 HR	6 30%
24-MAY 0500 HR	7 GAS CAP
25-MAY 0500 HR	7 GAS CAP

26-MAY	0500 HR	7	30%
27-MAY	0500 HR	7	30%
28-MAY	0500 HR	8	30%
29-MAY	0500 HR	8	30%
*30-MAY	0500 HR	8	30%
*31-MAY	0500 HR	8	30%
1-JUN	0500 HR	9	GAS CAP
2-JUN	0500 HR	9	GAS CAP
*3-JUN	0500 HR	9	GAS CAP
*4-JUN	0500 HR	9	GAS CAP
5-JUN	0500 HR	10	GAS CAP
6-JUN	0500 HR	10	GAS CAP
7-JUN	0500 HR	10	30%
8-JUN	0500 HR	10	30%
9-JUN	0500 HR	11	30%
10-JUN	0500 HR	11	30%
11-JUN	0500 HR	11	GAS CAP
12-JUN	0500 HR	11	GAS CAP
13-JUN	0500 HR	12	30%
14-JUN	0500 HR	12	30%
15-JUN	0500 HR	12	GAS CAP
16-JUN	0500 HR	12	GAS CAP
17-JUN	0500 HR	13	GAS CAP
18-JUN	0500 HR	13	GAS CAP
19-JUN	0500 HR	13	30%
20-JUN	0500 HR	13	30%
21-JUN	0500 HR	14	GAS CAP
22-JUN	0500 HR	14	GAS CAP
23-JUN	0500 HR	14	30%
24-JUN	0500 HR	14	30%
25-JUN	0500 HR	15	30%
26-JUN	0500 HR	15	30%
27-JUN	0500 HR	15	GAS CAP
28-JUN	0500 HR	15	GAS CAP
29-JUN	0500 HR	16	30%
30-JUN	0500 HR	16	30%
1-JUL	0500 HR	16	GAS CAP
2-JUL	0500 HR	16	GAS CAP
3-JUL	0500 HR	17	GAS CAP
4-JUL	0500 HR	17	GAS CAP
5-JUL	0500 HR	17	30%
6-JUL	0500 HR	17	30%
7-JUL	0500 HR	18	30%
8-JUL	0500 HR	18	30%
9-JUL	0500 HR	18	GAS CAP
10-JUL	0500 HR	18	GAS CAP
11-JUL	0500 HR	19	30%
12-JUL	0500 HR	19	30%
13-JUL	0500 HR	19	GAS CAP
14-JUL	0500 HR	19	GAS CAP
15-JUL	0500 HR	20	30%
16-JUL	0500 HR	20	30%
17-JUL	0500 HR	20	GAS CAP
18-JUL	0500 HR	20	GAS CAP
19-JUL	0500 HR	21	GAS CAP
20-JUL	0500 HR	21	GAS CAP

21-JUL 0500 HR	21	30%
22-JUL 0500 HR	21	30%

* CHANGE TO SCHEDULE TREATMENT 29 MAY 2007

4. WHEN THE TREATMENT IS GAS CAP:

4.1 FROM 0500 - 1800 HOURS, OPERATE UNIT 1 WITHIN 1% OF BEST EFFICIENCY (OR UNIT 3 IF UNIT 1 IS OUT OF SERVICE) AND SPILL THE BALANCE UP TO 45.6 KCFS.

4.2 FROM 1800 - 0500 HOURS, SPILL TO THE 120% GAS CAP LEVEL (SEE PARAGRAPH 6).

4.3 SPILL USING THE SPILL PATTERN AS SPECIFIED IN TABLE IHR-10.

4.4 FROM 1800 - 0500 HOURS, IF THE TOTAL OUTFLOW IS BETWEEN THE 120% GAS CAP AND THE 120% GAS CAP PLUS THE MINIMUM FLOW TO RUN ONE GENERATOR (WITHIN THE 1% EFFICIENCY LIMITATIONS), RUN ONE GENERATOR AT THE LOW END OF THE 1% RANGE AND THEN SPILL THE REST OF THE OUTFLOW. RUNNING ONE UNIT TAKES PRIORITY OVER MEETING THE SPILL REQUIREMENT.

5. WHEN THE TREATMENT IS 30%:

5.1 SPILL 30% (+/- 1%) OF TOTAL PROJECT OUTFLOW 24 HOURS A DAY. MAKE BEST EFFORT TO SPILL AS CLOSELY AS POSSIBLE TO THE 30% OF TOTAL OUTFLOW AS POSSIBLE ON A HOURLY BASIS.

5.2 SPILL USING THE SPILL PATTERN AS SPECIFIED IN TABLE IHR- 9.

6. THE 120% GAS CAP LEVEL FOR ICE HARBOR IS FOUND IN THE CURRENT TTY TITLED "SPILL PRIORITY LIST". RCC POINTS OF CONTACTS ARE JIM ADAMS AND LAURA HAMILTON.

7. NOTE THAT IT MAY NOT BE POSSIBLE TO SPILL TO THE FULL SPILL VOLUME WHEN FLOWS ARE LOW. DO NOT DRAFT RESERVOIR BELOW THE OPERATING RANGE SPECIFIED IN THE REFERENCED TTY.

SPILL FROM 1800 - 0500 MAY BE LOWER THAN THE 120% GAS CAP RANGE DURING TIMES WHEN THERE IS NO GENERATION AND INFLOW IS LESS THAN THE 120% GAS CAP. THE AMOUNT OF SPILL MAY BE LOWER THAN THE SPECIFIED SPILL AMOUNT DURING TIMES WHEN THE MINIMUM GENERATION REQUIREMENT RESULTS IN SPILL LEVELS BELOW THE SPECIFIED AMOUNT.

8. AT NO TIME IS THE PROJECT TO SPILL MORE THAN THE 120% GAS CAP VOLUNTARILY.

9. THERE IS A MINIMUM SPILL AMOUNT OF 15.2 KCFS AT ICE HARBOR.

10. THERE IS A MINIMUM GENERATION REQUIREMENT AT ICE HARBOR OF 9.5 KCFS THAT BPA CAN USE FOR GENERATION IF NEEDED FOR SYSTEM RELIABILITY. IF IT IS NECESSARY TO GENERATE FOR SYSTEM RELIABILITY GENERATE WITH ONE UNIT USING EITHER THE

9.5 KCFS MINIMUM GENERATION REQUIREMENT OR THE MINIMUM GENERATION FLOW LEVEL THAT STAYS WITHIN THE 1% OF BEST EFFICIENCY OPERATION, WHICHEVER IS GREATER.

11. THIS OPERATION WAS REQUESTED BY SCOTT BETTIN (BPA) AND COORDINATED WITH TIM WIK (NWW), BILL BERRY (BPA) AND JACK SHELDON (IHR).
CC POINTS OF CONTACT ARE SCOTT BOYD AND BERNARD KLATTE

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MEMORANDUM

TO: Agnes Lut, OR-DEQ

FROM: Margaret Filardo
DATE: June 18, 2007
RE: Questions regarding Gas Bubble Trauma

On June 15, 2007 you sent an email asking the following questions and requested answers.

1. Does Gas Bubble Trauma kill fish? What level kills fish? Did the 1996 high flows and spills kill fish? How many?
2. 4% GBT = how many fish?
3. 1% GBT = how many fish?
4. In the Order it says that the Director will terminate the modification if there is 15% GBT. 15% GBT = how many fish?

Gas Bubble Trauma is used as a sign that a fish has been exposed to TDG. It does not equate to dead fish. The voluntary spill program is not "killing" fish. In fact, NMFS estimated in the 2000 Biological Opinion that the "voluntary" spill program to 120% increases overall juvenile system survival by 4 to 6% over a spill program to 110%. The 1996 flow year was 135% of average runoff and is not an example of a "voluntary" spill year. High levels of total dissolved gas like those observed in 1996 (135% or more), well in excess of that produced during "voluntary" spill (120%), may cause mortality. However, these high levels only occur in the system due to the presence of hydroelectric projects; that is, when flow exceeds hydraulic capacity of the project or when the flow exceeds generation needs.

The potential for mortality due to total dissolved gas is related both to the concentration of the TDG and to the length of exposure. The present monitoring program addresses both the

concentration and exposure by observing both the incidence and severity of signs of GBT. Both incidence and severity of signs of GBT increase with exposure and time. We assume that if our action criteria are not exceeded, then the likelihood of fish dying from total dissolved gas is negligible i.e. voluntary spill does not kill fish. Observing levels of TDG in the monitoring that exceeds the action criteria doesn't equate with mortality, it only means the probability of mortality increases.

Allow me to guide through the development of the present monitoring program to explain. When spill was incorporated into the 1995 Biological Opinion as a protective measure for juvenile migrants passing hydroelectric projects, NOAA-NMFS assembled a "Gas Bubble Expert Panel" to advise them relative to the protocol for the GBT monitoring program. They advised that a monitoring program would:

1. Use clinical signs that do not change upon collection;
2. Use representative sampling sites;
3. Use adequate sample sizes;
4. Know the relative significance of the signs of GBT.

The existing protocol addresses each of the elements suggested by the Panel. The State, Tribal and Federal fishery agencies also wished to develop a protocol that met these elements, but were concerned that the number of fish examined and extent of examination did not impose undue harm on the migrating fish. Knowing the relative significance of the signs of GBT was addressed using laboratory studies. In the mid-1990s, bioassays had determined lethal TDG levels primarily under shallow-water laboratory conditions, which are not representative of the conditions experienced by migrating juveniles. The Columbia River is sufficiently deep throughout the FCRPS that migrants could benefit from depth compensation for supersaturated conditions. Studies conducted by the U.S. Geological Survey, Biological Resources Division (Maule et al. 1997a, 1997b) found that significant mortality did not occur in their test fish until approximately 60% of the exposed population exhibited bubbles in the fins or 30% displayed bubbles covering 25% or more of any unpaired fin. The action levels for the monitoring program were developed based on this study. However, the action levels were reduced to 15% and 5% to provide a large margin of safety primarily because the research results indicated some uncertainty between fin bubble percentage and the onset of mortality. The present action levels require that action to reduce voluntary spill and TDG levels would be taken if more than 5% of the fish examined exhibited bubbles covering 25% or more (rank 3) of the surface of any unpaired fin, or if 15% of the fish showed any bubbles on unpaired fins. This wide margin of safety is why I believe the mortality is negligible due to the "voluntary" spill program.

What has been observed through the monitoring program is that when the system is operated to the "voluntary" spill program the percentage of fish affected with even minor signs of GBT is even much lower than the action criteria, consequently, mortality associated with the "voluntary spill" is considered minimal.

You asked me if I knew of any documented fish kills that occurred in the Columbia that were related to spill and TDG. I only know of one documented occurrence and I need to stress that this was in conditions far outside of what occurs under a "voluntary" spill program. The 1997 water year had the third highest runoff volume at The Dalles when compared to the 50 year

runoff records. Grand Coulee Dam spilled significant amounts of water and TDG levels exceeded 135% for significant amounts of time. The Columbia River Fish Farms, located 16 miles below Grand Coulee, and Global Aqua located 22 miles below Grand Coulee, both reported significant numbers of fish dying in their net pens.

In response to the fourth question above, when we talk about 15% of the fish, we are talking about 15% of the sample taken. The incidence in the sample is relative to the incidence in the population passing at that time.

I hope this helps address your questions. Please let me know if you need any additional information.

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MEMORANDUM

TO: Data Request

FROM: Jerry McCann, Brandon Chockley

DATE: June 11, 2007

RE: Analysis of Jack Spring Chinook Returns at Bonneville Dam in 2007

In response to data requests, FPC staff examined information relating to jack spring Chinook returns at Bonneville Dam this year. Because of the relatively large number of jacks passing the project in 2007, many people were curious as to the origin of these fish. FPC examined PIT-tags to provide some information on the origin of jacks. Other information regarding the run-at-large out-migration was also summarized to provide a more complete understanding of what may have contributed to the return.

Caution should be used when interpreting jack counts, since the large return of jacks is usually but not always a good indication of the size of the returning adult population the following year. Based on a CRITFC analysis of historic age composition data, for the brood years 1985 to 2001, the mean proportion of the returning spring Chinook adults that were jacks was 5.8% with a minimum of 2.8% (BY 1993) and a maximum of 9.2% (BY 1990). Furthermore, PIT-tag data do not fully represent the run-at-large, because of differential marking in various sub-basins and tributaries, as well as proportions of hatchery origin fish compared to wild fish. However, PIT-tags are useful for making some inferences to the run-at-large about the origin and migration history (either transported or in-river migrants for example) of returning adults. FPC summarized PIT-tag detections of Chinook adults at Bonneville Dam for the time period April 1 through May 29, 2007. Jacks were identified based on their year of out-migration; in this case, 2006 migration year fish were considered jacks and are included in this summary. A summary of migration conditions and information related to the run-at-large (e.g., reach survivals, proportion transported, hatchery releases) is provided for spring Chinook that out-migrated in 2006. Our conclusions are summarized below:

- The 2006 juvenile migration year clearly showed the effects of flow and spill on downstream juvenile migrants. The high in-river survivals resulting from the relatively high flow and spill provide support for flow and spill measures to enhance in-river survival.
- It is too early to determine the combined effect of the 2006 out-migration conditions, ocean conditions and delayed transportation on listed and unlisted stocks of salmon and steelhead. However, a review of past data shows that the highest smolt to adult return rates for both in-river migrants and transported migrants occurs from out-migration years with higher flow and spill levels.
- The complete result of the passage strategy implemented in 2006 will not be determined until all of the adult return data is available.
- At this point, the 2006 implemented passage strategy, of delayed transportation of smolts, as it relates to recovery of listed stocks cannot be determined. However, indications from PIT-tag data suggests early migrants that were returned to river prior to the initiation of transportation returned at rates similar to later bypassed fish from CSS study groups.

The number of out-migrating juvenile fish was similar to other recent years based on the number of hatchery spring Chinook releases above Bonneville Dam in 2006 (Figure 1). However, reach survivals in 2006 were relatively high for spring Chinook originating in the Snake River (Table 4), based on estimates by NOAA technical staff memo from August of 2006. Furthermore, from our analysis of PIT-tag survival data, we estimated the proportion of transported fish in the Snake River in 2006 at approximately 60%. This estimate was lower than recent years, although comparable to 2003 (Table 5). This lower proportion transported was due, in part, to the delayed start to transportation at Snake River projects in 2006 compared to recent years. The combination of high in-river survival, coupled with a higher proportion of in-river migrants, likely produced the highest population of untagged in-river migrant spring Chinook surviving to below Bonneville Dam that we've had in recent years from the Snake River. Transported fish likely benefited from good in-river conditions as well, since SAR's of both in-river and transported spring Chinook tend to improve during higher flow years. It is likely that the increased jack counts seen in 2007 are a result of higher return rates from both in-river and transported fish from 2006. However, a more thorough analysis of PIT-tag adult returns, in 2007 and 2008 will be needed to determine the effects of 2006 operations on overall returns.

Our initial review of PIT-tagged returning jacks provided a clear answer to the question of what groups might be contributing to the higher numbers seen in 2007. The PIT-tag jacks appeared to return in relative proportion to the number released in each river zone (Table 1). For example, 85% of the PIT-tags released in 2006 were released from the Snake River and 85% of the jacks returning to Bonneville Dam in 2007 were of Snake River origin. The majority of PIT-tagged returning jacks were from the Snake River, with 361 total detected at Bonneville adult ladders. However, this is due to the larger number of tags released in the Snake River compared to other river zones.

PIT-tag counts don't shed a great deal of light on what river-zone the run-at-large jacks are from, since numbers of PIT-tags only represent the numbers of PIT-tags released in each basin. A comparison of jack counts at Ice Harbor and Priest Rapids dams was considered as a way to determine the relative proportion of the upriver groups (Snake River versus Mid Columbia). However, the jack count at Priest Rapids Dam as of May 29 was only 221, while the

number from Ice Harbor Dam was 5,891. The count at Priest Rapids is likely under-representing the total jacks passing the project, since the jack count at Rock Island Dam was 1,004. Therefore, the origin of the large return of jacks seen at Bonneville is difficult to determine based on available information.

PIT-tags do provide some insight into the route of passage as juveniles of the returning jacks. Of the 361 Snake River origin fish, 228 were in-river migrants in 2006, 108 were transported, and 25 were released below Ice Harbor Dam (presumably transported and then released below IHR). The PIT-tag data from two study groups, NOAA transportation studies and the CSS studies, are summarized in Tables 2 and 3 below. The information in Table 3 was summarized for releases from which the majority of jacks returned. In addition to the 124 jacks summarized in Table 2 and the 141 jacks summarized in Table 3, 94 jacks returned from various other releases above Lower Granite Dam.

As can be seen from Tables 2 and 3, transported and in-river fish appeared to return in relative proportion to the number of fish in that mark category. It is important to note that the data summarized in Tables 2 and 3 are not equivalent to SAR's of jacks, since numbers of tags in each category is simply a summary of total detected fish and are not adjusted to LGR equivalents. Furthermore, estimates of undetected in-river fish were not included. There were an additional 25 undetected jacks that returned from CSS groups shown in Table 3, but the starting number of undetected fish at Lower Granite Dam, which would make the PIT-tag starting groups equivalent, was not calculated.

Based on Smolt Monitoring Program estimates there were approximately 5.7 million yearling Chinook transported at Snake River collector projects in 2006, which is about average compared to other recent years (Table 6). This would indicate that transport returns likely make up a significant proportion of returning jacks, if transport returns benefit from good in-river conditions.

Figure 1. Number of juvenile spring-summer Chinook released above Bonneville Dam for the years 1998 to 2006.

Table 1. Total PIT-tag releases from releases sites with returning jacks in 2006, grouped by river zone where released; Lower Columbia (below Snake River), Snake River, Mid Columbia (above Snake River).

Release River Zone	Number of Tags released	Percent of total releases	Number of Jacks detected at BON	Percent of total Jacks detected
Lower Columbia	22,076	3%	8	2%
SNAKE RIVER	644,675	85%	361	85%
Mid Columbia	94,890	12%	57	13%
Total	761,641		426	

Table 2. Summary of PIT-tag releases in 2006 and 2007 jack returns related to NOAA transport studies.

Release Site	Number released ^a	Percent of total PIT-tag releases	Number of PIT jacks at BON	Percent of total jacks
LGR Barge	53,093	21%	26	21%
LGR InRiver	161,915	63%	73	59%
Below IHR Dam	40,132	16%	25	20%
Total	255,140		124	

^aIncludes fish released prior to May 25, 2006.

Table 3. Summary of PIT-tags detected in-river or transported in 2006 and subsequent jack returns in 2007 from CSS and related releases.

Release Site	Number Detected	Percent of total tags detected (both categories)	Number of PIT jacks at BON	Percent of total jacks (both categories)
In-River PIT Summary				
CATHEP	2,158	2%	3	2%
DWOR	2,768	2%	2	1%
DWORNF	38,569	32%	40	28%
RAPH	39,405	33%	47	33%
Total In River	82,900	69%	92	65%
Transport PIT Summary				
CATHEP	2,846	2%	3	2%
DWOR	118	0%	1	1%
DWORNF	14,528	12%	21	15%

RAPH	19,484	16%	24	17%
Total Transport	36,976	31%	49	35%
Total both categories	119,876		141	

Table 4. Reach survival (see.) of yearling Chinook from Snake River in 2006 compared to other recent years from NOAA Tech Memo August 30, 2006.

Reach	Migration Year					
	2001	2002	2003	2004	2005	2006
LGR-MCN	0.556 (0.009)	0.757 (0.009)	0.731 (0.01)	0.666 (0.011)	0.732 (0.009)	0.758 (0.007)
MCN-BON	0.501 (0.027)	0.763 (0.079)	0.728 (0.03)	0.594 (0.074)	0.788 (0.092)	0.806 (0.022)
LGR-BON	0.279 (0.016)	0.578 (0.06)	0.532 (0.023)	0.395 (0.05)	0.577 (0.069)	0.611 (0.018)

Table 5. Comparison of the 2006 estimate of the proportion of Snake River Basin smolt population in Lower Granite Dam fore bay that were “destined for transportation” and the corresponding estimates from 1999 to 2005. The results exclude transport at McNairy Dam.

Species-age group	Transport Proportion						
	2006	2005	2004	2003	2002	2001	2000
Yearling Chinook	0.611 (H) 0.579 (W)	0.92	0.870	0.629	0.683	0.980	0.71

Table 6. Estimated number of yearling Chinook at transported at Lower Granite, Little Goose and Lower Monumental dams from 1998 to 2006.

Migration Year	Transport total
1998	2,867,411
1999	7,275,653
2000	4,266,176
2001	3,157,045
2002	5,543,226
2003	5,552,257
2004	8,079,714
2005	7,727,186
2006	5,771,726
Average	5,582,266

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MEMORANDUM

TO: FPAC

FROM: Margaret Filardo and Jerry McCann

DATE: June 11, 2007

RE: Update on GBT

Crews monitored GBT at Little Goose Dam on Sunday June 10, 2007. They sampled 100 juvenile subyearling Chinook and found 3 with signs of GBT. All signs were of the lowest rank, Rank 1 with less than 5% of a non paired fin's surface area covered with bubbles. They also sampled 50 juvenile steelhead and found that 13 of these fish showed signs of GBT, with all signs being less than 25% of the non-paired fins with bubbles.

Our concern was that the juvenile subyearling migrants were affected with signs of GBT similar to the levels exhibited by juvenile steelhead. Based on the data collected yesterday this does not appear to be the case and the subyearling migrants are showing signs of GBT that are well below the action criteria.

However, the incidence and severity of signs in the juvenile steelhead migrants is very perplexing. As we have said before, we generally see an increase in signs of GBT in these few late-migrating steelhead. However, this year is particularly unique in that the incidence and severity of signs is higher than normal, and the total dissolved gas levels at Lower Granite tailwater and Little Goose forebay has been very close, or less than, the 110% standard. As we discussed last week the only logical way for steelhead to be exhibiting these signs is if they are spending very long periods of time in between projects. This is certainly plausible given the present low flows. In addition, the time spent migrating could be increased and negatively impacted by project operations.

A sample at Lower Monumental is being collected today and Little Goose sample will be repeated on Tuesday. We will keep you updated.

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MEMORANDUM

TO: Agnes Lut, OR-DEQ
Chris Maynard, WA DOE
Technical Management Team Members

FROM: Paul Wagner
FPAC Chairperson

DATE: June 8, 2007

RE: Incidence of GBT in Juvenile Snake River Steelhead

It has been brought to the attention of the Salmon Mangers that there has been a recent increasing trend in the observation of steelhead exhibiting signs of gas bubble trauma at the Little Goose and Lower Monumental sampling sites. The attached memo contains the technical information explaining the observations.

The information was discussed today by the Fish Passage Advisory Committee. The FPAC recommendation was to maintain the spill levels at these two projects and to continue to closely monitor the juvenile steelhead and fall Chinook. The basis of this recommendation was the decreasing numbers of steelhead, the increasing numbers of subyearling migrants, and the fact that the severity of GBT signs is still below that which would warrant a change in spill operations. The passage season for steelhead is almost over. We will advise you if any additional action needs to take place based on the monitoring information.

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MEMORANDUM

TO: The Files

FROM: Margaret Filardo and Jerry McCann

DATE: June 8, 2007

RE: Steelhead and GBT at Little Goose and Lower Monumental dams

Data from GBT exams has shown a high incidence of GBT in late migrating steelhead at both Little Goose and Lower Monumental dams. Sample sizes at Little Goose Dam have met the sample protocol while at Lower Monumental Dam they have been below sample size criteria. Although only 66 fish were examined on June 4, there were 12 steelhead with fin signs; a total of 18% fin signs. No severe signs were observed, but several fish had bubbles in more than one fin. There was also a relatively high incidence of signs recorded the following day, June 5 at Little Goose Dam.

Table 1. Summary of GBT signs at Little Goose and Lower Monumental in the past two days sampling.

Site and Date	Number Examined	Number with GBT	Number with Fin GBT	% Fin GBT	Fin Rank 1	Fin Rank 2
Little Goose						
05/29/07 Ch1 + St	100	8	8	8.0%	8	0
06/05/07 Ch1 + St	100	14	14	14.0%	13	1
06/08/07 Ch1 + St	101	37	37	36.6%	29	8
Lower Monumental						
05/28/07 Ch1+ St	100	5	5	5.0%	5	0
06/04/07 Ch1+ St	66	13	12	18.2%	11	1
06/07/07 Ch1+St	22	5	5	22.7%	5	0

All the signs were in steelhead, and with only a few Chinook examined. It should be noted that we typically see an increase in signs in steelhead as the season progresses, typically increasing to 10% incidence or less by this time of the season. And also, steelhead numbers are declining while subyearling Chinook indices are increasing.

Because of our concern for the steelhead migrants, and for the subyearling migrants, who are beginning to increase in their numbers, SMP crews were requested to conduct additional GBT monitoring this week at both sites. The result of that monitoring is incorporated into the table above. The high number of Lyons Ferry fish and the dwindling numbers of steelhead at the Lower Monumental site resulted in a sample of only 22 fish. The levels of GBT have increased in the observed fish. Few subyearling migrants were sampled; however, those that were observed showed no signs of GBT.

TDG has not exceeded waiver criteria, and for the most part has been well below criteria at these projects. It is unlikely that under normal migration conditions we would be observing these levels of GBT at these levels of TDG.

Date	LWG	LGNW	LGSA	LGSW	LMNA	LMNW
6/1/2007	105	111.3	113	111.2	114.5	118.7
6/2/2007	105.1	114.1	114	113.4	115.2	114.9
6/3/2007	105.1	112.7	113.8	113.6	115.2	114.8
6/4/2007	105	114	113	113.8	114.3	114.7
6/5/2007	104.6	112.9	112.8	113.6	113.8	114
6/6/2007	103.9	114.7	111.4	112.7	111.9	114.3
6/7/2007	101.5	113.7	108.7	112.2	109	117

Maule et al. (1997) observed that incidence and severity is a function of TDG level and exposure time. It seems likely that what we are observing is the result of the longer travel times observed for the late migrating steelhead. The present flows are in the mid 50s at these projects and the travel time estimates observed between Lower Granite to Little Goose Dam are about 4.9 days, which is a longer travel time than was observed in 2001 during the same time period. The average travel time between Little Goose and Lower Monumental is 6.5 to 7.5 days. It is likely that the long travel time is causing an increased exposure time and causing the fish to show the signs of GBT. There are also other factors that may be contributing to these long travel times. In addition to flow, there could be a delay in the forebays of the projects that might be a function of the present spill patterns, or spill amounts that are being provided at both Little Goose and Lower Monumental dams. Neither of these projects have RSWs in place.

There is a dilemma as to what to do regarding spill at these two Snake River projects. The late migrating steelhead are the last to arrive and represent a small portion of the run. The criteria established in the COE's waiver have not been exceeded. Decreasing spill would decrease the TDG in-river. However, if spill is decreased it would increase the residence time and take even more time for the steelhead to get through the river. In addition, the subyearling

migration is picking up and given that there is little data regarding the effects of transportation on these fish, it would not be appropriate to increase collection of these fish for transportation and to have a migration corridor with decreased spill for those fish that remain in-river. Based on 10-year average 98% of steelhead have passed Lower Granite by June 5. In contrast, 10% of subyearling Chinook have passed by June 8, and an additional 20% will have passed in the next two weeks; consistent with historic peak passage timing for subyearlings in the Snake River occurring over the next 6 to 8 weeks. The potential for project passage delay in the forebay may be exacerbated by the existing spill volumes and the remedy for the long travel times may be to actually increase spill to promote project passage.

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MEMORANDUM

TO: Mr. Raymond C. Bark, USBR

FROM: Jerry McCann, SMP Manager

DATE: June 7, 2007

RE: Absolute abundance in relation to Passage Index at Rock Island Dam

This memo is in response to your query regarding the utility of using Passage Index data from Rock Island Dam to estimate absolute abundance of various juvenile salmonids. The passage index is a relative number and not an absolute number of fish, estimated to be passing the dam. The index uses the number of collected fish, expanded at Rock Island by the proportion of total discharge through the dam that was "unsampled". Essentially, spillway and powerhouse 1 are not sampled, so that the number of fish arriving in the trap are expanded by the proportion of non-powerhouse 2 flows as shown in the following equation.

$$\text{PassageIndex} = \text{collection} * ((\text{powerhouse1 flow} + \text{powerhouse2 flow} + \text{totalspill}) / \text{powerhouse2 flow})$$

The assumption of the index is that fish pass in equal proportions (i.e. 1:1 fish to flow) via each route at the dam. This assumption simplifies calculation of the index and makes it relatively simple to understand, but is likely not necessarily. Nor does collection in powerhouse2 represent the total number of fish passing via that route, since an unknown, but likely small percentage of fish entering the powerhouse are captured in the trap. So it follows that the index expansion does not represent a population estimate. We generally assume that the smolt trap collects less than 5% of passing fish.

The strength of the index is that it provides an indication of passage timing. In other words, while magnitude is not reliable when comparing one year to another, relative magnitude within a single season is more likely reliable, so that day to day changes in numbers can be used to characterize timing.

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MEMORANDUM

TO: FPAC

FROM: Jerry McCann

DATE: June 6, 2007

RE: GBT exceedance at Lower Monumental Dam

Data from GBT exams has shown the waiver criteria of 15% incidence has been exceeded at Lower Monumental Dam. Although only 66 fish were examined on June 4, there were 12 steelhead with fin signs; a total of 18% fin signs. No severe signs were observed, but several fish had bubbles in more than one fin. There was also a relatively high incidence of signs recorded the following day, June 5 at Little Goose Dam.

Table 1. Summary of GBT signs at Little Goose and Lower Monumental in the past two days sampling.

Site and Date	Number Examined	Number with GBT	Number with Fin GBT	% Fin GBT	Fin Rank 1	Fin Rank 2
Little Goose						
05/29/07 Ch1 + St	100	8	8	8.0%	8	0
06/05/07 Ch1 + St	100	14	14	14.0%	13	1
Lower Monumental						
05/28/07 Ch1 + St	100	5	5	5.0%	5	0
06/04/07 Ch1 + St	66	13	12	18.2%	11	1

All the signs were in steelhead, and with only a few Chinook examined. It should be noted that we typically see an increase in signs in steelhead as the season progresses, typically increasing to 10% incidence or less by this time of the season. And also, steelhead numbers are declining while subyearling Chinook indices are increasing. It is likely that the incidence level in subyearling chinook will be lower when we switch over to monitoring them in the next week. If necessary, additional sampling can occur over the next few days, in the Snake River to provide more information about the levels of signs occurring. The next samples are not scheduled until June 11 and 12th.

Another consideration is the potential effect of the tailwater eddy at Little Goose Dam. It may be that longer egress times results in longer exposure to higher tailwater TDG. There has been some discussion in FPAC regarding the bulk spill pattern causing a moderate eddy at low flows and this may have made fish more susceptible to GBT due to increased time in tailwater at that site.

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MEMORANDUM

TO: FPAC

FROM: FPC Staff

DATE: May 29, 2007

RE: Little Goose Fish Counts

At your request the FPC staff has reviewed the adult and jack counts in the Lower Snake river in an attempt to discover any anomalous trends in counts or project operations over the spring of 2007. Of particular interest was adult passage at Little Goose Dam, as adult counts over the season have totaled 21,456 adults at LMN through May 28, 2007 and 14,391 adults at LGS through May 28, 2007. FPAC was reviewing a concern that fish were being held up below Little Goose Dam and were not able to pass the project.

FPC summarized PIT-tag adult chinook detected at IHR and compared to detection at LGR (adult PIT-tag data are only available for these two projects). The proportion detected at LGR declined through time (Figure 1). Although jack proportion increased through time, jack detection proportion (0.74) was not much higher than 2-3 ocean return detection proportion (0.69). No PIT-tags from Tucannon River were found, however, no tagged yearling chinook were released in the Tucannon River in 2004 and 2005. Only in 2006 were any PIT-tags released; just over 2,000 tags were released at Curl Lake Acclimation Pond, and another 163 wild fish were marked in the winter of 2005-2006.

Figure 1. Proportion of adult Chinook detected at IHR dam that were subsequently detected at Lower Granite Dam, by date of passage at IHR.

Average Travel Time for those fish that were detected at Lower Granite did not indicate a delay occurring. Travel times were no more dispersed with the Median remaining at approximately 4 days through the month of May.

Although adult counts are fewer at Little Goose Dam in comparison to Lower Monumental Dam, there have been no indications that adult fish have had problems passing Little Goose Dam. Adult counts have been consistently lower at Little Goose over the season in comparison to Lower Monumental Dam as is the case in most years (Steve Richards, WDFW-Personal Communication). Operationally nothing has changed in 2007 that would have prevented adult passage at Little Goose Dam with the exception of Unit #1 being down over the last two days due to a fish screen problem (Dave Hurson, Walla Walla COE, email). In past years when passage at Little Goose has been a problem, fish catching along the LGS wall before the entrance was not good. This was a result of a large eddy formed under high spill and low powerhouse flows. This year, fishing has been excellent along the LGS wall (Anne Dowdy, ODFW Personal Communication), so it is unlikely that the eddy is preventing fish from locating the entrances (although the last fishway inspection did mention the formation of a moderate eddy on the south shore). Also, the adult fishways were in criteria on the last two fishway inspections performed by ODFW personnel on May 17, 2007 and May 29th, 2007 (with the exception of the subsurface collection channel velocity meter reading slightly below criteria velocity, however visual surface velocities were within criteria).

Although there is no clear indication of what could be causing a passage problem at Little Goose Dam, adult passage at Little Goose is a high priority and the FPC staff will continue to keep track of fish passing through the Snake River system.

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MEMORANDUM

TO: Agnes Lut, OR-DEQ
Margaret Filardo
FROM: Margaret Filardo
DATE: May 23, 2007
RE: Spill in 2007 and Forebay Monitors

Earlier this month I pointed out to you that the forebay monitor at Ice Harbor Dam was limiting spill at Lower Monumental Dam, and that similar problems existed at The Dalles and Camas/Washougal monitors. You asked that I elaborate on the issues and this memo is in response to your request.

The FPC has developed an interactive link on our web page

<http://www.fpc.org/WebForm2.0/MAINCHART.ASPX>

that shows the spill provided at each project relative to the Court Order, along with both the tailrace TDG at the project and the forebay TDG levels at the next downstream project relative to the 115/120% criteria. You will note from the graphs that often spill volume is limited by the forebay monitors, when tailrace monitors read levels of TDG that are much below the tailrace criteria.

For example, if you consider the spill provided at John Day Dam, the Court Order calls for 60% of instantaneous flow to be spilled. The provision of spill at John Day Dam has met the Court Order only a few times thus far this year. The restriction of spill is most often based on the forebay TDG readings at The Dalles Dam (the tailrace monitor exceeded the 120% TDG by 0.1% on 3 of the 54 days thus far this season). Using the TDG data the COE sets a spill cap that establishes a maximum amount of spill that can occur at the John Day project. Essentially this COE spill cap has limited the amount of spill at John Day Dam so that the Court's Order of 60% instantaneous spill during nighttime hours cannot be met.

The following table was extracted from the COE website. http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/html/200705.html. The table is included here to

demonstrate that the daily average 12 hour high tailwater TDG variation at John Day Dam (JHAW) has been very small (usually varying less than 1% day to day) while the downstream forebay TDG has varied quite a lot (as much as 5% day to day). In fact, the tailrace monitor most often reads near 118% and could allow the implementation of the Court Order without exceeding the 120%.

Similarly, the Court Order calls for 100 Kcfs spill at Bonneville Dam. You will see from the graphs that often the Court Order is not being implemented most often due to TDG at Camas/Washougal, while the tailrace monitor is reading below the 120%.

Attached are graphs showing spill thus far this season at John Day and Bonneville dams. While these graphs show the seasonal trend in spill relative to the Court Order, the graphs on the Fish Passage Center web page show the same data in weekly blocks that are somewhat easier to read. There are also comments associated with each day describing the TDG levels and spill implementation.

We realize the generation of TDG is due to several processes and the impact of the biological and physical processes is difficult to predict on a real-time basis. However, we hope that this memo explains some of our concern with the present use of the forebay monitors to represent the total dissolved gas generated from spill at upstream projects. If we can provide any additional information please let us know.

Average percent TDG for 12 highest hours - May 2007

Date	Monitoring Stations (full list)																	
	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW	JDY	JHAW	TDA	TDDO	BON	CCIW	WRNO	CWMW
Gas Cap %	115	120	115	120	115	120	115	120	115	120	115	120	115	120	115	120	115	120
05/01/2007	103.6	110.7	113.9	117.9	116.2	114.1	115.6	117.9	114.5	116.0	112.8	119.1	114.7	117.6	113.5	118.7	114.8	115.0
05/02/2007	103.3	110.3	112.4	118.3	118.1	116.4	115.6	116.8	114.0	115.7	113.3	119.2	113.6	116.4	114.7	118.8	115.0	113.3
05/03/2007	102.3	109.2	109.1	116.8	115.5	116.4	112.7	115.7	111.2	115.7	111.8	118.7	113.3	116.1	113.7	118.7	114.6	114.0
05/04/2007	101.6	109.4	106.5	116.3	114.0	117.7	112.2	115.8	109.1	115.8	110.8	118.5	112.4	115.4	112.5	118.8	113.7	113.4
05/05/2007	101.5	109.3	104.5	115.6	112.0	116.9	111.8	115.7	108.9	115.6	108.4	117.9	111.8	114.6	111.3	118.6	112.7	113.0
05/06/2007	102.0	110.0	104.8	116.1	111.8	117.3	112.4	114.8	110.0	115.5	107.2	118.0	111.6	114.2	111.2	118.3	113.3	112.7
05/07/2007	102.8	110.7	105.7	116.9	113.1	120.1	113.7	114.5	113.0	115.9	108.3	117.6	113.4	114.1	112.5	118.3	114.3	115.2
05/08/2007	105.0	110.9	108.5	117.9	115.8	120.9	116.1	116.2	113.7	116.6	110.6	118.2	115.4	115.7	114.2	118.3	116.3	115.4
05/09/2007	104.8	110.8	109.5	117.8	115.8	117.5	116.5	115.7	113.9	116.3	111.8	118.7	113.4	117.6	112.7	118.6	114.0	114.3
05/10/2007	105.2	110.7	110.4	117.2	116.5	115.4	117.0	116.8	115.7	115.9	113.8	118.9	114.6	117.7	112.6	118.8	113.9	113.8
05/11/2007	104.1	110.4	111.4	117.3	117.0	116.2	116.8	117.2	117.6	115.6	114.0	118.7	115.0	118.6	113.3	118.6	114.3	114.3
05/12/2007	0.0	110.1	112.3	117.2	117.5	115.7	116.7	117.0	115.5	115.9	113.7	118.4	113.7	117.2	113.8	118.7	114.7	113.2
05/13/2007	0.0	109.3	108.5	113.8	115.7	113.7	114.4	116.2	111.3	115.8	110.4	118.1	110.7	115.8	109.7	117.8	113.2	112.5
05/14/2007	102.5	109.1	105.9	115.4	113.2	115.9	113.0	116.6	110.6	115.0	110.6	118.8	113.9	118.1	112.2	119.3	113.3	112.5
05/15/2007	103.5	110.0	106.9	115.9	112.8	117.4	114.2	116.8	113.3	114.9	111.1	118.6	115.9	119.1	115.9	118.7	115.5	114.1
05/16/2007	105.3	110.2	108.4	116.3	114.5	117.6	114.9	116.2	113.2	115.0	109.7	117.9	111.9	116.1	113.5	118.3	115.0	115.1
05/17/2007	105.2	110.5	108.5	115.6	114.5	115.1	114.8	115.6	112.6	114.6	110.0	118.2	112.4	116.3	111.3	118.2	113.5	114.1
05/18/2007	104.6	110.4	108.4	116.3	114.0	116.8	114.3	117.7	111.5	116.4	110.8	117.9	113.6	117.3	112.3	118.2	114.0	113.6
05/19/2007	103.8	109.8	108.1	116.1	113.8	115.0	113.9	116.7	110.7	115.7	109.7	117.6	112.6	116.5	112.7	118.3	114.3	112.9
05/20/2007	103.5	109.8	107.9	116.0	113.8	121.2	113.3	116.9	111.2	115.5	108.8	117.8	113.9	117.3	113.2	118.3	114.3	113.5
05/21/2007	102.8	109.3	106.8	115.8	113.5	120.1	112.7	116.3	109.1	115.2	107.8	117.8	109.2	114.0	111.9	118.2	115.0	112.1
05/22/2007	101.7	109.4	105.4	114.3	112.8	114.4	111.8	115.0	107.7	114.2	106.2	113.9	104.6	111.3	109.2	118.0	112.2	110.1
05/23/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
05/24/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
05/25/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
05/26/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
05/27/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
05/28/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
05/29/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
05/30/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
05/31/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Generated: Tue May 22 11:25:00 2007

Number of hours of data reported in a given day

Big, bold, red text denotes exceedances.

--- indicates No Data

Dates run from hour 1 to 24 (not 0 to 23).

The gas caps shown only apply when spilling to facilitate juvenile fish passage ("voluntary spill") between April 3rd and August 31st. At all other times, the gas cap is 110%.

John Day

Bonneville

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MEMORANDUM

TO: Nicole Cordan

FROM: Michele DeHart

DATE: April 25, 2007

RE: Snake River Spill in 2007

We have received your request for hourly Snake River spill operations in 2007, with particular attention to April 3 and April 4. The Fish Passage Center maintains hourly spill data and monitors spill relative to the Court Order. Hourly flow and spill data are used by the fishery managers in consideration of fish passage operations. The FPC staff evaluates the hourly spill and documents the circumstances in which spill may not be achieving the Court's Order. The primary reasons why spill may not be achieved include:

- Spill is less than the Court's Order due to the waiver criteria for total dissolved gas at the forebay and tailrace monitors.
- Planned outages of projects necessary for construction/research/facility maintenance.
- Low river flows combined with the requirement of maintaining the operation of one turbine unit at each project.
- Unforeseen system changes requiring decreases in spill (usually reported by the COE to the Technical Management Team after the fact).

Spill was initiated at the Snake River projects at 001 hours on April 3, 2007. Attached are graphs of the hourly data for the Snake River projects since the initiation of spill. The red line representing the Court's order has been adjusted for the operation of one turbine unit at each project when flows are too low to provide both the operation of one unit and spill to the Court's Order, with the exception of Lower Monumental. At Lower Monumental the COE establishes, on a daily basis a spill level they designate as the gas cap. This Spill Cap is plotted as the Court's Order and the exceptions are annotated subsequent to each graph.

We are also providing the same type of graphs for each of the projects for the hourly data on the specific days that you requested (April 3 and April 4).

The following is a short synopsis of operations at each of the Snake River Projects since that time:

Lower Granite Dam – The Court Order calls for 20 Kcfs instantaneously at this project. Spill has consistently been meeting (within reason) the Court Order. Hourly spill has averaged 20 Kcfs since April 3, and ranged from 19.7 to 20.3 Kcfs. As you can see from the Apr 3-4 graph, there were no significant deviations from the Court Order.

Little Goose Dam – The Court's Order calls for an instantaneous spill of 30%. The COE has done a good job of meeting the 30% on a daily basis, generally being within 1% of the 30% on an hourly basis. The only exception occurred on April 13 from 1300 to 1500 hours when there was a spill outage to accommodate a research project that needed to access a specific area of the project to install hydrophones. On April 3 the 24-hour average for spill was 30.5% and on April 4 it was 31.4 %, meeting the Court Order.

Lower Monumental Dam - This project is a little different since the Court's Order says to operate to the gas cap 24 hours a day. The gas cap is established by the COE based on the total dissolved gas readings in the Lower Monumental tailrace and downstream at the Ice Harbor Dam forebay. The gas cap was initially established as being 27 Kcfs and has been modified several times based on total dissolved gas. The red line on the graph represents the COE established gas cap. The annotation accompanying the graphs specifies how much spill was provided and the specific reasons for any restrictions. As you can see on April 3 and there were a few hours (maybe 6 hours) when the project could have spilled a few Kcfs closer to the gas cap, but did not. On April 4 it appears the Court Order was implemented. The following reason was provided at the Technical management Team (April 4th notes) for this deviation:

“On Monday morning, April 2, the control room operator at Little Goose had to manually enter forebay elevations into the computer because a technician working on calibrating the automated GDACS system, Bernard Klatte (COE) said. Because this was a departure from the normal automated operation and the operator was distracted from this task, the forebay elevation dropped below MOP of 633-634 feet elevation. BPA schedulers received incorrect information (received via computer) and managed the system accordingly. This created problems at all the other projects downstream of LGS resulting in fluctuating spill volumes to maintain MOP. At present, all projects are at MOP and spilling what they should be spilling. Dropping below MOP is a navigational issue, not a power generation or a flood control issue.”

Ice Harbor Dam –Spill at Ice Harbor Dam has generally been at the Court Order after accounting for the low flows and the minimum operation of one turbine unit. As you can see on April 3 and there were a few hours (maybe 2 hours) when the project could have spilled a few Kcfs closer to the gas cap, but did not. Other than that on April 3 and April 4 it appears the Court Order was implemented. Again, the explanation for this deviation was provided as above.

No anomalies so far this year!

11-Apr Spilled above agreement for 9 hours (11:00-20:00)

13-Apr No spill/Lower spill than agreement 13:00-15:00 due to outage (hydrophones in spillway)

A-3

3-Apr Spilling below gas cap; Gas not exceeding; Flows too low to meet minimum powerhouse operation requirements and spill to gas cap; Reduced spill on some hours according to COE explanation

4-Apr Spilling below gas cap; Gas not exceeding; Flows too low to meet minimum powerhouse operation requirements and spill to gas cap; Reduced spill on some hours according to COE explanation

5-Apr Spilling below gas cap; Gas not exceeding; Flows too low to meet minimum powerhouse operation requirements and spill to gas cap

6-Apr Spilling below gas cap; Gas not exceeding; Flows too low to meet minimum powerhouse operation requirements and spill to gas cap

7-Apr Spilling below gas cap; Gas not exceeding; Flows too low to meet minimum powerhouse operation requirements and spill to gas cap

8-Apr Spilling 26.4 kcfs; Gas exceeded waiver at IHR Forebay (12-hr Avg = 115.5%)

9-Apr Spilling 26.2 kcfs; Gas exceeded waiver at IHR Forebay (12-hr Avg = 115.1%)

10-Apr Spilling 26.4 kcfs; Gas not exceeding waiver; Flows high enough to meet powerhouse operation requirements and spill to gas cap

11-Apr Spilling 23.6 kcfs; Gas not exceeding waiver; Flows high enough to meet powerhouse operation requirements and spill to gas cap; No spill 14:00-15:00 due to outage (RSW preparation, movement of contractor barge)

12-Apr Spilling 26.6 kcfs; Gas not exceeding waiver; Flows high enough to meet powerhouse operation requirements and spill to gas cap

13-Apr Spilling 26.7 kcfs; Gas @ LMN Tailrace close to waiver; Flows high enough to meet powerhouse operation requirements and spill to gas cap

14-Apr Spilling 23.2 kcfs; Gas @ LMN Tailrace close to waiver; Flows high enough to meet powerhouse operation requirements and spill to gas cap; No spill 09:00-12:00 due to outage (equipment removal in forebay & install research equipment)

15-Apr Spilling 29.6 kcfs; Gas @ LMN Tailrace close to waiver; Flows high enough to meet powerhouse operation requirements and spill to gas cap

16-Apr Spilling 29.6 kcfs; Gas @ IHR Forebay exceeding waiver (12-hr Avg = 115.7%)

17-Apr Reduced spill in afternoon to 28.2 kcfs; Gas @ IHR Forebay exceeding waiver (12-hr Avg = 115.3%)

18-Apr Reduced spill in afternoon to 24.2; Gas @ IHR Forebay exceeding waiver (12-hr Avg = 115.4%)

19-Apr Spilled 25.5 kcfs; Gas @ LMN Tailrace exceeding waiver (12-hr Avg = 120.1%)

20-Apr Spilled 25.1 kcfs; Gas @ LMN Tailrace exceeding waiver (12-hr Avg = 120.6%)

21-Apr Reduced spill to 23.4 kcfs; Gas not exceeding waiver; Flows high enough to meet powerhouse operation requirements and spill to gas cap

22-Apr Spilled 23.4 kcfs; Gas @ IHR Forebay exceeding waiver (12-hr Avg = 115.2%); Flows too low to meet powerhouse operation requirements and spill to gas cap

23-Apr Spilled 23.4 kcfs; Gas @ IHR Forebay exceeding waiver (12-hr Avg = 115.3%); Flows too low to meet powerhouse operation requirements and spill to gas cap

24-Apr Spilled 23.4 kcfs; Gas @ IHR Forebay exceeding waiver (12-hr Avg = 115.5%); Flows too low to meet powerhouse operation requirements and spill to gas cap

12-Apr No spill/Lower spill than agreement 11:00-15:00 due to outage (hydrophones in spillway)
 14-Apr Spilling below agreement (04:00-07:00); Gas not exceeding waiver

[illegible]

A-195

Lower Monumental Dam

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MEMORANDUM

TO: FPAC

Margaret Filardo

FROM: Margaret Filardo

DATE: April 23, 2007

RE: Summary Memo on Spring Creek

On April 12, 2007 approximately 4.2 million subyearling tule fall Chinook were released from the Spring Creek National Fish Hatchery. The subyearlings began to arrive at Bonneville Dam sampling facility at about 6:45 am on April 13, about 21 hours after release. At that time, according to SMP personnel at the site, moribund and dead fish were immediately apparent in the sample tank. A sub-sample taken after two hours (two hours of collection 7 am to 9 am), found 10% mortality in the 1,232 fish sample. An emergency FPAC conference call was held on the afternoon of Friday the 13th and included the assistant manager of the hatchery, SMP personnel at Bonneville Dam, as well as Fish Health personnel from the Abernathy laboratory. Based on observations of the fish the Fish Health lab was concerned that the mortality was likely due to mechanical or physical injury. There have only been two modifications to Bonneville dam this year, the turbine intake extensions (TIES) were not installed due to a broken crane and, there were turbine modifications made to some units at Powerhouse 2.

There were limited management changes that could be made to the Bonneville project to address the mortality, since the project was already spilling and the PH2 corner collector was in operation. After discussing the potential negative effects, it was decided to request that the flow through the modified units in PH 2 be decreased to the lower end of the 1% peak efficiency range. The salmon managers also requested that spill be increased slightly to offset the reduction in flow through PH 2, before adding units at PH 1. At the time, there was some room to increase spill and not exceed the 120% TDG gas cap. BPA and the COE agreed and made the change in turbine loading, but there was some question as to whether Jim Adams, COE-RCC, could be contacted to change the spill cap he had established at BVL for the weekend.

The following table shows the daily and sub sample mortality rates. Mortality dropped substantially the next sample day and continued to drop with SMP monitors reporting 2.7% mortality for the sample ending on April 15, and 0% mortality on April 16.

Spring Creek Mortality/Descaling Summary, 4/13 - 4/16 2007

Date/Time	Spring Creek sample total	Mortality (%)	Descaling (%)	Comments
4/13 0700-0900	1232	10.10%	1.60%	The Spring Creek run began arriving at the facility around 0645 on 13 April, approximately 21 hours after release. Mortality and moribund fish were immediately apparent. No mortality and minimal descaling was observed in non-Spring Creek fish
4/13 - 4/14 0900-0700	564	3.20%	0.90%	Mortality numbers decreased substantially after operational change the evening of 4/13. No mortality and minimal descaling was observed in non-Spring Creek fish
Totals for sample period 4/13-4/14	1796	7.90%	1.40%	Majority of Spring Creek run passed the facility evening of 4/13
4/14 - 4/15 totals	113	2.70%	0%	No mortality and minimal descaling was observed in non-Spring Creek fish
4/15 - 4/16 totals	69	0%	0%	No mortality and minimal descaling was observed in non-Spring Creek fish

In summary, what we do know is that there was a decrease in mortality that was coincident with the operational changes made at the project. Spill was not increased, even though the TDG was below the gas cap. Apparently, the COE was not able to coordinate the change. This information will be taken into consideration for the upcoming May Spring Creek Hatchery release.

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MEMORANDUM

TO: Mitch Silvers, Regional Director to U.S. Senator Mike Crapo

FROM: Michele DeHart

DATE: April 9, 2007

RE: Relationship between Fish Travel Time and Water Transit Time in the Lower Snake and Lower Columbia rivers.

As you requested Fish Passage Center has summarized data regarding the relationship between fish travel time and flows in the hydro-system. Our analysis shows that Fish Travel Time shows good correlation with Water Transit Time in all reaches where these data can be measured. The relationship is highly significant for yearling Chinook and steelhead during spring migration, and also for subyearling Chinook when those fish are actively migrating in the summer. See below figures that summarize the relationship between fish travel time and water transit time for The Lower Snake River and Lower Columbia River.

Fish Travel Time is measured using detections of PIT-tagged fish at dams in the Lower Snake River and Lower Columbia River as well. Travel time for an individual fish is the time, measured in days, from first detection at an upstream dam, to detection at a downstream dam. Typically, median travel time is reported for a group of PIT-tagged fish. In the analysis presented here, median travel time was estimated for groups of fish detected during weekly time periods at Lower Granite Dam through the spring migration, and biweekly periods for summer migrants. For the Lower Columbia median travel time was estimated biweekly for yearling Chinook and monthly for steelhead due to fewer PIT-tags being available in the Lower Columbia Reach.

Water Transit Time is the average time it takes a particle of water to pass through a reservoir above a dam. Essentially this is the time it takes the volume of water stored in the pool to pass the dam based on the average flow at the dam and the average forebay elevation. The relationship between water transit time and flow in the Lower Snake River was plotted in figure

1. The figure shows the relationship between average total discharge at Little Goose, Lower Monumental and Ice Harbor dams, and the estimated Water Transit Time through the three pools the dams impound – the reach from the head of Little Goose Pool to Ice Harbor Dam. Figure 2 shows a similar relationship for the Lower Columbia River Reach from the head of John Day Pool to Bonneville Dam.

For juvenile salmon Water Transit Time is the best measure to compare to travel time since water velocity through the reservoirs is predominantly what out-migrating juvenile fish experience as they pass through the hydro-system. In addition to the rate of water transit through the reservoirs, flow characteristics occurring at the dam, such as spill proportion, and water temperature also are correlated to fish travel time. However, the primary effect on fish travel time, based on our analysis, is the rate of water movement through the reservoirs or Water Transit Time.

Thanks for the opportunity to provide you this data. Hopefully this answers your questions regarding the relationship between fish travel time and water transit time. If you have any further questions, don't hesitate to call us.

Figure 1. Relationship between Water Transit Time from the head of Little Goose Pool to Ice Harbor Dam plotted against Average Discharge or (River Flow) measured at 3 Snake River dams; Little Goose, Lower Monumental, and Ice Harbor. Lines depict the Biological Opinion Flow Targets for the Lower Snake River of 85 to 100 kcfs and corresponding Water Transit Times head of Little Goose Pool to Ice Harbor Dam.

Figure 2. Relationship between Water Transit Time from the head of McNary Pool to Bonneville Dam plotted against Average Discharge or (River Flow) measured at 4 Lower Columbia River dams; McNary, John Day, The Dalles, and Bonneville. Lines depict the Biological Opinion Flow Targets for the Lower Columbia River of 220 to 260 kcfs and corresponding Water Transit Times head of McNary Pool to Bonneville Dam.

Figure 3. Juvenile Steelhead Travel Time from Lower Granite Dam to McNary Dam plotted against Water Transit Time in that same reach.

Figure 4. Juvenile Yearling Chinook Travel Time from Lower Granite Dam to McNary Dam plotted against Water Transit Time in that same reach.

Figure 5. Juvenile Subyearling Fall Chinook Travel Time from Lower Granite Dam to McNary Dam plotted against Water Transit Time in that same reach.

Figure 6. Juvenile Steelhead Travel Time from McNary Dam to Bonneville Dam plotted against Water Transit Time in that same reach.

Figure 7. Juvenile Yearling Chinook Travel Time from McNary Dam to Bonneville Dam plotted against Water Transit Time in that same reach.

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MEMORANDUM

TO: FPAC

FROM: Margaret Filardo

DATE: April 10, 2007

RE: Transportation Research Fish Passage Center

We just got off an FPAC phone meeting where we spoke with Doug Marsh, NOAA Fisheries, to try and review the numbers of fish collected, handled and transported for research purposes prior to the initiation of transport this year. I agreed to summarize the numbers for distribution to FPAC members.

For the transportation indexing study, the overall goal of the researchers was to transport no more than 50% of the fish collected. In actuality, Doug felt that the numbers were closer to 60/40 or 65/35, with the larger number going back to the river. (The schedule you received the other day outlines specific days for each objective.)

In general, if transport research were occurring during transportation operations this time of year, marking would occur 5 days per week, with three barges leaving the project each week. The present research has reduced that to 3 days of marking with 1 barge transported each week.

The transport research and in-river survival goal is to mark 3K transport and 3K in-river for both hatchery and wild Chinook weekly. Presently, about 1400 Hatchery steelhead are being marked, but will increase as the numbers increase. The wild steelhead targets are 3K/3K for both hatchery/in-river.

About three (?) raceways of fish are collected per week (each raceway with 10-15K fish), with fish holding times averaging 72 hours as opposed to the normal operation of 48 hours. Approximately 1/4 of these fish are bypassed back to the river and the rest are transported.

Beginning April 21st fish will start being collected for the alternate barge release site study. This requires tagging a mixture of hatchery and wild Chinook and steelhead totaling 20K for weekly transport. This study has 6 weekly releases beginning April 23.

The last study begins o collection on April 22. A total of 12K hatchery Chinook (no estimate of fish handled to get these fish is available, depends on collection density) will be collected every 2 days Monday through Saturday for a total of 36K per week.

To put all these numbers into perspective we are providing the following table showing the average daily collection for April at Lower Granite Dam averaged over the past three years. Hopefully all of these data are useful to you in your consideration. I am sending this memo to Doug Marsh and he will hopefully correct any mistakes in my summary.

Table 1. Average daily collection of hatchery and wild yearling Chinook and steelhead at Lower Granite Dam in April (2004-2006).

Date	Yearling Chinook		Steelhead	
	Hatchery	Wild	Hatchery	Wild
1-Apr	667	430	1,597	397
2-Apr	1,024	1,347	3,759	799
3-Apr	1,570	2,420	2,937	927
4-Apr	1,487	2,180	2,877	830
5-Apr	1,253	1,843	3,907	1,097
6-Apr	1,810	2,947	4,290	1,150
7-Apr	2,177	3,487	3,008	890
8-Apr	4,690	4,725	3,742	1,303
9-Apr	5,733	5,070	3,217	1,697
10-Apr	5,792	5,015	4,755	1,455
11-Apr	6,587	4,833	3,493	2,347
12-Apr	9,545	7,125	4,615	2,526
13-Apr	11,400	8,883	3,633	2,183
14-Apr	10,308	7,122	5,067	2,386
15-Apr	15,833	7,917	10,100	2,517
16-Apr	22,150	13,050	9,483	1,883
17-Apr	19,654	10,075	17,799	2,963
18-Apr	17,780	8,913	20,334	3,849
19-Apr	23,197	13,138	16,888	3,441
20-Apr	24,376	11,477	22,792	3,431
21-Apr	30,905	12,274	27,596	4,481
22-Apr	33,012	11,090	36,731	3,864
23-Apr	25,672	11,711	52,688	6,287
24-Apr	34,384	13,929	34,664	4,187
25-Apr	54,753	16,275	56,123	3,579
26-Apr	56,028	21,988	119,498	5,563
27-Apr	105,799	37,594	150,270	8,481
28-Apr	130,881	38,907	85,425	5,863
29-Apr	191,487	35,232	94,626	12,890
30-Apr	178,655	32,194	166,239	17,385

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MEMORANDUM

TO: Fish Passage Advisory Committee
Rob Lothrop, CRITFC

FROM: Michele DeHart

DATE: March 27, 2007

RE: Snake River Fall Chinook life history investigations

In response to your request we reviewed the 2007 proposal by Tiffan (USGS) and Connor (USFWS). In addition, for reference, we reviewed the project proposal posted on the CBFWA web site. However, our comments are limited to the specific proposal which was discussed at the March 20, 2007 FPAC meeting (attached). Our following comments do not offer any opinion on whether or not production fish should be provided for the proposal. Our comments focus on the potential management application of results of the proposed study and potentially misleading inferences in the proposal. **Our overall conclusion is that the study results will not be applicable to management decisions and will not inform transportation study design options.**

Purpose of the study

The researchers state that this study on the effects of juvenile fall Chinook salmon life history will inform transportation study design options on summer spill and transportation studies. Further these state that it is assumed that fish not detected at Lower Granite Dam are mortalities in survival estimation. This is not actually true. Survival estimations, in particular those related to survival in spill, utilizing Cormack Seber Jolly methodology compares PIT tagged fish detected at Lower Granite Dam with PIT Tagged fish detected at down stream projects, both seen and unseen at Lower Granite Dam.

Reservoir versus stream life history

These terms are misleading and infer that these are two separate fall Chinook life histories. Extensive estuary sampling occurred in 1980 and 1981 through the Columbia River Estuary Studies. Fall Chinook were sampled throughout the year including winter. Results of that study indicate that fall Chinook overwintering is not an alternate life history but a facet of fall Chinook life history that has always occurred to some degree. Review of PIT tag results (May 5, 2005 FPC memorandum) indicates that fall Chinook overwintering appears to be related to fish size and time of release. In addition it appears that overwintering may be variable year-to-year. It is likely that regardless of transportation or in-river migration fall Chinook overwinter to some degree. This may specifically relate not to an alternate life history but to fish management differences between the Snake River and Clearwater components of the Snake River fall Chinook ESU.

The study groups are not representative of the actual migration or production and management programs, therefore it would be difficult to use results in any management application. The key element of any tagging study is the assumption that the tagged population is representative of the untagged populations to which study results will inform management decisions. This proposal raises serious concerns about that assumption. The study fish will be manipulated for size and held in an acclimation facility and released throughout the summer and fall and tagged with acoustic tags and PIT tags. The manipulation of size, rearing, handling and release as proposed does not reflect any management or production group. Fish size requirements for tagging select for the larger fish in the population. Double tagging as proposed has been discouraged in other applications due to the unknown effect on behavior and survival raising questions about the application of these results to the run at large. The data that is available thus far on “surrogate” hatchery groups utilized in research indicates that they are not representative of the run at large or any management groups or wild groups, raising questions about the usefulness of the results.

ATTACHMENT

2007 Request for 2,000 Production Size LFH Subyearlings – BPA Project 2002032

USFWS (Billy Connor) and USGS (Ken Tiffan)

We are conducting a study on the effects of juvenile fall Chinook salmon life history on summer spill and transportation studies. It is currently assumed that PIT-tagged fish that are not detected at Lower Granite Dam are mortalities in survival estimation. This assumption is violated when subyearlings delay their migration, overwinter in a reservoir, and complete seaward migration undetected during the spring when spill is prevalent at the dams. This "reservoir-type" life history invalidates SAR estimates made by use of conventional methods. It is the primary reason that consensus on a long-term transportation study design has not been reached. The data collected on the subyearlings we are requesting will help to bring about a consensus study design.

We originally planed to obtain authorization to tag some of the surrogates at DNFH to provide data for our study. In the absence of surrogate releases in 2007, we are requesting 2,000 production subyearlings from LFH. Of these, 750 will be either radio tagged or acoustic tagged. The extra 1,250 subyearlings will insure that fish meet tagging-size criteria and provide for limited mortality during holding. The subyearlings would be tested for disease in late April and then transported to DNFH in early May. Groups of the subyearlings would be tagged and released monthly from mid-June to mid-November at the Big Canyon Creek acclimation facility. The left over fish from radio and acoustic tagging will be PIT tagged and released at Big Canyon Creek one week after last release of radio-tagged and acoustic tagged fish.

Complete details on the original study design are available at <http://www.cbfwa.org/projects>. Enter 200203200 in the search box.

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MEMORANDUM

TO: The Files

FROM: Jerry McCann

DATE: March 15, 2007

RE: Time line of events related to increased mortality in samples at Bonneville Dam during the Spring Creek release.

Chronology of Events related to Spring Creek release and Bonneville Passage

Spring Creek NFH released 6.6 million subyearling Chinook salmon on March 5 at about 10 am. The smolts began arriving at Bonneville Dam March 6 in the early afternoon. Fish arriving on that date were part of the sample examined at 7:00 am March 7. Those fish showed a "normal" level of mortality (about 1.5%) when the sample was worked up. In the late afternoon of March 7, mortalities began arriving in the sample tank, according to SMP personnel at Bonneville Dam. The mortalities continued arriving the next day, March 8, when SMP personnel contacted COE biologists at Bonneville Dam and the Fish Passage Center. See table 1 for a summary of daily samples and mortalities during this time period.

Smolt Monitoring personnel reported unusually high mortality in the Spring Creek smolts collected at Bonneville Dam (see Table 1). They reported roughly 4.5% mortality on March 8, and 8% mortality on the 9th. This was much higher than the typical mortality rate of 1 to 1.5%. No immediate cause of the mortality was apparent. The COE inspected gatewells and orifices on March 8 and 9 and found no blocked orifices, or dead fish in gatewells, or other likely cause for mortality. The COE also reported no visible dead fish in the forebay of Powerhouse 2. The COE continued inspections on March 9 to determine other possible causes of mortality.

Approximately 30 dead fish were obtained from the sample on March 8, and examined at the USFWS health lab at Spring Creek NFH and were found to show no obvious signs of disease or

injury. So the cause of the mortality is unknown at this point. SMP personnel report that most mortalities were neutrally buoyant when they enter the sample tank, possibly indicating mortality had occurred within a relatively short time period prior to arriving in the tank. A few fish were seen to have eyes missing or other trauma in the March 9 sample and the mortality rate rose to 8%.

Table 1. Summary of SMP sample data related to Spring Creek release mortalities in 2007.

Sample enddate	Passage Index	Collection Count	Sample Count	Percent Descaled	Sample Morts	Facility Morts (in sample)	Percent Facility Morts	Estimated Collection Morts
03/03/07	9	5	1	0%	0	0	0.0%	0
03/04/07	26	15	3	0%	0	0	0.0%	0
03/05/07	8	5	1	0%	0	0	0.0%	0
03/07/07	106,076	63,400	318	0%	0	5	1.6%	997
03/08/07	429,248	258,400	1,292	0%	1	55	4.3%	11,000
03/09/07	298,932	175,600	878	0%	2	72	8.2%	14,400
03/10/07	37,238	20,600	103	0%	0	12	11.7%	2,400
03/11/07	80,973	50,333	755	0%	0	17	2.3%	1,133
03/12/07	71,001	42,067	373	0%	0	11	2.9%	1,241
03/13/07	32,204	17,733	246	0%	0	11	4.5%	793
03/14/07	7,633	4,200	63	0%	0	2	3.2%	133
03/15/07	1,855	1,000	179	0%	0	3	1.7%	17

Facility morts are those fish that were dead prior to entering sample tank, while sample morts died while in sample tank or during sampling.

Based on the previous information, the Salmon Managers issued an SOR requesting spill begin immediately to decrease the proportion of fish passing via powerhouse 2, and thereby reduce the mortality risk for the population. The concern was both for the continued passage of the March 5 release, but also for the release that did occur on the morning of March 9. On the afternoon of the 9th TMT met and discussed the SOR. The COE noted their concern for the fish mortalities, and suggested that if new information was presented that indicated the bypass system at Bonneville was causing the mortalities, the COE would change course to implement a spread the risk operation. With the current information, the COE believed the best operation would be to continue operating the B2 corner collector and not to provide spill at the project. In other words, the SOR was not implemented. No spill was provided.

SMP personnel continued monitoring through the day on Friday. During the period from 7 am to about 3 pm the mortality rate spiked to 26%. This information, along with the fact that the mortalities appeared “old” (i.e. grey in appearance not fresh) was provided via phone to the TMT conference call. The Action Agencies decided not to spill based on the evidence that the mortalities appeared old, indicating the incident had occurred earlier and was not continuing.

Gary Fredricks of NOAA fisheries was at Bonneville Dam during SMP sampling on March 9. He also walked through the facility with the COE biologists that day. He reported that orifice lights in some of the units had been changed to LED lights that did not appear as bright as the older lights previously used. He requested that the old incandescent light be reinstalled as a precaution. Fish in the gatewells use lights as a cue to find the orifices and he thought this might

cause fish to delay in the gatewells. Delay in the gatewells could in turn lead to mortality if fish were exhausted swimming around in the turbulent environment.

Mortality rates remained above normal (1 to 1.5%) throughout the period of the Spring Creek release passage. As of March 15, the mortality rate was returning to normal at 1.7%. SMP personnel reported that subyearling morts in the past few days looked “extremely old” suggesting the mortality event was not continuing.

Mortality related to the Spring Creek fish passage at Bonneville 2 juvenile bypass

The mortality rates reported in table 1 are based upon the number of mortalities in the sample on the date. Just as the live fish from the sample are expanded for the total collection, the facility morts can be expanded by the sample rate for a given day to arrive at the estimated number of morts in the collection. In other words the mortality rate presented in table 1 should be applied to the collection estimate to arrive at the total number of mortalities in the bypass over the course of the Spring Creek release. The last column in table 1 shows the estimated collection morts, which is the daily number of dead smolts in the bypass based on the sample rate. The sum of the daily numbers of morts through March 15, yields approximately 32,000 morts in the bypass during the Spring Creek release. That equates to about 5% bypass mortality for subyearling Chinook compared to the total collection of 633,000 estimated for the 2006 Spring Creek releases. However, if the mortality occurred during the first release (with morts trickling in the sample after a single mortality event), then the mortality rate in the bypass would have been close to 6%.

Based on the past 3 years sample data during the Spring Creek release, the average mortality rate was very low for Spring Creek releases; with the overall mortality well below 1%. This year’s rate was much higher and resulted in unusually high direct mortality through the bypass. Based on RT survival studies, bypass survival for subyearling Chinook would be predicted between 0.968 to 1.007 (from Counihan et al 2006). During the 2007 Spring Creek subyearling passage at Bonneville, the 5 to 6% mortality was “direct mortality” not relative. As such it is a much higher rate than would have predicted given RT research results.

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MEMORANDUM

TO: Bob Heinith, CRITFC

FROM: Michele DeHart

DATE: March 26, 2007

RE: Review of "Columbia River Stage and Discharge at Vernita Bar Under Current and Unimpounded Scenarios, 2004-2006."

In response to your request, the FPC has reviewed the report prepared by Battelle Pacific Northwest Division for Grant County PUD titled "Columbia River Stage and Discharge at Vernita Bar Under Current and Unimpounded Scenarios, 2004-2006." The following is a brief study summary and our comments.

Study Summary:

The authors used Modular Aquatic Simulation System 1D (MASS1) to simulate river flow and stage through the Hanford reach of the Columbia River. Further, the authors developed two models 1) with the Grant County complex (Priest Rapids and Wanapum dams) in place and 2) without the Grant County complex in place. Three years of data from Priest Rapids and Rock Island Dams were utilized (2004, 2005, and 2006) with the focus on two annual periods 1) spring, defined as February 1 to July 1 and 2) fall, defined as October through November. The primary objective of the study was to compare modeled daily flow fluctuations in the Hanford Reach of the Columbia River under both with and without the Priest Rapids Complex in place.

Comments:

It would be useful if the authors included more information on the development of these models. For example, how many actual river cross-sections were used? It is assumed that many cross-sections are available in the heavily studied Hanford reach, however, how many were available between Rock Island and Priest Rapids Dams? There should be

some discussion of the river cross-section inputs to the model, and from past uses of the MASS1 model, how many cross-sections are needed to accurately model a river reach over 60 miles long. The authors should also have a discussion of the accuracy of their model. Has it been calibrated? The USGS gauge 12472800 COLUMBIA RIVER BELOW PRIEST RAPIDS DAM, WA is located 2.6 miles downstream from Priest Rapids Dam. This USGS gauge has both discharge and stage height data. The models developed by Battelle have MASS1 output for exactly the river mile that the USGS gauge is located (RM 394.5). The output from the MASS1 model with the Grant County Complex in place should contain very similar stage fluctuations as to the USGS gauge. This would be one way of validating the Battelle MASS1 model. The USGS gauge mentioned can be found at the following web address:

http://waterdata.usgs.gov/wa/nwis/uv/?site_no=12472800&PARAMeter_cd=00060,00065.

The start and end dates for the spring period in the Battelle study were 2-1 to 7-1. However, the study does not recognize the two different operational strategies that have been historically implemented over this period below Priest Rapids in any year. The first is a period of incubation that typically occurs from the end of spawning through February and March, and sometimes into April. During this period, the Vernita Bar minimum incubation flow needs to be met, this flow is typically between 55 and 70 Kcfs. Establishment of the minimum incubation flow limits river fluctuations below the minimum incubation flow. The incubation period is operationally much different than the period of emergence/rearing where operations attempt to minimize flow fluctuations and operate to flow bands. Because most of the spring runoff tends to occur from early April through June, the emergence/rearing period typically has greater flow fluctuations. These operations can be seen in the following figures that show both Rock Island and Priest Rapids actual hourly flows between February 1st and June 30th in 2004 and 2006.

Figure 1. Priest Rapids and Rock Island Hourly flows between February and June of 2004.

Figure 2. Priest Rapids and Rock Island Hourly flows between February and June of 2006.

The above figures display the two different operations that are targeted below Priest Rapids Dam over the period that Battelle labeled as spring. As most fish are not available to entrap or strand until the end of the incubation period, and flow fluctuations during the emergence/rearing are the primary fishery concern, the study is somewhat

misfocused on fluctuations also during the incubation period. The study should focus on only fluctuations during the emergence/rearing period.

The three years that Battelle selected to use in their study were 2004, 2005, and 2006. Both 2004 and 2005 were below average water years, at 84% and 78% of average at Rock Island Dam (April-August). 2006 was a near average water year at 99% of average at Rock Island (April –August). Battelle should consider revising their study to include a variety of water years, possibly between 1995 and 2006, which would include very high and very low water years.

In conclusion, the FPCs main concerns are:

1. The Battelle MASS1 model should be calibrated, a suggestion would be to use the USGS gauge below Priest Rapids Dam.
2. Concerning the definition of the spring period, the study should focus on only fluctuations during the emergence/rearing period. Flow fluctuations during the emergence/rearing are the primary fishery concern.
3. Battelle should include more years in their model runs. The three years selected were either average or below average water years.

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March 21, 2007

Mr. Chris Maynard
Water Quality Program
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

Dear Chris,

You recently contacted us regarding the potential ways to calculate total dissolved gas in the Columbia and Snake Rivers to determine compliance with the water quality standard. We understand that Washington Department of Ecology (DOE) as well as Oregon Department of Environmental Quality (DEQ) are contemplating changing the measurement from the average of the 12 highest total dissolved gas (TDG) readings in a 24-hour period to the average of twelve consecutive hours. You requested our input on which period made the most sense for use in this new compliance standard. We agree with both DOE and DEQ that changing to the average of twelve consecutive hours is a better measure of actual fish exposure to total dissolved gas levels. However, we are concerned that changes in how TDG is measured should not unnecessarily impose additional restrictions regarding the ability to provide spill for fish mitigation.

In order to respond to your question regarding the definition of a "day" time period, we analyzed the resulting TDG values for the average of twelve consecutive hours over different definitions of "a day" and compared them to the data collected over the past several years using the current procedure of determining compliance. The current procedure for reporting daily TDG is one that averages the 12-highest hours in one day, from midnight to midnight. On the basis of our analysis we would recommend that the 12 consecutive hour average be implemented with compliance relative to a defined, specific 24-hour day. The 24 hour period chosen as a day is not particularly important, except for the projects where spill occurs for only 12 hours during the nighttime hours (see Appendix table A1 for the number of hours spilled in a given year). Here the existing midnight to midnight definition of a compliance period does not encompass the full spill period at the projects that spill for only twelve hours. We recommend that the 24-hour period should be consistent in that it captures both peak spill and peak fish passage hours. We examined a noon-to-noon day and a 0700 to 0659 day and found only minor differences between the two. Arbitrarily, we recommend the noon to noon reporting period based on the ability to make within day decisions regarding spill implementation.

The following is an explanation of each alternative reviewed:

1. The first alternative defined one day from midnight to midnight (existing definition of a 24-hour day for compliance monitoring). This alternative contained thirteen twelve-hour periods in one day over which averages were calculated. The maximum of each day's thirteen twelve-hour averages was utilized to represent the day's highest 12-consecutive hour TDG average.
2. The second alternative defined one day from 7am to 7am. This alternative contained thirteen twelve-hour periods over two days in which averages were calculated. This alternative was difficult to assign a date to, as 18 hours were in one day and 6 hours in the next day. For this analysis, it was decided to assign this as the day with the majority of hours used in averaging. The maximum of each day's thirteen twelve-hour averages was utilized to represent the day's highest 12-consecutive hour TDG average.
3. The third alternative defined one day from noon to noon. This alternative contained thirteen twelve-hour periods over two days in which averages were calculated. This alternative was also difficult to assign a date to, as 12 hours were in one day and 12 hours in the next day. For this analysis, it was decided to assign this as the day with the first 12 hours. The maximum of each day's thirteen twelve-hour averages was utilized to represent the day's highest 12-consecutive hour TDG average.
4. Rolling 12-hour average: This alternative continually averages 12-consecutive hours. With this alternative, many 12-hour averages contained hourly readings from two different days. When a 12-hour period was encountered that contained six hours in one day and six hours in the next day, it was assumed that the 12-hr average would be labeled as the previous day. For all other 12-hour periods, the 12-hour average would be labeled as the day with the majority of hours in the average. The maximum of each day's twelve-hour averages was utilized to represent the day's highest 12-consecutive hour TDG average.

Hourly % TDG data was used for the following locations: Lower Granite Tailrace, Lower Granite Forebay, Little Goose Tailwater, Little Goose Forebay, Lower Monumental Tailrace, Lower Monumental Forebay, Ice Harbor Tailrace, Ice Harbor Forebay, McNary Tailrace, McNary Forebay Oregon Side, McNary Forebay Washington Side, John Day Tailrace, John Day Forebay, The Dalles Tailrace, The Dalles Forebay, Bonneville Forebay, Cascade Island, Warrendale, and Camas/Washougal. Hourly % TDG data was obtained from April through June over the last five years (2002, 2003, 2004, 2005, 2006) at each location. Hourly data was obtained from the COE's online data query at:

<http://www.nwd-wc.usace.army.mil/perl/dataquery.pl>.

The daily average of the twelve highest hourly %TDG recordings were obtained through the following COE website over the period of April through June from 2002-2006:

http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/html/.

On this site, many of the projects did not report a daily average of the 12-highest TDG recordings in June of 2002, in this case the average of the highest 12-hours was calculated

manually using hourly data from the COE's data query website listed above. Also, in the case where the average of the 12-highest TDG recordings were missing for a single day, these values were estimated through trend fitting, which was based on recordings from the day before and the day after the missing date. These missing dates were infrequent and only accounted for 0% to 0.88% of all dates analyzed for any given site.

Results and Conclusions:

After calculating daily average % TDG using alternatives #1, #2, #3 and #4 above and obtaining the daily average of the 12-highest hours of TDG from the COE website, five estimations of daily average % TDG were available for each day: 1) The current procedure that averages the 12-highest (non-consecutive) hours in each day 2) Alternative #1 which used the highest 12-consecutive hour average between midnight and midnight 3) Alternative #2 which used the highest 12-consecutive hour average between 7am and 7am , 4) Alternative #3 which used the highest 12-consecutive hour average between noon and noon and 5) Alternative #4 – the rolling 12-hour average was investigated separately since the question regarding this alternative was a fixed or moving compliance day.

The analysis evaluated how each of the different alternatives, using consecutive hourly averages, differed from the current procedure of calculating daily average TDG. Daily deviations were calculated between the current procedure and each of the three alternatives that used highest consecutive averages. Daily deviations were summarized in terms of a 95% Confidence Interval range at each site, both yearly and over the entire five-year period. Tables A2 and A3 display these results.

Several patterns have emerged from the results of this study.

1. Forebay TDG stations are the least impacted by any of the alternatives used in calculating daily average % TDG. That is, 95% confidence intervals rarely exceeded a deviation of $\pm 1\%$ TDG from the current procedure. However, both the alternatives of using consecutive hours between 7am-7am and noon-noon more often contained 95% Confidence Intervals of deviations that included zero. A confidence interval of deviation that contains zero indicated that there was no difference between the "current" alternative and the "new" alternative. For example, under the midnight-midnight alternative, only 23.5% of the forebay confidence intervals of deviations contained zero. In comparison, 86.3% and 94.1% of the forebay confidence intervals of deviations contained zero when using the noon-noon and 7am-7am alternatives, respectively (Tables A2 and A3).
2. Tailrace stations are the most impacted by the alternative of calculating daily average % TDG and appear to be especially susceptible to daily patterns of spill i.e., 12-hr or 24-hr. Again, as expected the midnight-to-midnight alternative seemed to deviate the most from the current procedure of calculating average TDG, with only 7.1% of the confidence intervals of deviations containing zero. Interestingly, under this alternative, the projects that showed the most deviation from zero were those that spilled 12-hours per day (usually from 1800 to 0600). For example, John Day was on a 12-hr spill pattern (Table A1) from 2002 to 2005 and during this time the 95% confidence intervals of deviations at the John Day Tailwater were 1.04-1.81, 1.87-2.6, 2.35-3.18, and 2.54-3.43, respectively

(Tables A2 and A3). When John Day switched to a 24-hour spill program in 2006 (Table A1), the 95% confidence interval of deviations shifted closer to zero, at 0.05-0.8, while still covering a similar spread (Table A3). Generally, the midnight-to-midnight alternative does not seem to predict average TDG levels that are similar to the current procedure, especially under a 12-hr spill pattern. The reason for the differences is that only six hours of any one 12-hr consecutive hour average would be associated with a period of spill. For this reason, the midnight-to-midnight alternative would consistently yield a lower average of TDG than would the current procedure, which averages the twelve highest hours in one day.

3. In comparison to the midnight-to-midnight alternative, the noon-noon alternative resulted in 95.2% of the confidence intervals of deviations containing zero. Under the 7am-7am alternative, this percentage decreased to 78.6%(Tables A2 and A3). It appears that the noon to noon time period would both capture the peak consecutive TDG readings at the projects that only spill for 12 hours and not introduce additional unwarranted exceedences.

The analysis then looked at the potential exceedences that would occur if the 12 consecutive hours employed a running 12-hour average for compliance versus designating a fixed period for compliance. For comparison purposes, it was useful to calculate the number of TDG exceedences produced by each alternative and compare them to the current procedure of estimating daily average TDG. This exercise simply summed each daily TDG value that exceeded either the 120% TDG criteria at tailrace locations or the 115% TDG criteria at forebay locations at each site over the period of April through June in the years 2002 to 2006. The results of this summation are displayed in Table 1.

Table 1. Summation of each daily TDG value that exceeded either the 120% TDG criteria at tailrace locations or the 115% TDG criteria at Forebay locations for each alternative at each site over the period of April through June in the years 2002 to 2006¹.

	Number of Days Exceeding TDG Criteria (Apr-June 2002-2006)				
	Current ave. of highest 12-hrs	Alternative 1 midnight-midnight	Alternative 2 7am-7am	Alternative 3 noon-noon	Alternative 4 rolling
LGR-tw	55	43	55	58	62
LGR-fb	0	0	0	0	0
LGS-tw	30	25	30	29	37
LGS-fb**	36	33	41	43	45
LMN-tw	51	54	50	48	61
LMN-fb**	81	76	79	78	89
IHR-tw	37	35	40	39	52
IHR-fb**	93	93	93	93	98
MCN-tw	78	59	86	86	108
MCN-fb-OR	74	77	77	73	81
MCN-fb-WA**	71	71	81	78	90
JDA-tw	70	63	62	54	74
JDA-fb**	11	13	12	12	13
TDA-tw	22	18	18	18	23
TDA-fb	80	77	85	81	96
Warrendale	18	17	18	19	22
Casc-Island**	67	65	63	64	72
Cam/Wash	157	158	159	157	167
BON-fb	100	100	102	95	111

From Table 1, several points are clear:

- 1) The alternative of using rolling averages (rather than a fixed day for compliance) always contained more exceedences of the TDG criteria than did the current procedure of calculating daily average TDG².
- 2) The alternative of using noon-to-noon consecutive averages did not display any noticeable trend when comparing its exceedences of the TDG criteria to exceedences produced under the current procedure of calculating daily average TDG.

There is at least one possible explanation as to why the rolling average alternative appears to produce more exceedences than does the current procedure for calculating daily average TDG. An examination of the data showed many circumstances where the current procedure produced a grouping of exceedences and the rolling average alternative contained the same grouping of exceedences but also included an exceedence either on the day ahead of the grouping or a day behind. Any particular rolling average can contain hours from the previous day or from the next day. If these “edge” hours contain high TDG, the average for a particular day can be impacted.

¹ At Sites with an asterisk, the number of days of data varied between the normal method (high 12hr ave) and the methods that used consecutive averages. At these sites, datasets were shortened to the one with the least data. By shortening these data sets, each method contained the same exact days to compare exceedences.

² With the exception of the Lower Granite Forebay, which had no exceedences under any alternative.

The following figure displays an actual example of the impact of the “edge” hour at the Bonneville Dam Forebay.

Figure 2. Example of the impact of the “edge” hours on TDG exceedences produced by the rolling average alternative at the Bonneville Forebay.

In conclusion, both the noon-to-noon and 7am-to-7am alternative of calculating daily average TDG using consecutive averages resulted in daily average TDG that was similar to that calculated using the current procedure of using the average of the highest 12-hours in one day. Both these alternatives seemed to track the current procedure reasonable well at both forebay and tailrace locations and under 24-hour or 12-hour daily spill periods, as would any designated “day” the included the peak hours of spill. As expected, if one were to implement an alternative using the midnight-to-midnight period as a day it would not track the current procedure well, especially at projects that are spilling only 12-hour per day.

After considering the use of a fixed 24-hour period versus a rolling 12 hour average for compliance monitoring, it is our recommendation that the WDOE not use the rolling average alternative. This alternative will artificially produce more days of TDG exceedences in comparison to the current procedure. This will unnecessarily result in less spill, or longer periods of reduced spill for juvenile anadromous fish. Instead, we suggest that the WDOE consider a alternative that uses consecutive 12-hour averages from noon-to-noon. The noon-to-noon alternative of calculating daily average TDG did not display any noticeable trend when comparing exceedences to the current procedure.

Thank you for your consideration. Please contact us if you need any additional information.

Sincerely,

A handwritten signature in black ink that reads "Michele DeHart". The signature is written in a cursive, flowing style.

Michele DeHart

cc:

Agnes Lut, Oregon DEQ
Fish Passage Advisory Committee

Appendix Tables

	Spill Operation by Year				
	2002	2003	2004	2005	2006
Lower Granite	12-hr	12-hr	24-hr Apr 3-23	No Planned Spill	24-hr
Little Goose	24-hr April 12-hr May-June	12-hr	12-hr April 7-23	No Planned Spill	24-hr
Lower Monumental	No spill	24 hr	Variable Mostly 24-hr	No Planned Spill	24-hr
Ice Harbor	24-hr	24-hr	24-hr	24-hr	24-hr
McNary	12-hr	12-hr	12-hr	12-hr	24-hr
John Day	12-hr	12-hr	12-hr	12-hr	24-hr
The Dalles	24-hr	24-hr	24-hr	24-hr	24-hr
Bonneville	24-hr	24-hr	24-hr	24-hr	24-hr

Table A1. Daily period of spill over the years between 2002 and 2006 at each Snake River and lower Columbia project.

	2002			2003			2004		
	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3
LGR-tw	1.66 - 3.07	-0.05 - 0.8	-0.22 - 0.92	1.98 - 3.28	-0.9 - 0.28	-0.87 - 0.34	-0.24 - 0.38	-0.44 - 0.26	-0.43 - 0.34
LGR-fb	0.04 - 0.07	-0.01 - 0.07	0 - 0.11	0.02 - 0.07	-0.01 - 0.13	-0.01 - 0.17	0.06 - 0.11	-0.02 - 0.17	0 - 0.26
LGS-tw	1.02 - 1.66	-0.29 - 0.26	-0.33 - 0.32	1.65 - 2.29	-0.43 - 0.08	-0.42 - 0.12	0.26 - 0.73	-0.2 - 0.2	-0.18 - 0.26
LGS-fb	-0.16 - 1.32	-0.5 - 1.4	-0.49 - 1.75	0.05 - 0.17	-0.08 - 0.24	-0.13 - 0.29	0.08 - 0.23	-0.09 - 0.19	-0.13 - 0.27
LMN-tw	0.07 - 0.19	-0.06 - 0.13	-0.09 - 0.29	0.01 - 0.13	-0.15 - 0.17	-0.03 - 0.51	-1.55 - -0.1	-1.67 - -0.18	-1.62 - -0.07
LMN-fb	0.1 - 0.3	-0.49 - 0.65	-0.74 - 0.84	0.14 - 0.31	-0.07 - 0.26	-0.15 - 0.3	0.09 - 0.16	-0.02 - 0.13	-0.03 - 0.19
IHR-tw	0.49 - 1.04	-0.08 - 0.27	-0.12 - 0.26	0.01 - 0.29	-0.11 - 0.43	-0.14 - 0.54	-0.23 - 0.28	-0.11 - 0.52	-0.32 - 0.37
IHR-fb	-0.05 - 0.36	-0.12 - 0.49	-0.11 - 0.73	0.03 - 0.1	0 - 0.16	0 - 0.23	0.06 - 0.12	-0.06 - 0.11	-0.12 - 0.16
MCN-tw	1.1 - 1.74	-0.15 - 0.32	-0.25 - 0.49	1.45 - 2.27	-0.35 - 0.15	-0.39 - 0.13	1.84 - 2.5	-0.04 - 0.31	-0.22 - 0.13
MCN-fb-OR	0 - 0.13	-0.03 - 0.11	0.07 - 0.28	-0.07 - 0.1	-0.07 - 0.11	0.01 - 0.23	0.06 - 0.16	0.06 - 0.18	0.14 - 0.28
MCN-fb-WA	0.05 - 0.32	-0.03 - 0.24	-0.03 - 0.28	0.05 - 0.12	-0.52 - 0.32	-0.86 - 0.76	0.06 - 0.16	-0.17 - 0.06	-0.14 - 0.15
JDA-tw	1.04 - 1.81	0 - 0.44	-0.2 - 0.31	1.87 - 2.6	0.16 - 0.63	-0.42 - 0.12	2.35 - 3.18	0.3 - 0.82	-0.22 - 0.28
JDA-fb	-0.02 - 0.22	0.03 - 0.34	0.06 - 0.67	0.01 - 0.09	-0.03 - 0.12	0.03 - 0.24			
BON-fb	0.06 - 0.11	-0.15 - 0.12	-0.16 - 0.24	0.05 - 0.12	-0.08 - 0.16	-0.11 - 0.29	0.07 - 0.14	-0.06 - 0.15	-0.18 - 0.17
Cam/Wash	0.03 - 0.08	-0.07 - 0.05	-0.07 - 0.16	-0.06 - 0.11	-0.13 - 0.06	-0.08 - 0.12	0 - 0.09	-0.05 - 0.05	-0.03 - 0.08
Warrendale	0.16 - 0.36	0.05 - 0.55	-0.33 - 0.38	0.12 - 0.22	0.08 - 0.52	-0.38 - 0.17	0.13 - 0.24	0.27 - 0.61	-0.13 - 0.35
Casc-Island									
TDA-tw	0.11 - 0.21	-0.06 - 0.21	-0.1 - 0.32	0.16 - 0.31	-0.15 - 0.09	-0.21 - 0.1	0.11 - 0.3	-0.09 - 0.17	-0.15 - 0.16
TDA-fb	0.08 - 0.54	-0.01 - 0.28	0.1 - 0.87	0.12 - 0.34	-0.08 - 0.11	-0.03 - 0.2	0.27 - 0.53	-0.09 - 0.18	-0.12 - 0.23

Table A2. 95% Confidence Intervals of the difference between the current procedure of calculating daily average TDG and three alternate alternatives for calculating daily average TDG.

	2005			2006		
	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3
LGR-tw	0.04 - 0.14	-0.14 - 0.34	-0.43 - 0.43	0.14 - 0.31	0.01 - 0.48	-0.23 - 0.46
LGR-fb	0.05 - 0.09	-0.01 - 0.16	0 - 0.23	0.04 - 0.08	-0.07 - 0.07	-0.09 - 0.11
LGS-tw	0.03 - 0.07	-0.15 - 0.18	-0.33 - 0.28	0.09 - 0.28	-0.13 - 0.41	-0.25 - 0.47
LGS-fb	0.05 - 0.08	-0.07 - 0.06	-0.14 - 0.07	0.03 - 0.07	-0.09 - 0.17	-0.19 - 0.24
LMN-tw	0.04 - 0.15	-0.11 - 0.18	-0.01 - 0.55	0.12 - 0.23	-0.06 - 0.31	-0.23 - 0.43
LMN-fb	0.03 - 0.07	-0.1 - 0.06	-0.16 - 0.08	0.04 - 0.08	-0.2 - 0.07	-0.34 - 0.17
IHR-tw	-0.01 - 0.62	-0.17 - 0.6	-0.62 - 2.03	0.21 - 0.38	-0.09 - 0.3	-0.26 - 0.35
IHR-fb	0.03 - 0.06	-0.08 - 0.07	-0.11 - 0.1	0.03 - 0.06	-0.1 - 0.07	-0.16 - 0.13
MCN-tw	1.24 - 1.83	-0.06 - 0.42	-0.25 - 0.28	0.05 - 0.22	-0.03 - 0.19	-0.13 - 0.22
MCN-fb-OR	0.05 - 0.09	0.06 - 0.13	0.11 - 0.23			
MCN-fb-WA	0.04 - 0.09	-0.13 - 0.05	-0.17 - 0.11	0.05 - 0.09	-0.07 - 0.09	-0.04 - 0.16
JDA-tw	2.54 - 3.43	-0.14 - 0.27	-0.22 - 0.2	0.05 - 0.8	0.06 - 0.6	0.09 - 0.68
JDA-fb						
BON-fb	0.11 - 0.19	-0.1 - 0.12	-0.14 - 0.18	0.06 - 0.12	-0.18 - 0.12	-0.3 - 0.16
Cam/Wash	0.06 - 0.11	-0.07 - 0.02	-0.08 - 0.03	0.03 - 0.08	-0.01 - 0.09	0 - 0.17
Warrendale	0.03 - 0.08	0.44 - 0.79	-0.15 - 0.26	0.04 - 0.07	-0.08 - 0.12	-0.18 - 0.16
Casc-Island	0.49 - 0.68	-0.1 - 0.09	-0.15 - 0.1	0.14 - 0.24	0.07 - 0.43	-0.02 - 0.5
TDA-tw	0.16 - 0.29	-0.01 - 0.18	-0.05 - 0.22	0.06 - 0.16	-0.07 - 0.18	-0.16 - 0.26
TDA-fb	0.34 - 0.61	-0.13 - 0.25	-0.23 - 0.32	0.04 - 0.08	-0.11 - 0.11	-0.1 - 0.24

Table A3. 95% confidence intervals of the difference between the current procedure of calculating daily average TDG and three alternate alternatives for calculating daily average TDG.

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MEMORANDUM

TO: Bob Heinith

Michele DeHart

FROM: Michele DeHart

DATE: March 12, 2007

RE: Fall Chinook Timing

You requested that the FPC review the graphs (attached) of fall chinook timing in 2006 developed by Billy Connor, USFWS. The graphs were developed based on the PIT tagged fish recaptured for wild Snake and Clearwater River migrants, surrogate Snake and Clearwater river migrants, and production releases for the Snake and Clearwater rivers. The expansion of the PIT tag data was based on daily estimates of detection probability. There are variations in daily detection probabilities estimated dependent on the methods employed for expansion. However, while there might be slight variations in the timing graphs produced, it would not lead to different conclusions regarding overall migration timing.

However, when considering Snake River fall Chinook timing it is important to note the factors that have changed in the Snake River over the past several years that have contributed to the present timing observed for the subyearling migration.

- The run at large is dominated by hatchery supplementation releases.
- Over the past few years' hatchery releases have been earlier and over shorter time frames. These two factors have skewed the population such that it now has significantly earlier timing.
- Runoff volume has been on average less post 2000 than pre 2000.
- The volume of summer flow augmentation from Dworshak has decreased by approximately 200 KAF and is now used in September.
- The operation of Dworshak for flow and temperature control has changed over the time period.
- Temperature of released water from Dworshak has decreased over the time period.
- Spill for summer migrants in the Snake was implemented beginning in 2005. Spill aids passage through the Snake River projects and decreases forebay residence time.

-
- Brownlee augmentation pre draft agreement ended in 2001.
 - Flows below Hells Canyon Dam have been lower post 2000.
 - The collective result of the above action has been lower flow at Lower Granite during the summer migration period and colder water temperatures.

Snake River Fish

- Between 1995 and 2006 the proportion of PIT tagged wild and hatchery Snake River fall chinook passing Lower Granite Dam during August decreased steadily. This proportion is based on PIT tag recoveries between May and November of each year.
- All detections for a given migration year were used in this analysis (i.e., from the initialization of PIT-Tag detectors until the time they were turned off for the winter). All individuals that were determined to be holdovers were removed prior to determining the monthly proportion of the estimated PIT-Tag population passing each project. Holdovers were defined as subyearling Chinook that were detected the year after their initial migration as yearlings.
- The subyearling run at large is now dominated by hatchery supplementation releases. Supplementation releases began increasing in the late 1990's, but increased significantly after the 2000 migration year. These releases are generally earlier than the normal timing observed in previous years for wild fish, skewing the distribution earlier.
- Initially the hatchery releases were made in mid to late May and were allowed to exit volitionally through July. However, over the past few years' hatchery releases have been made earlier and over shorter time frames.
- These two factors have contributed to skew the population such that it appears to have significantly earlier timing.

Clearwater River Fish

- As with Snake River hatchery subyearling Chinook, there has been a gradual decline in the proportion of Clearwater River hatchery subyearling Chinook passing Lower Granite Dam in August. The maximum proportion of Clearwater River hatchery subyearling Chinook passing in August occurred in 1996, with 0.45. Over the past three years (2004-2006), no PIT tagged hatchery subyearling Chinook passed Lower Granite Dam from the Clearwater River in August. In 2001 there was an increase in the proportion of Clearwater subyearling Chinook passing Lower Granite Dam in August (to 0.23). This increase in August passage coincided with drought conditions and low flows on the Snake and Clearwater Rivers.
- Clearwater River wild subyearling Chinook show a different pattern of passage timing to Lower Granite Dam than any of the other groups analyzed thus far. From 1998 to 2003 there was an increase in the proportion of wild subyearling Chinook passing Lower Granite Dam in August. In 2004, the proportion passing in August decreased to 0.19, compared to 0.52 in 2003. Following 2004, there has been a decrease in the proportion passing in August. In 2006, the proportion of the estimated PIT-tag population of Clearwater River wild subyearling Chinook passing Lower Granite Dam in August was 0.13.

Flow

- Overall runoff volume above Dworshak and Brownlee reservoirs has on average been less post 2000 than pre 2000. Consequently, flow at Lower Granite during the summer migration period has been lower.
- Other factors affecting flow and temperature are:
 - Brownlee augmentation pre-draft agreement ended in 2001.
 - Approximately 200 KAF of the summer flow augmentation from Dworshak has been shifted to post August 31.
 - The operation of Dworshak for flow and temperature control has changed over the time period.
 - Temperature of released water from Dworshak has decreased as a result of selective withdrawals of colder water (Figure 1 and Table 2).
- Spill for summer migrants in the Snake was implemented beginning in 2005. Spill aids passage through the Snake River projects and decreases forebay residence time.

Table 1. Historic changes in volume runoff, augmentation water and flow.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Dworshak Runoff Volume (MAF)	1.81	3.07	4.64	2.06	3.19	2.68	1.47	3.70	2.30	2.39	1.64	2.68
DWR flow Jul 1-Aug 31	10.62	10.30	15.99	11.57	10.59	11.5	9.15	12.92	10.17	10.55	9.56	10.16
Dwr elev Aug 31	1530	1537	1500	1520	1527	1520	1520	1534*	1534*	1534*	1534*	1532*
Brownlee Runoff Volume (MAF)	6.59	8.27	9.83	8.77	8.02	4.39	2.4	3.24	3.52	3.19	3.61	8.98
HCA Flow June 21-Aug 31	18.5	17.6	25	20	19.3	13.1	9.5	10.6	11.1	10.7	12.1	14.7
Snake Aug (KAF)	425	428	427	422	437	427	427	90	286	285	341	427
LGR Vol Jan-Jul KAF	29.41	42.43	49.48	30.84	36.08	24.6	14.38	23.98	23.81	20.68	19.4	32.19
LGR flow June 21-Aug 31	55.3	52.7	66.3	53.2	56	33.7	25.4	41	62.3	33.2	33.4	37.6

Table 2. Average July temperature (°C) in the Snake and Clearwater Rivers as measured at the Anatone gauge, Lower Granite Dam, Peck gauge, and Dworshak Dam tailwater from 1995-2006.

Migration Year	Anatone Gauge	Lower Granite Dam	Dworshak Dam Tailwater	Peck Gauge
1995	19.18	19.32	12.03	14.55
1996	19.19	19.29	11.40	14.22
1997	19.38	17.83	11.11	12.26
1998	21.23	19.73	9.65	12.40
1999	18.87	18.11	10.67	14.12
2000	20.71	18.91	8.90	12.39
2001	20.71	19.27	9.13	13.57
2002	21.16	18.50	8.56	13.03
2003	21.58	19.03	7.99	12.58
2004	21.22	19.21	7.36	12.19
2005	21.19	19.04	7.13	11.98
	22.36	19.85	6.32	11.49

Figure 1. Historic (1995-2006) tailrace temperatures in the Dworshak Dam tailrace.

Conclusions

- It is clear that significant changes have occurred in the Snake and Clearwater rivers relative to hatchery practices and the management of flow, spill and temperature. These changes have significantly altered juvenile passage in the lower Snake River from historic passage. However, the impact that these changes have had on adult production and recovery of these stocks has yet to be determined.
- Wild fish timing has become more similar to hatchery timing over the years, as production releases have increased. Possible mechanisms might include density dependent effects or genetic dilution by wild spawning supplementation returns. The

supplementation program has not addressed this effect nor shown means of evaluating the effects of this change to wild population, either genetic or density/competition related. Both of these effects are common concerns with hatchery supplementation programs in general.

- It is premature to develop long-term conclusions regarding fall chinook from the Snake and Clearwater since data has not yet been collected and evaluated regarding adult returns for fish that passed the Snake River with spill.
- There is a also good chance that the operations at Dworshak that provide cold water instead of providing higher flows out of Dworshak may be causing more Clearwater fish to hold over and begin migrating into the fall months. The question is what is the overall return of adults to the Clearwater under this management scenario of Dworshak and the resulting effects on smolts migration.

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MEMORANDUM

TO: Jim Adams, COE

Michele DeHart

FROM: Michele DeHart

DATE: March 5, 2007

RE: Data Request from COE regarding "Spring Spill 2006" memorandum

In an email dated 2-26-07, FPC staff received inquiries from the Corps of Engineers regarding the Fish Passage Center's memo titled "Spring Spill 2006" dated September 29, 2006. The following memorandum is in response to your data request. In your email to the FPC you articulated three different questions.

1. "... I would like to understand how the spill caps were calculated in the spill analysis that estimated the volume of increased spill had spill been managed only to tailwater TDG gauges at 120%."

The spill caps were calculated using 2006 hourly spill and TDG data from the COE's website: <http://www.nwd-wc.usace.army.mil/perl/dataquery.pl>. For each day's hourly spill and TDG data, we began by sorting all of the data (both TDG and spill) by the highest hours of TDG. Both the average of the days 12 highest hours of TDG and the average of the hourly spill that was associated with each hour of high TDG was calculated. We performed this calculation for each day between April 3rd and June 20th in the Lower Snake River and between April 20th and June 31st in the Lower Columbia River. We then conducted a regression analysis of the daily averages of spill on the daily averages of high TDG, and obtained a regression equation. The last step in the analysis was to solve this equation for either 120% TDG at tailrace monitors or 115% TDG at forebay monitors. Again, it should be clear that these regressions used 2006 spill and TDG data, not historical data. Because our analysis was based on 2006 operations, we felt the 2006 data should be used to predict spill caps. Based on past experience, it is clear that even slight changes to spill patterns or sensor locations can alter the relationship between spill and TDG. For this reason we did not use historical data.

2. “I would also like to know what was the value of the spill caps used in the analysis for each of the 8 Lower Columbia and Lower Snake rivers.”

All of the TDG caps used in this analysis were displayed in Table 2 in the memo of question. This table has been added below.

Project	Spill (Kcfs) if Gas Cap Managed to Project Tailrace Monitor (120%)	Spill (Kcfs) if Gas Cap Managed to Downstream Forebay Monitor (115%)
Lower Granite	54.1	53.1
Little Goose	50.7	30.2
Lower Monumental	39.0	29.5
Ice Harbor	76.2	63.5
McNary	179.2	161.1
John Day	133.5	131.0
The Dalles	147.0	122.2
Bonneville	101.3	113.3

Table 2. Gas cap estimates generated based on regressions between spill volumes and tailrace TDG or in the next downstream forebay for the Spring 2006 data.

3. “Also, the memo indicates that spill above load limitations was not included in the analysis. I was wondering how that was estimated.”

We believe this question was in reference to how we calculated the actual spill in 2006. Basically, for this calculation we did not include spill above the Court Ordered Spill. It was our assumption that spills above the court ordered spill would be because of other factors that would force an involuntary spill situation. This was explained on Page 2, it states,

“Then the actual volume of spill that occurred was calculated (b). This volume did not include any involuntary spill, or spill that was in excess of the court order. This excess spill occurred due to project capacity limits (flow in excess of hydraulic capacity or limited hydraulic capacity due to unit outages) or due to overgeneration or lack of market spill.”

We hope that we have sufficiently answered all of your questions you submitted regarding our September 29, 2006 memorandum. Please do not hesitate to contact us if you need any further assistance.

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MEMORANDUM

TO: Ed Bowles, ODFW

Michele DeHart

FROM: Michele DeHart, FPC

DATE: February 7, 2007

RE: Water Travel Time through JDA Pool at Minimum Irrigation Pool and at Minimum Operating Pool at Various Flows and the Impact of the Montana Plan as Outlined in the Proposed Action

This memorandum is a follow-up to the February 6, 2007 memorandum from FPC to ODFW titled "Water Travel Time through JDA Pool at Minimum Irrigation Pool and at Minimum Operating Pool at Various Flows and the Impact of the Montana Plan." The February 6th, 2007 memorandum assumed the flow impact of the MT Plan to be 7 Kcfs, taken directly from Montana's System Operation Request dated July 6, 2005. It is our understanding that the MT Operations outlined in the Proposed Action are somewhat different than that presented in Montana's 2005 SOR. This memorandum utilizes the Proposed Action to determine the potential flow impacts of Montana Operations to the Lower Columbia River.

The Reservoir Replacement Method was used for calculating water travel times through a reservoir.

This formula is:

$$\text{WTT (s)} = \text{Reservoir Volume (ft}^3\text{)} / \text{Flow (ft}^3\text{/s)}$$

This method was suggested by personnel from the US Army Corps of Engineers. In particular, Lester Cunningham from the COE in Walla Walla, Washington suggested using the storage replacement method for calculating water particle transit time between respective pools based on the fact that the average water transit time is the same as the time that it takes to completely replace the volume of water contained in a reservoir. An "average" particle of water starting at

the upstream end of the pool will "theoretically" exit at the downstream end when the volume of water that was in the pool has exited from the downstream end of the pool.

Furthermore, the use of the storage replacement method was validated by computer program HEC-2 developed by the U.S. Army Corps of Engineers Hydrological Engineering Center over the Lower Snake River.

The storage replacement method is relatively simple if the following are known: flow rate exiting the pool, pool elevation, and pool storage/elevation rating curve.

Reservoir volumes for this analysis were taken from Reservoir Storage Tables developed by the Corps of Engineers. For this analysis, the elevation at John Day under MIP was assumed to be 262 feet with a gross storage volume of 2217.8 Kaf. The elevation at John Day under MOP was assumed to be 257 feet with a gross storage volume of 1989.9 Kaf.

Calculations were performed under three flow scenarios for the summer season (see Table 1), 100 Kcfs, 150 Kcfs, and 200 Kcfs.

For this analysis, the Proposed Action was utilized to determine the potential flow impacts of Montana Operations to the Lower Columbia River. The Proposed Action (PA) states,

“Consistent with the 2003 Council’s Mainstem Amendments, an experimental operation consisting of interim summer reservoir drafting limits at Hungry Horse and Libby should be 10 feet from full pool by the end of September (elevations 3550 and 2449, respectively) in all years except the lowest 20th percentile water supply (drought years) when the draft limit is increased to 20 feet from full pool by the end of September.”

The end of August draft elevations for Libby and Hungry Horse Reservoirs were not specified in the PA. It was assumed that under each operation outlined in the PA that the August 31st draft elevation could be determined by either: 1.) Linear interpolation between the July 1st and September 30th elevations and, or, 2.) That one-half of the draft would occur in July and August and the other half would occur in September. This resulted in four potential Montana Operations:

1. Operation #1: 20-foot linear draft by the end of September, with an August 31st elevation of 2445.6 at Libby and 3546.6 at Hungry Horse.
2. Operation #2: 20-foot draft by the end of September with 10 feet drafted by the end of August and another 10 feet drafted by the end of September, with August 31st elevations of 2449 at Libby and 3550 at Hungry Horse.
3. Operation #3: 10-foot linear draft by the end of September, with an August 31st elevation of 2452.3 at Libby and 3553.3 at Hungry Horse.
4. Operation #4: 10-foot draft by the end of September with 5 feet drafted by the end of August and another 5 feet drafted by the end of September, with August 31st elevations of 2454 at Libby and 3555 at Hungry Horse.

For each Montana Operation, we calculated the amount of flow augmentation volume that was lost over July and August relative to an operation where 20-feet were drafted out at each project by the end of August (2004 BIOP). These calculations were determined using the Reservoir Storage Tables for Libby and Hungry Horse. Each lost flow augmentation volume was converted to a loss in flow over the 62 days between July and August. The following are the flow calculated flow losses:

1. MT Operation #1: 20-foot linear draft by the end of September, with an August 31st elevation of 2445.6 at Libby and 3546.6 at Hungry Horse. Resulted in a **3.6 Kcfs** loss in flow relative to an operation that drafted 20 feet at both projects by the end of August.
2. MT Operation #2: 20-foot draft by the end of September with 10 feet drafted by the end of August and another 10 feet drafted by the end of September, with August 31st elevations of 2449 at Libby and 3550 at Hungry Horse. Resulted in a **5.5 Kcfs** loss in flow relative to an operation that drafted 20 feet at both projects by the end of August.
3. MT Operation #3: 10-foot linear draft by the end of September, with an August 31st elevation of 2452.3 at Libby and 3553.3 at Hungry Horse. Resulted in a **7.3 Kcfs** loss in flow relative to an operation that drafted 20 feet at both projects by the end of August.
4. MT Operation #4: 10-foot draft by the end of September with 5 feet drafted by the end of August and another 5 feet drafted by the end of September, with August 31st elevations of 2454 at Libby and 3555 at Hungry Horse. Resulted in a **8.3 Kcfs** loss in flow relative to an operation that drafted 20 feet at both projects by the end of August.

Calculations of water travel times through John Day Pool under MOP and MIP conditions were calculated under five scenarios. The water travel times under the Base case were calculated at all three flow levels, 100,150, and 200 Kcfs. Because the Proposed Action only drafts Libby and Hungry Horse 20 feet by the end of September in the lowest 20th Percentile water years, calculations of water travel times under MT Operations #1 and #2 were only calculated with a flow level of 100 Kcfs (assumed to be 20th Percentile flow). Under all other water years, the Proposed Action drafts Libby and Hungry Horse 10 feet by the end of September, therefore, calculations of water travel times under MT Operations #3 and #4 were calculated with flow levels of 150 and 200 Kcfs (assumed to be greater than the 20th Percentile flow). The following outline each calculation:

1. The Base Case: This was the “normal scenario,” was simple calculation of the water travel time (in days) through John Day Pool under MIP and MOP at summer flow levels of 100 Kcfs, 150 Kcfs, and 200 Kcfs.
2. MT Operation #1: This scenario was similar to the Base Case, however reduced the base flow by 3.6 Kcfs, the estimated flow impact of the MT Operation #1. Essentially, this scenario was a calculation of the water travel time (in days) through the John Day Pool under MIP and MOP at a summer flow level of 96.4 Kcfs.
3. MT Operation #2: This scenario was similar to the Base Case, however reduced the base flow by 5.5 Kcfs, the estimated flow impact of the MT Operation #2. Essentially, this

- scenario was a calculation of the water travel time (in days) through the John Day Pool under MIP and MOP at a summer flow level of 94.5 Kcfs.
4. MT Operation #3: This scenario was similar to the Base Case, however reduced each base flow by 7.3 Kcfs, the estimated flow impact of the MT Operation #3. Essentially, this scenario was a calculation of the water travel time (in days) through the John Day Pool under MIP and MOP at summer flow levels of 142.7 Kcfs and 192.7 Kcfs.
 5. MT Operation #4: This scenario was similar to the Base Case, however reduced each base flow by 8.3 Kcfs, the estimated flow impact of the MT Operation #4. Essentially, this scenario was a calculation of the water travel time (in days) through the John Day Pool under MIP and MOP at summer flow levels of 141.7 Kcfs, and 191.7 Kcfs.

Table 1 displays the results of this analysis.

Table 1. Water travel times at various flow rates through JDA Pool at Minimum Irrigation Pool (MIP) and at Minimum Operating Pool (MOP) and the impact the Montana (MT) Plan would have on these water travel times.

Summer Flows						
	JDA at MIP			JDA at MOP		
	WTT through JDA at MIP at 100,000 cfs	WTT through JDA at MIP at 150,000 cfs	WTT through JDA at MIP at 200,000 cfs	WTT through JDA at MOP at 100,000 cfs	WTT through JDA at MOP at 150,000 cfs	WTT through JDA at MOP at 200,000 cfs
Base	11.2	7.5	5.6	10.0	6.7	5.0
MT Operation #1, (3600 cfs reduction)	11.6	na	na	10.4	na	na
MT Operation #2, (5500 cfs reduction)	11.8	na	na	10.6	na	na
MT Operation #3 (7300 cfs reduction)	na	7.8	5.8	na	7.0	5.2
MT Operation #4 (8300 cfs reduction)	na	7.9	5.8	na	7.1	5.2

The following are the main points of Table 1:

1. Under a flow scenario of 100 Kcfs (assumed to be lowest 20th Percentile flow), the water travel time through John Day Pool at MIP was 11.2 days and at MOP was 10.0 days, a decrease in water travel time of 1.2 days. When the base flow was reduced by

-
- 3.6 Kcfs and 5.5 Kcfs (MT Plans), the water travel times through John Day Pool under MOP conditions was 10.4 to 10.6 days. Therefore, the decrease in flow resulting under the MT Operations would negate 33-50% of the water travel time benefit seen when JDA was operated under MOP instead of MIP under normal base conditions.
2. Under a flow scenario of 150 Kcfs (assumed to be greater than the 20th Percentile flow), the water travel time through John Day Pool at MIP was 7.5 days and at MOP was 6.7 days, a decrease in water travel time of 0.8 days. When the base flow was reduced by 7.3 Kcfs and 8.3 Kcfs (MT Plans), the water travel time through John Day Pool under MOP conditions was 7.0 to 7.1 days. Therefore, the decrease in flow resulting under the MT Plan would negate 38-50% of the water travel time benefit seen when JDA was operated under MOP instead of MIP under normal base conditions.
 3. Under a flow scenario of 200 Kcfs (assumed to be greater than the 20th Percentile flow), the water travel time through John Day Pool at MIP was 5.6 days and at MOP was 5.0 days, a decrease in water travel time of 0.6 days. When the base flow was reduced by 7.3 Kcfs, and 8.3 Kcfs (MT Plans), the water travel time through John Day Pool under MOP conditions was 5.2 days. Therefore, the decrease in flow resulting under the MT Plan would negate 33% of the water travel time benefit seen when JDA was operated under MOP instead of MIP under normal base conditions.

In summary, this simple analysis indicates that implementing the Montana Plan after the John Day Reservoir has been drawn down from MIP to MOP negates 33-50% of the benefit in water travel time at flows of 100 Kcfs, 38-50% of the benefit in water travel time at flows of 150 Kcfs, and 33% of the benefit in water travel time at flows of 200 Kcfs.

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MEMORANDUM

TO: Ed Bowles, ODFW

Michele DeHart

FROM: Michele DeHart, FPC

DATE: February 6, 2007

RE: Water Travel Time through JDA Pool at Minimum Irrigation Pool and at Minimum Operating Pool at Various Flows and the Impact of the Montana Plan

In response to your request, the FPC staff has estimated water travel times at various flow rates through JDA Pool at Minimum Irrigation Pool (MIP) and at Minimum Operating Pool (MOP) and the impact the Montana (MT) Plan would have on these water travel times. The Reservoir Replacement Method was used for calculating water travel times through a reservoir.

This formula is:

$$\text{WTT (s)} = \text{Reservoir Volume (ft}^3\text{)} / \text{Flow (ft}^3\text{/s)}$$

This method was suggested by personnel from the US Army Corps of Engineers. In particular, Lester Cunningham from the COE in Walla Walla, Washington suggested using the storage replacement method for calculating water particle transit time between respective pools based on the fact that the average water transit time is the same as the time that it takes to completely replace the volume of water contained in a reservoir. An "average" particle of water starting at

the upstream end of the pool will "theoretically" exit at the downstream end when the volume of water that was in the pool has exited from the downstream end of the pool.

The use of the storage replacement method was validated by computer program HEC-2 developed by the U.S. Army Corps of Engineers Hydrological Engineering Center for the Lower Snake River.

The storage replacement method is relatively simple if the following are known: flow rate exiting the pool, pool elevation, and pool storage/elevation rating curve.

Reservoir volumes for this analysis were taken from Reservoir Storage Tables developed by the Corps of Engineers. For this analysis, the elevation at John Day under MIP was assumed to be 262 feet with a gross storage volume of 2217.8 Kaf. The elevation at John Day under MOP was assumed to be 257 feet with a gross storage volume of 1989.9 Kaf.

Calculations were performed under three flow scenarios for the summer season (see Table 1), 100 Kcfs, 150 Kcfs, and 200 Kcfs.

For this analysis, it was assumed that the impact of the MT Plan would be a reduction in summer flows of 7 Kcfs in the lower Columbia River. This flow value was taken directly from Montana's System Operation Request dated July 6, 2005. This SOR can be found at on the COE's website at http://www.nwd-wc.usace.army.mil/tmt/sor/2005/2005-MT-1_final_v2.pdf. The flow value used in this analysis was taken from the first paragraph on page 6, this paragraph reads,

"Council staff estimated the 50-year-average change in flow at McNary dam to be diminished by 8.3 Kcfs in July and 5.6 Kcfs in August, but increased by 0.9 Kcfs in September..."

Based on this statement, the average impact of the MT Plan over the entire summer (July and August) was assumed to be the average of the July and August impacts, 7 Kcfs.

Calculations of water travel times through John Day Pool under MOP and MIP conditions were calculated under two scenarios for all three flow levels:

1. The Base Case: This was the "normal scenario," was simple calculation of the water travel time (in days) through John Day Pool under MIP and MOP at summer flow levels of 100 Kcfs, 150 Kcfs, and 200 Kcfs.

2. The Base case with the MT Plan: This scenario was similar to the Base Case, however reduced each base flow by 7 Kcfs, the estimated flow impact of the MT Plan. Essentially, this scenario was a calculation of the water travel time (in days) through the John Day Pool under MIP and MOP at summer flow levels of 93 Kcfs, 143 Kcfs, and 193 Kcfs.

Table 1 displays the results of this analysis.

Table 1. Water travel times at various flow rates through JDA Pool at Minimum Irrigation Pool (MIP) and at Minimum Operating Pool (MOP) and the impact the Montana (MT) Plan would have on these water travel times.

Summer Flows						
	JDA at MIP			JDA at MOP		
	WTT through JDA at MIP at 100,000 cfs	WTT through JDA at MIP at 150,000 cfs	WTT through JDA at MIP at 200,000 cfs	WTT through JDA at MOP at 100,000 cfs	WTT through JDA at MOP at 150,000 cfs	WTT through JDA at MOP at 200,000 cfs
Base	11.2	7.5	5.6	10.0	6.7	5.0
Base w/ MT Plan	12.0	7.8	5.8	10.8	7.0	5.2

In Summary:

1. Under a flow scenario of 100 Kcfs, the water travel time through John Day Pool at MIP was 11.2 days and at MOP was 10.0 days, a decrease in water travel time of 1.2 days. When the base flow was reduced by 7 Kcfs (MT Plan), the water travel time through John Day Pool under MOP conditions was 10.8 days. Therefore, the decrease in flow resulting under the MT Plan would negate 67% of the water travel benefit seen when JDA was operated under MOP instead of MIP under normal base conditions.
2. Under a flow scenario of 150 Kcfs, the water travel time through John Day Pool at MIP was 7.5 days and at MOP was 6.7 days, a decrease in water travel time of 0.8 days. When the base flow was reduced by 7 Kcfs (MT Plan), the water travel time through John Day Pool under MOP conditions was 7.0 days. Therefore, the decrease

in flow resulting under the MT Plan would negate 38% of the water travel benefit seen when JDA was operated under MOP instead of MIP under normal base conditions.

3. Under a flow scenario of 200 Kcfs, the water travel time through John Day Pool at MIP was 5.6 days and at MOP was 5.0 days, a decrease in water travel time of 0.6 days. When the base flow was reduced by 7 Kcfs (MT Plan), the water travel time through John Day Pool under MOP conditions was 5.2 days. Therefore, the decrease in flow resulting under the MT Plan would negate 33% of the water travel benefit seen when JDA was operated under MOP instead of MIP under normal base conditions.

In summary, this simple analysis indicates that implementing the Montana Plan after the John Day Reservoir has been drawn down from MIP to MOP negates 67% of the benefit in water travel time at flows of 100 Kcfs, 38% of the benefit in water travel time at flows of 150 Kcfs, and 33% of the benefit in water travel time at flows of 200 Kcfs. It is also important to note that the implementation of the Montana Plan with the John Day reservoir at MIP would increase water travel times through the reservoir by 7% at flows of 100 Kcfs, and 4% at flows of 150 Kcfs and 200 Kcfs.

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MEMORANDUM

TO: FPAC

FROM: David A. Benner

DATE: January 12th, 2007

RE: Winter Fish Counting at Lower Snake Projects 2004-2007

At your request, I have compiled the dates of adult fish counting at all lower Snake River projects over the last three winters. Overall, the biggest changes appear to have occurred at Little Goose, Lower Monumental and Ice Harbor Dams. Specifically, in past years, adult counting had occurred at these projects at least in November and December. Last year counts were not available until March at Ice Harbor and April at Little Goose and Lower Monumental. This year, counting appears to be on a similar schedule as last year.

Lower Granite Dam

2004: 11/1/03 to 1/22/04 then 3/1/04 through the season

2005: 11/1/04 to 12/31/04 then 3/1/05 through the season

2006: 11/1/05 to 12/16/05 then 3/1/06 through the season

2007: 11/1/06 to 12/16/06

Little Goose Dam

2004: 11/1/03 to 3/31/04 then 4/1/04 through the season

2005: 11/1/04 to 12/31/04 then 4/1/05 through the season

2006: No counts Nov, Dec, Jan, Feb, March then 4/1/06 through the season

2007: No counts Nov, Dec, Jan

Lower Monumental Dam

2004: 11/1/03 to 3/31/04 then 4/1/04 through the season

2005: 11/1/04 to 12/31/04 then 4/1/05 through the season

2006: No counts Nov, Dec, Jan, Feb, March then 4/1/06 through the season

2007: No counts Nov, Dec, Jan

Ice Harbor Dam

2004: 11/1/03 to 1/22/04 then 3/1/04 through the season

2005: 11/1/04 to 12/31/04 (all zeros, questionable data) then 3/1/05 through the season

2006: No counts Nov, Dec, Jan, Feb, then 3/1/06 through the season

2007: No counts Nov, Dec, Jan

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MEMORANDUM

TO: Scott Marshall, USFWS

Michele DeHart

FROM: Michele DeHart

DATE: January 18, 2007

RE: Associations between upstream migration success and smolt outmigration history for returning adult Snake River-origin hatchery and wild summer steelhead

In response to your 5 December 2006 request, the FPC staff analyzed associations between juvenile transportation and adult homing success for Snake River summer steelhead of hatchery and wild origin. We approached this task in a manner similar to prior analyses investigating linkages between spring/summer Chinook salmon conversion rates and juvenile transportation history (e.g., Berggren et al. 2006). Thus, using the available PIT-tag data, we compared measures relating to the homing behavior and upstream migration success of returning adult steelhead between groups of individuals that out-migrated via inriver and juvenile-transportation (i.e., barge and truck) passage routes. Also, we assessed the level of straying exhibited by returning adult steelhead in these two groups. Our analysis should be viewed as complementary to the recent University of Idaho technical publication (Keefer et al. 2006), as it draws (in part) on a common PIT-tagging effort (i.e., NOAA-Fisheries' transportation studies)¹. Our findings can be summarized as follows:

- Returning adults that were transported as juveniles were significantly less successful (~ 10% reduction) at homing to their natal basin (i.e., above LGR) than those with

¹ Our analysis draws on records of fish marked both at and above Lower Granite Dam, due to the limited number of PIT-tagged returning-adult steelhead available. The Keefer et al. (2006) study was limited to a subset of the Lower Granite marks listed in our Table 1. Our work additionally includes return years 2004 and 2005 and incorporates detections at all BON adult ladders (i.e., see J. Williams's comment in the 5 January 2007 Columbia Basin Bulletin).

inriver out-migration histories. This differential includes losses due to straying, harvest, and other agents of mortality.

- Transported adult steelhead returned to BON slightly later (particularly hatchery steelhead) and took a significantly longer time to complete their migration from BON to LGR, than did inriver fish.
- Anecdotally, 18 individuals in our tag set were known to have strayed (inclusive of hatchery and wild groups) to the Mid-Columbia River, based on detections at adult ladders at Priest Rapids, Rock Island, and Wells dams. The majority of these individuals (13/18) were transported as juveniles.
- Though our analysis demonstrates a clear effect of juvenile outmigration history on the homing success of both hatchery and wild adult summer steelhead, some limitations/caveats worth noting include: i) because adult detection capabilities are absent from most tributaries receiving strays, our stray estimate likely underestimates the actual stray rate; ii) too few above-LGR (i.e., released in sub-basins with fish of known race type) tags were available for a race-level (i.e., ‘A’ vs. ‘B’) delineation of transportation effects.

Dataset overview and analysis methods

To address your steelhead transportation-effects analysis request, we constructed a dataset containing the interrogation histories of all steelhead (hatchery and wild, to bolster sample sizes) that were i) PIT tagged as juveniles and of Snake River origin (i.e., from above LGR); and ii) detected on a Bonneville Dam (BON) fish ladder as an adult in return years 2001-2005. Due to the small number of records available for the analysis, we drew on records for individuals tagged at trap, tributary, and hatchery sites, as well as those marked at LGR as part of NOAA-Fisheries’ transportation study (e.g., Marsh et al. 2005). Individual fish were classified as being transported as juveniles based on their interrogation details in bypass systems at transportation sites; fish undetected as smolts and those detected at transportation sites, but routed back to the Snake River (via bypass) were classified as members of an ‘inriver’ group. Using these data (**Table 1**), we quantified and compared between transport and inriver groups several measures related to adult steelhead homing behavior and upstream migration success:

Survival and homing success.--For the first step of our analysis, we evaluated whether or not there was a systematic difference in the homing success of adult steelhead of different outmigration histories. Thus, all returning adults were classified as failing or succeeding in their BON-LGR migration based on their detection status at LGR (i.e., seen = success; unseen = failure). In our analysis, homing success is taken as being equivalent to apparent BON-LGR survival and therefore includes losses due to straying, harvest, and other mortality agents. Assuming that the latter two causes of fish loss affect transported and inriver groups similarly, it can be inferred that a measurable portion of any survival difference observed is likely due to a straying component.

We compared the homing success of transported and inriver histories in three ways, for each wild and hatchery steelhead *separately*. First, we graphically compared the overall proportion of successful upstream migrants between transported and inriver groups. Second,

we statistically tested whether or not homing success or failure was independent of outmigration history using χ^2 tests, on both a year-by-year (migration and return years, separately) and pooled basis. Finally, we tested for an influence of outmigration history and river conditions on homing success using logistic regression. In particular, we modeled the binary response (success or failure) as a function of the continuous environmental variables water temperature and discharge (both indexed at BON based on an individual's arrival date²), as well as a dummy variable characterizing outmigration history.

Migration characteristics.--For the second part of our analysis, we compared adult return timing (BON detection dates, *for all returning adults*) and upstream migration rates (BON-LGR travel times, *for successful migrants only*) between outmigration histories, as both of these migration characteristics are likely to be influenced by impaired homing behavior (e.g., greater rates of non-natal basin wandering increases travel times). We tested for an effect of outmigration history on return dates and migration rates, while accounting for return-year effects, using a two-way analysis of variance (ANOVA, factors: outmigration history [inriver, transport], return year [2001-2005], and their interaction).

Non-natal basin stray rates.--Finally, using all available PIT-tag detections reported in PTAGIS (i.e., all mainstem dam and tributary 'obs' sites, as well as reported recoveries—mortalities or otherwise), we estimated a stray rate (defined as a detection at non-natal basin facilities, independent of ultimate LGR-detection fate) for adults contained in our dataset. It should be noted that the overall PIT-tag recovery effort present in the basin is likely inadequate to estimate a 'true' straying rate (e.g., the majority of sub-basins to which steelhead have the opportunity to stray into lack passive detection sites). As the estimates computed for this memo should be likely gross underestimates of actual stray rates, they should be taken primarily as a validation of inferences made based on other migration characteristics.

Findings and general conclusions

Based on a combination of behavioral and demographic parameters, we summarize below several lines of evidence demonstrating the existence of a non-trivial effect of juvenile transportation history on the homing ability of hatchery and wild adult summer steelhead. Briefly, we will show that transported fish return the Lower Columbia River later, take longer to travel from BON to LGR during their upstream migration, have lower homing success rates, and have higher documented stray rates, compared to inriver outmigrants.

Survival and homing success.--Overall, we found that about 80% of all steelhead detected at BON arrived (i.e., survived) upstream for detection at LGR. However, the probability of an individual migrating successfully from BON to LGR was less for transported than inriver steelhead (**Tables 2 and 3; Figure 1**). For both hatchery and wild groups, adults that were transported as juveniles survived their migration from BON to LGR at a ~10% lower rate than their inriver counterparts. Despite some inter-annual variability, the pattern of lower upstream-migration success for transported relative to inriver fish was evident for

² Given that the majority (88%) of fish that failed in their BON-LGR migration dropped out before reaching McNary Dam, we modeled river conditions for the Lower Columbia River only.

hatchery and wild steelhead and for both migration and return year-based groupings. Further, χ^2 tests indicate that the observed differences were statistically significant (or nearly so) in most years, and on a total-sample basis (**Table 3**); this was particularly true for wild steelhead. Finally, though not presented herein, we also assessed differences on tag-site basis (i.e., decomposed into LGR and above-LGR groups described in **Table 1**). Though fewer of these tests were statistically significant, the trend towards reduced survival for transported fish prevailed.

In addition to our χ^2 analysis, we also fit logistic regression models predicting homing success as a function of outmigration history, river temperatures, and discharge (**Table 4**). For both hatchery and wild steelhead models, the outmigration history parameter was a significant predictor of homing success ($P < 0.05$ for both). Further, individual inriver fish were more likely to survive to LGR than those that were transported previously (inriver:transport odds ratios, 95% CI: hatchery -- 1.6, 1.2-2.1; wild -- 1.7, 1.5-2.0). With respect to environmental conditions, wild steelhead homing success was significantly (negatively) affected by flow and (positively) by temperature; though non-significant ($P > 0.4$ both), hatchery-model temperature and discharge slope parameters were similar to those fitted for wild steelhead. Thus, some portion of return year-specific variability in homing success was due to environmental conditions present in the Lower Columbia River.

Migration characteristics.--Similar to homing success patterns, return timing and travel time patterns similarly suggest an effect of transportation on the expression of straying behavior by returning adult steelhead. For hatchery steelhead, BON return dates were significantly later and BON-LGR travel times longer for fish of transported compared to inriver histories (**Tables 5 and 6**). Though there was some return-year variance in the difference between groups, on average transported hatchery steelhead returned on August 25th whereas inriver fish returned on the 19th (**Figure 2**). At 40 days on average, transported hatchery adults typically took ~4 days longer to travel from BON to LGR than their inriver counterparts (**Figure 3**).

In contrast to hatchery steelhead, we found little evidence indicating a systematic effect of transportation on wild steelhead return timing (**Tables 5 and 6**). In some years wild transported fish returned earlier and other years later than inriver outmigrants (**Table 5**), with both groups having a similar overall average return date (August 10th and 11th for transport and inriver groups, respectively; **Figure 2**). In contrast, we did observe a significant influence of outmigration history on upstream migration rates. That is, wild adult steelhead that were transported as juveniles took approximately seven days more than inriver fish to complete their migration from BON to LGR (**Figure 3**).

Non-natal basin stray rates.--The increase in straying behavior due to juvenile transportation, as implied by the homing success rate, travel time, and return date patterns described above, was anecdotally confirmed by actual stray documentation available for individuals in our tag set. Based on a query of Mid-Columbia dam adult detection records, as well as PIT-tag recovery and mortality databases, we documented straying behavior for both hatchery and wild steelhead tagged at and above LGR in four of five migration years (2002-2005), totaling 18 confirmed strays (**Table 6**). Of these individuals, the majority (13/18) were

wild, which also constituted the majority of our original tag set; also, 13/18 (73%) of these individuals were of transport origin. Across 2002-2005 (years where straying was documented in our dataset), we estimated a stray rate of 0.45% overall and 1.0-1.5% for transported fish. Again, it needs to be emphasized that these are minimum estimates of pre-LGR straying levels, given the limited coverage of PIT-tag recovery efforts available for estimating actual stray rates.

Implications, limitations, and future work

Based on this analysis, it appears that inter-basin straying by Snake River steelhead is measurably influenced by the smolt transportation program. As hypothesized previously (Berggren et al. 2006; Keefer et al. 2006), this is likely due to a disruptive effect of collection and rapid downstream transportation on the natal-basin imprinting process, which out-migrating pre-smolts are assumedly undertaking (e.g., Pascual et al. 1995; Bugert et al. 1997; Chapman et al. 1997). The management implications of this impact of transportation on the homing success of returning adult salmon and steelhead are many-fold, and at a minimum raise considerable concern about the genetic integrity of imperiled populations recipient to hatchery and wild strays of non-endemic stock origin (Keefer et al. 2006). The importance of this statement becomes even more apparent when considering the fact that the majority of run-at-large outmigrants are transported as juveniles (i.e., PIT-tagged fish are under-represented in the transportation program relative to the run at large).

Despite the apparent negative effects of juvenile transportation on adult homing and straying behavior described here, there are significant limitations with the steelhead tagging program as it presently exists that need to be acknowledged. In particular, the majority of wild and hatchery steelhead records used in our analysis (60%) were tagged at two sites (Lower Granite Dam and the Snake River Trap) where race (i.e., A vs. B) cannot be discerned (i.e., as opposed to basin-specific marking efforts where the local race is known). Thus, whether or not transportation effects are confounded with race effects (e.g., differing exposures to the transportation program due to differing outmigration timing patterns) is not amenable to robust evaluation at the present time. Enhanced hatchery- and basin-specific hatchery and wild tagging—at levels similar to those presently attained through the combined CSS and SMP efforts for spring/summer Chinook salmon—will allow for a thorough resolution of this issue. Given the convergence of multiple measures and studies (ours and Keefer et al.'s), as well as our previous documentation of a similar transport effect on spring/summer Chinook salmon, however, we preliminarily conclude that transportation affects steelhead straying.

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Table 1. Sample sizes for hatchery and wild summer steelhead groups, by return year and tag location. ‘Above-LGR’ includes all hatchery and wild adults that were tagged and released upstream of Lower Granite Dam (i.e., SMP, tributary marking, etc.). ‘LGR’ fish are those tagged at Lower Granite Dam as part of NOAA’s transportation study. To maximize sample sizes, we combined both Above-LGR and LGR fish for our analysis.

Origin	Return year	Above-LGR	LGR	Total
hatchery	2001	182	365	547
	2002	123	96	219
	2003	132	130	262
	2004	173	123	296
	2005	139	63	202
wild	2001	134	1,075	1,209
	2002	176	1,370	1,546
	2003	115	714	829
	2004	134	512	646
	2005	127	267	394

Table 2. Apparent BON-LGR survival estimates for inriver (‘I’) and transported (‘T’) outmigrant hatchery and wild steelhead, by migration year, return year, and across the pooled tag set. Note: data are not presented for MY2001, due to the small number of fish for study groups. Also, inference was restricted to those years where both I and T groups had a minimum of 15 adults detected at LGR initially (i.e., ‘.’ denotes that insufficient data were available).

	Year	hatchery				wild			
		<i>n</i>	I	<i>n</i>	T	<i>n</i>	I	<i>n</i>	T
Migration Year	2000	429	0.77	56	0.64	1,119	0.81	1,283	0.71
	2002	.	.	.	.	489	0.77	553	0.69
	2003	209	0.81	109	0.79	201	0.82	255	0.75
Return Year	2001	392	0.76	155	0.63	574	0.85	635	0.69
	2002	176	0.75	43	0.70	578	0.77	968	0.70
	2003	242	0.82	20	0.65	213	0.79	616	0.71
	2004	235	0.80	61	0.82	199	0.53	447	0.73
	2005	136	0.82	66	0.79	88	0.81	306	0.74
All tags		1,181	0.79	345	0.70	1,652	0.81	2,975	0.71

Table 3. χ^2 test results evaluating independence between juvenile outmigration history (transported vs. inriver) and apparent BON-LGR survival (i.e., success vs. failure), by MY, RY, and rearing type (hatchery vs. wild). Bold-faced test statistics and *P*-values indicate a significant association between juvenile transport history and upstream migration success at $\alpha = 0.05$; underlined values were deemed significant at $\alpha = 0.10$ (*for this table and those hereafter*). ‘na’ denotes that a particular test could not be performed due to low cell frequencies (i.e., < 5). Note: tests were not done for MY2001, due to the small number of inriver fish.

Grouping	Year	hatchery		wild	
		χ^2	<i>P</i> -value	χ^2	<i>P</i> -value
Migration	2000	4.272	0.039	33.398	0.000
Year	2002	na	na	16.786	0.000
	2003	0.251	0.616	<u>2.771</u>	0.096
Return	2001	10.424	0.001	40.201	0.000
	2002	0.491	0.483	10.026	0.002
	2003	<u>3.552</u>	<u>0.059</u>	6.094	0.014
	2004	0.174	0.677	8.661	0.003
	2005	0.228	0.633	1.566	0.211
	All	10.615	0.001	59.490	0.000

Table 4. Logistic regression parameter estimates and statistical tests.

Origin	Parameter	Estimate	SE	<i>t</i>	<i>P</i> -value
hatchery	Intercept	0.357	0.843	0.42	0.672
	Outmigration history	0.447	0.139	3.23	0.001
	Temperature	0.033	0.042	0.78	0.434
	Discharge	-0.001	0.002	-0.82	0.411
wild	Intercept	0.262	0.451	0.58	0.562
	Outmigration history	0.555	0.075	7.38	0.000
	Temperature	0.047	0.022	2.18	0.029
	Discharge	-0.002	0.001	-2.99	0.003

Table 5. Analysis of variance (ANOVA) results for a comparison of Bonneville Dam arrival dates between outmigration histories across available return years.

Origin	Source	SS	df	MS	F-ratio	P-value
hatchery	Outmigration history	5,940	1	5,940	9.742	0.002
	Return year	6,428	4	1,607	2.636	0.033
	OH x RY	5,985	4	1,496	2.454	0.044
	Error	924,253	1,516	610		
wild	Outmigration history	425	1	425	0.601	0.438
	Return year	135,321	4	33,830	47.833	0.000
	OH x RY	8,420	4	2,105	2.976	0.018
	Error	3,263,291	4,614	707		

Table 6. ANOVA results for a comparison of Bonneville-to-Lower-Granite travel times (in days, log transformed) between outmigration histories across available return years.

Origin	Source	SS	df	MS	F-ratio	P-value
hatchery	<u>Outmigration history</u>	<u>1.1</u>	<u>1</u>	<u>1.12</u>	<u>3.233</u>	<u>0.072</u>
	Return year	15.5	4	3.88	11.239	0.000
	OH x RY	2.4	4	0.59	1.714	0.144
	Error	400.5	1159	0.35		
wild	Outmigration history	14.4	1	14.40	25.622	0.000
	Return year	30.3	4	7.57	13.467	0.000
	OH x RY	6.8	4	1.70	3.028	0.017
	Error	1,923.83	3,423	0.56		

Table 7. ‘Stray’ steelhead of Snake River origin (tagged at or above LGR) detected at mid-Columbia River adult ladders (PRD = Priest Rapids Dam; RIS = Rock Island Dam; WEL = Wells Dam). ‘ND’ = not detected.

PIT-tag ID	Return year	Origin	Tag site	History	PRD	RIS	WEL	Home to LGR?
3D9.1BF0F2C528	2002	hatchery	LGR	transport	ND	ND	23-Oct	fail
3D9.1BF11EB929	2003	hatchery	Grande Ronde River	transport	7-Aug	ND	18-Aug	fail
3D9.1BF18224BC	2004	hatchery	Lemhi River	transport	7-Sep	ND	ND	success
3D9.1BF1B3A3C9	2005	hatchery	Imnaha River	inriver	29-Jul	ND	ND	success
3D9.1BF1C43EB4	2005	hatchery	LGR	inriver	11-Aug	16-Aug	29-Aug	success
3D9.1BF0FEDA01	2002	wild	LGR	inriver	ND	ND	10-Nov	fail
3D9.1BF1059801	2002	wild	LGR	transport	ND	ND	6-Oct	fail
3D9.1BF1093012	2002	wild	LGR	transport	ND	ND	24-Sep	fail
3D9.1BF10E7031	2003	wild	Squaw Creek	inriver	27-Jul	ND	ND	fail
3D9.1BF11D172A	2003	wild	LGR	transport	7-Aug	ND	29-Aug	success
3D9.1BF11D309E	2003	wild	LGR	transport	1-Aug	ND	ND	success
3D9.1BF11DA75E	2003	wild	LGR	transport	4-Aug	ND	ND	success
3D9.1BF1121146	2004	wild	LGR	inriver	3-Aug	ND	ND	success
3D9.1BF11CB93C	2004	wild	LGR	transport	23-Aug	1-Sep	10-Sep	fail
3D9.1BF11DA9BD	2004	wild	LGR	transport	25-Jul	ND	ND	success
3D9.1BF11E0B0C	2004	wild	LGR	transport	25-Aug	6-Sep	ND	success
3D9.1BF130D8EB	2005	wild	Lookingglass Creek	transport	20-Sep	ND	ND	fail
3D9.1BF1BE78B5	2005	wild	LGR	transport	4-Aug	ND	ND	success

Figure 1. Overall estimates of wild and hatchery summer steelhead homing success (± 2 SE), by out-migration history, for return years 2001-2005.

Figure 2. Least-squares mean (± 2 SE) Bonneville Dam return dates for wild and hatchery summer steelhead, by out-migration history, for return years 2001-2005 (Note: day 200 = 19 July, day 250 = 7 September).

Figure 3. Least-squares mean (± 2 SE) Bonneville-to-Lower Granite travel times for wild and hatchery summer steelhead, by out-migration history, for return years 2001-2005.

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Memorandum

TO: FPAC

FROM: *Michele DeHart*
Michele DeHart

DATE: January 4, 2007

RE: Summary of PIT-tag detections of fall Chinook salmon at Lower Granite Dam in 2006

The Fish Passage Advisory Committee (FPAC) discussed their concern regarding male to female ratio of returning fall Chinook to the Snake River in 2006. FPAC requested that the FPC staff review and summarize the available data on adult returns of fall Chinook to the Snake River Basin. In response to that request, FPC staff prepared a summary of PIT-tags detected at the Adult Ladder at Lower Granite Dam during the fall chinook migration in 2006. The review focused on tag groups that would provide inference to the unmarked population. This includes tag groups that were part of production releases or wild marking efforts. In order to address the female to male ratio of the adult return, since female proportion increases with increasing age of return, the tag data was analyzed the 2006 data by migration year to determine the age of adults (2 to 5-ocean) as well as jacks (1-ocean) and minijacks (0-ocean).

Tag detection data was summarized from August 1 and November 7, 2006. Late arriving spring, summer migrants were excluded from the analysis, where possible, in order to focus primarily on fall Chinook PIT-tags. A few fish initially marked as part of spring marking operations may be included in the analysis, when those fish were designated '15W', '15H' or '15U'.

Our findings for 2006 PIT-tag detections at Lower Granite Dam adult ladder are summarized below:

- The FPC analysis suggests that existing PIT-tag marks do not represent the overall population since coordinated marking basin wide has not been attempted until the 2006 fall Chinook transportation study.
- In 2006 the largest return group was comprised of fall Chinook which were released from Snake River acclimation ponds as yearlings in 2006. These fish were mostly in-river migrants (only 2 were transported) that appeared to pass Bonneville Dam by mid-May. Return detections at Bonneville Dam ladders began in early September, indicating that these fish could have spent at most 3 to 4 months in salt-water.
- The second largest return group was comprised of fall Chinook jacks released as sub-yearlings and yearlings from production facilities in 2005. There were some wild fall Chinook that returned as jacks from the 2005 outmigration.

- The smallest fall Chinook return group in 2006 was comprised of true adult returns. The largest component of the adult PIT tag return of fall Chinook to Lower Granite Dam was comprised of jacks and mini-jacks, mostly 1-ocean or younger fish.
- Because of limited PIT tagging this analysis may not represent the run-at-large. However a large component of jacks and mini-jacks in the adult return would result in more males than females in the return. This may provide some understanding of the large proportion of males in the population, since many of those males are likely jacks and minijacks returning from 2005 and 2006 out-migration.

For the analysis the Fish Passage Center summarized all PIT-tag marks detected at Lower Granite Dam in the adult facility since August 1, 2006. Only those fish likely to be fall Chinook salmon were included in the summary. For example PIT-tags with srtr "12H", "11H" or other designation for spring/summer migrant Chinook, were excluded, as were other species. We removed those detections that were likely out-migrant fall chinook that appeared to pass through the adult ladder. Only one juvenile out-migrant was excluded as a spurious adult detection. All other 2006 juvenile releases that were subsequently detected at the Lower Granite adult ladders, were previously detected at Bonneville and/or McNary dam adult ladders prior to Lower Granite detections. We designated PIT-tagged fish that returned to LGR in 2006, as jacks or mini-jacks if the fish were released as migrants in 2005 or 2006, respectively. A returning fish was considered an adult if it was released in 2004 or earlier year.

- A total of 546 PIT-tag detections were identified as likely fall chinook.
- 315 detections were determined to be adult fish (2-ocean or older); 220 of those detections were from adults tagged at Bonneville (5) and Ice Harbor (215) dams in 2006.
- 232 fish were PIT-tagged above Lower Granite Dam, 193 of these fish were either jacks (89-2005 releases) or minijacks (104-2006 releases). One of the 2006 releases was determined to be downstream migrant detected in the adult ladder.
- 140 of the returns that were PIT-tagged above Lower Granite Dam were part of production or wild marking programs. There were 17 2-ocean or older adult returns, from tags representing larger populations; either as part of production releases (direct hatchery or acclimation) or wild populations. By ocean age there were; 6 2-ocean, 7 3-ocean, 2 4-ocean, 2 5-ocean fish. Nine of these 16 adults were wild origin.
- There were a total of fifteen holdover PIT-tag fish detected at LGR in 2006. Overall twelve of the fifteen holdover returns were either transportation research releases at LGR or surrogates. Six of the holdover fish were jacks (BCCAP surrogate releases in 2005). Two of the holdover fish were adult fish, although one return was a 2004 subyearling migrant that exited the hydrosystem in 2005, so might be described as a 1+ adult.

Table 1 summarizes all of the marks detected at Lower Granite in 2006 that FPC identified as fall Chinook returns. A large portion (220) of the marks detected at Lower Granite in 2006 were adults released at either Bonneville Dam (5) or Ice Harbor Dam (215) as part of adult salmon studies (SNAKE1, BONAFF release sites). Jack detections (104) of fish released in 2005, and mini-jack detections (127) of fish marked and released as out-migrants in 2006 are the next largest groups of detections at Lower Granite.

Those PIT-tags that might best represent the unmarked population would be those released above Lower Granite Dam and released as part of hatchery production releases or wild marking programs in the Clearwater and Snake rivers. Of the 546 PIT-tags detected in the adult

ladders, 232 were marked above Lower Granite, but only 140 were from fish released as part of production releases or wild marking programs. Those data are summarized in Table 2. There were 17 2-ocean or older adult returns, from tags representing larger populations; either as part of production releases (direct hatchery or acclimation) or wild populations. By ocean age there were; 6 2-ocean, 7 3-ocean, 2 4-ocean, 2 5-ocean fish. Nine of these 17 adults were wild origin. We identified two of the 17 adult returns as fish that heldover in the hydrosystem after being released above Lower Granite Dam. Each were production fish, one released from BCCAP in 2004 and one from CJRAP in 2001. In essence the BCCAP released fish would be 1+ ocean (similar to a jack) since it spent 1 year in freshwater. But it likely would be larger than a jack when returning. In addition two of the 17 adults were fish transported as subyearlings.

Table 1. Summary of PIT-tag detections of fall Chinook salmon at Lower Granite Dam adult detection array, from August 1 to November 7, 2006. Detections were grouped by release site and organized by year of marking for juveniles. Adults marked in 2006 were also shown separately.

Release Site – Type	srtr	Year of Juvenile Mark/Release						Adult Marks 2006	Total
		2001	2002	2003	2004	2005	2006		
BONAFF-ADULT	15U							5	5
SNAKE1-ADULT	15U							215	215
BCCAP-PROD	13H				2	8	19		29
CJRAP-PROD	13H	1			2		66		69
HCD-PROD	13H			1	1				2
LYFE-PROD	13H					1			1
PLAP-PROD	13H					4	19		23
SNAKE4-PROD	13H			1		1			2
BCCAP-RES	13H	1							1
IHRCOL-RES	13H					2			2
IHRSPF-RES	13H		2						2
IHRTAL-RES	13H			2					2
IHRTAL-RES	15H						4		4
LGRRBR-RES	13W						1		1
LGRRBR-RES	15H				1				1
LGRRBR-RES	15W					1			1
LGRRRR-RES	13U				11				11
LGRRRR-RES	15H						15		15
LGRRRR-RES	15W				1				1
LGRRT-RES	13U		9	20	12	11			52
SNAKER-RES	13H		2			2			4
SNKTRP-RES	15H			1			1		2
UNKNOWN-SUR	13H						1		1
BCCAP-SUR	13H					30	1		31
SNAKE3-SUR	13H		13	2		38			53
CLWR-WILD	13W					1			1
CLWR-WILD	15U			1					1
SNAKE3-WILD	15W			2		3			5
SNAKE4-WILD	15W				1	2			3
SNAKER-WILD	15W	1	2	2					5
TUCR-WILD	13W		1						1
Total	Total	3	29	32	31	104	127	220	546

^a PIT-tags were grouped into “release types” as follows: “ADULT” – fish marked downriver migrating toward LGR in 2006; PROD – juveniles PIT-tagged and release in association with production releases from direct hatchery releases or acclimation releases; RES – released for research studies, such as transportation, hatchery release evaluations, smolt monitoring; SUR – research releases reared to small size to mimic wild fish; WILD – Fish marked as part of wild marking programs typically Clearwater River “CLWR” and Snake River Wild “SNAKE3,” “SNAKE4,” “SNAKER” marking of wild subyearling fall Chinook.

We compared the PIT-tag returns with the run-at-large adult return data in 2006. The proportion of PIT-tagged adults was $17/140 = 0.12$ compared to the run-at-large where there were 8,044 adults and 6,666 jacks or $8,044/14688 = 0.55$. This large difference in adult ratios between the PIT-tag population and the run-at-large is likely due largely to the disproportionate marking of the juvenile population. We compared the timing of PIT-tag adult returns to the run-at-large but due to low numbers found it difficult to draw any conclusions about adult timing. PIT-tag jack timing did seem to match up fairly well with run-at-large jack timing in 2006. It suggests that the PIT-tag marks do not represent the overall population well. This is not surprising since coordinated marking basin wide has not been attempted until the 2006 transportation study. And marking of wild fish proportionate to hatchery fish is not possible, since the wild population is unknown in any given year as well as difficult to mark. Finally, there may be differences in how fish are designated jacks. PIT-tagged fish are known release age, while the counting of adults at the windows relies on length criteria to separate mini-jacks, jacks and adults.

Based on the PIT-tag data, the largest source of returns were yearling fall chinook released from acclimation facilities in 2006. These fish were mostly in-river migrants (only 2 were transported) that appeared to pass Bonneville Dam by mid-May. Return detections at Bonneville Dam ladders began in early September, so that these fish could have spent at most 3 to 4 months in salt-water. The next largest proportion of returns were the jacks from 2005 which were a combination of subyearling and yearling production releases, as well as wild marks that returned as 1 ocean fish. Finally, the small proportion of true adult PIT-tagged fish would suggest that the population at Lower Granite Dam was made up of mostly 1 ocean or younger fish. While the analysis of the PIT-tag returns likely do not represent the run-at-large well, it is also likely that the PIT-tags do help explain to some extent the large proportion of males in the population, since many of those males are likely returning from 2005 and 2006 out-migration.

Table 2. Summary of PIT-tag detections in 2006 of fish released above Lower Granite Dam either from wild marking programs or as part of larger production releases.

SITE-Release Type ^a	srtr	Year of Juvenile Mark/Release						Total
		2001	2002	2003	2004	2005	2006	
BCCAP-PROD	13H				2	8	19	29
CJRAP-PROD	13H	1			2		66	69
HCD-PROD	13H			1	1			2
PLAP-PROD	13H					4	19	23
SNAKE4-PROD	13H			1		1		2
CLWR-WILD	13W					1		1
CLWR-WILD	15U			1				1
SNAKE3-WILD	15W			2		3		5
SNAKE4-WILD	15W				1	2		3
SNAKER-WILD	15W	1	2	2				5
Total		2	2	7	6	19	104	140

^a PIT-tags were grouped into "release types" as follows: PROD – juveniles PIT-tagged and release in association with production releases from direct hatchery releases or acclimation releases; WILD – Fish marked as part of wild marking programs typically Clearwater River "CLWR" and Snake River Wild "SNAKE3", "SNAKE4", "SNAKER" marking of wild subyearling fall Chinook.

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December 3, 2007

Davis G. Moriuchi
Acting Director, Programs
U.S. Army Corps of Engineers
Northwestern Division
PO Box 2870
Portland, OR 97208-2870

Dear Mr. Moriuchi,

As per your request we are providing both you and Dr. Mark Schneider of NOAA Fisheries with a copy of our "Gas Bubble Trauma Monitoring and Data Reporting for 2007". This report summarizes data collected during the 2007 juvenile salmonid migration.

Please feel free to contact us if you require any additional information.

Sincerely,

Michele DeHart
Fish Passage Center Manager

CC: David Ponganis, COE
Jim Adams, COE
Dr. Mark Schneider, NOAA-Fisheries

Gas Bubble Trauma Monitoring and Data Reporting for 2007

Overview

The monitoring of juvenile salmonids in 2007 for gas bubble trauma (GBT) was conducted at Mid Columbia, Lower Columbia and Snake river sites. Fish were collected and examined for signs of GBT 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. Prior to 2005, monitoring was conducted at all sites during the spring spill season and at Mid Columbia and lower Columbia river sites during the summer spill program. However, beginning in 2005 summer monitoring at the Snake River sites started as a result of the Court ordered summer spill program. This year summer spill in the Snake River occurred from June 20, 2007 until August 31, 2007.

Yearling Chinook and steelhead were sampled through the spring at all the sites. Once subyearling Chinook predominated smolt collections, the sampling of subyearling Chinook occurred until the end of August.

Sampling occurred two days per week at the Columbia River sites and one day a week at each of the Snake River sites during the time period that spill was implemented. 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 (Table 1).

Table 1. Ranking criteria used in monitoring for signs of gas bubble trauma.

Rank	Sign
0	no bubbles present
1	up to 5% of a fin area covered with bubbles
2	6% to 25% of a fin area covered with bubbles
3	26% to 50% of a fin area covered with bubbles
4	> than 50% of a fin area covered with bubbles

The eyes of the fish were also examined and the eye with the highest amount of bubbles 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 similar 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.

The runoff for the 2007 water year was 63% of average (1971-2000) at Lower Granite and 89% of average at The Dalles Dam. This below average water year resulted in markedly low flows during most of the 2007 spill season at Lower Granite Dam (Figure 1).

Figure 1. Average daily flows at Lower Granite Dam (2007, 2006, and the 10 year average)

Results

In all, 13,054 juvenile salmonids were examined for GBT between April and August of 2007 (Table 2).

Table 2. 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 2007 as part of the GBT Monitoring Program.

Species	Site						Total
	BON	MCN	LMN	LGS	LGR	RIS	
Chinook Subyearlings	1,785	1,957	43	609	1	1,145	5,540
Chinook Yearlings	1,609	1,157	344	311	259	992	4,672
Steelhead	252	186	605	972	318	509	2,842
Total	3,646	3,300	992	1,892	578	2,646	13,054

Fin signs were found in 319 or 2.4% of the fish sampled at all sites (Table 3). Four fish were found with severe fin signs (rank 3 or higher) while, 47 and 268 fish had less severe fin signs of rank 2 and 1, respectively. Table 4 compares the 2007 estimates of the overall percentage of fish with signs of GBT to past years' estimates.

Table 3. Number of juvenile salmonids found with fin GBT at dams on the Lower Snake River and on the Columbia River from April to August 2007 as part of the GBT Monitoring Program.

Species	Site						Total
	BON	MCN	LMN	LGS	LGR	RIS	
Chinook Subyearlings	2	0	0	19	0	6	27
Chinook Yearlings	38	0	1	2	0	7	48
Steelhead	10	0	51	180	0	3	244
Total	50	0	52	201	0	16	319

Table 4. Percent of sampled fish with signs of fin GBT estimated for the total fish observed.

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total % Signs	3.3	3.2	1.0	0.3	0.2	0.001	0.7	1.5	0.18	0.46	1.6	2.4
% signs excluding RIS	4.2	4.3	1.6	1.4	0.2	0.1	0.7	0.5	0.18	0.11	1.4	2.9

The Biological Opinion Spill Program was managed using the data collected for total dissolved gas (TDG) levels. However, signs of GBT in fins of juvenile fish, examined as part of the biological monitoring, were used to complement the physical monitoring program. NOAA Fisheries originally established the action criteria for the biological monitoring program at 15% prevalence of total fish having fin signs **or** 5% with severe signs (rank 3 or greater) in fins. At times these criteria were exceeded in 2007. The criteria were exceeded in the Snake River at Little Goose Dam during early and mid-June and again in late July. The criteria were also exceeded at Lower Monumental Dam sporadically throughout June and July.

The Fish Passage Center Staff provided information on the incidence of gas bubble trauma (GBT) in juvenile Snake River steelhead on June 8, 2007 (<http://www.fpc.org/documents/memos/90-07.pdf>) and again on June 11, 2007 (<http://www.fpc.org/documents/memos/92-07.pdf>) and technical discussions took place among the Salmon Managers at the Fish Passage Advisory Committee. In past years' the Snake River GBT sampling program typically ended on June 20th (or earlier) since, until 2005, there was no summer spill program at the fish transportation sites in the Snake River. In the few years of monitoring at the Snake River projects since 2005 it has been observed that typically the incidence of GBT in steelhead tends to increase slightly towards the end of the season, although not to the degree that occurred in 2007. The question then arose as to why the higher incidence was being observed in 2007.

Steelhead Sampling at Little Goose and Lower Monumental Dams:

In an effort to understand the implications of the increase in incidence of Rank 1 signs of GBT, the frequency of monitoring was increased at Little Goose and Lower Monumental dams. During this time the projects were requested to initiate the collection of subyearling Chinook for GBT monitoring, as their passage numbers had begun to increase.

Table 5 shows the percent GBT for steelhead at Little Goose Dam and Table 6 shows that data for Lower Monumental Dam. Three things can be noted regarding the observations:

1. An increased proportion of steelhead smolts were observed with mostly Rank 1 signs of GBT, but at the same time very few subyearling migrants exhibited signs of GBT.
2. The goal of obtaining 100 individuals of the predominate species was often not achieved.
3. With the exception of the first June observation at either site, the TDG levels observed in the forebays were below the state and federal standards of 110% and not within the range of the waiver standards.

Table 5. Observation of GBT in yearling Chinook, steelhead, and sub-yearling Chinook at Little Goose Dam in 2007.

Date	Yearling Chinook		Steelhead		Subyearling Chinook		All Species	Percent TDG	
	# Exam.	% GBT	# Exam.	% GBT	# Exam.	% GBT	% GBT	LGS-FB	LGR-TW
5-Jun	6	0%	94	14.9%	0	N/A	14.0%	112.8	112.9
8-Jun	2	50.0%	92	39.1%	6	0.0%	37.0%	108.2	112.2
10-Jun	0	N/A	50	26.0%	100	3.0%	10.7%	110.9	113.6
12-Jun	2	0.0%	50	22.0%	98	5.1%	10.7%	109.3	111.8
19-Jun	2	0.0%	61	55.7%	14	7.1%	45.5%	109.6	115.7
26-Jun	1	0.0%	2	50.0%	99	3.0%	3.9%	109.3	114.8
3-Jul	3	0.0%	4	25.0%	97	2.1%	2.9%	110.3	113.6
10-Jul	0	N/A	12	66.7%	90	5.6%	12.7%	109.2	113.6
24-Jul	0	N/A	82	28.0%	16	0.0%	23.5%	107.5	111.0

Table 6. Observation of GBT in yearling Chinook, steelhead, and sub-yearling Chinook at Lower Monumental Dam in 2007.

Date	Yearling Chinook		Steelhead		Subyearling Chinook		All Species	Percent TDG	
	Exam.	% GBT	# Exam.	% GBT	# Exam.	% GBT	% GBT	LMN-FB	LGS-TW
4-Jun	2	0%	64	18.8%	0	N/A	18.2%	114.3	113.8
7-Jun	4	0%	18	27.8%	0	N/A	22.7%	109	112.2
11-Jun	3	33%	33	48.5%	5	0%	41.5%	110.2	109.4
25-Jun	0	N/A	1	0.0%	0	N/A	0.0%	106.9	108.3
1-Jul	0	N/A	2	50.0%	23	0%	4.0%	107	107.8
8-Jul	0	N/A	1	100.0%	3	0%	25.0%	107.6	109.3
22-Jul	0	N/A	3	0.0%	3	0%	0.0%	105	107.6
29-Jul	0	N/A	5	40.0%	3	0%	25.0%	106.3	107.9

From the data it was apparent that the late migrating juvenile steelhead were disproportionately displaying the signs of GBT. The Salmon Managers were addressing a situation that affected the tail end of the steelhead migration, where water quality standards were not being exceeded, and where there was a desire to maintain protection for the increasing subyearling population. Given the low TDG levels at the projects the Salmon Managers investigated the potential causes of this occurrence from a project operations and migration conditions perspective.

Passage Timing and Travel Time

Historically steelhead smolt passage at Lower Granite Dam peaks in early May (50% passage date) with over 90% of steelhead migrants passing by late May, which was the migration pattern exhibited in 2007 (Figure 2).

Figure 2. The 2007 steelhead passage index compared to historic data at Lower Granite Dam.

Observations of steelhead smolts displaying an increase in Rank 1 signs of GBT were first detected at Little Goose Dam on June 5, 2007. Based on migration timing data, approximately 95.1% of the steelhead population had passed Little Goose Dam by this date (Figure 3). However, while most of the steelhead had passed the project, the subyearling migration was beginning to increase significantly with 5.3% of the subyearling Chinook past Little Goose Dam on that date and with the magnitude of the subyearling population ten times that of the steelhead migrants. There was a desire to provide good in-river migration conditions for subyearling Chinook as long as they were not exceeding criteria for GBT.

Figure 3. Cumulative proportion of yearling and subyearling Chinook and steelhead passing Little Goose Dam. The GBT incidence in steelhead passing Little Goose Dam was first observed on June 5, 2007 at Little Goose Dam.

Fish Travel Time Conditions in 2007

From laboratory studies that had been conducted (Mesa et al., 2000) it had been shown that up to 80% of Chinook would display minor signs of GBT at low levels of TDG if left sufficiently long in the water at that exposure. There were no mortalities in this group throughout the duration of the experiment, which lasted for 22 days. Given this information the Salmon Managers began to consider the flow and fish travel time conditions that existed in 2007.

As pointed out above, flow at Lower Granite Dam during June was significantly less than observed in 2006, or as represented by the ten year average. Steelhead juvenile migrants are particularly sensitive to changes in flow as expressed by their fish travel time estimates. The hypothesis was that steelhead travel time was longer during June of 2007 due to extremely low flows, and the few late migrating steelhead were displaying minor signs of GBT because of the long exposure to these sub-lethal levels of TDG.

The hypothesis was evaluated by plotting travel time of steelhead smolts between Lower Granite and Little Goose dams as a function of their arrival timing at Little Goose Dam. From the graph (Figure 4) it can be seen that the later arriving fish in 2007 had much longer travel times in 2007 than observed in 2006. This is consistent with the hypothesis that a higher incidence of signs of GBT in steelhead juveniles at Snake River projects in 2007 was a result of longer travel times between projects. These long travel times were most likely due to the low flows seen in 2007 as steelhead tend to residualize late in the season when flows are low.

Figure 4. Travel time of steelhead juveniles migrating between Lower Granite and Little Goose Dam in 2007 as a function of arrival time at Little Goose Dam.

Steelhead Survival

Finally, it is worth mentioning that, despite the higher incidence of GBT in steelhead at Little Goose and Lower Monumental dams in 2007, in-river survival for steelhead juveniles in 2007 was higher than recent years and not significantly different from the high survivals seen in 2006 (Table 7).

Table 7. Reach survival (s.e.) for juvenile Snake River steelhead (data from NOAA Technical Staff Memo released August 31, 2007)

Reach	2001	2002	2003	2004	2005	2006	2007
LGR-MCN	0.168 (0.006)	0.536 (0.025)	0.597 (0.013)	0.379 (0.023)	0.593 (0.018)	0.702 (0.016)	0.695 (0.020)
LGS-BON	0.042 (0.003)	0.262 (0.050)	0.309 (0.011)	N/A	N/A	0.455 (0.056)	0.386 (0.069)

Discussion

GBT sampling was successfully accomplished for the 2007 migration season. In general, the incidence of GBT in migrating salmonids was low in 2007, with the exception of a short time period in the Snake River where higher incidence of mostly Rank 1 GBT signs were observed among late arriving steelhead. The higher levels were observed for steelhead smolts passing in the tail of the migration (>95% passed) when TDG levels were generally below the 110% standard for TDG in the forebay of the projects where fish were sampled. From the observations presented above, it is clear that the high incidence of GBT among steelhead juveniles in 2007 was likely due to the prolonged exposure to non-lethal TDG due to longer travel times, as a result of low flows in the Snake River. Finally, according to survival studies conducted by NOAA Fisheries juvenile steelhead survival in 2007 was comparable to the high levels of survival observed in 2006 and among the highest observed in recent years.

References:

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**In-river Survival (LGR to BON, and LGR to MCN)
compared to SAR (LGR to LGR) for Snake River
yearling chinook and steelhead at 3 Ocean Productivity
Levels**

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Introduction

Recent analyses by NOAA have considered in-river survival (Lower Granite Dam to Bonneville Dam) compared to adult returns and found no relation [Mainstem Passage Survival--NOAA presentation to NPCC](#) . A fact sheet on The Federal Caucus website (salmonrecovery.gov) entitled “Facts on 2007 returns of adult spring Chinook to the Columbia and Snake Rivers” quotes NOAA Fisheries as follows; “According to NOAA Fisheries Science Center, the percentage of juvenile spring Chinook salmon that survive the migration through the dams on the Snake and Columbia Rivers on their way to the ocean has little correlation to their subsequent adult return rate.” From their finding a lack of a relationship, NOAA has suggested it would be difficult to determine reach survival standards relevant to recovery of endangered stocks. One might infer that because no significant relation between juvenile survival and adult return has been found that no improvement in hydrosystem survival is necessary to recover endangered stocks. Logically, it follows that improving in-river survival and in-river conditions for passage of juvenile fish, should lead to improvements in adult returns. Based on recent attempts by NOAA the connection between juvenile hydrosystem survival and adult returns has remained obscured.

However the analytical approach used by NOAA did not account for the role of ocean productivity on adult returns. Studies documenting the influence of ocean climate regimes on adult salmon survival have left little doubt that ocean productivity has a large impact on salmon production. Several papers addressing this issue as it pertains to Columbia River salmon and other geographically linked populations of salmon have expanded upon the basic links between climate indices and salmon returns put forward by Mantua et al 1997. Specifically, Schaller and Petrosky 2007, Schaller et al 2007, Scheuerell and Williams 2005, have demonstrated links between ocean indices and various measures of adult ocean survival, such as SAR (smolt to adult return rate), S/R (spawner recruit) and S3 (first year ocean survival). Scheuerell and Williams 2005 argued convincingly about the importance of ocean conditions for survival of salmon to adult return. They identified several indices such as PDO (Pacific Decadal Oscillation) and upwelling and discussed potential reasons those indices might improve ocean survival for salmon. Schaller and Petrosky 2007 also linked water transit time, an environmental condition that affects juvenile salmon, with ocean indices and adult returns. Their paper laid the theoretical ground work for this analysis. Our findings, suggest that when you use ocean productivity to account for that part of survival attributable to the ocean, there is a strong relationship between in-river survival and adult return for Snake River spring\summer Chinook and steelhead.

Methods

Juvenile Reach Survival

Survival estimates were produced for yearling chinook and steelhead that migrated during the years 1995 to 2005 in the reach Lower Granite Dam to McNary Dam and for the years 1998 to 2005 in the reach Lower Granite Dam to Bonneville Dam. Passage date at Lower Granite Dam and travel time to Little Goose Dam was used to group juvenile migrants into 5 discrete two-week cohorts for each year.

Unlike prior analyses of juvenile reach survival that include fish detected or released at Lower Granite Dam, a new approach (at least for juvenile salmon reach survival estimates) was developed that included fish first detected at Little Goose Dam as part of the survival cohort. The benefit of this new approach was to increase PIT-tag cohort sizes so that more time periods were included during each year. Additionally, greater tag numbers result in lower variances for reach survival estimates.

Fish travel time from Lower Granite Dam to Little Goose Dam was calculated for fish detected at Lower Granite that passed during a two-week date range and were subsequently detected at Little Goose Dam. Based on median travel time for the cohort, fish first detected at Little Goose Dam during the two week period adjusted by travel time were then added to the release at Lower Granite Dam. For example, if fish detected at Lower Granite Dam during April 8 to April 21 time period had a median travel time of 3 days to Little Goose Dam, then those fish arriving at Little Goose Dam from April 11 to April 24, that had not been detected at Lower Granite Dam, were added to the re-release group at Little Goose Dam. These fish were assumed, based on similar arrival timing, to have passed Lower Granite Dam at the same time as detected fish, but through other routes, that did not have PIT-tag detection capability, such as turbines and spill. For each two-week interval of passage at Lower Granite Dam, survival was estimated using Cormack-Jolly-Seber methodology.

The key underlying assumptions of the new approach were consistent with the Cormack-Jolly-Seber survival method assumptions (Burnham et al., 1987). The new method assumed detected and undetected fish at Lower Granite Dam were equally mixed, survived at an equal rate over the reach, and had equal detection probability at Little Goose Dam, as well as subsequent dams downstream. The new cohort included fish released or detected at Lower Granite Dam, and additional fish that, based on travel time, passed Lower Granite Dam undetected during the same time period, and then arrived at Little Goose Dam mixed with the initial release group. The approach has been used in other types of CJS single-age mark-recapture survival estimation (see Williams et al 2002), but to our knowledge it is the first such application of this method to juvenile salmon reach survival analyses on the Columbia River. For that reason we expand upon the approach in the methods and results sections as well.

The standard closed form survival estimate for the first reach from Lower Granite Dam to Little Goose Dam was calculated as follows:

$$S_1 = \frac{m_2 + z_2 \left(\frac{R_2}{r_2} \right)}{R_1} \quad (1)$$

Where,

S_1 = Survival LGR to LGS

R_1 = fish released or detected at LGR

m_2 = fish detected at LGS

z_2 = detects of fish not detected at LGS

R_2 = fish released at LGS, either having been detected at LGR or first time
detects at LGS

r_2 = subsequent detections of fish released at LGS

The R_2 release in equation 1 was made up of fish released at Lower Granite Dam, detected and re-released (bypassed) at Little Goose Dam designated R_{2x11} , and first time detected fish re-released at Little Goose Dam R_{2x01} . Since the S_1 estimate is a ratio of two population estimates, the effect of adding fish at Little Goose Dam R_{2x01} would primarily affect the ratio R_2/r_2 . This ratio multiplied by z_2 , the downstream detections of fish unseen at Little Goose, is the estimate of the undetected population at Little Goose Dam. Concern about potential bias would be warranted, if previously undetected (R_{2x01}) and previously detected fish (R_{2x11}) had different detection probabilities downstream of Little Goose Dam. However, we did not anticipate that this would be the case, and if it were, it would violate the assumptions of the CJS model, such that the reach estimate would be biased.

To assess potential unanticipated bias associated with the new method, we compared the new estimates of reach survival that contained Lower Granite and Little Goose releases with the more traditional approach (using only Lower Granite detections). The effect on reach survival estimates of adding in fish detected at Little Goose Dam was evaluated using a dataset of subyearling Chinook survival estimates in the reach Lower Granite Dam to McNary Dam as well as steelhead reach survival estimates from Lower Granite Dam to Bonneville Dam from the dataset generated for this analysis. The original estimates with only Lower Granite detects were plotted against the modified estimates for the same Lower Granite Passage period using both Little Goose and Lower Granite detected fish.

Smolt to Adult Survival or Returns (SAR)

The overall population of juvenile migrants destined to migrate in-river was expressed in Lower Granite Dam equivalents by tracking fish removed for transportation or added at Little Goose Dam as described above, and expressing those removals or additions in equivalents at LGR based on survival to the downstream dam. Other removals at Lower Monumental or McNary dams (the other two transport sites) were also expressed in Lower Granite equivalents and removed from the starting population. This approach to estimating the Lower Granite starting population was developed for the Comparative Survival Study and theoretical considerations as well as detailed statistical derivations are well defined in (Schaller et al 2007).

For each two week juvenile cohort, the starting population, or estimated Lower Granite Equivalent population destined to migrate in river was calculated;

$$\text{LGRE}_{\text{pop}} = R_1 + \frac{R_{2 \times 01}}{S_1} - \frac{t_2}{S_1} - \frac{t_3}{S_1 \bullet S_2} - \frac{t_4}{S_1 \bullet S_2 \bullet S_3}$$

(2)

Where,

- S_1 = Survival Lower Granite Dam to Little Goose Dam
- S_2 = Survival Little Goose to Lower Monumental Dam
- S_3 = Survival Lower Monumental Dam to McNary Dam
- t_2 = fish transported or removed at Little Goose Dam
- t_3 = fish transported or removed at Lower Monumental Dam
- t_4 = fish transported or removed at McNary Dam

In effect, fish removed for transportation or other purposes, reduced the starting population at Lower Granite Dam that would be used to calculate the in-river SAR back to that site. The additional fish first detected and re-released at Little Goose Dam ($R_{2 \times 01}$) increased the starting population.

Once the population at Lower Granite Dam destined to migrate in river was estimated, PIT-tag adult returns to Lower Granite Dam were counted. Returns were sorted based upon ocean age (e.g. minijacks would be 0-ocean, jacks were 1-ocean, 2-ocean, 3-ocean). The smolt to adult return rates from Lower Granite starting juvenile population to adult returns, $\text{SAR}_{\text{lgr to lgr}}$ were calculated based on the number of adult returns AR_{lgr} divided by the in-river population (see equation 3 below). For yearling chinook, minijacks and jacks (0-ocean and 1-ocean) were not included in the adult return numbers, while for steelhead 1-ocean and older returns were considered adults.

$$\text{SAR}_{\text{lgrtolgr}} = \frac{\text{AR}_{\text{lgr}}}{\text{LGRE}_{\text{pop}}}$$

(3)

Ocean Indices

Ocean indices were used to characterize the ocean productivity that juvenile fish would experience the year of ocean entry. So for juvenile salmon that migrated in-river in 1995, indices would be assigned from that calendar year. Several indices were used in the analysis based on their correlations to SAR's, S/R, and first year ocean survival (S3) as shown by Scheuerell and Williams 2005, Schaller and Petrosky 2007: April and October Upwelling at transect Latitude 122 W, Longitude 45 N were used. Units are cubic meters/second/100 meters of coastline. Data were obtained from NOAA Pacific Fisheries Environmental Laboratory at the following link:

www.pfeg.noaa.gov/products/PFEL/modeled/indices/upwelling/upwelling.html. May and September Pacific Decadal Oscillation (PDO) for the North Pacific were also used. The Pacific Decadal Oscillation (PDO) Index is defined as the leading principal component of North Pacific monthly sea surface temperature variability (poleward of 20N for the 1900-93 periods). Data were obtained from The Joint Institute for the Study of the Atmosphere and Ocean at <http://jisao.washington.edu/pdo/>.

A significant regime shift occurred in the mid-1970's with a larger proportion of warm PDO values occurring after 1976 (Hare and Mantua 2000). Since our survival data was all within the latter time period we included years 1977 to 2006 for our classification procedure. Ocean productivity classification was assigned for each year based on the four indices listed above. The time series provided 18 years of information prior to 1995 - the first year of the survival analysis.

Figure 1. May PDO, one of four ocean indices used in our analysis, demonstrates the regime shift identified by Hare and Mantua that occurred around 1976-1977.

For each of the ocean indices, the best one third of the years were assigned to ocean productivity category “good”, the middle one third of years to “moderate” and the worst one third of years to “poor” . After all years were assigned to these categories, criteria for relatively good, moderate and poor ocean conditions were combined. Each year was then assigned to good, moderate or poor ocean productivity category based on the number of indices which fell into each of those categories (see Table 1).

Table 1. Possible combinations of ocean index ranks and the resulting overall category assigned to each year based those ranks.

Ranks assigned to four indices each year			Overall Category
Good (3)	Moderate (2)	Poor (1)	
3	1	0	good
3	0	1	good
2	2	0	good
2	1	1	good
1	2	1	moderate
1	3	0	moderate
0	3	1	moderate
2	0	2	moderate
1	0	3	poor
0	1	3	poor
0	2	2	poor
1	1	2	poor

So, for example, if a year had 3 of 4 ocean indices in the good category, and 1 of 4 the moderate category, that year would receive an overall good rank, while if 3 indices were poor and 1 were good that year would receive a poor rank. And, if two indices were good and two bad, the overall rank would be moderate. The ranking procedure separated years based on the relative score of the indices assigned. Therefore the productivity rankings that resulted were relative to other recent years and for that reason may not be useful to understand historical ocean productivity prior to the regime shift.

Results

Juvenile Reach Survivals and SAR's

Juvenile survival data is summarized in Tables 2 through 5. Survivals ranged from 3% in 2001 to nearly 70% in 1998 for steelhead in the Lower Granite to Bonneville Dam reach (Table 2), while survivals in the same reach for yearling spring/summer Chinook ranged from 25% in 2001 to 83% in 1998 (Table 4).

Insufficient tags were available in all time periods to estimate survival from Lower Granite to Bonneville or from Lower Granite to McNary Dam. However, during most years at least two estimates of survival were possible while in others up to 5 estimates were available, particularly for the shorter Lower Granite to McNary Dam reach (Tables 3 and 5). SAR's ranged between 0 and 0.037 for steelhead, while the yearling Chinook SAR's varied between 0 and 0.023.

Table 2. Juvenile Steelhead Survival from Lower Granite Dam to Bonneville Dam and corresponding adult return rate to Lower Granite Dam.

Migration Year	Date Range	LGR to BON juvenile Survival	LGR to LGR Smolt to Adult Return Rate
1998	4/22 to 5/5	0.692	0.003
1998	5/20 to 6/02	0.124	0.003
1999	4/8 to 4/21	0.439	0.008
1999	4/22 to 5/5	0.549	0.037
1999	5/6 to 5/19	0.478	0.006
1999	5/20 to 6/02	0.408	0.005
2000	4/8 to 4/21	0.616	0.027
2000	4/22 to 5/5	0.564	0.018
2000	5/6 to 5/19	0.275	0.006
2001	4/22 to 5/5	0.037	0.000
2001	5/6 to 5/19	0.030	0.000
2002	4/8 to 4/21	0.629	0.016
2002	4/22 to 5/5	0.356	0.006
2002	5/6 to 5/19	0.235	0.006
2002	5/20 to 6/02	0.318	0.005
2002	6/03 to 6/16	0.091	0.001
2003	4/8 to 4/21	0.526	0.015
2003	4/22 to 5/5	0.400	0.007
2003	5/6 to 5/19	0.443	0.004
2003	5/20 to 6/02	0.438	0.002
2004	5/6 to 5/19	0.117	0.001
2005	4/22 to 5/5	0.284	0.001
2005	5/6 to 5/19	0.377	0.001

Table 3. Juvenile Steelhead Survival from Lower Granite Dam to McNary Dam and corresponding adult return rate to Lower Granite Dam.

Migration Year	Date Range	LGR to McN juvenile Survival	LGR to LGR Smolt to Adult Return Rate
1996	4/22 to 5/5	0.760	0.004
1996	5/6 to 5/19	0.758	0.000
1997	4/8 to 4/21	0.780	0.001
1997	4/22 to 5/5	0.839	0.004
1997	5/6 to 5/19	0.973	0.002
1998	4/8 to 4/21	0.571	0.007
1998	4/22 to 5/5	0.682	0.003
1998	5/6 to 5/19	0.658	0.002
1998	5/20 to 6/2	0.615	0.003
1999	4/8 to 4/21	0.712	0.008
1999	4/22 to 5/5	0.675	0.037
1999	5/6 to 5/19	0.646	0.006
1999	5/20 to 6/2	0.733	0.005
1999	6/3 to 6/16	0.404	0.001
2000	4/8 to 4/21	0.735	0.027
2000	4/22 to 5/5	0.620	0.018
2000	5/6 to 5/19	0.500	0.006
2000	5/20 to 6/2	0.510	0.002
2001	4/8 to 4/21	0.242	0.000
2001	4/22 to 5/5	0.173	0.000
2001	5/6 to 5/19	0.154	0.000
2001	5/20 to 6/2	0.071	0.000
2001	6/3 to 6/16	0.037	0.000
2002	4/8 to 4/21	0.764	0.016
2002	4/22 to 5/5	0.500	0.006
2002	5/6 to 5/19	0.454	0.006
2002	5/20 to 6/2	0.556	0.005
2002	6/3 to 6/16	0.272	0.001
2003	4/8 to 4/21	0.664	0.015
2003	4/22 to 5/5	0.595	0.007
2003	5/6 to 5/19	0.563	0.004
2003	5/20 to 6/2	0.602	0.002
2003	6/3 to 6/16	0.373	0.000
2004	4/8 to 4/21	0.577	0.004
2004	4/22 to 5/5	0.515	0.003
2004	5/6 to 5/19	0.308	0.001
2004	5/20 to 6/2	0.334	0.000
2004	6/3 to 6/16	0.187	0.001
2005	4/8 to 4/21	0.482	0.006
2005	4/22 to 5/5	0.604	0.001
2005	5/6 to 5/19	0.632	0.001
2005	5/20 to 6/2	0.312	0.000
2005	6/3 to 6/16	0.197	0.000

Table 4. Juvenile Spring/Summer Chinook Survival from Lower Granite Dam to Bonneville Dam and corresponding adult return rate to Lower Granite Dam.

Migration Year	Date Range	LGR to BON juvenile Survival	LGR to LGR Smolt to Adult Return Rate
1998	4/8 to 4/21	0.478	0.010
1998	4/22 to 5/5	0.827	0.005
1998	5/6 to 5/19	0.481	0.004
1999	4/8 to 4/21	0.559	0.010
1999	4/22 to 5/5	0.541	0.014
1999	5/6 to 5/19	0.574	0.014
1999	5/20 to 6/2	0.636	0.018
2000	4/8 to 4/21	0.726	0.023
2000	4/22 to 5/5	0.524	0.017
2000	5/6 to 5/19	0.505	0.015
2001	4/8 to 4/21	0.294	0.001
2001	4/22 to 5/5	0.284	0.001
2001	5/6 to 5/19	0.253	0.000
2002	4/8 to 4/21	0.627	0.006
2002	4/22 to 5/5	0.680	0.006
2002	5/6 to 5/19	0.651	0.007
2002	5/20 to 6/2	0.729	0.011
2003	4/8 to 4/21	0.565	0.002
2003	4/22 to 5/5	0.577	0.002
2003	5/6 to 5/19	0.570	0.003
2003	5/20 to 6/2	0.530	0.001
2004	4/8 to 4/21	0.376	0.002
2004	4/22 to 5/5	0.401	0.001
2004	5/6 to 5/19	0.360	0.001
2004	5/20 to 6/2	0.573	0.002
2005	4/8 to 4/21	0.569	0.001
2005	4/22 to 5/5	0.450	0.001
2005	5/6 to 5/19	0.600	0.001
2005	5/20 to 6/2	0.309	0.000

Table 5. Juvenile Spring/Summer Chinook Survival from Lower Granite Dam to McNary Dam and corresponding adult return rate to Lower Granite Dam.

Migration Year	Date Range	LGR to McN juvenile Survival	LGR to LGR Smolt to Adult Return Rate
1995	4/8 to 4/21	0.884	0.003
1995	4/22 to 5/5	0.724	0.003
1995	5/6 to 5/19	0.729	0.001
1995	5/20 to 6/2	0.456	0.004
1996	4/8 to 4/21	0.789	0.002
1996	4/22 to 5/5	0.710	0.001
1996	5/6 to 5/19	0.729	0.002
1997	4/8 to 4/21	0.733	0.006
1997	4/22 to 5/5	0.695	0.007
1997	5/6 to 5/19	0.733	0.005
1997	5/20 to 6/2	0.732	0.001
1998	4/8 to 4/21	0.702	0.010
1998	4/22 to 5/5	0.788	0.005
1998	5/6 to 5/19	0.794	0.004
1999	4/8 to 4/21	0.728	0.010
1999	4/22 to 5/5	0.787	0.014
1999	5/6 to 5/19	0.796	0.014
1999	5/20 to 6/2	0.803	0.018
2000	4/8 to 4/21	0.875	0.023
2000	4/22 to 5/5	0.729	0.017
2000	5/6 to 5/19	0.729	0.015
2001	4/8 to 4/21	0.611	0.001
2001	4/22 to 5/5	0.586	0.001
2001	5/6 to 5/19	0.489	0.000
2002	4/8 to 4/21	0.661	0.006
2002	4/22 to 5/5	0.718	0.006
2002	5/6 to 5/19	0.678	0.007
2002	5/20 to 6/2	0.755	0.011
2003	4/8 to 4/21	0.729	0.002
2003	4/22 to 5/5	0.736	0.002
2003	5/6 to 5/19	0.721	0.003
2003	5/20 to 6/2	0.826	0.001
2004	4/8 to 4/21	0.719	0.002
2004	4/22 to 5/5	0.686	0.001
2004	5/6 to 5/19	0.676	0.001
2004	5/20 to 6/2	0.818	0.002
2005	4/8 to 4/21	0.671	0.001
2005	4/22 to 5/5	0.754	0.001
2005	5/6 to 5/19	0.757	0.001
2005	5/20 to 6/2	0.626	0.000

Ocean Indices

The overall productivity category assigned to each year are shown in Table 6. The ocean productivity ranking system we used produced a good contrast of indices for the years when reach survival and SAR's were calculated; 1995 to 2005. The pattern in ocean productivity we assigned to the years 1995 to 2005 matched fairly well with the pattern of years described by Scheuerell and Williams 2005. April upwelling is generally positively correlated with good ocean productivity, while May PDO, September PDO, and October Upwelling are negatively correlated with good ocean productivity. Scheuerell and Williams 2000 provides some discussion of potential ecological significance of these indices.

Figure 2. Results of ranking procedure used to divide years based on assigning approximately 1/3 years into each of 3 categories (upper panel) and resulting overall ranks for years (lower figure) showing the October upwelling values and what overall ocean category was assigned to each year. In the case of October upwelling, the index corresponded quite well with the overall productivity ranking indicated by the colored symbols in the lower panel (red circle - poor ocean productivity year, clear square - moderate, blue triangle good ocean productivity).

Table 6. Ocean indices of productivity and relative productivity category assigned based on relative ranking system of assigning best 1/3 as 'good', worst 1/3 as 'poor' and middle 1/3 as 'moderate' to ocean indices based on the years 1977 to 2006. The relative productivity category shown below is the result of combining the ranks for the 4 ocean indices.

Year	Ocean Indices of Productivity and Scores				Ocean Productivity Category
	April Upwelling	May PDO	September PDO	October Upwelling	
1995	2	1.46	1.16	0	poor
1996	-53	2.18	0.24	-1	poor
1997	-2	1.83	2.19	-13	poor
1998	9	0.7	-1.21	-14	good
1999	31	-0.68	-1.53	-2	good
2000	0	-0.05	-1.24	-4	good
2001	0	-0.3	-1.37	2	good
2002	17	-0.63	0.43	13	good
2003	-17	0.89	0.01	-16	moderate
2004	1	0.88	0.75	2	poor
2005	-10	1.86	-0.46	-24	moderate

Relationship between Juvenile Survival in two reaches and SAR LGR to LGR

The results showed that when ocean productivity was taken into account, there was a strong relationship between in-river survival and adult return rates for both Snake River spring/summer Chinook and Snake River steelhead (Figures 3 and 4). Seven of the eight curves fitted resulted in p values below 0.10, with 6 having p values below 0.01. Multiple R^2 values ranged from 0.38 to 0.82. By separating survival groups into poor, moderate and good ocean groups, the effect of ocean productivity was held relatively constant for each category, so that the effects of in-river survival on adult return rates could be more easily evaluated. Logistic regression lines were fitted to the data for good and moderate ocean productivity categories. For the curve fitting, a value of 0.00001 was added to 0 values so that a logistic function could be used. It is likely the curves would plateau at some SAR value well above the range of values observed in recent years; in which case the relationship might look more like a classic S-shaped logistic curve.

Figure 3a. Steelhead reach survival LGR to BON plotted against SAR LGR to LGR for the years 1998 to 2005 under good, moderate and poor ocean productivity categories.

Figure 3b. Steelhead reach survival LGR to McN plotted against SAR LGR to LGR for the years 1995 to 2005 under good, moderate and poor ocean productivity categories.

Figure 4a. Yearling spring/summer Chinook reach survival LGR to BON plotted against SAR LGR to LGR for the years 1998 to 2005 under good, moderate and poor ocean productivity categories.

Figure 4b. Yearling spring/summer Chinook reach survival LGR to McN plotted against SAR LGR to LGR for the years 1995 to 2005 under good, moderate and poor ocean productivity categories.

Exploration of potential bias in modified reach survival estimates

Our analysis of possible bias in reach survival estimates in which fish were added at Little Goose Dam suggested no biologically significant bias in modified reach estimates. The modified estimates differed from the original estimates. But it was anticipated that adding additional tags to the starting population, would cause the modified cohort estimates to vary somewhat from the original estimates. What was of concern was potential systematic bias through all the reach estimates. In Figure 5 a small bias effect was exhibited in the Steelhead survival dataset used in this analysis. At high reach survivals the new method resulted in slight negative bias in reach survival. While the bias was identified and found significant using a Wilcoxon signed-rank test (Mendenhall et al 1981), the biological significance of this bias is minimal compared to the original method that used only fish detected or released at Lower Granite Dam. And the impact of such a bias in the overall reach survival estimate as part of this analysis was considered negligible. In fact, it was impossible to decide which approach yielded a reach survival estimate more representative of the untagged population. Since the new method estimates were always well within 95% confidence bounds of the original method, the bias exploration led to interesting questions, but further exploration of the cause of that bias was considered unimportant for and beyond the scope of this analysis.

We concluded that the new approach of adding tags to the releases at Little Goose Dam was appropriate and so it was adopted for all analyses in this paper. The modified method increased the number of PIT-tags available, especially for yearling chinook estimates, which allowed for up to 5 two-week LGR to BON reach survival cohorts during each year for this analysis. The additional tags also improved precision of the reach estimates.

Figure 5. Steelhead survival estimates in the reach Lower Granite Dam to Bonneville Dam. Original estimates using fish detected at LGR were plotted against themselves (1:1 line dark circles). Then the modified estimates (open circles) were plotted against the original estimates to explore potential systematic bias in the modified approach.

Discussion

The use of regression analysis to describe the relationship between juvenile survival and adult return rates can be difficult because the assumption of independence is likely violated when adult return rates are in part a function of juvenile reach survival, which was here treated as an independent variable. However, this analysis was an exploration of the nature of the relationship between juvenile survival and adult returns by which the existence of the inter-relationship, which had been called into question, was reconfirmed. For that reason the use of regression analysis is justified. Further analysis of juvenile salmon hydrosystem passage can use this approach as a foundation for analyzing physical variables fish experienced in the hydrosystem.

Our analysis shows that in-river survival has significant correlation to adult returns when ocean productivity changes are accounted. In years when in-river survivals were high and ocean productivity was high, or even moderate according to our ranking system, the SAR's were high. Conversely, when reach survivals were low, even in years when ocean indices suggested good or moderate ocean productivity SAR's were poor. And, when either in-river survival was low, or ocean productivity was in the poor category, SAR's

were low. These basic relationships support that to achieve good adult returns rates good in-river survival rates are needed regardless of ocean conditions.

Typically reach survival from Lower Granite Dam to Bonneville Dam ranges between 30 and 70 percent for yearling Chinook and Steelhead, - averaging less than 50% for steelhead, and just over 50% for Chinook. Our analysis is compelling evidence for seeking reach survivals above what we are currently achieving. In fact, the shape of the relationship, the exponential curves fitted to our data sets, suggests that any improvement in reach survival beyond the average of roughly 50 percent could produce relatively large improvements in adult return rates, when ocean productivity is moderate to good.

As we begin to better understand the influence of the ocean productivity on adult returns, it will allow further refinement of this sort of analysis, taking account of environmental factors as fish migrate through the hydrosystem, and directly assessing their impacts on adult returns. The strength in this approach is that the influence of factors affecting both in-river survival and delayed hydrosystem mortality, such as spill passage proportion and fish travel time, and arrival timing at the estuary, could be assessed simultaneously. The results might better inform future management actions, so that standards achieve more than just project-by-project or reach-by-reach goals, but instead achieve improved adult returns.

The recent ocean regime shift that occurred in 1976-77 may have favored Alaskan fisheries over Columbia River stocks as suggested by Mantua et al.1997. However, within this current regime (that may be less than ideal for endangered stocks affected by the Federal Columbia River Power System (FCRPS)) it appears that recovery level returns of 3 to 6% are possible for in-river migrants with improvements in juvenile survival under most ocean conditions.

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The Relation Between Juvenile Salmon Hydro-system survival and Adult returns

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Preliminary Results

Fish Passage Center

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Changing relationship between reach survival and SAR

- Past analyses of juvenile Reach survival have emphasized the “unknown” importance to adult return
- Recently NOAA has shown “no statistically significant relation” between juvenile survival and adult return (Smith and Muir ppt to NPCC 2007)—emphasizing instead the relative importance of ocean conditions on SARs (Williams and Scheuerell 2005)
- (Schaller and Petrosky 2007), used ocean indices to explain variability in S_3 and SAR as well as “common year effect”. In another analysis these authors also showed a relation between SAR and WTT at out-migration as surrogate for inriver survival under different ocean productivity levels (Schaller personal comm).

FPC approach to juvenile survival vs SAR

- Characterized relative ocean productivity/condition for the year of ocean entry for juvenile Snake River yearling Chinook salmon and steelhead
- Estimated reach survivals and compared to adult returns under different levels of ocean “productivity/conditions”

Ocean Indices

Combination of indices described and used by Williams and Scheuerell (2005), Schaller and Petrosky (2007 & unpublished)

- April upwelling
 - Monthly upwelling indices as measured at Lat. 45°N, 125 W (Near Columbia mouth). Units are cubic meters/second/100 meters of coastline. NOAA Pacific Fisheries Environmental Laboratory at the following link: www.pfeg.noaa.gov/products/PFEL/modeled/indices/upwelling/upwelling.html
- May PDO
 - The Pacific Decadal Oscillation (PDO) Index is defined as the leading principal component of North Pacific monthly sea surface temperature variability (poleward of 20N for the 1900-93 period) <http://jisao.washington.edu/pdo/>. (Joint Institute for the Study of the Atmosphere and Ocean)
- September PDO
- October upwelling

Regime Shift

- Limited years considered in ocean data set to time period after regime shift in 1976-77 identified by Hare and Mantua 2000

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1977 regime shift identified in Hare and Mantua (2000)

Developed ranking system to categorize relative ocean productivity/condition by year

- Each index was divided into thirds over 30 year span
- Each third of data was used as a category to “score” ocean year

Summarizing the logic used to classify each year

Good (3)	Moderate (2)	Poor (1)	Overall Category
3	1	0	good
3	0	1	good
2	2	0	good
2	1	1	good
1	2	1	moderate
1	3	0	moderate
0	3	1	moderate
2	0	2	moderate
1	0	3	poor
0	1	3	poor
0	2	2	poor
1	1	2	poor

Example of categorization method

- 1999 categorized as “good” 3-rank “good” (3), 1-rank “mod.” (2)

Results of rankings

Years listed would be associated with year of juvenile salmon outmigration

Reach Survival and SAR

- Estimated LGR to Bonneville and LGR to McNary Reach Survival from 1998 to 2005
- Divided each year into 4-two week blocks based on passage timing at LGR
Dates at LGR 4/8 to 4/21, 4/22 to 5/5,
5/6 to 5/19, 5/20 to 6/2
- Estimated SAR based on each two-week interval each year

Juvenile Reach Survival

- CJS method, with addition of LGS detections of fish undetected at LGR added based on travel time LGR to LGS

$$S_1 = (m_2 + z_2(R_2/r_2))/R_1$$

S_1 = Survival LGR to LGS

R_1 = fish released or detected at LGR

m_2 = fish detected at LGS

z_2 = detects of fish not detected at LGS

R_2 = fish released at LGS, either having been detected at LGR or first time detects at LGS

r_2 = subsequent detections of fish released at LGS

- This greatly increased sample sizes to provide better precision in reach survivals as well as greater likelihood of getting estimates of juvenile survival in 2-week blocks

Estimate of SAR

- Calculated smolt to adult returns from LGR to LGR
- Adjusted initial number of fish detected at LGR to account for transport removals at LGS and LMN and for additional first-time detects at LGS (R_2 from example)
- Used method of calculating LGR equivalents described in CSS 10 year report (Schaller et al 2007)

Starting juvenile population at LGR

- LGS Releases expressed in LGR equivalents

$$R_2 = R_{2 \times 11} + R_{2 \times 01} - t_2$$

$$S_1 = \text{LGR to LGS survival}$$

$$R_{2\text{Lgr-equiv}} = R_2 / S_1$$

- LMN removals expressed in LGR equivalents

$$t_3 / S_1 S_2$$

- McNary removals expressed in LGR equivalents

$$t_4 / S_1 S_2 S_3$$

- Lower Granite Starting Juvenile population

$$\text{LGR}_{\text{Pop}} = R_1 \pm R_2 / S_1 - t_3 / S_1 S_2 - t_4 / S_1 S_2 S_3$$

LGR to LGR SAR

- Adult returns were counted detections at LGR dam
- $SAR = LGR_{AR}/LGR_{pop}$
- Jack returns were not included in analysis

Results for Yearling Chinook - LGR to BON vs SAR

Results for Yearling Chinook - LGR to McN vs SAR

Results for Steelhead LGR to BON vs SAR

Results for Steelhead – LGR to McN vs SAR

Conclusions

- Results show strong relation between in-river survival and adult returns at different ocean productivity/conditions levels
- Next step: assign in-river environmental variables to reach survival groups (such as FTT, WTT, Spill Pct, Temperature) and analyze in-river effects on SARs at various levels of ocean productivity/conditions

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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 Tailwater and daily average spill at McNary.

Figure B-11. 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-12. 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-13. 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-14. 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-15. 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-16 Comparison of the daily average of the 12 highest hourly TDGS readings (as reported by the COE) at Bonneville Tailwater (at Cascade Island) and daily average spill at Bonneville Dam.

Figure B-17 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 fin 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 fin 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 fin 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 fin 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 fin GBT with associated dissolved gas saturation levels in the Lower Granite Dam forebay and the Dworshak Dam tailwater.

Figure C-5. Percent of fish examined at Rock Island Dam showing signs of fin GBT with associated dissolved gas saturation levels in the Rock Island Dam forebay and the Rocky Reach and the Grand Coulee Dam tailwaters.

APPENDIX D

Migration Timing Plots

Figure D-1 Smolt migration timing a Salmon River trap(WTB) with associated flow 2007

Figure D-2 Smolt migration timing a Snake River trap(LEW) with associated flow 2007

Figure D-3 Smolt migration timing at Imnaha River trap(IMN) with associated flow 2007

Grande Ronde River trap (GRN) Collection Counts

Figure D-4 Smolt migration timing a Grande Ronde River trap(GRN) with associated flow 2007

Figure D-5 Smolt migration timing at Lower Granite Dam(LGR) with associated flow 2007

Figure D-6 Smolt migration timing at Little Goose Dam(LGS) with associated flow 2007

Figure D-7 Smolt migration timing at Lower Monumental Dam(LMN) with associated flow 2007

Figure D-8 Smolt migration timing at Rock Island Dam(RIS) with associated flow 2007

Figure D-9 Smolt migration timing at McNary Dam(MCN) with associated flow 2007

Figure D-10 Smolt migration timing at John Day Dam(JDA) with associated flow 2007

Figure D-11 Smolt migration timing at Bonneville Dam(BO2) with associated flow 2007

Figure D-12 Subyearling Chinook smolt migration timing at Snake River sites with associated flow 2007

Figure D-13 Subyearling Chinook smolt migration timing at Columbia River sites with associated flow 2007

Spring Creek Hatchery Chinook (Tule) released on:

<u>Date</u>	<u>Number Released</u>
03/05/2007	6598443
03/06/2007	1168812
04/12/2007	4210573
05/01/2007	3494735

Figure D-14 Subyearling Chinook smolt migration timing at Columbia River sites with associated flow 2007

APPENDIX E

Travel Time Tables

DISTANCES OVER WHICH TRAVEL TIME IS MEASURED:**Snake River Basin Traps****Distance to Lower Granite Dam**

<u>Drainage</u>	<u>Trap Location</u>	<u>Kilometers</u>	<u>Miles</u>
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

Key Index Reaches**Reach Distance**

<u>Reach Location</u>	<u>Kilometers</u>	<u>Miles</u>
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: Flow 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 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 the 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 are indexed at Priest Rapids Dam.

Table E-1. 2007 travel time of PIT-tagged wild Chinook released from the Salmon River trap to Lower Granite Dam.

Salmon Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/14	13.3	33.7	52	31.1	35.1	66	49.2
3/15	15.6	34.2	56.4	32.5	37.2	62	49
3/16	11.7	34.6	54.4	32.6	38.5	34	48.7
3/17	18.4	33.4	51.8	31.8	35.4	55	48.8
3/18	21.1	33.5	50.3	31.9	40.3	55	48.8
3/19	13.6	32.6	60.8	31.4	34.4	102	48.8
3/20	16.1	32.4	53.5	30.6	42.3	54	48.6
3/21	16.7	38.3	51.6	31	42.7	57	48.6
3/22	12.6	32.1	55.6	28.6	42.1	43	47.8
3/23	15.9	30.5	49.9	27.4	40.8	29	47.5
3/24	11.4	29.4	50.9	26.4	39.5	33	47.3
3/25	16.9	30.4	45.9	24.4	39.2	24	47.3
3/26	14.2	25	45.7	23.9	32	33	47.5
3/27	16.9	36.6	55.2	29	38.6	18	51.9
3/28	17.7	35.8	48.8	21.5	36.5	12	51.5
3/29	18.7	35.1	44.7	22	36.7	10	51.3
3/30	13.5	33.7	45.5	19	36.3	17	51.2
3/31	12.7	27.9	43.6	18	34.7	17	46.2
4/1	16.7	29.7	36.2	16.9	32.4	11	48.5
4/2	16.3	30.9	41.5	17.4	36.7	11	51.5
4/3	13.6	18.7	39.5	17.2	31.8	19	44.8
4/4	14.5	18.4	29	-	-	5	44.9
4/5	11	13.7	27.9	-	-	6	45.1
4/6	11.2	19.5	37	11.2	37	7	46.2
4/7	10.1	13.7	39.7	10.7	31.9	13	46.6
4/8	9.6	12.5	33	10.6	27.2	9	47.4
4/9	7.4	17.7	41.9	12.2	23.6	39	48.2
4/10	9.9	22.6	38.7	15.8	25.2	32	55.1
4/11	8.7	21.3	35.5	19.4	21.8	58	53.6
4/12	9.4	20.7	32.7	14.5	21.7	40	55.6
4/13	8.5	20.5	36.8	19.5	23.2	61	57.4
4/14	14.4	25	36.3	21	29	13	60.3
4/15	10.1	17.8	48.3	16.5	26.4	13	56.6
4/16	14.6	24.4	27.5	17.3	26.9	10	62.1

Table E-2. 2007 travel time of PIT-tagged hatchery Chinook released from the Salmon River trap to Lower Granite Dam.

Salmon Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/15	31.8	44	51.2	35.3	48.3	23	48.9
3/16	28.1	36.3	55.7	33.5	48.9	15	48.7
3/17	15.9	35.5	54.6	32.6	37.9	35	48.6
3/18	28.3	34.1	46.6	31.4	38	18	48.8
3/19	23.7	33.1	46.3	27.9	37.7	17	48.8
3/20	29.2	41.2	51.5	30.8	44.4	13	49.6
3/21	24.8	35.7	50.6	30.8	44.7	15	48.3
3/22	26.6	35.3	50.5	26.9	42.2	9	47.8
3/25	19.2	39.8	45.6	37.5	41.1	19	52.7
3/26	20.5	36.8	45.7	25.3	39.4	24	50.9
3/27	18.6	33.4	43.7	25.8	37.4	26	48
3/28	21.4	32.4	44	25.3	37.2	16	47.5
3/29	13.4	35	47.9	30.9	36.6	20	51.3
3/30	15.8	34.6	44.1	33.4	36	22	52.3
4/1	17.5	32.6	41.8	23.6	33.7	16	52.2
4/2	16.2	30.6	38.3	19	31.7	12	51.5
4/3	18.1	29.5	37.7	23.8	30	23	51.5
4/4	14.8	28.6	39.4	19.3	31.6	12	51.8
4/5	13.5	26.6	39.5	17.5	28.7	18	50.8
4/9	14.1	23.9	33.7	22.5	25.5	25	54.8
4/10	15.6	23.2	33.7	22.3	25.4	32	55.1
4/11	10.8	23.6	33.8	22.1	27.7	31	57.7
4/12	13.4	23.7	31.5	21.6	26.5	26	58.6
4/13	17.4	21.9	33.2	20	27	22	58.4
4/16	13.6	16.7	24	16.2	17.4	28	57.3
4/17	14	16	23.6	15.3	18.9	13	57.7
4/18	11.1	16	29.3	14.3	23.3	15	60.1
4/19	11.7	13.7	19.9	12.7	15.5	9	59.1
4/23	9	11.6	20.6	9.3	16.8	14	66.9
4/24	8.1	9.9	18.7	8.6	11.3	19	67.5
4/25	6.9	9.3	24.7	8.4	13.5	26	69.7
4/26	6.5	9.9	13.8	7.4	12.7	12	72.8
4/27	5.8	8.1	15.7	6.6	14.2	17	75.3
4/30	5.5	10	15.4	6.3	12.5	17	78
5/7	5.5	6	9.9	5.5	9.9	8	81.1
5/8	3.4	6.4	11.2	5.3	9.2	24	85.7

Table E-3. 2007 travel time of PIT-tagged wild steelhead released from the Salmon River trap to Lower Granite Dam.

Salmon Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/20	41.7	41.7	41.7	-	-	1	50.4
3/24	19.8	19.8	19.8	-	-	1	47.4
4/1	10	10	10	-	-	1	42.1
4/6	5.9	5.9	5.9	-	-	1	43.6
4/10	6.5	7.6	9.7	-	-	4	48.5
4/11	4.5	6.5	15.8	5.7	10.5	12	48.2
4/12	5.4	10.8	19.7	-	-	4	47.4
4/13	5.5	12.6	19.5	-	-	4	47.5
4/14	18.4	18.9	19.4	-	-	2	56.2
4/15	6.4	10.9	15.4	-	-	2	47.4
4/16	9.2	9.7	17.5	-	-	3	47.6
4/20	12.6	12.6	12.6	-	-	1	59.9
4/21	11.6	11.6	11.6	-	-	1	61
4/22	10.6	10.6	10.6	-	-	1	62.1
4/23	10.4	10.4	10.4	-	-	1	63.7
4/25	7.4	7.4	7.4	-	-	1	64.3
4/26	4.6	5.8	11.5	4.6	11.5	7	66.5
4/27	4.6	5.4	6.3	-	-	2	69
4/28	3.2	3.9	5.9	3.2	5.9	7	72
4/29	3.2	3.7	5.4	3.3	4.8	11	79.7
4/30	2.5	2.7	3.6	-	-	3	84.3
5/7	4.9	6.8	8.8	-	-	2	83.4
5/8	4.4	4.6	4.7	-	-	2	83.4
5/9	3.7	3.7	3.7	-	-	1	86.9
5/10	3.6	3.6	3.7	-	-	2	92.9
5/11	3.9	4	4.1	-	-	2	95.9

Table E-4. 2007 travel time of PIT-tagged hatchery steelhead released from the Salmon River trap to Lower Granite Dam.

Salmon Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/2	6.5	10.4	32.4	6.8	30.8	10	43.1
4/3	31.8	31.8	31.8	-	-	1	53.5
4/4	9.7	25.6	41.6	-	-	2	47.7
4/5	5.9	13.6	27.2	9.9	26.8	13	45.1
4/6	4.8	6.8	24.8	4.8	24.8	7	44.4
4/7	4.7	16.3	37.1	5.6	27.8	9	46.5
4/8	5	11.4	34.5	6.7	25.1	13	47.5
4/9	3.8	21.7	30.9	6.9	23.8	17	51.6
4/10	6.9	7.9	26.7	-	-	4	48.5
4/11	4.7	23.6	30	4.7	30	8	57.7
4/12	5.5	14.2	22.9	-	-	2	47.7
4/13	4.9	12.2	19.5	-	-	2	47.2
4/14	6.5	16.5	18.6	-	-	6	52.3
4/15	3.6	8.4	25.3	3.6	25.3	7	46.9
4/16	3.3	16.9	30.9	6.6	23.7	17	57.3
4/17	3.7	4.6	22.3	-	-	5	46.9
4/18	4.7	5.6	23.7	-	-	5	46.4
4/19	7.5	11.6	16.7	-	-	6	54.2
4/20	4.7	10	21.4	6.1	16.8	16	52.1
4/21	6.8	12.1	16.7	6.8	16.7	8	61
4/22	8.5	9.6	21.6	8.5	21.6	8	59.2
4/23	4.6	7.9	19.6	5.7	18.6	9	57.5
4/24	3.8	5.8	18.5	4.7	7.9	15	55.5
4/25	3.4	5.6	9.5	-	-	4	60.8
4/26	3.7	4.9	30	4.6	5.6	35	62.8
4/27	3.6	5.7	17.1	4	7.7	19	72.6
4/29	2.5	3.9	20.2	3.5	5.6	31	79.7
4/30	2.5	2.8	8.8	2.6	3.6	19	84.3
5/7	3.7	6.6	18.1	3.8	15	11	83.4
5/8	2.6	4.8	13.9	4.6	6.5	46	83.4
5/9	2.7	3.9	22.5	3.7	4.6	45	86.9

Table E-5. 2007 travel time of PIT-tagged wild Chinook released from the Snake River trap to Lower Granite Dam.

Snake Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/23	17.4	17.4	17.4	-	-	1	47.3
3/24	4.8	4.8	4.8	-	-	1	54.4
4/10	7.1	7.1	7.1	-	-	1	48.7
4/12	6.5	6.5	6.5	-	-	1	48
4/13	6.4	6.6	6.9	-	-	2	47.6
4/14	4.3	5.5	6.5	-	-	4	47.2
4/15	3.6	5.6	7.6	-	-	2	47.2
4/18	5.8	5.8	5.8	-	-	1	46.4
4/21	4.6	4.6	4.6	-	-	1	47.5
4/29	3.4	3.4	3.4	-	-	1	76.1
4/30	2.5	2.5	2.5	-	-	1	84.3
5/1	2.3	2.8	5.6	2.4	3.8	18	88.6
5/2	1.9	4.4	9	3.6	5.3	38	84.7
5/3	4	6.5	7.6	-	-	5	76.9
5/4	4.8	6.7	7.5	-	-	4	76.8
5/5	5	5.4	8	-	-	4	72.1
5/6	5.3	5.3	5.3	-	-	1	74.1
5/7	4.4	4.4	4.4	-	-	1	74.7
5/10	2.4	3.2	3.6	-	-	4	91.4
5/11	1.7	2.4	5.5	-	-	3	95.8
5/12	2.9	4	8.5	-	-	6	95.2
5/13	2.9	5.5	8.1	-	-	2	93.2
5/14	2.9	4.9	7.5	-	-	5	91.9
5/15	2.6	4	6.4	-	-	6	90.5
5/16	2.5	3.4	4.4	-	-	2	89.9
5/17	3	3.8	3.9	-	-	3	88.9
5/19	5.6	5.6	5.6	-	-	1	81.9
5/21	3.5	8.6	13.6	-	-	2	69.6
5/22	17	17	17	-	-	1	61.6

Table E-6. 2007 travel time of PIT-tagged hatchery Chinook released from the Snake River trap to Lower Granite Dam.

Snake Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/14	4.2	6.5	18.8	5.9	8.3	21	4/14
4/15	4.6	7.2	21.8	-	-	3	4/15
4/17	7.7	8.2	10.9	-	-	3	4/17
4/18	7.2	7.2	7.2	-	-	1	4/18
4/19	3.9	7.4	13.4	-	-	3	4/19
4/21	5.7	6.2	7	-	-	4	4/21
4/24	3.1	6.6	7.8	-	-	6	4/24
4/25	5.9	5.9	5.9	-	-	1	4/25
4/27	3.8	5.7	6.7	3.8	6.7	7	4/27
4/28	2.8	3.5	5.7	-	-	5	4/28
4/29	2.5	2.6	2.7	-	-	2	4/29
4/30	2.3	3.1	5	2.6	3.5	33	4/30
5/1	1.7	3.2	10.3	3	3.7	58	5/1
5/2	2.7	5.8	10.3	4.6	7.6	34	5/2
5/3	3.2	7.1	9.4	6.5	7.8	28	5/3
5/4	4.6	6.6	9.7	5.6	7.5	24	5/4
5/6	3.9	5.1	7.5	4.6	6.3	22	5/6
5/7	3.5	4.4	6.2	4.1	5.4	14	5/7
5/8	2.5	4	6.2	2.5	6.2	7	5/8
5/9	2.8	2.8	2.8	-	-	1	5/9
5/10	1.7	2	3.2	-	-	6	5/10
5/11	1.6	2.2	8.8	1.9	2.6	28	5/11
5/12	1.5	2.5	5.5	2.2	2.7	39	5/12
5/13	1.6	2.5	3.9	1.6	3.9	8	5/13
5/14	2.4	3.4	5.9	3.2	4.1	20	5/14
5/15	2.5	3.8	5.5	3.2	4	23	5/15

Table E-7. 2007 travel time of PIT-tagged wild steelhead released from the Snake River trap to Lower Granite Dam.

Snake Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
5/1	1.3	1.7	2.4	1.5	2	19	88.5
5/2	1.3	1.6	12.4	1.5	1.8	49	90.4
5/3	1.4	1.7	4.4	1.6	2.4	48	87.9
5/4	1.5	2.3	5.6	1.6	2.5	30	80.3
5/5	1.7	2.7	4.2	2.5	2.7	24	71.4
5/6	1.7	2.7	15.5	2.5	3.6	17	68.4
5/7	2.4	3.5	3.9	-	-	3	74.7
5/8	2.6	2.8	3.7	-	-	5	76.5
5/9	2.5	2.5	2.5	-	-	1	83.4
5/10	1.5	2.5	3.5	-	-	5	91.4
5/11	1.5	1.6	2.5	-	-	6	95.8
5/12	1.4	1.6	4.4	1.4	2.7	10	97.8
5/13	1.5	1.7	3.8	1.6	3	17	97.6
5/14	1.6	2.4	3.6	1.6	3.4	11	94
5/15	1.5	1.8	2.6	1.7	2.5	14	89.5

Table E-8. 2007 travel time of PIT-tagged hatchery steelhead released from the Snake River trap to Lower Granite Dam.

Snake Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/19	2.6	3.4	22.1	2.7	4.4	12	46.7
4/20	2.6	3.5	5.7	-	-	5	46.2
4/21	2.6	3.4	9.1	-	-	5	46.1
4/22	3.4	3.4	3.4	-	-	1	46.5
4/23	2.6	3	6.9	-	-	5	48.1
4/24	1.5	5.5	5.6	-	-	3	55.5
4/25	2.7	2.7	2.7	-	-	2	52.5
4/28	1.8	1.8	1.8	-	-	1	62.8
4/29	1.5	1.7	3.4	-	-	5	71.9
4/30	1.4	1.6	14.3	1.5	1.7	44	81.1
5/1	1.4	1.6	25	1.5	1.7	57	88.5
5/2	1.4	1.6	5	1.6	1.8	28	90.4
5/3	1.3	1.6	7.5	1.5	1.8	21	87.9
5/4	1.4	1.9	23.8	1.7	2.6	43	80.3
5/6	1.5	2.7	20.9	2.6	3.1	48	68.4
5/7	1.8	3.2	8.3	2.5	5.6	12	70.1
5/8	1.6	2.6	13.6	1.8	8.1	14	76.5
5/9	1.6	2.5	10	1.8	2.8	23	83.4
5/10	1.4	1.8	23.3	1.7	2	31	88.2
5/11	1.4	1.6	8.6	1.5	1.7	42	95.8
5/12	1.4	1.6	10.7	1.6	1.8	26	97.8
5/13	1.4	1.7	13.8	1.7	1.8	64	97.6
5/14	1.4	1.7	6.3	1.7	2.1	43	94
5/15	1.4	2	12.5	1.8	2.1	45	89.5
5/16	1.4	1.8	13.9	1.7	3	28	89.5
5/17	1.5	2.1	8.3	1.8	2.8	20	89.9
5/18	1.4	1.6	3.4	1.5	2	9	90.6
5/19	1.4	2.5	3.4	-	-	5	87.7
5/20	1.5	1.8	3.2	1.5	2.5	10	86.6

Table E-9. 2007 travel time of PIT-tagged wild Chinook released from the Imnaha River trap to Lower Granite Dam.

Imnaha Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/26	10.3	22.9	37.2	19.1	25.6	22	47.5
3/27	12.7	20	44.1	17.9	23	28	47.1
3/28	11.4	21.3	49.3	20.3	23.1	49	46.3
3/29	13.3	18.8	34.9	17	20.7	22	45.7
3/30	13.2	18.9	34	17.2	20.3	23	45.3
3/31	13	16.6	34.2	14.5	23.8	12	44.7
4/1	12.9	16.1	36.7	15.2	34.1	11	44.3
4/2	10	17.8	30.6	10	30.6	8	45
4/3	12.8	18	38.1	15.7	28.2	32	44.7
4/4	9.6	14	43.3	12.1	21.7	16	44.4
4/5	8.8	14.1	28.1	11	19.7	13	45.1
4/6	10.6	16.4	30	11.1	26.5	16	45.8
4/7	9.9	17.2	27.5	11	19.4	13	46.4
4/8	10.3	13.4	34.2	-	-	6	47.4
4/9	8.7	13.7	34	11.8	23.1	22	47.7
4/10	8.1	14.9	37.1	12.7	21.5	40	47.7
4/11	9.4	21	40.3	13.9	27	22	53.6
4/12	7.1	19.3	39.2	16.5	20.3	67	52.1
4/13	7.3	13.4	42.2	11.2	19	25	47.5
4/14	7.2	18	24.3	12.3	18.9	19	54.2
4/15	10	16.1	22	12.1	17.7	17	52.6
4/16	9.3	15.8	34.9	14.3	17.1	40	55.1
4/17	8.6	13.8	37.3	12.8	15.3	24	53.3
4/18	9.2	13.8	34.3	12.9	14.8	38	56
4/19	8	13	24	12.1	14	37	56.6
4/20	6.8	11.3	18	11	11.9	27	54.7
4/21	9.2	11.2	34.3	10.9	12	34	58.2
4/22	8.6	10.3	21.2	9.9	11.2	26	59.2
4/23	7	9	18.3	8	10.1	22	60.6
4/24	6.4	8	17.5	7.6	9	30	62.2
4/25	6	7.1	19.7	7	7.4	77	64.3
4/26	4.9	6.9	19.6	6.3	7.1	77	69.9
4/27	3.9	6.1	28.4	5.3	6.9	53	72.6
4/28	3.4	5.1	30.3	4.8	6	68	75.7
4/29	3	5.2	19.2	4.9	6	89	81.2
4/30	2.9	9	19.1	6.2	10.1	58	78.1
5/1	3.9	9.2	16.2	8.2	10.1	23	78.7
5/2	4.3	9.6	19	8	10.1	18	80.9
5/3	4.3	7.8	14.9	7	9.8	12	78.7
5/4	6	7.7	17.3	6.6	8.7	17	78.6
5/5	5.3	7.9	15.9	7.2	8.4	82	80
5/6	4.5	7	26.1	6.7	8.3	47	79.9

Table E-10. 2007 travel time of PIT-tagged wild steelhead released from the Imnaha River trap to Lower Granite Dam.

Imnaha Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/21	6.1	10	23.7	6.1	20	9	55.5
4/22	7	10	19	-	-	5	59.2
4/23	4.3	9.4	21.1	7.3	10.7	12	60.6
4/24	4.1	7	21.4	-	-	5	59
4/25	4.1	5.4	17	5.1	9.2	19	57.1
4/26	3.3	5	6.1	4.2	5.9	18	62.8
4/27	3	4.2	16.6	3.3	6.3	19	65.1
4/28	2	3.6	15.5	3.2	4	42	72
4/29	1.9	3	14	3	3.2	85	76.1
4/30	1.1	3	10.8	2.5	3.3	63	84.3
5/1	1.1	3	14.1	2.3	3.6	59	88.6
5/2	1.1	3.1	16.3	2.9	3.3	98	88.1
5/3	2	5	14.3	4.2	5.6	82	78
5/4	3	6.2	15.7	4.5	7	34	74.5
5/5	3	5	26.1	4.3	5.4	49	72.1
5/6	3	4.4	12.6	4.2	4.8	54	70.3
5/7	2.2	4	22.4	3.4	4.9	38	74.7
5/8	2	3.1	9.4	3.1	3.2	127	76.5
5/9	1.9	3	10.1	2.9	3.1	111	83.4
5/10	2.8	3.9	24.4	3.9	4	60	92.9
5/11	1.9	3.2	13.3	3	4	70	96.7
5/12	2	3.1	20.1	2.5	3.2	63	96.5
5/13	2	3.9	27.3	3.5	4.7	45	93.7
5/14	2	3.4	19.5	3.1	4.1	45	91.9
5/15	1.3	3.1	22.6	2.5	3.5	45	90.3
5/16	1.4	3.1	6.7	3	3.3	49	89.9
5/17	1.9	2.5	7.6	2.3	2.9	49	89.4
5/18	1.5	3.2	7.2	2.9	3.6	28	89.7
5/19	1.9	3	19.5	2.9	3.3	74	87.7
5/20	1.9	4	14.6	3.3	4.1	47	81.8
5/21	2.1	3.4	14.7	3	4.2	39	80.3
5/22	3	3.2	14.1	3.1	6.1	18	76.8
5/23	3.2	4.6	12.6	4	10.3	14	67.1
5/24	3	4.1	5.2	-	-	2	65.5
5/25	3.6	4.2	6.2	-	-	5	63.2
5/26	3.3	7	10.6	-	-	2	58.6
5/27	4.5	5	5.6	-	-	2	58.3
5/28	2.1	4	8.4	3	6.4	14	58.3
5/29	3.1	4.2	7.4	3.1	6.4	10	57.7

Table E-11. 2007 travel time of PIT-tagged hatchery steelhead released from the Imnaha River trap to Lower Granite Dam.

Imnaha Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/13	9.4	19.8	47.5	18.5	28.3	15	55.9
4/14	5.2	18.1	39.9	10.1	35.4	13	54.2
4/17	3.8	18	20.3	3.8	20.3	8	60.6
4/19	11.1	15.3	29.4	12.9	23.4	13	61
4/20	3	11.9	15	3	15	7	57.3
4/21	5.6	10	21.4	5.6	21.4	7	55.5
4/24	3.6	6	9.7	-	-	6	55.5
4/25	3.4	6.4	17	4.1	15.9	10	60.8
4/26	2.3	5.3	15.5	3.3	11.2	13	62.8
4/28	3.3	4.2	4.6	-	-	3	72
4/29	2	3.4	9.6	-	-	4	76.1
4/30	1.2	1.5	11.1	-	-	5	81.1
5/1	1.2	3.3	18.1	1.2	18.1	7	88.6
5/2	2	3.8	17.6	2.1	17.3	10	84.7
5/3	1.4	8.2	17.1	7.4	9.1	20	78.7
5/4	2.4	6.7	17.1	6.3	7.7	23	76.8
5/6	2.4	5.4	7.7	4	6.1	11	74.1
5/7	2	3.1	4.4	-	-	5	70.1
5/8	2.1	3.1	4.7	2.2	4.4	11	76.5
5/9	2.2	3.2	7.1	2.4	3.6	14	83.4
5/10	2.9	3.9	10.9	2.9	5.7	11	92.9
5/11	2.2	3.8	20.2	2.2	20.2	8	95.9
5/13	1.1	2.1	11.3	1.2	3.4	15	97.6
5/14	1.4	2.5	8.4	1.4	6.5	9	91.9
5/15	1.1	2.8	6.9	2	5.4	12	90.3
5/16	1.1	3.2	8	2	5.3	16	89.9
5/17	1.4	2.2	19.5	2	2.9	12	89.9

Table E-12. 2007 travel time of PIT-tagged wild Chinook released from the Grande Ronde River trap to Lower Granite Dam.

Grande Ronde Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/22	12.9	21.4	42	17.8	28.2	18	48
3/23	12.4	17.7	39.4	15.7	23.5	15	47.5
3/24	8.7	15.2	23.8	-	-	4	46.8
3/25	10.7	25.4	43.7	15.6	40.8	9	47.5
3/26	8.8	19	28.1	11.7	25.3	11	47.6
3/27	7.9	19.8	30	15.5	23.7	18	47.1
3/28	11.2	21	33.9	19.5	24.4	15	46.3
3/29	11.2	18.1	32.7	14.8	24.8	12	45.6
3/30	14.4	16.4	21	-	-	6	44.8
3/31	12.8	16.8	51.9	12.8	51.9	7	44.7
4/1	13.7	16.2	19.5	13.7	19.5	8	44.3
4/2	10.2	15.6	20.4	13.7	18.7	12	44.7
4/3	11.3	14.4	18.9	11.3	18.9	8	44.1
4/4	12.6	14.2	49.2	-	-	5	44.4
4/5	8.1	36.6	45.4	35.7	37.4	24	58.5
4/7	6.5	11	12.5	-	-	6	46.4
4/8	8.6	13.2	17.7	-	-	2	47.4
4/9	8.5	10.8	25.9	8.5	25.9	8	48.1
4/10	6.9	9.6	20.5	7.4	12.6	12	48.2
4/11	6.3	11	29.3	9.4	13.4	30	47.7
4/12	6.3	8.3	18.5	7.1	16.1	11	47.9
4/13	6.4	9.5	18.4	6.4	18	9	47.2
4/14	7.6	12	18.9	7.6	18.9	7	47.4
4/15	9.8	9.8	9.8	-	-	1	47
4/16	8.1	10.8	17.2	-	-	6	48.1
4/17	12.5	14.7	18.9	13.2	17.5	11	55.5
4/18	10.6	12.6	13.6	-	-	3	53.6
4/19	7.9	11.2	15.8	7.9	15.8	7	51.8
4/20	7.7	11.8	15.4	-	-	6	57.3
4/21	8.5	9.3	12.4	8.5	12.4	7	52.7
4/22	9.5	10.2	10.8	-	-	2	59.2
4/23	6.3	7.6	9.4	-	-	6	57.5
4/25	5.5	6.6	9.5	5.5	9.5	7	64.3
4/26	4.3	5	8.5	4.3	8.5	7	62.8
4/27	4.4	4.4	5.5	-	-	3	65.1
4/28	4.5	5.1	5.7	-	-	2	75.7
4/29	3	4.2	8.4	3.7	4.7	18	79.7
4/30	3	3.4	6.7	3.4	4.4	16	84.3
5/1	3.2	4.4	9.8	3.6	4.6	28	87
5/2	3.1	6.1	10.4	4.3	9.7	11	79.5
5/3	2.9	7	11.7	6.6	7.6	36	76.9
5/4	5.7	7	10.7	6.8	7.8	61	76.8

Table E-13. 2007 travel time of PIT-tagged hatchery Chinook released from the Grande Ronde River trap to Lower Granite Dam.

Grande Ronde Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/5	14.5	37.3	44.9	25.2	39.7	15	58.5
4/6	20.8	22.2	23.5	-	-	2	47
4/7	14.7	20.8	27.5	-	-	4	47.5
4/8	9.8	23.8	25.6	-	-	5	52.6
4/9	9.7	18.9	23.5	-	-	5	48.6
4/10	21.8	23	25.5	-	-	4	55.1
4/11	11.8	21.1	30.3	-	-	5	53.6
4/12	3.4	19.5	23.5	-	-	5	53.8
4/13	18.6	20.4	23.3	18.6	23.3	8	55.9
4/14	17.7	19.6	20.3	-	-	3	57.7
4/15	17.7	19	27.5	-	-	4	58.3
4/16	7	16.7	24.8	15.7	20.7	9	57.3
4/17	13.2	15.6	18.1	13.2	18.1	8	57.7
4/18	13.5	14.8	22.2	-	-	6	58.3
4/19	12.3	13.4	14.5	-	-	3	56.6
4/20	11.5	12.9	23.4	-	-	5	59.9
4/21	11.9	13.4	18.1	-	-	3	63
4/22	9.8	10.8	18.9	-	-	6	62.1
4/23	9	13.2	17.5	-	-	2	67.2
4/24	7.2	9.2	19.2	8.4	18.7	10	65.4
4/25	5.5	8.1	12.5	7	11.2	13	67.6
4/26	5.4	7	14.5	5.4	14.5	8	69.9
4/27	5.2	5.8	6.4	-	-	5	72.6
4/28	3.9	5.5	7.5	4	6.7	9	77.5
4/29	3.4	4.4	6.6	3.5	5.4	11	79.7
4/30	3.4	5.1	12.4	3.4	9.7	10	84.5
5/2	3.6	6.7	10.3	-	-	6	78.2
5/3	4.9	6.4	8.2	-	-	5	76.8
5/4	7.7	8.4	11.5	-	-	6	78.6
5/6	3.5	4.6	5.5	3.5	5.5	7	74.1
5/7	4.5	4.7	6	-	-	5	77.8
5/8	3.6	4.5	6.1	3.6	6.1	7	83.4
5/14	3.3	4.6	6.6	-	-	6	91.9

Table E-14. 2007 travel time of PIT-tagged wild steelhead released from the Grande Ronde River trap to Lower Granite Dam.

Grande Ronde Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
3/10	56.5	56.5	56.5	-	-	1	52.7
3/19	47.4	47.4	47.4	-	-	1	53.6
4/5	32.4	33.4	38.1	32.5	34.6	9	55.6
4/11	5.5	5.5	5.5	-	-	1	48.4
4/13	19.6	19.6	19.6	-	-	1	55.9
4/14	4.4	4.4	4.4	-	-	1	47.3
4/22	10.3	10.3	10.3	-	-	1	59.2
4/28	3.7	3.7	3.7	-	-	1	72
4/30	2.4	2.5	3.7	-	-	3	84.3
5/1	2.3	2.4	2.6	-	-	2	88.5
5/2	1.5	1.8	2.4	-	-	5	90.4
5/3	1.9	2.6	5.5	2.4	3.7	14	83.8
5/4	2.8	4	7.7	2.8	5.4	14	74.8
5/6	3.7	3.7	3.7	-	-	2	70.3
5/8	2.6	2.6	2.6	-	-	1	76.5
5/9	3.4	3.4	3.4	-	-	1	83.4
5/10	2.5	3.3	3.9	-	-	5	91.4
5/11	2.1	2.4	6.5	-	-	5	95.8
5/12	1.6	2	2.3	-	-	2	97.8
5/13	2.5	2.7	6.8	2.5	4.1	9	95.7
5/14	2.5	3.1	3.8	-	-	5	91.9
5/15	3	3	3	-	-	1	90.3
5/16	3.9	3.9	3.9	-	-	1	89.5
5/17	7.2	7.2	7.2	-	-	1	84.9
5/18	2.1	2.1	2.1	-	-	1	90.6
5/20	4.8	4.8	4.8	-	-	1	80.4
5/21	2.5	2.5	2.5	-	-	1	80.3
5/22	3.5	3.5	3.5	-	-	1	74.4
5/23	2.6	2.6	2.6	-	-	1	71.8

Table E-15. 2007 travel time of PIT-tagged hatchery steelhead released from the Grande Ronde River trap to Lower Granite Dam.

Grande Ronde Trap	Travel Time			Confidence Limits		Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
4/5	32.5	33.2	45.6	32.7	35.8	30	55.6
4/11	3.5	3.6	3.6	-	-	2	48.2
4/12	4.5	5.1	9.5	-	-	3	48.4
4/13	8.9	19.6	34.5	-	-	5	55.9
4/14	4.5	15.7	20.6	-	-	3	50.5
4/15	16.6	16.6	16.6	-	-	1	54.6
4/16	3.5	3.5	3.5	-	-	1	47.6
4/17	6.4	7.7	9	-	-	2	46.9
4/19	5.6	15.6	36	9.7	21.4	15	62.2
4/20	9.2	9.5	11	-	-	3	52.1
4/21	11.8	11.8	11.8	-	-	2	61
4/22	8.7	8.7	8.7	-	-	1	56.3
4/23	7.7	7.7	7.7	-	-	1	57.5
4/25	5.6	5.6	5.6	-	-	1	60.8
4/27	3	3.2	3.4	-	-	2	60.6
4/29	4.1	9.5	16.8	4.1	16.8	7	76.5
4/30	1.6	2.2	2.8	-	-	2	81.1
5/1	1.4	1.9	14.1	1.6	2.4	16	88.5
5/2	1.4	2	22.4	1.7	2.7	18	90.4
5/3	1.6	2.7	9.5	2.6	3.5	38	83.8
5/4	2.7	4.7	22.6	3.7	5.4	44	73.9
5/6	2.4	3.2	30	2.7	5.1	18	68.4
5/7	3.2	5.6	10	-	-	4	81.1
5/8	2.9	4.7	5.1	-	-	3	83.4
5/9	2.2	2.5	2.8	-	-	3	83.4
5/10	2.5	2.5	2.7	-	-	3	91.4
5/11	1.8	2	15.7	1.8	15.7	7	95.8
5/12	1.6	1.9	5.8	1.6	4.1	16	97.8

Table E-16. 2007 Travel time of PIT-tagged subyearling Chinook salmon released from Rock Island Dam to McNary Dam.

Rock Island Dam	Travel Time			Confidence Limits		Priest Rapids	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
7/5	6.7	22.1	34.8	10.6	28.4	12	142.2
7/6	18.5	21.7	27.7	18.5	27.7	7	141.5
7/7	13.6	15.9	30.7	-	-	5	141.5
7/8	13.7	24.8	28.7	13.7	28.7	7	141.8
7/9	17.6	21.8	23.9	-	-	6	142.1
7/10	14.3	23.7	32.2	-	-	3	141.4
7/11	7.7	17.2	23.2	-	-	6	144.4
7/12	11.7	15.4	28.9	-	-	4	145.1
7/13	7.8	13.7	20.9	7.8	20.9	7	144.3
7/15	7.1	17.3	27.2	9.3	21.3	9	139
7/16	10.9	17.1	25.1	12.9	19.4	12	138.5
7/17	8.2	14.2	49.2	9.6	37.8	10	135.9
7/18	10.4	15.2	27.7	13.9	23.5	14	137.2
7/19	6.2	14.2	23.9	6.2	23.9	8	136.8
7/22	6.6	11.8	62	10.4	15.7	21	136.5
7/23	6.8	11.9	19.2	10.7	14.6	25	135.1
7/24	4.6	9.8	58.9	9.2	13.3	18	136.3
7/25	7.2	8	12.1	-	-	3	140.8
7/29	8.7	11.4	77	-	-	4	123.9
7/30	7.4	10.6	52.3	7.4	14.2	9	127
7/31	9.3	11.2	33.8	9.5	19.7	9	123.7
8/1	8.3	12.3	26.9	8.7	20.4	9	122.7
8/2	7.7	11.2	77	7.9	27.7	14	119.8

Table E-17. 2007 Travel time of PIT-tagged yearling Chinook salmon released from Rock Island Dam to McNary Dam.

Rock Island Dam	Travel Time			Confidence Limits		Priest Rapids	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow
5/11	8.1	9.3	22.7	8.9	13.6	13	167.1
5/12	6.5	9	18.1	7	15.6	11	166.7
5/13	6.9	8.8	11.8	-	-	4	167.1
5/14	6.8	7.8	8.8	-	-	2	166.5
5/15	5.9	8.6	10.9	-	-	4	169.4
5/16	6.8	10.8	14.8	-	-	2	172.8
5/17	6.7	9.1	13.9	6.7	13.9	7	171.5
5/18	9.2	9.9	10.8	-	-	4	172.8
5/19	6.2	7	17	-	-	5	171.1
5/20	9	9	9	-	-	1	174.6
5/21	9.9	9.9	9.9	-	-	1	177.2
5/22	7	10.4	16	-	-	6	177.9
5/23	5.6	8	14.8	7.6	10.2	15	178.5
5/24	6.6	9.1	13.7	6.6	13.7	8	177.3
5/25	6.9	10.2	16.7	6.9	16.7	8	173.7

Table E-18. 2007 Travel time of PIT-tagged wild steelhead released from Rock Island Dam to McNary Dam.

Rock Island Dam Release Date	Travel Time			Confidence Limits		Priest Rapids	
	Min	Med	Max	Lower	Upper	Number	Flow
5/3	3.4	5	6.4	-	-	6	185.6
5/4	4.3	4.6	27.8	-	-	5	191.4
5/5	3.7	5.4	7.6	-	-	4	189.9
5/7	5.1	6.5	8.5	-	-	6	180.1
5/8	4.5	5.3	6.8	-	-	5	185
5/9	5.4	5.6	13.3	-	-	4	171.8
5/10	4.5	5.2	7.3	-	-	3	168
5/14	4.4	5.8	7.3	-	-	3	165.2
5/15	4.2	4.5	5.8	-	-	4	167.3
5/16	5.3	5.3	5.3	-	-	1	167.4
5/17	4.3	5.2	10.2	4.3	6.4	11	167.8
5/18	4.3	7.2	9.7	-	-	5	170.6
5/19	4.5	7.6	12.7	5.2	8.8	9	172.6
5/20	4.7	7.4	7.7	-	-	4	173.9
5/21	5.5	7	8.5	-	-	2	176.7
5/22	5.9	7.2	8.5	-	-	2	178.1
5/26	9.5	10	10.6	-	-	2	173.3
5/27	4.3	5.8	7.4	-	-	3	177.1
5/30	7.7	7.7	7.7	-	-	1	170.4
6/1	6.5	6.5	6.5	-	-	1	172.3
6/2	6.1	6.1	7	-	-	3	172.2
6/3	4.3	4.3	4.3	-	-	1	166.7
6/4	6.6	9.1	11.7	-	-	2	180.5
6/5	6.6	6.6	8.5	-	-	3	184.5
6/6	4.9	5.4	5.8	-	-	4	184

Table E-19. 2007 Travel time of PIT-tagged hatchery steelhead released from Rock Island Dam to McNary Dam.

Rock Island Dam Release Date	Travel Time			Confidence Limits		Priest Rapids	
	Min	Med	Max	Lower	Upper	Number	Flow
5/8	4.4	5.6	20.1	5.2	10.5	14	180.4
5/9	4.3	5.6	13.8	5.3	8.7	15	171.8
5/10	4.2	5.8	11.1	4.2	11.1	7	169
5/11	5.6	6.7	7.5	-	-	4	169.1
5/12	5.6	5.6	5.6	-	-	1	169.2
5/13	5.4	6.5	7.6	-	-	2	166.1
5/15	5.9	6.7	11.4	-	-	4	168.3
5/16	5	5.7	7.8	-	-	3	168.8
5/17	4.3	6.3	12.6	5.2	12.4	11	168.8
5/18	4.9	6.3	15.5	5.4	7.2	15	168.3
5/19	4.5	6.6	19.3	4.5	12.4	11	171.1
5/20	5.6	7.8	8.6	-	-	6	174.4
5/21	4.9	6.5	8.3	-	-	4	176.7
5/22	5.7	6.6	15.3	5.8	9.7	11	178.1
5/26	7.3	8.8	11.7	7.6	11.6	9	172.4
5/27	5.3	8.6	11.8	6.6	10.8	10	173.2
5/28	5.8	7.4	10.7	6.8	9.3	12	170.7

Table E-20. 2007 Travel time of PIT-tagged yearling Chinook from Lower Granite Dam to McNary Dam.

Lower Granite Passage Date	Travel Time			Confidence Limits		Ice Harbor Dam	
	Min	Med	Max	Lower	Upper	Number	Flow
4/2	19.3	27.4	22.8	22.5	25.6	11	47.0
4/3	22.4	35.6	23.0	22.4	35.6	8	46.6
4/4	20.1	38.6	24.1	23.1	28.1	23	47.4
4/5	11.9	38.7	22.4	19.9	29.6	22	47.4
4/6	15.6	36.3	22.6	20.4	26.1	29	48.6
4/7	9.7	48.1	24.5	19.7	27.8	30	53.0
4/8	13.2	40.0	22.0	20.0	24.4	66	50.9
4/9	11.0	43.8	23.8	22.6	25.2	111	55.8
4/10	10.6	37.0	22.6	21.6	23.1	103	56.1
4/11	11.3	45.8	22.7	19.8	24.3	101	57.4
4/12	8.7	37.7	18.5	17.1	20.3	106	53.1
4/13	10.7	42.6	20.0	19.2	20.9	196	56.6
4/14	10.3	45.1	18.6	17.8	19.4	248	56.8
4/15	9.5	40.0	18.3	17.8	18.9	224	57.2
4/16	9.2	42.1	15.6	14.3	16.2	223	55.9
4/17	8.7	37.2	14.8	14.1	15.3	330	56.2
4/18	7.6	36.5	13.3	12.6	14.0	355	54.3
4/19	7.7	34.8	13.2	12.6	13.5	268	57.6
4/20	7.8	29.4	12.7	12.3	13.0	287	60.6
4/21	7.2	34.4	12.6	12.3	12.9	393	63.5
4/22	7.4	33.3	12.4	12.2	12.7	408	64.2
4/23	8.2	29.7	12.2	11.8	12.5	218	67.5
4/24	8.0	30.2	11.4	10.5	11.6	116	69.3
4/25	7.3	26.4	10.1	9.9	10.4	217	71.0
4/26	6.8	27.8	9.9	9.6	10.3	196	73.3
4/27	6.5	24.7	9.4	9.0	9.7	259	75.4
4/28	5.6	24.9	8.9	8.7	9.3	230	76.3
4/29	5.9	25.0	9.2	8.7	9.7	105	77.3
4/30	5.3	25.4	8.1	7.9	8.3	279	79.1
5/1	4.9	28.4	8.3	8.0	8.4	431	78.5
5/2	5.0	31.9	8.7	8.6	8.8	925	79.2
5/3	4.7	30.9	8.9	8.8	9.1	1144	79.9
5/4	5.8	24.7	9.6	9.4	9.7	662	82.0
5/5	6.4	22.7	9.3	9.1	9.4	530	81.4
5/6	6.6	24.4	9.3	9.0	9.5	278	82.7
5/7	3.3	16.2	9.1	8.9	9.4	201	84.3
5/8	5.8	22.0	8.7	8.4	9.0	209	85.8
5/9	5.5	17.9	8.4	8.1	8.6	150	88.0
5/10	5.4	19.3	7.6	7.5	7.7	359	91.2
5/11	2.2	16.8	7.3	7.1	7.6	254	92.6
5/12	4.9	22.3	7.4	7.1	7.6	288	92.3
5/13	4.6	20.9	7.7	7.5	8.0	360	91.3
5/14	4.9	17.7	7.9	7.8	8.2	230	90.1

Table E-20. 2007 Travel time of PIT-tagged yearling Chinook from Lower Granite Dam to McNary Dam. (con't)

Lower Granite	Travel Time			Confidence Limits		Ice Harbor Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
5/15	5.7	20.3	8.2	7.9	8.6	130	87.3
5/16	5.8	14.1	7.9	7.5	8.3	78	84.4
5/17	5.1	20.9	7.7	7.0	8.4	78	82.6
5/18	5.7	13.1	8.5	8.0	9.4	54	78.4
5/19	5.3	12.4	8.0	7.5	8.7	64	76.5
5/20	4.3	13.5	8.0	7.7	8.3	53	72.9
5/21	5.0	15.5	8.4	7.7	9.3	46	70.1
5/22	5.3	17.0	10.9	7.7	15.2	17	63.4
5/23	7.5	15.6	10.9	9.3	13.9	12	61.0
5/24	6.5	14.8	9.2	8.0	12.0	19	60.3
5/25	7.1	14.6	9.8	9.1	12.8	9	58.3
5/26	8.2	17.5	10.9	9.8	13.5	10	56.9
5/27	9.1	13.6	9.9	9.2	11.0	9	55.9
5/28	8.2	11.4	9.1	8.2	11.4	7	56.1
5/29	7.6	14.8	10.1	8.1	12.1	13	56.0

Table E-21. 2007 Travel time of PIT-tagged steelhead from Lower Granite Dam to McNary Dam.

Lower Granite	Travel Time			Confidence Limits		Ice Harbor Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
4/21	8	22.1	11.35	9.1	17.6	10	59.1
4/22	9.2	16.7	12.2	9.2	16.7	8	64.2
4/23	9.7	20.5	11.2	9.9	13.7	12	66.2
4/24	8.3	10.4	9.8	8.3	10.4	3	68.0
4/25	7.7	32.1	9.8	7.7	32.1	7	71.0
4/26	8.1	15.9	10.1	8.1	15.9	6	73.3
4/27	7.2	35.4	9.5	7.2	35.4	7	74.5
4/28	6	15.7	9	6	15.7	8	76.3
4/29	5.7	10.9	7.1	6.7	8.3	15	80.2
4/30	5.7	11.4	6.5	6	8.4	13	80.8
5/1	5.7	14	7	6.7	7.1	43	79.9
5/2	5.8	20.2	7.75	6.9	8.1	44	77.8
5/3	5.5	16.2	7.7	7.3	7.9	81	78.4
5/4	5.9	18	8.35	7.3	9.1	60	78.6
5/5	6.4	18.4	8.75	8	9	32	81.4
5/6	6.5	15.4	8.1	7.7	10.3	27	81.2
5/7	7.1	14	10.05	7.9	12.4	10	84.0
5/8	6.7	15.5	8.95	8.1	10	18	85.8
5/9	6.8	24.9	9.1	7.2	10.7	12	88.8
5/10	5.8	18.2	6.95	6.2	8.3	12	90.7
5/11	6	11.7	7.7	6.6	8.3	13	92.3
5/12	4.7	15.9	6.2	5.9	7	23	92.7
5/13	4.8	27.6	7.25	6	9.3	30	91.5
5/14	5.3	21.3	8.2	6.6	11	19	90.1
5/15	5.1	13	7.45	6.3	9.2	14	89.0
5/16	5.3	14.3	7.55	6.1	10.9	12	84.4
5/17	6.5	16.9	8	6.9	11	9	82.6
5/18	5.9	27.9	8.2	6.7	13	12	81.2

Table E-22. 2007 Travel time of PIT-tagged subyearling Chinook from Lower Granite Dam to McNary Dam.

Lower Granite	Travel Time			Confidence Limits		Ice Harbor Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
6/2	9.7	16.9	11.8	10.5	13.7	13	55.4
6/3	8.2	26.9	10.9	9.7	12.3	19	55.3
6/4	7.5	17.3	10.0	8.9	10.5	27	55.4
6/5	7.2	23.5	11.2	9.3	13.4	19	53.9
6/6	7.2	31.4	14.0	8.8	21.6	18	50.5
6/7	8.7	30.0	13.3	10.7	22.4	18	50.1
6/8	7.5	28.4	10.7	8.8	18.2	16	50.0
6/9	10.0	17.5	12.0	10.0	17.5	5	47.9
6/12	10.3	24.0	13.5	10.3	24.0	7	43.2
6/13	11.4	13.0	11.9	11.4	13.0	3	42.5
6/14	11.5	11.5	11.5	11.5	11.5	1	40.5
6/15	8.9	11.7	10.3	8.9	11.7	2	40.2
6/16	8.5	10.6	9.6	8.5	10.6	2	38.6
6/17	9.4	16.1	12.1	9.4	16.1	4	36.9
6/18	9.8	11.8	10.7	9.8	11.8	5	36.0
6/19	8.4	52.0	16.2	8.4	52.0	6	34.4
6/20	8.7	13.1	10.0	8.7	13.1	3	35.2
6/21	12.7	17.2	15.0	12.7	17.2	2	33.7
6/22	7.6	13.3	10.3	7.6	13.3	4	34.1
6/23	9.6	13.4	13.3	9.6	13.4	3	32.9
6/24	8.5	8.5	8.5	8.5	8.5	1	32.6
6/25	8.4	9.4	8.9	8.4	9.4	2	32.2
6/26	8.6	12.7	11.2	8.6	12.7	4	32.4
6/27	10.8	10.8	10.8	10.8	10.8	1	33.1
6/28	8.1	10.7	10.1	8.1	10.7	3	33.4
7/1	8.8	8.8	8.8	8.8	8.8	2	34.1
7/2	9.5	9.5	9.5	9.5	9.5	1	34.1
7/3	37.9	37.9	37.9	37.9	37.9	1	29.5
7/4	7.7	11.4	11.2	7.7	11.4	3	34.1

Table E-23 2007 Travel time of PIT-tagged yearling Chinook from McNary Dam to Bonneville Dam.

McNary Dam	Travel Time			Confidence Limits		Bonneville Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
4/22	5.9	18.9	9.4	5.9	12.9	11	218.8
4/23	4.3	19.6	7.3	6.3	9.1	22	215.7
4/24	4.5	19.7	6.2	5.9	7.6	31	215.6
4/25	4.3	25.8	6.6	6.2	6.9	62	227.2
4/26	4.7	15.5	6.3	6.1	7.0	66	230.1
4/27	4.3	27.2	6.0	5.7	6.3	95	236.7
4/28	3.7	59.3	5.9	5.7	6.2	163	243.7
4/29	4.2	16.6	5.8	5.6	6.0	201	251.7
4/30	3.7	37.9	5.9	5.6	6.0	256	258.1
5/1	3.4	19.2	5.6	5.4	5.8	221	259.8
5/2	3.5	58.6	5.2	5.1	5.4	309	261.8
5/3	3.4	56.9	5.2	5.0	5.3	525	260.5
5/4	3.2	21.0	5.2	5.1	5.3	748	262.2
5/5	3.4	18.0	5.2	5.1	5.3	822	261.0
5/6	3.5	18.3	5.3	5.2	5.4	619	260.4
5/7	3.4	62.3	5.0	4.9	5.1	595	259.4
5/8	3.3	11.1	4.8	4.7	4.9	728	261.2
5/9	3.1	9.8	4.5	4.4	4.6	1029	267.2
5/10	3.2	12.0	4.4	4.4	4.5	941	266.1
5/11	3.2	17.1	4.4	4.3	4.5	796	266.5
5/12	3.3	12.4	4.7	4.6	4.7	586	261.0
5/13	3.3	21.9	4.7	4.6	4.8	578	259.3
5/14	3.4	12.6	4.4	4.4	4.5	575	262.0
5/15	3.2	9.5	4.5	4.4	4.6	366	256.8
5/16	3.3	10.6	4.7	4.5	4.8	430	254.5
5/17	3.2	11.4	4.3	4.2	4.4	515	255.1
5/18	3.3	14.3	4.3	4.2	4.3	637	255.5
5/19	3.1	11.7	4.1	4.1	4.2	471	256.4
5/20	3.1	8.9	4.4	4.3	4.4	290	254.5
5/21	3.2	9.0	4.6	4.5	4.7	268	250.8
5/22	3.5	10.2	4.7	4.6	4.8	208	242.7
5/23	3.5	9.1	4.6	4.4	4.8	178	243.0
5/24	3.5	10.5	4.5	4.3	4.7	146	238.9
5/25	3.3	17.4	4.4	4.2	4.7	81	237.6
5/26	3.3	7.7	4.6	4.1	5.0	41	232.3
5/27	3.5	8.6	4.6	4.4	5.2	60	229.3
5/28	3.4	8.7	5.0	4.3	5.4	40	229.0
5/29	3.7	9.6	4.7	4.5	5.2	42	223.3
5/30	4.1	7.9	5.5	4.3	6.2	12	222.1
5/31	3.6	13.3	4.8	4.3	5.4	36	219.1
6/1	3.6	6.3	4.4	4.2	5.0	20	216.5
6/2	3.6	6.7	4.6	4.0	5.2	17	219.2

Table E-23 2007 Travel time of PIT-tagged yearling Chinook from McNary Dam to Bonneville Dam. (con't)

McNary Dam	Travel Time			Confidence Limits		Bonneville Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
6/3	3.5	5.5	4.2	3.6	4.7	13	222.1
6/4	3.4	12.0	4.1	3.8	5.3	20	228.2
6/5	3.1	6.6	3.9	3.6	4.5	23	238.4
6/6	3.0	6.7	4.1	3.6	4.5	19	241.2
6/7	3.1	5.9	4.3	4.0	4.6	25	242.9
6/8	3.1	6.7	4.1	3.9	4.4	25	246.8
6/9	3.3	4.9	4.1	3.5	4.5	16	244.1
6/10	3.3	6.9	4.1	3.9	4.9	15	235.8
6/11	3.7	4.7	4.4	3.7	4.7	6	237.5
6/12	3.5	6.2	4.1	3.8	4.5	10	227.3

Table E-24. 2007 Travel time of PIT-tagged steelhead from McNary Dam to Bonneville Dam.

McNary Dam	Travel Time			Confidence Limits		Bonneville Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
4/19	4.7	5.4	21.5	4.8	12.9	12	210.8
4/20	5.2	6.5	18.4	5.2	18.4	7	212.9
4/21	4.8	7.5	38.4	6.8	14	20	214.5
4/22	4.7	6	11.5	5.7	10.4	11	213.1
4/23	4.8	6.2	16.3	4.8	16.3	8	214.6
4/24	3.6	7.1	12.3	4.7	8.8	14	219.6
4/25	4.5	6.3	15.9	4.9	15.9	9	223.3
4/26	4.2	6	24	4.9	7.2	15	230.1
4/27	4.3	5.7	8.4	5.2	6.6	15	236.7
4/28	4.5	5.8	13	4.9	7.5	19	243.7
4/29	4.2	5.9	22.4	4.8	7.6	20	251.7
4/30	4	4.8	9.4	4.2	6.3	10	256.1
5/1	3.6	4.8	9.8	4.1	6.4	17	263.9
5/2	3.5	4.4	11.1	3.9	5.8	13	267.2
5/3	3.2	4.8	8.8	3.7	5.7	27	260.5
5/4	3.2	4.6	9.5	4.3	4.9	50	262.2
5/5	3.4	4.5	9.7	4.3	4.8	46	261
5/6	3.3	4.2	13.7	4	4.4	46	258.5
5/7	3.6	4.3	14.3	4.1	4.8	26	258.5
5/8	3.2	4.5	21.7	4.4	4.6	70	261.2
5/9	3.5	4.4	35.1	4.2	4.6	59	264
5/10	3.6	5.4	8.1	4.5	5.7	36	266.6
5/11	3.6	5	35.2	4.9	5.6	47	264
5/12	3.5	4.8	20.7	4.5	5.3	35	261
5/13	3.3	4.9	18.5	4.5	5.6	48	259.3
5/14	3.8	5.6	33.2	4.6	8	36	260.5
5/15	3.5	5.6	14.3	4.8	6.5	24	256.6
5/16	3.5	5	18.5	4.4	6.6	32	254.5
5/17	3.6	4.7	25.3	4.5	5.3	63	255
5/18	3.2	5.2	32	4.7	5.7	43	255.9
5/19	3.8	5	21	4.5	5.6	40	254.6
5/20	3.5	6.6	22.4	4.8	7.6	32	246.3
5/21	3.9	5.8	17.4	5.4	6.2	46	244.5
5/22	3.7	5	21.5	4.7	5.4	38	242.7
5/23	3.8	4.5	20.1	4.2	6	41	243
5/24	4.2	6.4	13.2	5.3	7	22	237
5/25	3.7	5.8	7.6	5.4	6.3	17	235.1
5/26	3.8	6.4	26.5	5	14.4	12	230.8
5/27	3.7	5.5	51.2	4.6	7	21	225.8
5/28	4.2	5.1	15.7	4.4	6.7	19	229

Table E-25. 2007 Travel time of PIT-tagged subyearling Chinook from McNary Dam to Bonneville Dam.

McNary Dam	Travel Time			Confidence Limits		Bonneville Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow
6/5	4.3	8.8	6.4	5.0	8.0	16	238.0
6/6	4.2	13.6	6.6	5.3	8.2	18	240.9
6/7	3.7	24.9	6.1	4.7	10.9	14	240.5
6/8	4.6	17.9	5.5	4.8	7.0	10	245.5
6/9	4.6	20.3	6.6	5.5	8.2	18	236.0
6/10	4.7	14.9	5.8	5.3	7.1	26	230.1
6/11	4.9	9.9	5.5	5.1	6.4	13	223.8
6/12	4.1	20.0	5.4	4.7	6.5	26	219.1
6/13	3.8	17.0	5.2	5.0	5.9	28	217.9
6/14	3.8	20.3	5.3	4.9	6.8	35	214.6
6/15	4.5	21.1	5.7	5.2	6.5	39	201.0
6/16	3.4	17.5	6.1	5.5	7.0	34	195.8
6/17	4.5	17.2	7.2	5.6	7.8	28	190.3
6/18	4.4	17.8	5.9	5.5	7.0	23	192.1
6/19	5.1	15.7	5.7	5.4	7.6	18	187.0
6/20	3.7	9.5	5.9	4.5	6.5	12	182.5
6/21	4.2	16.3	5.6	5.2	10.3	15	179.3
6/22	4.5	20.9	5.7	4.7	7.7	21	178.2
6/23	5.3	11.6	8.1	5.3	11.6	7	170.6
6/24	4.3	9.5	5.6	4.5	7.4	11	171.6
6/25	4.3	12.8	5.5	4.8	6.4	12	173.2
6/26	4.1	10.6	5.6	4.9	6.4	24	160.8
6/27	4.3	10.4	6.0	4.3	10.4	7	158.5
6/28	4.4	18.7	5.0	4.5	6.5	16	157.6
6/29	4.1	9.4	4.9	4.5	6.2	20	154.8
6/30	4.3	6.5	5.1	4.4	5.4	16	154.7
7/1	4.2	10.1	4.9	4.5	6.6	17	154.7
7/2	3.7	6.8	4.7	4.1	5.2	17	155.0
7/3	4.0	7.1	5.0	4.7	5.9	25	158.9
7/4	3.9	6.4	4.7	4.5	5.4	18	159.3
7/5	3.9	8.7	4.6	4.3	5.2	27	162.9
7/6	3.9	7.6	5.2	4.9	5.5	52	164.6
7/7	3.2	9.1	5.0	4.6	5.4	30	164.3
7/8	4.1	6.2	4.6	4.3	5.6	17	173.4
7/9	3.3	5.6	4.6	4.1	5.3	9	181.2
7/10	3.4	4.8	4.1	3.8	4.4	14	182.6
7/11	3.5	12.3	4.3	3.9	4.5	28	186.3
7/12	3.5	5.7	4.4	3.9	4.7	22	191.9

APPENDIX F

Hatchery Release Schedule

Coleville Tribe

Cassimer Bar Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
ST		SU	4/13/2007	4/13/2007	9,874	11.1	Omak Creek	Okanogan River	2006	100% PIT; Scatter plant into Omak Creek (RM 4.6)
ST		SU	4/14/2007	4/14/2007	9,000	14	Omak Creek	Okanogan River	2006	100% PIT; Rel @ St. Mary Acclim Pond (RM 4.6)
Cassimer Bar Hatchery Total					18,874					

Eastbank Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SU	4/20/2007	4/20/2007	8,000	10	Bonaparte Acclimation Pond	Okanogan River	2005	100% AD/CWT
Eastbank Hatchery Total					8,000					

Coleville Tribe Total	26,874
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Idaho Dept. Fish and Game

Clearwater Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	3/23/2007	4/4/2007	373,977	15.4	Powell Acclim Pond	Lochsa River	2005	100% AD; 86655 CWT; 15000 PIT
CH	1	SP	3/29/2007	3/29/2007	133,829	16	Crooked R Acclim Pond	S Fk Clearwater River	2005	133330 AD; 499 AD/PIT
CH	1	SP	3/29/2007	3/30/2007	517,092	16	Crooked R Acclim Pond	S Fk Clearwater River	2005	100% AD; 42425 CWT; 14993 PIT; Rel @ Crooked R. Trap
CH	1	SP	3/31/2007	4/6/2007	375,759	15.4	Red River Acclim Pond	S Fk Clearwater River	2005	318733 AD Only; 42049 AD/CWT; 14977 AD/PIT
Spring Chinook Yearling Total					1,400,657					
ST		SU	4/12/2007	4/13/2007	151,296	4.92	Crooked R Acclim Pond	S Fk Clearwater River	2006	100% AD; 66085 CWT/LV; 300 PIT
ST		SU	4/15/2007	4/17/2007	100,329	5.11	Red River	S Fk Clearwater River	2006	100% AD; 300 PIT
ST		SU	4/13/2007	4/17/2007	272,819	4.59	Redhouse (SFk ClearH20 R)	S Fk Clearwater River	2006	100% AD; 67823 CWT; 300 PIT
Summer Steelhead Total					524,444					
Clearwater Hatchery Total					1,925,101					

Eagle Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
SO	1	UN	5/8/2007	5/8/2007	329	6.49	Salmon River (ID)	Salmon River (ID)	2005	100% AD/PIT
Eagle Hatchery Total					329					

Magic Valley Hatchery										
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Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
ST		SU	4/9/2007	4/10/2007	63,597	4.89	Squaw Cr Acclim Pond	Salmon River (ID)	2006	100% AD/CWT; 500 PIT
ST		SU	4/9/2007	4/10/2007	59,567	4.99	Squaw Cr Acclim Pond	Salmon River (ID)	2006	100% AD/CWT; 500 PIT
ST		SU	4/10/2007	4/12/2007	215,170	4.53	Little Salmon River	Salmon River (ID)	2006	59415 AD/LV/CWT; 300 PIT
ST		SU	4/12/2007	4/16/2007	129,930	4.33	Salmon River (ID)	Salmon River (ID)	2006	100% AD; 29705 CWT; 293 PIT; Rel in Section 16 (Red Rock)
ST		SU	4/16/2007	4/17/2007	165,473	4.18	Salmon River (ID)	Salmon River (ID)	2006	100% AD; 31981 CWT; 300 PIT; Rel in section 17 (Colston Corner)
ST		SU	4/17/2007	4/18/2007	78,847	4.22	Salmon River (ID)	Salmon River (ID)	2006	100% AD; Rel in section 17 (Shoup Bridge)
ST		SU	4/18/2007	4/18/2007	41,136	4.4	Slate Creek	Salmon River (ID)	2006	100% AD; 31123 CWT; 293 PIT
ST		SU	4/19/2007	4/20/2007	119,727	4.18	Salmon River (ID)	Salmon River (ID)	2006	100% AD; 29770 CWT; 298 PIT; Rel in section 18 (McNabb Point)
ST		SU	4/20/2007	4/20/2007	30,591	4.45	Pahsimeroi River	Pahsimeroi River	2006	100% AD/CWT
ST		SU	4/20/2007	4/23/2007	60,439	4.1	Salmon River (ID)	Salmon River (ID)	2006	100% AD; Rel in section 18 (Tunnel Rock)
ST		SU	4/23/2007	4/25/2007	207,487	4.36	East Fk Salmon River	Salmon River (ID)	2006	100% AD; 299 PIT
ST		SU	4/25/2007	4/27/2007	132,159	4.04	Squaw Creek	Salmon River (ID)	2006	100% AD; 481 PIT
ST		SU	4/26/2007	4/26/2007	63,669	4.42	Squaw Creek	Salmon River (ID)	2006	100% AD/CWT; 492 PIT
ST		SU	4/27/2007	4/27/2007	60,783	4.28	Yankee Fk (Salmon R)	Salmon River (ID)	2006	100% AD; 30567 CWT
ST		SU	4/27/2007	4/27/2007	30,451	4.32	Yankee Fk (Salmon R)	Salmon River (ID)	2006	100% Unclipped; 298 PIT
ST		SU	4/30/2007	4/30/2007	50,592	4.15	East Fk Salmon River	Salmon River (ID)	2006	100% CWT; No Clip; Rel above E. Fk. Weir
ST		SU	4/30/2007	4/30/2007	54,640	4.25	Valley Creek	Salmon River (ID)	2006	No Clip; 299 PIT
ST		SU	5/1/2007	5/2/2007	60,392	4.23	Slate Creek	Salmon River (ID)	2006	No Clip; 292 PIT
Magic Valley Hatchery Total					1,624,650					

McCall Hatchery										
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Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SU	3/19/2007	3/22/2007	1,087,170	19.12	S Fk Salmon River	Salmon River (ID)	2005	100% AD; 262225 CWT; 52105 PIT
McCall Hatchery Total					1,087,170					

Niagara Springs Hatchery										
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Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
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ST	SU	3/19/2007	3/29/2007	527,701	4.99	Hells Canyon Dam	Snake River	2006	100% AD; 30806 CWT (10-14-80 Rel 3/26); 288 PIT
ST	SU	3/29/2007	4/4/2007	239,868	5.27	Little Salmon River	Salmon River (ID)	2006	100% AD; 31378 CWT(10-15-80); 295 PIT
ST	SU	4/4/2007	4/26/2007	266,738	5.11	Little Salmon River	Salmon River (ID)	2006	100% AD; 30096 CWT (10-49-80); 298 PIT; Rel @ Stinky Springs
ST	SU	4/6/2007	4/24/2007	830,447	4.58	Pahsimeroi River	Pahsimeroi River	2006	100% AD; 63422 CWT (10-50-80 10-51-80); 294 PIT

Niagara Springs Hatchery Total 1,864,754

Oxbow-Idaho Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	5/8/2007	5/8/2007	124,539	55.03	Hells Canyon Dam	Snake River	2006	100% AD; 114585 CWT; 9954 PIT (w/o CWT)

Fall Chinook Subyearling Total 124,539

SO	1	UN	5/8/2007	5/8/2007	54,582	8.8	Redfish Lake	Salmon River (ID)	2005	100% AD/CWT/RV; 1019 PIT
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Sockeye Yearling Total 54,582

Oxbow-Idaho Hatchery Total 179,121

Pahsimeroi Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SU	10/16/2006	10/16/2006	90	30.4	Pahsimeroi River	Pahsimeroi River	2005	100% AD
CH	1	SU	4/15/2007	4/15/2007	987,460	16.47	Pahsimeroi River	Pahsimeroi River	2005	100% AD; 55467 CWT; 498 PIT

Pahsimeroi Hatchery Total 987,550

Rapid River Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	3/12/2007	3/15/2007	350,388	21.5	Hells Canyon Dam	Snake River	2005	100% AD
CH	1	SP	3/14/2007	3/14/2007	135,738	21.64	Pine Bar/Salmon River	Salmon River (ID)	2005	100% AD
CH	1	SP	3/15/2007	4/27/2007	2,498,246	20	Rapid River	Little Salmon River	2005	100% AD; 109883 CWT (10-83-77 10-84-77); 51914 PIT (CSS); 52832 PIT (USACE)

Rapid River Hatchery Total 2,984,372

Sawtooth Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/11/2007	4/11/2007	995,262	17.2	Salmon River (ID)	Salmon River (ID)	2005	100% AD; 121713 CWT; 14934 PIT

Spring Chinook Yearling Total 995,262

SO	1	UN	10/2/2006	10/2/2006	26,994	71.84	Alturas Lake	Salmon River (ID)	2005	100% AD; 1020 PIT; Pre-Smolt Rel
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SO	1	UN	10/2/2006	10/2/2006	18,494	73.46	Pettit Lake	Salmon River (ID)	2005	100%AD; 1020 PIT; Pre-smolt Release
SO	1	UN	10/3/2006	10/3/2006	61,804	73.46	Redfish Lake	Salmon River (ID)	2005	100% AD; 1021 PIT; Pre-smolt Rel
SO	1	UN	5/8/2007	5/8/2007	46,765	20.91	Salmon River (ID)	Salmon River (ID)	2005	100% AD/CWT; 1025 PIT
Sockeye Yearling Total					154,057					
Sawtooth Hatchery Total					1,149,319					
Idaho Dept. Fish and Game Total					11,802,366					

Nez Perce Tribe

Clearwater Hatchery										
Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/2/2007	4/3/2007	269,349	15.4	Selway River	Clearwater River M F	2005	89917 CWT Only; 179432 AD/CWT
Spring Chinook Yearling Total					269,349					
CO	1	UN	9/26/2006	9/27/2006	322,051	56	Eldorado Creek	Clearwater River M F	2005	80518 CWT Only; 61-27-05; 2996 PIT; 238537 Unmarked; Presmolts
Coho Yearling Total					322,051					
ST		SU	4/15/2007	4/17/2007	83,811	4.96	Crooked R Acclim Pond	S Fk Clearwater River	2006	100% Unclipped; 21299 CWT; 299 PIT; Reared and Rel by IDFG per Interim Mgmt Agreement
ST		SU	4/15/2007	4/17/2007	151,317	5.33	Red River	S Fk Clearwater River	2006	100% Unclipped; 300 PIT; Reared and Rel by IDFG per USvOR Interim Mgmt Agreement
ST		SU	4/17/2007	4/17/2007	28,050	5.61	Meadow Creek - CLES	S Fk Clearwater River	2006	100% Unmarked; 297 PIT; Reared and Rel by IDFG per USvOR Interim Mgmt Agreement
ST		SU	4/17/2007	4/17/2007	28,338	5.61	Mill Cr Bridge	S Fk Clearwater River	2006	100% Unmarked; 300 PIT; Reared and Rel by IDFG per USvOR Interim Mgmt Agreement
ST		SU	4/19/2007	4/19/2007	51,415	5.6	Lolo Creek	Clearwater River M F	2006	100% Unmarked; 300 PIT; Reared by IDFG; Transported to and Rel by NEZP per USvOR Interim Mgmt Agreement
Summer Steelhead Total					342,931					
Clearwater Hatchery Total					934,331					
Dworshak NFH										

CO	1	UN	4/12/2007	4/12/2007	291,845	20.2	Clear Creek	Clearwater River M F	2005	120259 CWT Only; 171586 Unmarked; 1000 PIT
Coho Yearling Total					291,845					
ST		SU	4/10/2007	4/13/2007	109,365	5.7	American River	S Fk Clearwater River	2006	No Marks; Rel @ S. Fork; Reared and Rel by USFW per USvOR Interim Mgmt Agreement
ST		SU	4/10/2007	4/14/2007	124,106	6.3	Newsome Creek	S Fk Clearwater River	2006	No Marks; Rel @ S. Fork; Reared and Rel by USFW per USvOR Interim Mgmt Agreement
Summer Steelhead Total					233,471					
Dworshak NFH Total					525,316					
Eagle Creek NFH										
Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CO	1	UN	3/5/2007	3/5/2007	283,331	18.5	Clear Creek	Clearwater River M F	2005	30153 CWT Only (61-27-18); 30151 AD/CWT (61-27-19); 223027 Unmarked
CO	1	UN	3/7/2007	3/7/2007	284,981	15.8	Lapwai Creek	Clearwater River M F	2005	30472 CWT Only (61-26-42); 30471 AD/CWT (61-26-43); 224038 Unmarked
Eagle Creek NFH Total					568,312					
Hagerman NFH										
Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
ST		SU	3/26/2007	4/4/2007	150,115	4.53	Little Salmon River	Salmon River (ID)	2006	100% Unmarked; 300 PIT; Rel @ Stinky Springs; Reared and Rel by USFW per USvOR Interim Mgmt Agreement
ST		SU	4/2/2007	4/2/2007	47,014	4.29	Hazard Creek/Little Salmon R	Little Salmon River	2006	100% Unmarked; Reared and Rel by USFW per USvOR Interim Mgmt Agreement
Hagerman NFH Total					197,129					
Lookingglass Hatchery										
Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	3/16/2007	3/26/2007	105,109	22.2	Lostine Accim Pond	Wallowa River	2005	99854 AD/CWT; 946 CWT Only; 4204 AD Only; 105 Unmarked; 2434 PIT; CWT Codes (09-43-56 09-43-53); Conventional Broodstock

CH	1	SP	4/7/2007	4/17/2007	124,901	20.1	Lostine Accim Pond	Wallowa River	2005	98.9% AD; 96.2% CWT; 125 Unmarked; 4035 PIT; 100297 Conv. Brood. (09-43-54 09-43-55); 24604 Capt. Brood. (24407 VIE LE Red 09-43-60)
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Lookingglass Hatchery Total 230,010

Lyons Ferry Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	5/28/2007	5/29/2007	506,706	57	Big Canyon (Clearwater River)	Clearwater River M F	2006	100103 CWT Only (61- 27-29); 98546 AD/CWT (61-27-30); 789 AD Only; 307268 Unmarked; 2891 PIT
CH	0	FA	5/29/2007	5/29/2007	514,483	50	Cpt John Acclim Pond	Snake River	2006	99212 CWT Only (61- 27-27); 99017 AD/CWT (61-27-28); 1456 AD Only; 314798 Unmarked; 2892 PIT

Fall Chinook Subyearling Total 1,021,189

CH	1	FA	4/6/2007	4/13/2007	158,499	9.9	Cpt John Acclim Pond	Snake River	2005	78588 CWT Only (61- 25-09); 69180 AD/CWT (61-25-06); 112 AD Only; 10619 Unmarked; 3995 PIT
CH	1	FA	4/16/2007	4/17/2007	146,683	9.3	Pittsburg Landing Acclim Pond	Snake River	2005	72805 CWT Only (61- 25-10); 70969 AD/CWT (61-25-05 61-26-61); 142 AD Only; 2767 Unmarked; 4966 PIT
CH	1	FA	4/18/2007	4/19/2007	155,480	8.4	Big Canyon (Clearwater River)	Clearwater River M F	2005	77220 CWT Only (61- 25-08); 67891 AD/CWT (61-25-07); 10369 Unmarked; 4874 PIT

Fall Chinook Yearling Total 460,662

Lyons Ferry Hatchery Total 1,481,851

McCall Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SU	3/12/2007	3/14/2007	120,415	26.9	Johnson Cr Idaho	South Fork Salmon River	2005	100% Unclipped; 12060 PIT; 100% CWT/VIE (LE Orange)

McCall Hatchery Total 120,415

Nez Perce Tribal Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
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CH	0	FA	5/22/2007	5/23/2007	163,431	50.9	Lapwai Creek	Clearwater River M F	2006	44538 AD/CWT (61-27-10); 100303 CWT Only (61-27-10); 674 AD Only; 18590 Unmarked; 3090 PIT
CH	0	FA	6/4/2007	6/4/2007	24,955	37.2	Lukes Gulch Acclim.	S Fk Clearwater River	2006	24906 CWT (61-27-33); 49 Unmarked; 3093 PIT
CH	0	FA	6/11/2007	6/11/2007	24,988	47.3	Cedar Flats Acclim.	Selway River	2006	24890 CWT (61-27-34); 98 Unmarked; 3100 PIT
CH	0	FA	6/11/2007	6/15/2007	491,424	37.9	Nez Perce Tribal Hatchery	Clearwater River M F	2006	194988 AD/CWT (61-26-96); 98947 CWT Only (61-26-99); 665 AD Only; 197489 Unmarked; 3095 PIT

Fall Chinook Subyearling Total 704,798

CH	1	SP	8/10/2006	8/10/2006	51,228	20.7	Lolo Creek	Clearwater River M F	2005	No Clip; 50639 CWT 61-27-12; 589 Unmarked; 5764 PIT; Pre-smolt
CH	1	SP	10/3/2006	10/17/2006	49,639	12.6	Newsome Creek	S Fk Clearwater River	2005	No Clips; 49083 CWT 61-27-11; 556 Unmarked; 5929 PIT; Pre-smolt Acclimated

Spring Chinook Yearling Total 100,867

Nez Perce Tribal Hatchery Total 805,665

Umatilla Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	5/26/2007	5/26/2007	400,924	56.3	Pittsburg Landing Acclim Pond	Snake River	2006	98046 CWT Only (61-27-31); 97668 AD/CWT (61-27-32); 1117 AD Only; 204093 Unmarked; 2889 PIT

Umatilla Hatchery Total 400,924

Nez Perce Tribe Total 5,263,953

Oregon Department of Fish and Wildlife

Irrigon Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
ST		SU	4/8/2007	4/8/2007	183,603	4.05	Wallowa Acclim Pond	Wallowa River	2006	42.3% AD Only; 55.1% AD/RV; 44% CWT (09-44-03 09-44-04 09-44-05)
ST		SU	4/9/2007	4/9/2007	173,782	3.9	Wallowa Acclim Pond	Wallowa River	2006	49.2% AD Only; 48.5% AD/LV/CWT (09-44-01 09-44-02 09-43-05)
ST		SU	4/9/2007	4/11/2007	100,038	4.39	Big Sheep Creek	Imnaha River	2006	No Mark

ST		SU	4/10/2007	5/1/2007	158,103	4.6	Little Sheep Creek	Imnaha River	2006	83.1% AD Only; 16.9% AD/LV/CWT (09-43-04); Acclim @ Little Sheep Acc Facility
ST		SU	4/11/2007	4/11/2007	79,398	4.05	Big Canyon Acclim.Pd (Grande Ronde)	Grande Ronde River	2006	97.9% AD
ST		SU	4/12/2007	4/12/2007	78,544	4	Big Canyon Acclim.Pd (Grande Ronde)	Grande Ronde River	2006	77.6% AD only; 20.3% AD/LV/CWT (09-44-07)
ST		SU	4/28/2007	5/10/2007	121,738	4.25	Wallowa Acclim Pond	Wallowa River	2006	47.9% AD Only; 28.5% AD/RV; 21.3% AD/LV/CWT (09-43-63); 21.2% CWT (09-44-06)
ST		SU	5/1/2007	5/1/2007	82,352	3.95	Big Canyon Acclim.Pd (Grande Ronde)	Grande Ronde River	2006	97.9% AD
ST		SU	5/2/2007	5/2/2007	82,074	4.35	Big Canyon Acclim.Pd (Grande Ronde)	Grande Ronde River	2006	64% AD Only; 33.9% AD/LV/CWT (09-44-08)
Summer Steelhead Total					1,059,632					
CH	1	SP	8/14/2006	8/14/2006	23	27	Grande Ronde Acclim Pond	Grande Ronde River	2005	No mark
Spring Chinook Yearling Total					23					
Irrigon Hatchery Total					1,059,655					
Lookingglass Hatchery										
Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	3/21/2007	3/21/2007	110,000	21.8	Imnaha Acclim Pond	Imnaha River	2005	100% AD; 60% CWT (09-38-25 09-38-26 09-43-50); 4.9% PIT
CH	1	SP	3/31/2007	3/31/2007	10,000	21.8	Imnaha Acclim Pond	Imnaha River	2005	100% AD; 36.9% CWT (09-38-25 09-38-26 09-43-50); 4.9% PIT
CH	1	SP	4/1/2007	4/1/2007	312,530	21.5	Imnaha Acclim Pond	Imnaha River	2005	100% AD; 36.9% CWT (09-38-25 09-38-26 09-43-50); 4.9% PIT
Lookingglass Hatchey Total					432,530					
Oak Springs Hatchery										
Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
ST		SU	3/1/2007	3/2/2007	32,124	6	Hood River	Hood River	2006	100% AD
ST		SU	3/14/2007	3/15/2007	31,362	5.69	Hood River	Hood River	2006	100% AD

ST	SU	4/10/2007	4/26/2007	3,256	4.94	Deschutes River	Deschutes River	2006	100% AD/RV; PGE Passage Study; Rel @ Crooked River above Round Butte Dam
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Summer Steelhead Total 66,742

ST	WI	4/16/2007	4/16/2007	1,870	5.48	E Fk Hood River	Hood River	2006	100% AD/RV
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Winter Steelhead Total 1,870

Oak Springs Hatchery Total 68,612

Round Butte Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/12/2007	4/19/2007	309,621	9.75	Deschutes River	Deschutes River	2005	98.9% AD/CWT (09-44-40 09-44-41 09-44-42 09-44-43)
CH	1	SP	6/2/2007	6/2/2007	26,402	9.75	Deschutes River	Deschutes River	2005	98.9% AD/CWT (09-44-40 09-44-41 09-44-42 09-44-43)

Spring Chinook Yearling Total 336,023

ST	SU	4/4/2007	4/5/2007	178,997	3.97	Deschutes River	Deschutes River	2006	98% AD/LM
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Summer Steelhead Total 178,997

Round Butte Hatchery Total 515,020

Umatilla Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	5/15/2007	5/15/2007	306,695	46.55	Umatilla River	Umatilla River	2006	100% AD/CWT (07-01-52 07-01-53)

Fall Chinook Subyearling Total 306,695

ST	SU	10/24/2006	10/24/2006	43,054	46.9	Umatilla River	Umatilla River	2006	100% AD
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ST	SU	4/16/2007	4/16/2007	40,422	4.8	Meacham Creek	Umatilla River	2006	100% AD; 40% LV/CWT (09-44-63); Rel @ RM 2.0
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Summer Steelhead Total 83,476

Umatilla Hatchery Total 390,171

Willard NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/3/2007	4/3/2007	249,186	18.01	Walla Walla River	Walla Walla River	2005	100% AD; 49972 CWT (05-15-72); 3996 PIT; Rel @ Harris Park Bridge on S. Fork (RM48)

Willard NFH Total 249,186

Oregon Dept. of Fish and Wildlife Total 2,715,174

U.S. Department of Fish and Wildlife

Carson NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/12/2007	4/12/2007	1,158,425	17.17	Carson Hatchery	Wind River	2005	100% AD; 24654 CWT (05-21-86); 24772 CWT (05-21-85); 24703 CWT (05-21-87); 14980 PIT

Carson NFH Hatchery Total **1,158,425**

Dworshak NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	3/28/2007	3/29/2007	963,211	17.71	Dworshak Hatchery	Clearwater River M F	2005	100% AD; 130000 CWT; 104480 (~52000 CSS; ~53000 COE/NOAA)

Spring Chinook Yearling Total **963,211**

ST		SU	4/10/2007	4/13/2007	305,536	5.7	S Fk Clearwater River	Clearwater River M F	2006	100% AD
ST		SU	4/10/2007	4/13/2007	306,215	6.2	Clear Creek	Clearwater River M F	2006	100% AD
ST		SU	4/17/2007	4/21/2007	1,312,486	6	Dworshak Hatchery	Clearwater River M F	2006	100% AD/LV/CWT; 1492 PIT

Summer Steelhead Total **1,924,237**

Dworshak NFH Total **2,887,448**

Entiat NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/13/2007	4/13/2007	363,468	20	Entiat Hatchery	Entiat River	2005	100% AD; 193302 CWT 05-31-70 through 05-31-74; 05-49-05; 1000 PIT

Entiat NFH Total **363,468**

Hagerman NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
ST		SU	4/4/2007	4/6/2007	92,522	4.5	Little Salmon River	Salmon River (ID)	2006	100% AD; 298 PIT; Rel @ Stinky Springs
ST		SU	4/9/2007	4/30/2007	821,364	4.19	Salmon River (ID)	Salmon River (ID)	2006	100% AD; 81929 CWT (10-17-80 10-88-77); 300 PIT (Rel Apr 9)
ST		SU	5/1/2007	5/2/2007	102,551	4.59	East Fk Salmon River	Salmon River (ID)	2006	100% AD; 295 PIT
ST		SU	5/3/2007	5/9/2007	247,855	4.65	Yankee Fk (Salmon R)	Salmon River (ID)	2006	142342 No Clip (300 PIT); 105513 AD Only

Hagerman NFH Total **1,264,292**

Kooskia NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/2/2007	4/2/2007	178,687	30.5	Kooskia Hatchery	Clearwater River M F	2005	100% AD/CWT(05-17-85 10-24-80 10-75-71)
CH	1	SP	4/2/2007	4/2/2007	390,878	30.8	Kooskia Hatchery	Clearwater River M F	2006	100% AD; 9945 PIT

Kooskia NFH Total**569,565****Leavenworth NFH**

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/18/2007	4/18/2007	1,177,568	20	Icicle Creek	Wenatchee River	2005	100% AD; 586693 CWT (05-15-74 05-15-75 05-21-76 05-25-76 05-25-78 05-26-76 05-26-77)

Leavenworth NFH Total**1,177,568****Little White Salmon NFH**

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	6/28/2007	6/28/2007	2,061,924	77.1	Little White Salmon River	Little White Salmon River	2006	1664928 AD Only; 198480 CWT Only (05-38-89 05-38-88); 198516 AD/CWT (05-38-87 05-38-86)

Fall Chinook Subyearling Total**2,061,924**

CH	1	SP	4/12/2007	4/12/2007	1,006,105	14	Little White Salmon River	Little White Salmon River	2005	100% AD; 124790 CWT (05-25-98 05-25-79)
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Spring Chinook Yearling Total**1,006,105****Little White Salmon NFH Total****3,068,029****Spring Creek NFH**

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	3/5/2007	3/5/2007	6,598,443	149.3	White Salmon River	White Salmon River	2006	6472862 AD&CWT (05-43-36 05-25-88 05-28-97); 125581 CWT Only (05-43-35 05-25-89 05-28-98); Rel. @ Col. R. 1 mi below White Salmon R.
CH	0	FA	3/9/2007	3/9/2007	1,168,812	128.1	White Salmon River	White Salmon River	2006	1042689 AD&CWT (05-43-18 05-25-70 05-28-95); 126123 CWT Only (05-43-34 05-25-84 05-28-96); Rel. @ Col. R. 1 mi below White Salmon R.
CH	0	FA	4/12/2007	4/12/2007	4,210,573	88.58	White Salmon River	White Salmon River	2006	4110581 AD/CWT (05-25-77); 99992 CWT Only (05-34-84); Rel @ Col. R. 1 mi below White Salmon R.
CH	0	FA	5/1/2007	5/1/2007	3,494,735	74.24	White Salmon River	White Salmon River	2006	3396257 AD/CWT (05-35-92); 98478 CWT Only (05-34-85); Rel @ Col. R. 1 mi below White Salmon R.

Spring Creek NFH Total**15,472,563****Warm Springs NFH**

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	3/21/2007	4/18/2007	520,000	25	Warm Springs Hatchery	Deschutes River	2005	100% AD/CWT (05-25-82 thru -83_05-30-75 thru -77_05-30-79_05-30-81 thru -99_05-45-46 thru -47); 8000 PIT

Warm Springs NFH Total 520,000

Winthrop NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/11/2007	4/11/2007	589,693	18.6	Winthrop Hatchery	Methow River	2005	100% CWT 05-17-91 05-26-78 05-21-78 05-28-77 05-48-63 05-21-77; 3835 PIT

Spring Chinook Yearling Total 589,693

ST		SU	4/30/2007	4/30/2007	122,515	8	Winthrop Hatchery	Methow River	2006	100% AD
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Summer Steelhead Total 122,515

Winthrop NFH Total 712,208

U.S. Fish and Wildlife Total	27,193,566
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Umatilla Tribe

Bonneville Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	FA	3/9/2007	3/14/2007	236,781	11.68	Thornhollow Acclim Pond	Umatilla River	2005	11.3% AD/CWT (09-44-50); 88.7% ODFW Agency Tag/BWT; 0.4% PIT
CH	1	FA	4/6/2007	4/6/2007	190,940	10.45	Thornhollow Acclim Pond	Umatilla River	2005	12.7% AD/CWT (09-44-51); 87.3% ODFW Agency Code/BWT; 0.5% PIT

Bonneville Hatchery Total 427,721

Cascade Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CO	1	UN	3/8/2007	3/13/2007	249,732	20.8	Pendelton Acclim Pond	Umatilla River	2005	11.2% AD/CWT (09-44-47)
CO	1	UN	3/30/2007	4/26/2007	749,377	16.49	Pendelton Acclim Pond	Umatilla River	2005	3.7% AD/CWT (09-44-48)

Cascade Hatchery Total 999,109

Lookingglass Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	3/19/2007	3/25/2007	20,620	23.2	Grande Ronde Acclim Pond	Grande Ronde River	2005	100% AD/CWT (09-43-62); 2.4% PIT; Captive Brood
CH	1	SP	3/26/2007	4/11/2007	21,572	25.9	Catherine Cr Acclim Pond	Grande Ronde River	2005	100% AD/CWT/VIE (LE Blue); CWT Code (09-43-61); 48% PIT; Captive Brood

CH	1	SP	3/26/2007	4/11/2007	49,696	27.3	Catherine Cr Acclim Pond	Grande Ronde River	2005	100% AD/CWT (09-43-57); 21% PIT; Conventional F1
CH	1	SP	4/2/2007	4/11/2007	118,803	20.7	Grande Ronde Acclim Pond	Grande Ronde River	2005	Unclipped; 100% CWT (09-43-58 09-43-59 09-31-62); 1.3% PIT; Conventional F1

Lookingglass Hatchery Total 210,691

Lower Herman Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CO	1	UN	3/8/2007	3/13/2007	511,105	17.74	Pendelton Acclim Pond	Umatilla River	2005	5.2% AD/CWT (09-44-58)

Lower Herman Hatchery Total 511,105

Umatilla Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	5/15/2007	5/15/2007	309,178	53	Thornhollow Acclim Pond	Umatilla River	2006	100% AD; 97.9% CWT (07-01-51 07-01-54); 1% PIT

Fall Chinook Subyearling Total 309,178

CH	1	SP	1/15/2007	1/15/2007	168,095	17.75	Imeques Acclim Pond	Umatilla River	2005	100% AD; 18% RV/CWT (09-44-59)
CH	1	SP	3/2/2007	3/7/2007	498,128	12.89	Imeques Acclim Pond	Umatilla River	2005	94.1% AD Only; 5.9% AD/RV/CWT (09-44-60); 0.2% PIT

Spring Chinook Yearling Total 666,223

ST		SU	4/19/2007	4/26/2007	53,606	5	Minthorn Acclimation Pond	Umatilla River	2006	40.5% AD; 59.5% AD/LV/CWT (09-44-62); 3.7% PIT
ST		SU	4/19/2007	4/26/2007	43,725	5	Pendelton Acclim Pond	Umatilla River	2006	47.9% AD Only; 52.1% AD/LV/CWT (09-44-61 09-44-17); 4.6% PIT

Summer Steelhead Total 97,331

Umatilla Hatchery Total 1,072,732

Willard NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/17/2007	4/17/2007	224,397	15.85	Imeques Acclim Pond	Umatilla River	2005	82.5% AD Only; 17.5% AD/RV/CWT (05-51-90); 0.4% PIT

Willard NFH Total 224,397

Umatilla Tribe Total 3,445,755

Warm Springs Tribe

Oak Springs Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
ST		WI	4/19/2007	4/25/2007	8,356	6.4	Parkdale Acclim Pond	Hood River	2006	100% AD/RV; 10% PIT

ST	WI	4/20/2007	5/15/2007	19,283	6.15	E Fk Irrig Dist Sand Trap	Hood River	2006	100% AD/RV; 10% PIT
ST	WI	5/3/2007	5/16/2007	8,357	5.8	Parkdale Acclim Pond	Hood River	2006	100% AD/RV; 10% PIT
ST	WI	5/15/2007	5/15/2007	146	6.15	Hood River	Hood River	2006	100% AD/RV; 10% PIT; Trucked and Rel @ mouth of Hood R
ST	WI	5/16/2007	5/16/2007	348	9.75	Hood River	Hood River	2006	100% AD/RV; 10% PIT; Trucked and Rel @ mouth of Hood River

Oak Springs Hatchery Total 36,490

Round Butte Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	3/20/2007	5/4/2007	31,578	13.7	Parkdale Acclim Pond	Hood River	2005	100% AD/LV/CWT (07-44-46); 10% PIT
CH	1	SP	4/10/2007	4/16/2007	26,233	11.7	Blackberry Acclim Pond	Hood River	2005	97.2% AD/RM/CWT (09-44-44); 10% PIT
CH	1	SP	4/10/2007	4/16/2007	19,419	11.7	Jones Creek Acclim Pond	Hood River	2005	97.2% AD/RM/CWT (09-44-44); 10% PIT
CH	1	SP	4/24/2007	5/7/2007	19,316	10.4	Jones Creek Acclim Pond	Hood River	2005	96.9% AD/RM/CWT (09-44-44 09-44-45); 10% PIT
CH	1	SP	4/24/2007	5/8/2007	26,188	10.4	Blackberry Acclim Pond	Hood River	2005	96.9% AD/RM/CWT (09-44-44 09-44-45); 10% PIT
CH	1	SP	5/7/2007	5/7/2007	1,454	12.3	Hood River	Hood River	2005	96.9% AD/RM/CWT (09-44-44 09-44-45); 10% PIT; Trucked and Rel @ mouth of Hood R.
CH	1	SP	5/8/2007	5/8/2007	2,904	12.2	Hood River	Hood River	2005	96.9% AD/RM/CWT (09-44-44 09-44-45); 10% PIT; Trucked and Rel @ mouth of Hood R.

Round Butte Hatchery Total 127,092

Warm Springs Tribe Total 163,582

Washington Department of Fish and Wildlife

Chiwawa Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/16/2007	5/15/2007	494,012	15.94	Chiwawa Hatchery	Wenatchee River	2005	487752 AD/CWT; 1912 AD Only; 4348 Bad Clip/CWT; CWT Code (63-28-96 63-32-96)
CH	1	SP	5/2/2007	5/2/2007	69,102	12.3	Lake Wenatchee	Wenatchee River	2005	100% CWT

Chiwawa Hatchery Total 563,114

Eastbank Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
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CH	1	SU	4/18/2007	5/9/2007	275,919	17.5	Similkameen Acclim Pd	Okanogan River	2005	272123 AD/CWT (63-35-94); 1340 AD Only; 2456 Bad Clip/CWT
CH	1	SU	4/25/2007	4/25/2007	99,660	10.4	Chelan Falls	Mid-Columbia River	2005	98.1% AD/CWT (63-35-95)
CH	1	SU	4/30/2007	4/30/2007	644,182	9.8	Dryden Acclim Pond	Wenatchee River	2005	618157 AD/CWT (63-35-92); 12690 AD Only; 13335 Bad Clip/CWT

Summer Chinook Yearling Total 1,019,761

SO	1	UN	10/30/2006	10/30/2006	140,542	10.4	Lake Wenatchee	Wenatchee River	2005	100% AD&CWT 63-30-67 63-34-70; 10%PIT
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Sockeye Yearling Total 140,542

Eastbank Hatchery Total 1,160,303

Lyons Ferry Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	5/23/2007	5/23/2007	200,692	61.4	Lyons Ferry Hatchery	Snake River	2006	1810 AD only; 191436 AD/CWT (63-39-86); 6000 Bad Clip/CWT; 1446 Unmarked; 15000 PIT
CH	0	FA	5/23/2007	5/23/2007	875	103	Lyons Ferry Hatchery	Snake River	2006	100% Unmarked/Untagged
					Fall Chinook Subyearling Total	201,567				
CH	1	FA	4/2/2007	4/6/2007	250,771	10.18	Lyons Ferry Hatchery	Snake River	2005	220825 CWT (63-35-97); 29946 Unmarked; VIE (LE Red)
CH	1	FA	4/2/2007	4/6/2007	252,389	11.06	Lyons Ferry Hatchery	Snake River	2005	226442 AD/CWT (63-35-98); 1805 AD Only; 24143 Unmarked; VIE (LE Red)
					Fall Chinook Yearling Total	503,160				

ST		SU	4/10/2007	4/18/2007	159,242	4.7	Cottonwood Acclim Pond	Grande Ronde River	2006	18572 AD/LV/CWT; 140144 AD Only; 62 Bad Clip/LV/CWT; 464 Unmarked; CWT Code (63-36-64)
ST		SU	4/9/2007	4/25/2007	86,985	4.6	Dayton Acclim Pond	Touchet River	2006	20005 AD/LV/CWT; 65160 AD Only; 426 Bad Clip/LV/CWT; 5000 PIT; 1394 Unmarked; CWT Code (63-36-65)
ST		SU	4/15/2007	4/18/2007	59,983	4.33	Lyons Ferry Hatchery	Snake River	2006	19818 AD/LV/CWT (63-36-67); 40138 AD Only; 27 Bad Clip/CWT
ST		SU	4/16/2007	4/18/2007	96,690	4.31	Tucannon River	Tucannon River	2006	4837 AD/CWT; 91853 AD Only; 5000 PIT

ST	SU	4/16/2007	4/18/2007	97,766	4.32	Walla Walla River	Walla Walla River	2006	20243 AD/LV/CWT (63-36-66); 77482 AD Only; 41 Bad Clip/CWT; 5000 PIT
ST	SU	4/19/2007	4/30/2007	58,989	4.43	Baileysburg Bridge	Touchet River	2006	100% VIE (LE Pink); 35138 PIT

Summer Steelhead Total 559,655

Lyons Ferry Hatchery Total 1,264,382

Methow Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/16/2007	4/18/2007	232,811	15	Chewuch Acclim Pond	Methow River	2005	100% CWT (63-32-94)
CH	1	SP	4/16/2007	4/18/2007	156,633	15	Methow River	Methow River	2005	154938 CWT Only (63-32-81 63-33-95); 1695 Unmarked
CH	1	SP	4/16/2007	4/18/2007	27,658	15	Twisp Acclim Pond	Methow River	2005	27182 CWT (63-34-83); 476 Unmarked

Spring Chinook Yearling Total 417,102

CH	1	SU	4/15/2007	4/30/2007	263,729	10	Carlton Acclim Pond	Methow River	2005	261019 AD/CWT (63-35-93); 1233 AD Only; 1477 Bad Clip/CWT
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Summer Chinook Yearling Total 263,729

Methow Hatchery Total 680,831

Priest Rapids Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	6/13/2007	6/22/2007	6,743,101	46.1	Priest Rapids Hatchery	Mid-Columbia River	2006	202000 AD/CWT (63-38-94); 6541101 Unmarked; PIT

Priest Rapids Hatchery Total 6,743,101

Ringold Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	6/15/2007	6/22/2007	3,402,530	61.3	Ringold Springs Hatchery	Mid-Columbia River	2006	222706 AD/CWT (09-45-04); 3179824 Unmarked; Transferred from Bonneville Hatchery

Fall Chinook Subyearling Total 3,402,530

ST	SU	4/9/2007	4/30/2007	258,200	6.77	Ringold Springs Hatchery	Mid-Columbia River	2006	136827 AD/RV; 98117 AD Only; 23256 Unmarked; Approx 150000 Reared @ Wells Hatch.
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Summer Steelhead Total 258,200

Ringold Hatchery Total 3,660,730

Skamania Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
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ST	SU	5/1/2007	5/2/2007	23,512	5.5	White Salmon River	White Salmon River	2006	23507 AD; 5 Unmarked
ST	SU	5/2/2007	5/9/2007	91,135	5.5	Klickitat River	Klickitat River	2006	91117 AD; 18 Unmarked

Summer Steelhead Total 114,647

ST	WI	5/1/2007	5/1/2007	23,998	5.4	White Salmon River	White Salmon River	2006	23995 AD; 3 Unmarked
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Winter Steelhead Total 23,998

Skamania Hatchery Total 138,645

Tucannon Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	4/2/2007	4/23/2007	90,056	7.4	Tucannon River	Tucannon River	2005	89606 CWT (63-34-77); 450 Unmarked
CH	1	SP	4/2/2007	4/23/2007	149,466	8	Tucannon River	Tucannon River	2005	148151 CWT (63-35-99)/VIE (RE Red); 1315 Unmarked

Spring Chinook Yearling Total 239,522

ST	SU	4/3/2007	4/11/2007	62,940	4.33	Tucannon River	Tucannon River	2006	100% VIE (LE Green); 8289 CWT; 9000 PIT
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Summer Steelhead Total 62,940

Tucannon Hatchery Total 302,462

Turtle Rock Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	SU	7/3/2007	7/3/2007	342,273	22.3	Turtle Rock Hatchery	Mid-Columbia River	2006	185025 AD/CWT (63-33-78); 1926 AD Only; 154023 Unmarked; 1299 Bad Clip/CWT
CH	0	SU	7/3/2007	7/3/2007	538,392	48.4	Turtle Rock Hatchery	Mid-Columbia River	2006	186782 AD/CWT (63-38-81); 1468 AD Only; 350142 Unmarked
Summer Chinook Subyearling Total					880,665					
CH	1	SU	5/27/2007	5/27/2007	104,984	13	Turtle Rock Hatchery	Mid-Columbia River	2005	102998 AD/CWT (63-35-95); 1188 AD Only; 798 Bad Clip/CWT
Summer Chinook Yearling Total					104,984					

ST	SU	5/1/2007	5/1/2007	7,500	6.78	Chiwawa River	Wenatchee River	2006	VIE (Pink RE); PIT; WxW; Rel. @ Chiwawa R.
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ST	SU	5/1/2007	5/1/2007	92,999	6.78	Nason Creek	Wenatchee River	2006	VIE (RE Pink); WxW; PIT
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ST	SU	5/2/2007	5/2/2007	41,240	6.78	Wenatchee River	Wenatchee River	2006	27656 AD/VIE (Gr LE); 13584 VIE (Gr LE); PIT; HxW; Rel. @ Chiwawa R.
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ST	SU	5/2/2007	5/4/2007	92,176	4.93	Wenatchee River	Wenatchee River	2006	61813 AD/VIE (Gr LE); 30363 Unclipped/VIE (Gr LE); PIT; HxW; Rel @ Upper Wenatchee R
ST	SU	5/3/2007	5/4/2007	28,120	5.8	Wenatchee River	Wenatchee River	2006	100% AD/VIE (Gr RE); PIT; HxW; Rel @ Upper Wenatchee
ST	SU	5/3/2007	5/4/2007	37,902	5.8	Wenatchee River	Wenatchee River	2006	100% AD/VIE (Gr RE); PIT; HxW; Rel. @ Lower Wenatchee R.

Summer Steelhead Total 299,937

Turtle Rock Hatchery Total 1,285,586

Washougal Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CO	1	N	4/2/2007	4/6/2007	2,403,690	18.7	Klickitat River	Klickitat River	2005	2347684 Unmarked; 55900 AD/CWT (63-11-88); 106 AD Only; Reared @ Lewis R. Hatch.

Washougal Hatchery Total 2,403,690

Wells Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	SU	5/16/2007	5/17/2007	204,525	58.5	Wells Hatchery	Mid-Columbia River	2006	201083 AD/CWT (63-33-85); 1867 AD Only; 1575 Bad Clip/CWT; 6000 PIT
CH	0	SU	6/13/2007	6/13/2007	192,013	30.4	Wells Hatchery	Mid-Columbia River	2006	189163 AD/CWT (63-33-86); 1506 AD Only; 1344 bad Clip/CWT; 6000 PIT
					Summer Chinook Subyearling Total	396,538				
CH	1	SU	5/23/2007	6/15/2007	333,587	9	Wells Hatchery	Mid-Columbia River	2005	322537 AD/CWT (63-35-96); 4845 AD Only; 6205 Bad Clip/CWT

Summer Chinook Yearling Total 333,587

ST	SU	4/25/2007	4/30/2007	40,793	5.5	Twisp River	Methow River	2006	31593 AD Only; 8849 AD/VIE (LE Yellow); 608 Unmarked
ST	SU	4/30/2007	4/30/2007	9,068	5.9	Similkameen Acclim Pd	Okanogan River	2006	8968 AD Only; 100 Unmarked
ST	SU	4/30/2007	4/30/2007	8,160	5.4	Chewuch River	Methow River	2006	5835 AD Only; 2194 AD/VIE (LE Yellow); 131 Unmarked
ST	SU	5/1/2007	5/16/2007	126,772	6.89	Okanogan River	Okanogan River	2006	125378 AD; 1394 Unmarked
ST	SU	5/1/2007	5/23/2007	99,385	6.7	Chewuch River	Methow River	2006	71065 AD Only; 26732 VIE (Yellow LE); 1588 Unmarked
ST	SU	5/1/2007	5/23/2007	79,826	6.7	Twisp River	Methow River	2006	57079 AD Only; 21471 VIE (Yellow LE); 1276 Unmarked

ST	SU	5/4/2007	5/23/2007	96,219	7.3	Methow River	Methow River	2006	68801 AD Only; 25880 AD/VIE (Yellow LE); 1538 Unmarked
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Summer Steelhead Total 460,223

Wells Hatchery Total 1,190,348

Washington Dept. Fish and Wildlife Total	19,393,192
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Yakama Tribe

Cascade Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CO	1	UN	4/16/2007	4/17/2007	233,836	0	Icicle Creek	Wenatchee River	2005	231475 CWT (Codes 05-31-88 through -90; 05-29-76); 3002 PIT; Acclim @ Leavenworth NFH
CO	1	UN	4/27/2007	4/27/2007	66,168	0	Nason Creek	Wenatchee River	2005	BWT/CWT (05-31-84); 3512 PIT; Acclim @ Coulter Pond
CO	1	UN	5/1/2007	5/1/2007	139,132	9	Wells Hatchery	Mid-Columbia River	2005	137462 AD/CWT (05-31-86 05-31-87); 1670 Bad Clip/CWT; Acclim @ Wells FH
CO	1	UN	5/7/2007	5/7/2007	62,014	0	Nason Creek	Wenatchee River	2005	BWT/CWT (05-31-82); Acclim @ Roling's Pond; Intermediate rearing @ Leavenworth NFH

Cascade Hatchery Total 501,150

Cle Elem Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	1	SP	3/15/2007	5/15/2007	287,127	0	Clark Flat Acclim Pond	Yakima River	2005	100% AD/VIE(Red 50% RE 50% LE; 95% CWT (61-34-22 61-34-23 61-34-27 61-34-31 61-34-34 61-34-35); 5% PIT
CH	1	SP	3/15/2007	5/15/2007	281,150	0	Easton Pond	Yakima River	2005	100% AD/VIE(Grn 51%RE 49%LE); 95% CWT (61-34-24 thru -26 61-34-28 thru -30); 5% PIT
CH	1	SP	3/15/2007	5/15/2007	291,725	0	Jack Creek Acclim Pond	Yakima River	2005	100% AD/VIE(Yel 50% LE 50% RE); 95% CWT (61-34-18 thru -21 61-34-33 61-34-33); 5% PIT

Cle Elem Hatchery Total 860,002

Eagle Creek NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CO	1	UN	4/6/2007	4/18/2007	50,000	0	Prosser Acclim Pond	Yakima River	2005	100% Unclipped

CO	1	UN	4/6/2007	4/18/2007	150,000	0	Yakama River	Yakima River	2005	100% AD; ~2500 PIT; Rel @ Holmes Acclim. Pond
CO	1	UN	4/6/2007	5/25/2007	150,000	0	Lost Creek Acclim Pond	Yakima River	2005	100% AD; ~2500 PIT
CO	1	UN	4/6/2007	6/8/2007	150,000	0	Stiles Pond	Yakima River	2005	100% AD; ~2500 PIT
CO	1	UN	4/12/2007	5/25/2007	48,321	0	Lost Creek Acclim Pond	Yakima River	2005	100% AD
CO	1	UN	4/13/2007	4/18/2007	56,445	0	Holmes Pond	Yakima River	2006	100% AD

Eagle Creek NFH Total 604,766

Klickitat Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	6/11/2007	6/15/2007	624,175	69	Klickitat Hatchery	Klickitat River	2006	100% AD/CWT (63-38-98 63-38-73 63-28-74)
CH	0	FA	6/12/2007	6/29/2007	3,732,325	69	Klickitat Hatchery	Klickitat River	2006	100% Unmarked
Fall Chinook Subyearling Total					4,356,500					
CH	0	SP	7/12/2006	7/12/2006	20,830	56	Klickitat Hatchery	Klickitat River	2005	100% AD; Pre-smolt release
Spring Chinook Subyearling Total					20,830					
CH	1	SP	3/5/2007	3/6/2007	606,000	15	Klickitat Hatchery	Klickitat River	2005	100% AD; 158061 CWT (63-33-92); 5000 PIT
Spring Chinook Yearling Total					606,000					
CO	1	N	5/7/2007	5/10/2007	1,071,000	15	Klickitat Hatchery	Klickitat River	2005	100% AD; 42940 CWT (63-32-70)
Coho Yearling Total					1,071,000					
Klickitat Hatchery Total					6,054,330					

Little White Salmon NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	4/20/2007	4/20/2007	1,200,000	0	Prosser Acclim Pond	Yakima River	2006	10% AD&CWT
Little White Salmon NFH Total					1,200,000					

Prosser Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	4/23/2007	4/23/2007	550,000	0	Prosser Acclim Pond	Yakima River	2006	10011 PIT
CH	0	FA	5/10/2007	5/10/2007	75,000	0	Stiles Pond	Yakima River	2006	10004 PIT
CH	0	FA	5/10/2007	5/10/2007	5,002	0	Yakama River	Yakima River	2006	100% PIT; Released @ Billy's Acclimation Pond
Fall Chinook Subyearling Total					630,002					
CO	1	UN	4/6/2007	4/18/2007	30,382	0	Yakama River	Yakima River	2005	100% AD; ~2500 PIT; Rel @ Holmes Pond
CO	1	UN	4/7/2007	6/8/2007	9,199	0	Stiles Pond	Yakima River	2005	100% AD

CO	1	UN	4/14/2007	6/8/2007	45,000	0	Stiles Pond	Yakima River	2005	100% AD
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Coho Yearling Total 84,581

Prosser Hatchery Total 714,583

Washougal Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CO	1	N	4/8/2007	4/18/2007	57,381	0	Yakama River	Yakima River	2005	100% AD; Rel @ Holmes Acclim. Pond
CO	1	N	4/9/2007	5/25/2007	52,693	0	Lost Creek	Yakima River	2005	100% AD
CO	1	N	4/10/2007	4/18/2007	50,517	0	Acclim Pond	Yakima River	2005	100% AD
CO	1	N	4/11/2007	6/8/2007	51,300	0	Prosser Acclim Pond	Yakima River	2005	100% AD

Washougal Hatchery Total 211,891

Willard NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CO	1	UN	4/16/2007	4/17/2007	360,275	0	Icicle Creek	Wenatchee River	2006	352544 CWT (Codes 05-32-71 05-32-72 05-31-91 through -98 05-31-65); 9076 PIT; Acclim @ Leavenworth NFH
CO	1	UN	4/27/2007	4/27/2007	33,212	0	Nason Creek	Wenatchee River	2006	BWT/CWT (05-29-64); 3513 PIT; Acclim @ Coulter Pond
CO	1	UN	5/6/2007	5/6/2007	132,473	0	Nason Creek	Wenatchee River	2005	BWT/CWT (05-32-64 through -67); Acclim @ Butcher Creek
CO	1	UN	5/7/2007	5/7/2007	99,463	0	Nason Creek	Wenatchee River	2005	32073 BWT/CWT (05-32-69); 35867 BWT/CWT (05-32-70); 30199 CWT (05-31-99); 4003 PIT; Acclim @ Roling's Pond
CO	1	UN	5/8/2007	5/8/2007	96,639	0	Wenatchee River	Wenatchee River	2006	31594 BWT/CWT (Codes 05-32-68); 65046 BWT/CWT (05-31-83); 6993 PIT; Rel. and Acclim @ Beaver Creek

Willard NFH Total 722,062

Winthrop NFH

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CO	1	UN	4/19/2007	4/19/2007	268,150	17.27	Winthrop Hatchery	Methow River	2005	265892 CWT (05-31-69 05-31-68 05-31-67)
CO	1	UN	4/25/2007	4/25/2007	69,381	20.3	Winthrop Hatchery	Methow River	2005	68965 CWT (05-31-85); Acclim and Rel @ Winthrop Back Channel

Winthrop NFH Total 337,531

Yakama Hatchery

Species	Age	Race	RelStart	RelEnd	NumRel	Size	ReleaseSite	RiverName	Brood	Comments
CH	0	FA	4/27/2007	4/27/2007	15,731	0	Marion Drain	Yakima River	2006	100% CWT; 4944 PIT

Yakama Hatchery Total	15,731
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Yakama Tribe Total	11,222,046
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Above BONNEVILLE DAM Total	81,226,508
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APPENDIX G

Transportation Proportion Tables

Proportion of Lower Granite Dam forebay population destined to be transported in 2007
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 $P_t = X1/N$ and the proportion of fish in the in-river category is $(1-P_t) = X2/N$. 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

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

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

$$\text{Lower Granite} \quad N1 = N*s1$$

$$\text{Little Goose} \quad N2 = (N1-t1)*s2 = N1*(1-t1/N1)*s2$$

$$\text{Lower Monumental} \quad N3 = (N2-t2)*s3 = N2*(1-t2/N2)*s3 = N1*(1-t1/N1)*s2*(1-t2/N2)*s3$$

Substituting these equalities into the equation for P_t gives

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

Letting $P_1=t_1/N_1$, $P_2=t_2/N_2$, and $P_3=t_3/N_3$ the equation for proportion of transport fish in Lower Granite Dam forebay destined for transportation becomes:

$$P_t = P_1 + (1-P_1)*P_2 + (1-P_1)*(1-P_2)*P_3$$

With McNary Dam transportation added the equation becomes:

$$P_t = P_1 + (1-P_1)*P_2 + (1-P_1)*(1-P_2)*P_3 + (1-P_1)*(1-P_2)*(1-P_3)*P_4$$

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 P_1 , P_2 , P_3 , and P_4 proportions are computed using facility collection, and transport, for Lower Granite ($J=1$), Little Goose ($J=2$), Lower Monumental ($J=3$), and McNary ($J=4$) dams.

In 2007 there was no spring time transportation at McNary Dam. However, transportation did occur in the summer time, beginning August 18. The estimate of proportion of Snake River subyearling Chinook “destined for transport” are presented with McNary Dam considered in the model. For subyearling Chinook originating in the Mid-Columbia River basin, the transportation proportion is simply estimated by P_4 above, and is presented in Tables 5 and 6.

The 2007 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 2007 (see tables G-1 to G-4). The 2007 collection efficiency for subyearling chinook was based on estimated FGE’s derived from the 2007 release of PIT tagged subyearling chinook at Snake River basin fall chinook acclimation ponds, production releases and wild marked fish in the Snake and Clearwater rivers by Nez Perce Tribe and USFWS (Tables G-5 and G-6).

Collection for transportation began May 1 at Lower Granite Dam, and was delayed at Little Goose until May 8, while at Lower Monumental Dam collection for transport began May 11. Because transportation was delayed in the Snake River in 2007, estimates of the fish timing at Lower Granite Dam were important for determining the overall probability of being transported. And because hatchery and wild yearling Chinook can to some extent be identified in SMP at Lower Granite Dam, separate timing estimates can be made for them. For steelhead, there are likely differences in timing, but PIT-tags alone are not a good measure of overall wild population timing, and markings are not useful for separating hatchery from wild with certainty, so that for transport estimations a single seasonal timing was developed for combined both rearing types. It was assumed for estimating overall seasonal transport probability that fish arriving at Lower Granite Dam prior to May 1 would not be transported, while those arriving on that date or later would be transported if collected at any of the transport dams.

The overall seasonal estimate of smolts arriving Lower Granite Dam forebay that were destined for transportation in 2007, was approximately 57% for hatchery yearling chinook, 443% for wild yearling Chinook (Table G-7). During the period when transport was occurring, 42% of hatchery Chinook were destined for transport, and 51% of wild Chinook.

The large difference in timing for hatchery versus wild fish made them much more likely to be transported, despite the higher transport probability. For hatchery and wild steelhead the seasonal estimates were similar, as were the estimated detection probabilities. For hatchery steelhead 47% were destined for transport for season, compared to 44% of wild. For steelhead passing after May 1, during transport operations, 63% of hatchery fish and 58% of wild fish were probable to be transported. For subyearling Chinook originating above Lower Granite all fish were assumed to pass after May 1, so that any differences between hatchery and wild fish were due to differences in estimates of detection probabilities at the dams (Tables G-5 and G-6). The estimated probability of being transported was 36% for hatchery origin subyearlings and also 36% for wild fish. For subyearlings originating in the Mid-Columbia River basin, the estimated percent of smolts arriving McNary Dam forebay that were transported was approximately 15-29%.

Table G-1. Hatchery yearling Chinook model input data in 2007, for time period when transportation was occurring.

Site	Estimated Collection Efficiency	Collection Transport Proportion	P(J)
LGR (J=1)	0.25	0.899	0.221
LGS (J=2)	0.17	0.946	0.162
LMN (J=3)	0.12	0.994	0.118

Table G-2. Wild yearling Chinook model input data in 2007, for time period when transportation was occurring.

Site	Estimated Collection Efficiency	Collection Transport Proportion	P(J)
LGR (J=1)	0.32	0.899	0.292
LGS (J=2)	0.20	0.946	0.194
LMN (J=3)	0.14	0.994	0.141

Table G-3. Hatchery steelhead model input data in 2007, for time period when transportation was occurring.

Site	Estimated Collection Efficiency	Collection Transport Proportion	P(J)
LGR (J=1)	0.22	0.956	0.211
LGS (J=2)	0.39	0.963	0.376
LMN (J=3)	0.25	0.988	0.249

**Table G-4. Wild steelhead model input data in 2007,
for time period when transportation was occurring.**

Site	Estimated Collection Efficiency	Collection Transport Proportion	P(J)
LGR (J=1)	0.24	0.956	0.234
LGS (J=2)	0.35	0.963	0.335
LMN (J=3)	0.18	0.988	0.180

**Table G-5. Hatchery subyearling Chinook model
input data for 2007.**

Site	Estimated Collection Efficiency	Collection Transport Proportion	P(J)
LGR (j=1)	0.13	0.767	0.100
LGS (j=2)	0.25	0.980	0.245
LMN (j=3)	0.06	0.899	0.052
MCN (j=4)	0.15	0.015	0.002

**Table G-6. Wild subyearling Chinook model
input data for 2007.**

Site	Estimated Collection Efficiency	Collection Transport Proportion	P(J)
LGR (j=1)	0.09	0.767	0.100
LGS (j=2)	0.29	0.980	0.245
LMN (j=3)	0.03	0.899	0.052
MCN (j=4)	0.29	0.015	0.002

Table G-7. Estimated proportion destined for transportation in 2007.

Species- age group	Probability of being transported during Transport operations	Proportion Passing During Transport	Overall Seasonal Transport Probability	
			Without McNary Dam transport	With McNary Dam transport
Hatchery Yearling Chinook	0.424	0.57	0.242	N/A
Wild Yearling Chinook	0.510	0.33	0.168	N/A
Hatchery Steelhead	0.63	0.75	0.47	N/A
Wild Steelhead	0.583	0.75	0.437	N/A
Wild Subyearling Chinook	0.357	1.0	0.356	0.357
Hatchery Subyearling Chinook	0.358	1.0	0.356	0.358

Model without McNary Dam: $P_t = P_1 + (1-P_1)*P_2 + (1-P_1)*(1-P_2)*P_3$

Model with McNary Dam: $P_t = P_1 + (1-P_1)*P_2 + (1-P_1)*(1-P_2)*P_3 + (1-P_1)*(1-P_2)*(1-P_3)*P_4$

Model for Mid-Columbia R Basin fish: $P_t = P_4$

The proportion of smolts transported in 2007 was different than most other years due to the delayed start in transportation for spring migrants, and to summer spill for Snake River subyearlings. For steelhead, the proportion transported in 2007 was much lower than seen in other recent years due to the delayed start to transport, low flows and relatively high spill proportion; with approximately 45% transported. For yearling Chinook, the proportion transported was also lower than other recent years and this was due not only to the delayed start date of May 1 but also due to low flows and thus relatively high spill proportions at Snake River dams. For subyearling Chinook the proportion transported was much lower than any other year for which we calculated the probabilities. This was due to the court ordered summer spill operation, which extended spill beyond June 20th in the Snake River. It should be pointed out that other years' detection probability estimates included some fish passage in "spring spill", since a good portion of the population passed prior to June 20. And also as with spring migrants, the low flows and relatively high spill proportion led to low numbers of fish in transportation.

Table G-8. Comparison of the 2007 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 1999 to 2006. For yearling chinook and steelhead, the results exclude transport at McNary Dam.

Species-age group	Transport Proportion¹								
	2007	2006	2005	2004	2003	2002	2001	2000	1999
Yearling Chinook	0.242 (H) 0.168 (W)	0.611 (H) 0.579 (W)	0.92	0.870	0.629	0.683	0.980	0.71	0.777 (H) 0.862 (W)
Steelhead	0.47 (H) 0.437(W)	0.76 (H) 0.793(W)	0.94	0.964	0.670	0.677	0.986	0.81	0.825
Subyearling Chinook	0.357 (H) 0.358(W)	0.521 (H) 0.562(W)	0.809	0.972	0.895	0.929	0.962	0.93	0.870

¹ In years 2000-2007, estimates of collection efficiency based on PIT tag data was used to generate a single annual estimate of proportion transported, while in 1999 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 H

2007 System Operational Requests (SOR)

2007 SORs

SOR #	Date	Subject	Response of Action Agencies
2007-07	06/26/07	Libby 2007 and Hungry Horse Summer Operations	Partially Implemented
2007-06	05/08/07	Spill for Fish Passage According to Court Order	Partially Implemented
2007-05	4/26/07	Bonneville Dam Operations for Spring Creek Hatchery Release on May 1, 2007	Implemented
2007-04	3/21/07	Early Spring Dworshak Operations	Partially Implemented
2007-03	3/9/07	Bonneville Dam Operations	Not Implemented
2007-02	2/27/07	Spill at Bonneville Dam for the March Spring Creek Hatchery Release Spill Evaluation Study	Denied
2007-01	1/30/07	Grand Coulee Operations and Chum Flows	Implemented

SYSTEM OPERATIONAL REQUEST: #2007-1

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, Nez Perce Tribe, Shoshone-Bannock Tribes, and the Columbia River Inter-Tribal Fish Commission.

TO:	Brigadier General Gregg F. Martin	COE-NWD
	James D. Barton	COE-Water Management
	Cathy Hlebechuk	COE-RCC
	Witt Anderson	COE-P
	Col. Thomas E. O'Donovan	COE-Portland District
	LTC Anthony Hofmann	COE-Walla Walla District
	J. William McDonald	USBR-Boise Regional Director
	Stephen J. Wright	BPA-Administrator
	Greg Delwiche	BPA-PG-5

FROM: Tom Lorz, Vice Chairperson, Salmon Managers

DATE: January 30, 2007

SUBJECT: Grand Coulee Operations and Chum Flows

SPECIFICATIONS:

Operate Grand Coulee Dam conservatively to better assure the ability to try and maintain the minimum 13.0-foot tailwater elevation below Bonneville Dam through chum salmon emergence, Vernita Bar flows, and to assure reaching the April 10 upper rule curve.

JUSTIFICATION:

Grand Coulee Reservoir is at an elevation of 1274.1 feet (1-29-07) and has drafted 4.5 feet in the last week (1-23-07 to 1-29-07) and 13.0 feet over the last 19 days (1-11-07 to 1-29-07). Between January 11th and January 29th, the Bonneville project tailwater has averaged 16.1 feet, well above the 13.0-foot minimum chum elevation. Based on the January final Water Supply Forecast (WSF) both the end of January and end of February FC elevations at Grand Coulee are 1290 feet (full) and the end of March FC elevation is 1269.2 feet. At the current draft rate, Grand Coulee will be within one foot of its end of March FC elevation by early next week.

It is also important to note that the month of January has been a relatively dry month. In particular, between January 1st and January 29th, precipitation has been 86% of average in Upper Columbia Basins, 36% of average in Middle Columbia Basins, 32% of average in Lower Snake Basins, and 21% of average in Upper and Middle Snake Basins (CRITFC Weekly Precipitation Update, attached). Additionally, Snowpack has decreased 4% in Columbia Basins above the Snake River Confluence (101% of average on January 1st, 2007 to 97% of average on January 29th), 15% in Snake River Basins (87% of average on January 1st, 2007 to 72% of average on January 29th), and 14% in Lower Columbia Basins (101% of average on January 1st, 2007 to 87% of average on January 29th)¹.

Considering that both precipitation and snowpack have been declining over the month of January, it is likely that February Final WSFs will decrease relative to January Final WSFs. Decreased water supply forecasts will equate to higher flood control elevations. If Grand Coulee continues to draft at a rate that is well above that needed to maintain chum elevations below Bonneville Dam, it is our concern that Grand Coulee will be in a situation where it is well below its future flood control elevations. This situation would force a decision between refilling Grand Coulee to its April 10th Flood Control elevation (possibly impacting refill) or maintaining chum flows. A reduction in chum flows this year could be particularly devastating. According to a document produced by the USFWS, "Distribution and Elevation calculations for 217 Chum redds mapped in the Ives Is. Complex during the 2006 Spawning Season December 22, 2006," a significant number (nearly 50%) of chum redds will be impacted even by minimal reductions in Bonneville Tailwater below 13.0 feet (see attached document and Table 1).

Table 1. Distribution of chum redds vs. 10 Kcfs flow band for both the original analysis conducted for 177 redds mapped through 11-22-2006 and all redds including the additional 40 redds mapped through 12-22-2006.

	Redds through 11-22-06			All Redds - 12-22-06			
	<i>Flow Band</i>	<i>Redds</i>	<i>% Total</i>	<i>Flow Band</i>	<i>Redds</i>	<i>% Total</i>	<i>Redd Delta</i>
13.0 Bon. Tailwater	120 - steady	18	10.2%	120 - steady	42	19.4%	24
	120-130	67	37.9%	120-130	75	34.6%	8
	130-140	62	35.0%	130-140	66	30.4%	4
	140-150	15	8.5%	140-150	15	6.9%	0
	150-160	12	6.8%	150-160	15	6.9%	3
	160-170	3	1.7%	160-170	4	1.8%	1
		177	100.0%		217	100.0%	

NOTE: USFWS has not been able to get spawning numbers or redds for the three Columbia mainstem sites to compare to the potential impacts at Ives Island.

¹ Data used from the Natural Resource Conservation Service
<ftp://ftp.wcc.nrcs.usda.gov/data/snow/update/columbia/>

As you are aware, this is not a new issue for this time of year. The Salmon Managers have shared similar concerns about Grand Coulee winter drafts in previous years. For example, on April 6th of 2004, the Salmon Managers unanimously signed a Joint Technical Staff memo that voiced significant concerns over Grand Coulee winter drafts². Also, in 2005, every agency comment to the Water Management Plan included concerns about excessive wintertime drafting³.

² Document available at
http://www.fpc.org/documents/joint_technical/38-04.pdf.

³ <http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2005/draft/comments/washington.pdf>.
http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2005/draft/comments/IDFG_20050118.pdf.
http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2005/draft/comments/critfc_20041215.pdf.
http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2005/draft/comments/critfc_20041217.pdf.

Water Year 2007	Precipitation January 1 - 29	(inches) Seasonal (Oct. 1 - now)	Pro-rated Monthly Temp. (degF)
Portland	58%	116%	-1.7

UPPER-COLUMBIA:

Penticton	76%	152%	-0.7
Kamloops	83%	115%	-2
Revelstoke	90%	113%	1.8
Cranbrook	93%	157%	-0.5
Creston	msg	msg	-1.3
average:	86%	134%	-0.5
Normal:	1.92	7.23	23.6

MIDDLE-COLUMBIA:

Pendleton	33%	86%	-2.7
Redmond	62%	99%	-3.4
Yakima	27%	105%	-0.8
Wenatchee	17%	126%	-1.3
Spokane	39%	115%	-2.1
average:	36%	106%	-2.1
Normal:	1.24	4.86	30.1

LOWER SNAKE:

Lewiston	14%	97%	-2.4
Stanley	52%	157%	-4.4
Challis	30%	189%	-4.5
average:	32%	148%	-3.8
Normal:	1.04	4.19	22.6

UPPER and MIDDLE SNAKE:

McCall	17%	68%	-8.2
Ontario	3%	62%	1.7
Boise	15%	76%	-1.2
Twin Falls	17%	109%	-2.2
Burley	24%	94%	-4.9
Pocatello	37%	92%	-6.2
Idaho Falls	32%	82%	-6.4
average:	21%	83%	-3.9
Normal:	1.95	5.21	25.3

Forecasted Daily Rain (in inches), BON dam area:	
30-Jan	0
31-Jan	0
1-Feb	0
2-Feb	0
3-Feb	0
4-Feb	0.15
5-Feb	0

**Distribution and Elevation calculations for 217 Chum redds mapped in the
Ives Is. Complex during the 2006 Spawning Season
December 22, 2006.**

Figure 1. General distribution of all 217 chum redds excavated in the Ives Island complex below Bonneville Dam and mapped with GPS by ODFW/WDFW survey crews. An additional 40 redds were mapped after 11-22-3006. Note: this analysis does not include redds mapped at any of the downstream spawning areas including Multnomah and I-205.

Table 1. Computed redd elevations for all 217 Redds.

Redd Elevations							
7.10	8.89	9.43	9.63	9.80	10.08	10.51	11.35
7.34	8.91	9.43	9.63	9.82	10.09	10.51	11.37
7.73	8.92	9.44	9.63	9.83	10.10	10.51	11.39
8.05	8.95	9.44	9.63	9.84	10.13	10.54	11.41
8.20	8.97	9.45	9.64	9.85	10.17	10.56	11.42
8.30	8.97	9.45	9.64	9.85	10.17	10.58	11.43
8.32	9.01	9.46	9.65	9.86	10.17	10.63	11.43
8.33	9.04	9.47	9.65	9.86	10.17	10.68	11.47
8.33	9.05	9.47	9.66	9.87	10.19	10.69	11.63
8.37	9.08	9.48	9.67	9.88	10.19	10.69	11.71
8.38	9.09	9.49	9.68	9.88	10.20	10.71	11.72
8.48	9.09	9.50	9.68	9.88	10.20	10.74	11.75
8.48	9.12	9.52	9.68	9.88	10.21	10.75	11.78
8.55	9.13	9.54	9.69	9.90	10.21	10.76	11.80
8.59	9.13	9.55	9.69	9.91	10.24	10.76	11.87
8.60	9.15	9.55	9.69	9.92	10.27	10.84	11.93
8.61	9.17	9.55	9.69	9.93	10.27	10.96	11.96
8.62	9.18	9.56	9.69	9.94	10.30	10.96	11.99
8.68	9.18	9.56	9.70	9.94	10.30	10.99	12.19
8.70	9.22	9.56	9.71	9.97	10.31	11.05	12.23
8.75	9.27	9.56	9.71	9.98	10.33	11.06	12.43
8.75	9.28	9.57	9.74	9.99	10.37	11.08	
8.79	9.32	9.58	9.74	10.00	10.41	11.18	
8.81	9.33	9.58	9.74	10.01	10.41	11.20	
8.84	9.36	9.58	9.76	10.04	10.44	11.22	
8.86	9.37	9.60	9.77	10.05	10.44	11.29	
8.87	9.40	9.61	9.78	10.05	10.45	11.32	
8.88	9.42	9.62	9.78	10.08	10.50	11.32

Figure 2. Graphic describing the relationship between the Bonneville tailwater and the chum spawning locations. Water flows downhill, it does not follow the dashed line in the figure above, which if it did would make managing by just redd bed elevations a snap! What we require is the relationship between the Bonneville tailwater and the water surface elevations over the redd spawning areas. Note that the redd elevations computed in Table 1 cannot be used solely as a bases for management.

Figure 3. Distribution of chum redds, plotted on modeled wetted area simulations (flow bands) ranging from 120 to 160 kcfs at 10 kcfs intervals.

Table 2. Distribution of chum redds vs. 10kcfs flow band for both the original analysis conducted for 177 redds mapped through 11-22-2006 and all redds including the additional 40 redds mapped through 12-22-2006.

Redds through 11-22-06				All Redds - 12-22-06			
	Flow Band	Redds	% Total	Flow Band	Redds	% Total	Redd Delta
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	130-140	62	35.0%	130-140	66	30.4%	4
	140-150	15	8.5%	140-150	15	6.9%	0
	150-160	12	6.8%	150-160	15	6.9%	3
	160-170	3	1.7%	160-170	4	1.8%	1
		177	100.0%		217	100.0%

Figure 4. Stage discharge relationship between the USGS Bonneville tailwater gage and Bonneville Discharge using data from 2000 – 2006.

Table 3. This table is based on the relationship of the data in Figure 4 and describes the range of scenarios and problematic nature of managing flows/tailwaters for the Ives Island chum.

elevation	Avg Q (kcfs) necessary	Range	
		min Q	max Q
11.5	114	71	151
12.0	122	71	165
12.5	130	71	160
13.0	137	89	162
13.5	145	103	172
14.0	153	90	173
14.5	161	98	195
15.0	169	119	207
15.5	177	145	211
16.0	184	148	214

SYSTEM OPERATIONAL REQUEST: #2007-2

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, Shoshone-Bannock Tribes, and the Columbia River Inter-Tribal Fish Commission¹.

TO:	Brigadier General Gregg F. Martin	COE-NWD
	James D. Barton	COE-Water Management
	Cathy Hlebechuk	COE-RCC
	Witt Anderson	COE-P
	Col. Thomas E. O'Donovan	COE-Portland District
	LTC Anthony Hofmann	COE-Walla Walla District
	J. William McDonald	USBR-Boise Regional Director
	Stephen J. Wright	BPA-Administrator
	Greg Delwiche	BPA-PG-5

FROM: Paul Wagner, Chairperson, Salmon Managers

DATE: February 27, 2007

SUBJECT: Spill at Bonneville Dam for the March Spring Creek Hatchery Release Spill Evaluation Study

SPECIFICATIONS:

The Salmon Managers listed above are requesting the following fishery operations at the Bonneville Project:

1. Operation of the Corner Collector for four days beginning one-day following either one of the releases of coded wire tagged (CWT) tule fall Chinook from Spring Creek National Fish Hatchery (Spring Creek NFH), scheduled for March 5 and March 9, 2007;
2. Spill at 75 kcfs beginning one-day following either one of the releases of coded wire tagged tule fall Chinook from Spring Creek NFH scheduled for March 5 and March 9. Alternatively, operate with 75 kcfs of spill plus the corner collector for four days following either one of the releases from Spring Creek NFH.

JUSTIFICATION:

¹ Due to the Agreement Regarding 2007 Federal Columbia River Power System Fish Operations between the CRITFC tribes and BPA, CRITFC cannot support the spill provision in this SOR, but does not oppose it. CRITFC fully supports all other operations requested in this SOR.

Spring Creek NFH, located upstream of Bonneville Dam on the Columbia River, annually produces tule fall Chinook (*Oncorhynchus tshawytscha*) that are released in the spring of each year as subyearlings. Half of the total production of 15 million fish is released in March, prior to the onset of the Biological Opinion spill program for ESA-listed salmonids. Historically, the March release of juvenile fish at Spring Creek NFH has produced 46% of the returning adults. Although Spring Creek NFH Chinook salmon are listed under the Endangered Species Act (ESA) as part of the Lower Columbia River Chinook ESU, they are deemed not necessary for recovery and therefore are available for harvest. The 7.5 million fish that are released in March are very important to United States/Canada treaty and domestic West Coast fisheries because these fish make up a significant portion of the Chinook caught in West Coast Vancouver Island (WCVI) fisheries, near shore fisheries off the Washington and northern Oregon coast, and local fisheries in the Columbia River. Historically, Spring Creek NFH fish contributed up to 9% of the Chinook catch in the WCVI fisheries and 27% of the Chinook catch off of the Washington and northern Oregon coasts. Spring Creek NFH has contributed as many as 65,600 fish to treaty Indian fisheries (1976) and 41,500 fish to non-treaty commercial fisheries (1977) in the Columbia River (PFMC, 1996). More recently, the 2002-2004 average catch of Spring Creek NFH origin fall Chinook in the fall season treaty Indian fisheries above Bonneville Dam was 54,900 Chinook, while non-treaty in-river commercial and sports fisheries averaged another 12,600 Chinook (PFMC 2006).

Spring Creek NFH tule salmon are important components of Columbia River Indian treaty and sport fisheries and provide a significant benefit for West Coast fisheries, outside the Columbia River, including Canada and Alaska. Every additional adult salmon available for tribal harvest is critical from a tribal cultural and use perspective. Tribal members are dependent on these salmon for ceremonial and subsistence uses. These salmon comprise a critical portion of sustenance for tribal members. In particular, because Spring Creek Hatchery tule fall Chinook have a lower oil content than other salmon, they are dried and become an important source of winter protein for tribal members.

Since much of the salmon wealth has been taken away from the tribes and redistributed to non-tribal people in the form of flood control, navigation, irrigation and municipal development, tribal people have experienced elevated poverty and death rates well in excess of the general population and are very dependent on harvested salmon, or indirectly, on the small income that salmon harvest provides for survival. Also, salmon are the main stay of tribal religious and cultural practices. Every juvenile salmon that survives hydrosystem passage brings back some of the river's wealth to the tribal economy and culture.

Over the past 12 years, fish hatchery programs for Columbia River production have been reduced significantly due to Congressional reduction or flat funding for Mitchell Act programs. These funding cuts have resulted in a very substantial reduction (approximately 25.0 million since 1995) in the production of tule fall Chinook salmon at both state and federal fish hatcheries and have caused the closure of some facilities. The State of Oregon has drastically reduced its production of tule fall Chinook salmon in the Columbia River system. Spring Creek NFH, is now the only facility producing tule fall Chinook above Bonneville Dam. Nearly all of the remaining Columbia River tule production is released from hatcheries in the State of Washington below

Bonneville Dam. These reductions and hatchery closures make maximizing survival and production at Spring Creek NFH even more important for maintaining and improving fisheries in the Pacific Ocean and Columbia River, especially in years of low ocean productivity. Early projections for 2007 adult returns of Spring Creek Chinook to the Columbia River indicate a continual decline with a forecasted run size likely of less than 21,800 fish to the Columbia River mouth (Figure 1).

Spill is generally accepted as the safest route for fish passage at Federal Columbia River Power System (FCRPS) facilities in terms of both immediate and delayed survival effects and the Action Agencies historically allowed spill at Bonneville Dam coinciding with the timing of the Spring Creek NFH releases in March to provide a non-turbine/bypass passage route and improve their survival past Bonneville Dam (Figure 2). The duration and volume of spill that has been allowed at Bonneville Dam for the Spring Creek March releases has varied over time. Since 1992, there have been three general categories of the duration and volume of spill allowed at Bonneville Dam during the March releases (Figure 2). During 1992-2000, spill duration and volume averaged 178 hours (7.4 days) and 1200 KAF. During 2001-2004, average spill duration and volume were reduced to 59 hours (2.5 days) and 177 KAF. During 2005 and 2006, BPA did not allow spill for the March releases. However, beginning in 2004, the Bonneville Dam corner collector was operated during the March releases, providing a non-turbine/bypass passage route through the dam. During 2004-2006, the corner collector was operated for 81 hours using 34 KAF, on average, during the March releases. These recent volumes using the corner collector are 2.8% of the volumes allowed using spill during 1992-2000. While ocean productivity has likely varied over time, the recent declines in returns has coincided with reduced levels of spill during the March release at Bonneville Dam (Figures 1 and 2).

In March 2004, the U.S. Fish and Wildlife Service (FWS) released over 220,000 subyearling fall Chinook from Spring Creek NFH with coded wire tags (CWT) to evaluate smolt-to-adult return rates (SAR) back to the hatchery under two operations at Bonneville Dam. Tagged fish were released in two groups: one group released during four days of spill operation at Bonneville Dam and one group released during four days of corner collector operation at Bonneville Dam. A continuation of this evaluation would help resolve uncertainties from a single year evaluation.

The FWS is scheduled to release a total of 250,000 coded wire tagged tule fall Chinook from Spring Creek Hatchery on two dates, March 5 and March 9, 2007. To continue the evaluation of the 2004 study conducted by FWS (Attachment 1) that showed significantly higher SARs for hatchery tule fall Chinook release during spill operations, we are requesting a spill period of four days.

We propose to reverse the order of experimental treatments from the 2004 experiment, and begin the spill operation or spill plus corner collector operation, followed by the corner collector operation. The projected hydrologic conditions should be taken into account and the Action Agencies are invited to make the final selection on order. To minimize potential effects of total Bonneville discharge on the resulting SARs, the total Bonneville Dam discharge should be the same during both operations. As the corner collector was designed to operate in conjunction with a minimum of 75 kcfs spill and 75 kcfs of spill would provide greater contrast

in the operational conditions than reduced levels of spill, we request that specifications for the two operations be 75 kcfs of spill versus 5 kcfs of corner collector.

Four days of spill or corner collector operations are capable of achieving 90-95% passage. Typically, the fish begin to arrive at Bonneville Dam 24h following their release. To minimize the potential for temporal effects, the releases from Spring Creek NFH in 2007 will be only four days apart. One group of fish is scheduled to be released from the hatchery on March 5th. The second group of fish is scheduled for release on March 9th. The corner collector will already be in operation for other study purposes (kelt passage) and will continue throughout the operation. Spill operation of 50-75 kcfs should begin about 24 hours after the release chosen for spill (March 5 or March 9) and continue for four days.

Current projections for the first week of March are for flows of 144-155 kcfs at Bonneville Dam (Feb. 20th STP run). Flows of 160 kcfs would translate to a 14.5 ft. tailwater elevation. This would provide 1.5 ft. of depth compensation for chum redds located at the current management level of a 13 ft. Bonneville Dam tailwater elevation. Based on the SYSTDG modeling provided by the COE, a 75 kcfs level of spill under a total discharge of 150 kcfs would result in dissolved gas levels of 106.4-108.3%. The COE modeling suggests that flows of 160 kcfs would provide sufficient depth compensation for the chum redds below Bonneville Dam. Flows of 160 kcfs or greater would additionally lower gas levels and provide more protection against gas supersaturation than the COE model runs using 150 kcfs.

The COE has stated that the John Day pool is expected to maintain its current full pool elevation through the March release. Using the available storage in the John Day pool between full pool elevation and minimum irrigation pool (MIP) over the first four days of the study would result in flows of 183-194 kcfs at Bonneville Dam. This would require no usage of the storage behind Grand Coulee Dam. If John Day pool storage was utilized down to minimum operational pool (MOP), flows at Bonneville Dam would be expected to be 212-222 kcfs for four days. Again, this would require no alteration or usage of the storage behind Grand Coulee Dam.

Figure 1. Returns of Spring Creek NFH fall Chinook to the Columbia River mouth 2002-2006 and projected return for 2007.

Figure 2. Hours and volume (KAF) of spill at Bonneville Dam during the March release from Spring Creek NFH, 1992-2006.

Attachment 1

Preliminary evaluation of two operations at Bonneville Dam on the return rate of fall Chinook salmon to Spring Creek National Fish Hatchery

By

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Columbia River Fishery Program Office
U.S. Fish and Wildlife Service
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Introduction

Spring Creek National Fish Hatchery (SCNFH), located upstream of Bonneville Dam on the Columbia River, annually produces tule fall Chinook (*Oncorhynchus tshawytscha*) that are released in the spring of each year as subyearlings. Half of the total production of 15 million fish is released in March, prior to the onset of the Biological Opinion spill program for ESA-listed salmonids. Although SCNFH Chinook salmon are listed under the Endangered Species Act (ESA) as part of the Lower Columbia River Chinook ESU, they are deemed not necessary for recovery and therefore are available for harvest. The 7.5 million fish that are released in March are very important to United States/Canada treaty and domestic West Coast fisheries because these fish make up a significant portion of the Chinook caught in West Coast Vancouver Island (WCVI) fisheries, near shore fisheries off the Washington and northern Oregon coast, and local fisheries in the Columbia River. Historically, Spring Creek NFH fish contributed up to 9% of the Chinook catch in the WCVI fisheries and 27% of the Chinook catch off of the Washington and northern Oregon coasts. Spring Creek NFH, historically, has contributed as many as 65,600 fish to treaty Indian fisheries (1976) and 41,500 fish to non-treaty commercial fisheries (1977) in the Columbia River (PFMC, 1996). More recently, the 2002-2004 average catch of Spring Creek NFH origin fall Chinook in the fall season treaty Indian fisheries above Bonneville Dam was 54,900 Chinook, while non-treaty in-river commercial and sports fisheries averaged another 12,600 Chinook (PFMC, 2006).

In addition to supplying large numbers of fish for harvest, the high abundance of tule fall Chinook stocks arguably has provided some level of stock protection for other depressed stocks of concern. Under the Chinook harvest ceiling management regime implemented by the initial Pacific Salmon Treaty in 1985, abundant Columbia River tule and upriver bright fall Chinook stocks had the effect of buffering impacts on other Chinook stocks of concern in certain Canadian and south east Alaskan ocean fisheries. With the adoption of an aggregate abundance based management (AABM) regime for these ocean fisheries under the renegotiation of the Pacific Salmon Treaty in 1999, the buffering effect of these Columbia River stocks only occurs when harvest for a particular fishery is constrained to a level substantially less than allowed under the AABM regime for that particular fishery. This management scenario has, in fact, been the case for the WCVI Canadian troll fishery in several recent years where Columbia River tule fall Chinook stocks are a significant contributor to the overall stock mix of this fishery. Up until 2003, the WCVI troll fishery has been managed by Canada to harvest a much lower number of Chinook than allowed under the AABM regime, primarily to address domestic concerns for depressed WCVI naturally spawning stocks and the need to rebuild this

stock group. Beginning in 2003, the WCVI troll fishery again expanded up to AABM quota limits as the fishery ostensibly found ways to maximize total catch, including significant numbers of Columbia River stocks, while minimizing impacts on their depressed local wild stocks through intensive time and area management actions.

However, even when AABM fisheries are harvested at their full allowable levels, harvest rate ceilings for particular stocks of concern (e.g., threatened Snake River fall Chinook and lower Columbia River Chinook) are now in place under ESA management constraints to provide an appropriate level of protection for these stocks while providing the opportunity to shape coastal and in-river fisheries to optimize the harvest of co-mingled healthy stocks when abundance levels for these stocks are high. For example, in addition to the AABM framework of the Pacific Salmon Treaty in Canadian and southeast Alaskan ocean fisheries, Washington, Oregon, and California ocean fisheries are managed under an ESA constraint that limits the annual allowable ocean fisheries impact on Snake River fall Chinook (including Canadian and Alaskan impacts) to 70% of the 1988-1993 base period average impacts. A similar 30% base period reduction in impacts for this stock in Columbia River fisheries is also required to provide an appropriate level of protection while allowing for management flexibility for other stocks. These impact rates are currently being reviewed by NOAA Fisheries relative to Snake River fall Chinook stock status and fisheries impacts.

Over the past 12 years, fish hatchery programs for Columbia River production has been reduced significantly due to Congressional reduction or flat funding for Mitchell Act programs. These funding cuts have resulted in a very substantial reduction (approximately 25.0 million since 1995) in the production of tule fall Chinook salmon at both state and federal fish hatcheries and have caused the closure of some facilities. The State of Oregon has drastically reduced its production of tule fall Chinook salmon in the Columbia River system. Spring Creek NFH, is now the only facility producing tule fall Chinook above Bonneville Dam. Nearly all of the remaining Columbia River tule production is released from hatcheries in the State of Washington below Bonneville Dam. These reductions and hatchery closures make maximizing survival and production at Spring Creek NFH even more important for maintaining and improving fisheries in the Pacific Ocean and Columbia River, especially in years of low ocean productivity. Early projections for 2007 adult returns of Spring Creek Chinook to the Columbia River indicate a continual decline with a run size likely less than 40,000 fish.

Spill is generally accepted as the safest route for fish passage at Federal Columbia River Power System (FCRPS) facilities in terms of both immediate and delayed survival effects. However, neither spillway nor delayed survival studies have been conducted on March releases from Spring Creek NFH. Various survival studies looking into these questions have targeted later times of the year and/or different fish species or stocks. Historically, the March release of juvenile fish at Spring Creek NFH has produced 46% of the returning adults (based on a recent 5-year average). The Service has released juvenile fall Chinook in March, April, and May to maximize the rearing capacity of the facility by splitting the April and May releases into available empty pond space after the March release has occurred. Along with maximizing rearing capacity, this release strategy also balances the risks associated with the possibility of low survival from a particular release month. Maximizing the survival of the March release fish is important for international and domestic fisheries operating both in the ocean and in-river.

Historically, the Bonneville Power Administration (BPA) allowed spill at Bonneville Dam, coinciding with the timing of the SCNFH releases in March to provide a non-turbine/bypass passage route and improve their survival past Bonneville Dam. The

duration and volume of spill that BPA has allowed at Bonneville Dam for the Spring Creek March releases has varied over time. Since 1992, there have been three general categories of the duration and volume of spill allowed at Bonneville Dam during the March releases (Figure 1). During 1992-2000, spill duration and volume averaged 178 hours (7.4 days) and 1200 KAF. During 2001-2004, average spill duration and volume were reduced to 59 hours (2.5 days) and 177 KAF. During 2005 and 2006, BPA did not allow spill for the March releases. However, beginning in 2004, the Bonneville Dam corner collector was operated during the March releases, providing a non-turbine/bypass passage route through the dam. During 2004-2006, the corner collector was operated for 81 hours using 34 KAF, on average, during the March releases. These recent volumes using the corner collector are 2.8% of the volumes allowed using spill during 1992-2000.

The provision of spill at Bonneville Dam for the SCNFH March releases has been an important issue among the FWS, other fishery management agencies, and the Action Agencies. In 2004, the FWS developed and distributed a research proposal to rigorously evaluate the effects of Bonneville Dam operations on the survival of SCNFH March releases (USFWS 2004). This study consisted of three years of CWT marking and releases under three operations at Bonneville Dam: a spill-only operation, a spill plus corner collector operation, and a corner collector-only operation. Partitioning the March release into three groups would help balance the risk caused by the uncertainty of the newly-constructed corner collector route, and this balanced block design would aid in understanding the additive and or multiplicative effects of the components of spill and corner collector operation on efficiency (through hydroacoustics) and long-term survival (through coded wire tag recovery rates). To achieve this balanced design, FWS requested that the treatment operations be: 75 kcfs spill-only, 75 kcfs spill with the corner collector, and the corner collector-only. Spill levels for the spill and spill with the corner collector needed to be similar in this study design to assess whether the effect of the corner collector is additive or not. FWS believed that spill levels at 75 kcfs would provide adequate survival conditions and would provide a level of precaution against the unknown survival rates associated with the other passage routes. The proposal to conduct the study over three years was made to ensure confidence and reliability in the results.

Following the distribution of this proposal, discussions between the FWS and the Action Agencies resulted in a single year of CWT-marking, only two operations being evaluated (spill versus corner collector), reduced levels of spill (50 kcfs instead of the proposed 75 kcfs), and no spill requests for two years. For the most part, this is what occurred. A major exception was that calibration errors in spill rates resulted in actual spill rates of 25 kcfs instead of the target of 50 kcfs in 2004.

In March 2004, the U.S. Fish and Wildlife Service (FWS) released over 220,000 subyearling fall Chinook from SCNFH with coded wire tags (CWT) to evaluate smolt-to-adult return rates (SAR) back to the hatchery under two operations at Bonneville Dam. Tagged fish were released in two groups: one group released during four days of spill operation at Bonneville Dam and one group released during four days of corner collector operation at Bonneville Dam. In determining the number of tagged fish to release (220,000), sample size calculations were conducted which found that a 25% reduction in the hatchery SAR of fish released during corner collector operation could be detected with 80% power ($\beta = 0.2$) and $\alpha = 0.1$, assuming the hatchery SAR for fish released during spill was 0.0016 (the average hatchery SAR for March-released fish over brood years 1992-1996). The releases were conducted to test the following null hypothesis:

$$H_0: SAR_{Spill} = SAR_{CC}, \text{ versus}$$

$$H_A: SAR_{Spill} \neq SAR_{CC},$$

where SAR_{Spill} is the hatchery SAR for fish released during spill operations at Bonneville Dam and SAR_{CC} is the hatchery SAR for fish released during corner collector operations at Bonneville Dam. At this point in time, we call this evaluation preliminary because age-4 adults from the 2004 releases (brood year 2003) will not return until fall 2007. Age-4 adults typically constitute 24% of the total brood year returns to the hatchery.

Methods

Tagging and releases

Spring Creek NFH staff randomly selected nine rearing ponds and tagged approximately 25,000 fingerlings with CWT from each pond. Four ponds were randomly assigned for release during the spill operation and the remaining five were assigned to release during corner collector operation. Mean fish weight at tagging was 2.2 grams for the spill release group fish and 2.3 grams for the corner collector release group fish. The spill release group fish were released from the hatchery in the early afternoon of March 1 and had a mean weight of 2.7 grams. The corner collector release group fish were released from the hatchery in the morning of March 10 and had a mean weight of 3.2 grams. After accounting for tags that were shed, there were 98,932 CWT fish in the spill release group and 122,853 CWT fish in the corner collector release group. In total, 221,785 CWT fish were released.

Bonneville Dam operations

Following the March 1 release, spill began at Bonneville Dam at 20:00 hours on March 2 with a spill target of 50 kcfs (actual spill rate was 25 kcfs, after accounting for spillgate mis-calibration). After 96 hours, spill was terminated at 20:00 hours on March 6. Following the March 10 release, corner collector operation began in the afternoon of March 11 and continued for 96 hours, until the afternoon of March 15. Flow in the corner collector was approximately 5-6 kcfs.

Results

Hatchery Returns

Returning adults from the 2004 releases (2003 brood year) returned to Spring Creek NFH as age-2 adults in 2005 and age-3 adults in 2006. In both years, adults returning to the hatchery were randomly selected across the duration of the run for examination of CWT presence. Hatchery processing constraints limit the number of fish that can be sampled in any year for CWT presence to approximately 10,000 fish. In 2005, 34,291 adults returned to the hatchery, of which 9,770 (28.5%) were examined for CWT (Table 1). In 2006, 10,745 adults returned to the hatchery, of which 9,605 (89.4%) were examined for CWT (Table 1). Within the sample examined for CWT in 2005, six fish were from the spill group and zero fish were from the corner collector group. Within the sample examined for CWT in 2006, 31 fish were from the spill group and 34 fish were from the corner collector group. Variance tests for homogeneity of the binomial distribution on the returns from each pond (Snedecor and Cochran, p. 240-241) within each treatment group (i.e., pond effects, Table 2) showed no differences among ponds for fish released under the spill treatment ($P = 0.58$ for age-2 fish and $P = 0.24$ for age-3 fish) or the corner collector treatment (test not applicable for age-2 fish and $P = 0.90$ for age-3 fish). Therefore fish from the individual ponds were combined and analyzed as

two treatment (spill operation and corner collector operation) groups. Within each experimental unit (release group), we make the assumption of independence at the individual fish level. The results above on the lack of group (i.e., pond) effects suggest that assuming independence at the individual fish level is appropriate. Our knowledge of the pond layout and operations at SCNFH, and the lack of any apparent systematic factor that could cause pond effects, further supports this assumption.

SARs and analysis

The objective of this study was to compare the hatchery SARs for the two release groups. Because the entire hatchery returns were not sampled for CWT examination, the numbers of tags observed in the sample required expansion factors to account for the number of tags in the un-sampled component of the hatchery returns. In 2005 the expansion factor was 3.51 (1/.285) and in 2006 the expansion factor was 1.12 (1/.894). Therefore the SARs for the two groups were calculated as:

$$SAR_{Spill} = \frac{3.51(6) + 1.12(31)}{98932} = 0.00056, \text{ and}$$

$$SAR_{CC} = \frac{3.51(0) + 1.12(34)}{122853} = 0.00031.$$

The SAR_{CC} is a 45% reduction compared to the SAR_{Spill} . We used bootstrapping (Efron and Tibshirani 1993) to calculate 95% confidence intervals for the SARs. The return data for the two groups of fish were re-sampled 1000 times with replacement, using the same expansion factors, to generate 1000 estimates of the SARs for the two groups. We used the 2.5th and 97.5th percentiles of the bootstrap estimates define the 95% confidence limits. The 95% confidence interval for the spill group was (0.00037, 0.00077) and the 95% confidence interval for the corner collector group was (0.00021, 0.00041) (Figure 2).

We used a randomization test to compare the SARs for the two release groups (Manly 1997). Randomization tests provide high statistical power and are especially useful in non-standard situations such as this one where the SARs were the sum of CWT returns over two years, with different expansion factors in each year. In this case, we tested whether the difference between the SARs, $SAR_{diff} = SAR_{Spill} - SAR_{CC}$, could have arisen by chance if there was no difference between the treatment effects. To generate a distribution of SAR_{diff} under the null hypothesis, we generated 5000 replicates of SAR_{Spill} and SAR_{CC} using the across-treatment mean SARs within the samples for the returns in each year. The across-treatment mean SAR in the 2005 sample was

$$SAR_{2005} = \frac{6 + 0}{98932 + 122785} = 0.0000271$$

and the across-treatment mean SAR in the 2006 sample was

$$SAR_{2006} = \frac{31 + 34}{98932 + 122785} = 0.000293.$$

We generated 5000 replicates of SAR_{Spill} and SAR_{CC} with random samples from binomial distributions using sample sizes of 98,932 and 122,785 with the probability of success (i.e., a CWT return) equal to the across-treatment mean SARs above, and with the above expansion factors that accounted for the sampling fraction. The 2.5th and 97.5th percentiles of the null distribution were -0.00022 and 0.00022. These represent the critical values at the 5% significance level. Because the observed difference (0.00025) exceeded the critical values, we reject the null hypothesis (P value = 0.028). We conclude that the SAR for fish released during the spill operation in 2004 is significantly higher than the SAR for fish released during the corner collector operation in 2004. The hatchery SAR was higher for the spill treatment than the corner collector treatment for both age-2 returns (0.00021 vs. 0.0) and age-3 returns (0.00035 vs. 0.00031).

Discussion

Using the above estimates for SAR_{Spill} and SAR_{CC} and the total number of subyearlings released on March 1st and 10th 2004 (7,331,523), we estimate that if this entire March release had occurred during the spill operation, the number of adults returning to the hatchery would have been 4,134. If the entire March release had occurred during the corner collector operation, the number of adult returning to the hatchery would have been 2,273. The difference between these two estimates, 1,861, is an estimate of the foregone loss of adults back to the hatchery (through age-3) associated with corner collector operations instead of spill operations at Bonneville Dam in 2004. The average proportion returning to the hatchery (hatchery return rate divided by total survival rate) for brood years 1992-2001 (data for most recent ten years) is 0.33 (Table 3). Therefore, the projected loss to intercepting fisheries from a corner collector operation versus actual spill of 25 KCFS for the 2004 release in March is 3,722 fish. When the expectations for age-4 returns is considered (i.e., that age-4 returns constitute 24% of the total brood year returns), the projected loss to intercepting fisheries increases to 4,545 fish. Had the originally-proposed operation of 75 kcfs spill been implemented, these differences may have been even more pronounced.

In a review of this draft report, Pereira (2007) provided several comments regarding this study. The two primary comments were that the study had a narrow scope of inference and that variation in the release groups (i.e., pond effects) may have influenced the confidence interval widths and P values. In terms of broadening the scope, Pereira (2007) suggests increased replication within the season (i.e., multiple treatment release groups in March) and increasing the number of release groups. We agree that additional replication would improve the confidence and reliability of the results. In our original study proposal, we proposed replicating the CWT releases over three years and three treatments. If the Action Agencies had implemented this original proposal, the additional replication proposed by the USFWS and suggested by Pereira (2007) would have been achieved, along with increasing the understanding the individual and combined effects of spill and corner collector operation on survival to the adult stage for March-released SCNFH tule fall Chinook salmon. We encourage the Action Agencies to reconsider these additional study years and treatments for the Spring Creek March release. The second primary comment of Pereira (2007) is that extra variation among the pond groups would tend to underestimate confidence interval width and cause P values to be too small. As described above in the section on hatchery returns, we found no evidence of pond effects, suggesting that our assumption of independence at the individual fish level was appropriate. We therefore believe that the confidence intervals and P values properly account for the uncertainty associated with the SARs and the

statistical significance of the difference in hatchery *SARs* between the two operations. Still, these results are preliminary, as age-4 returns from the releases in 2004 will return in 2007 and fishery recoveries (ocean and in-river) for the 2004 release will be completed in upcoming years.

Table 1. Number of adult returns to SCNFH, number of adults sampled for CWT examination, and the number of CWT fish in the samples for the spill group fish and corner collector (CC) group fish.

Return Year	Adult Returns	Examined for CWT	Number of CWT fish in samples			
			Age-2		Age-3	
			Spill group	CC group	Spill group	CC group
2005	34,291	9,770	6	0		
2006	10,745	9,605			31	34

Table 2. Number of fish marked with CWT and the number of observed returns to SCNFH, for each of the nine pond groups randomly assigned to the spill and corner collector operations treatments.

Treatment	Pond	Number tagged	Age-2 returns in 2005	Age-3 returns in 2006
Spill	Pond 1	24,515	0	10
Spill	Pond 2	24,822	2	3
Spill	Pond 3	24,448	2	8
Spill	Pond 4	25,147	2	10
CC	Pond 5	24,573	0	6
CC	Pond 6	23,453	0	5
CC	Pond 7	24,815	0	7
CC	Pond 8	25,030	0	9
CC	Pond 9	24,982	0	7

Table 3. Total percent survival rate (fisheries interceptions plus hatchery returns), hatchery percent SAR, and the proportion of total survivors that returned to the hatchery (hatchery SAR divided by total survival rate) for Spring Creek NFH releases over brood years 1992-2001.

Brood Year	Total Survival Rate (%)	Hatchery SAR (%)	Hatchery proportion
1992	0.16	0.05	0.34
1993	0.22	0.06	0.28
1994	0.10	0.04	0.36
1995	0.05	0.02	0.33
1996	0.43	0.13	0.31
1997	0.11	0.04	0.33
1998	1.30	0.47	0.36
1999	1.44	0.42	0.29
2000	1.14	0.36	0.32
2001	0.98	0.35	0.35
Average			0.33

Data from Annual Stock Assessment - CWT (USFWS)
BPA Project No. 1982-013-03

1980 through 1995 data from the 2004 Annual Report
1996 through 2001 data from the 2005 Annual Report

Figure 1. Hours of spill and KAF of spill at Bonneville Dam during the March release of Spring Creek NFH tule fall Chinook, 1992-2006.

Figure 2. Bootstrap 95% confidence intervals of the hatchery return rate for Spring Creek NFH Chinook salmon released during spill operations and corner collector (CC) operations at Bonneville Dam in 2004.

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DRAFT

February 6, 2007

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SYSTEM OPERATIONAL REQUEST: #2007-3

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: U.S. Fish & Wildlife Service, Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, NOAA Fisheries, Shoshone-Bannock Tribes, and the Columbia River Inter-Tribal Fish Commission (Due to the 2007 Operations Agreement between BPA and the CRITFC Tribes, we cannot support the SOR but will not oppose the SOR).

TO:	Brigadier General Gregg F. Martin	COE-NWD
	James D. Barton	COE-Water Management
	Cathy Hlebechuk	COE-RCC
	Witt Anderson	COE-P
	Col. Thomas E. O'Donovan	COE-Portland District
	LTC Anthony Hofmann	COE-Walla Walla District
	J. William McDonald	USBR-Boise Regional Director
	Stephen J. Wright	BPA-Administrator
	Greg Delwiche	BPA-PG-5

FROM: Tom Lorz, Vice Chairperson, Salmon Managers

DATE: March 9, 2007

SUBJECT: Bonneville Dam Operations

SPECIFICATIONS:

Beginning immediately, spill at Bonneville Dam to provide an alternate route of passage from the bypass system in order to spread-the risk at the project. Continue the spill operation until the Bonneville Dam bypass system has been eliminated as a source of the recent increased mortality rates for listed Spring Creek National Fish Hatchery subyearling fall chinook. Spill a minimum of 85 Kcfs at Bonneville Dam, using a minimum 2-foot spill gate opening at each spillbay. Continue until 95% of the Spring Creek hatchery releases have passed, likely this will occur by Wednesday morning March 14, 2007.

JUSTIFICATION:

The Spring Creek National Fish Hatchery released 6.6 million subyearling fall chinook smolts on March 5, 2007 and 1.2 million on March 9, 2007. Smolt Monitoring Program personnel at the site reported unusually high mortality in the Spring Creek smolts collected at Bonneville Dam (see Table 1). They reported 4.5% mortality on March 8, and 8% mortality on the 9th. Typically the mortality rate is 1 to 1.5%. No immediate cause of the mortality was apparent. The COE inspected gatewells and orifices on March 8 and 9 and found no blocked orifices, or dead fish in gatewells, or other likely cause for mortality. The COE also reported no visible dead fish in forebay of Powerhouse 2. The COE are continuing inspections on March 9 to determine other possible causes of mortality.

Dead fish obtained from the sample on March 8, were examined at the USFWS health lab at Spring Creek NFH and were found to show no obvious signs of disease or injury. Therefore, the cause of the mortality is unknown at this point. SMP personnel report that most mortalities were neutrally buoyant when they entered the sample tank, possibly indicating mortality had occurred within a relatively short time period prior to arriving in the tank. A few fish were seen to have eyes missing or other trauma in the March 9 sample.

Table 1. Summary of SMP data related to mortalities in Sample

Sample Date	Passage Index	Sample Count	Descaling Exams	Number Descaled	Sample Morts	Facility Morts	Percent Facility Morts
03/03/07	9	1	1	0	0	0	0%
03/04/07	26	3	3	0	0	0	0%
03/05/07	8	1	1	0	0	0	0%
03/07/07	106,076	318	313	0	0	5	2%
03/08/07	429,248	1,292	1,236	0	1	55	4%
03/09/07	298,932	878	804	0	2	72	8%

Facility Morts are those fish that were dead prior to entering the sample tank, while sample morts died while in sample tank or during sampling.

It would be prudent, given the significant numbers of juvenile fall chinook that are passing the project, to provide an alternate route of passage, that is not associated with the bypass. Current projections for flows at Bonneville Dam over the next four days range from 160 to 214 Kcfs (3/06/07 STP run). Flows of 160 kcfs would translate to a 14.5 ft. tailwater elevation. This would provide 1.5 ft. of depth compensation for chum redds located at the current management level of a 13 ft. Bonneville Dam tailwater elevation. Based on the SYSTDG modeling provided by the COE, a 75 kcfs level of spill under a total discharge of 150 kcfs would result in dissolved gas levels of 106.4-108.3%. The COE modeling suggests that flows of 160 kcfs would provide sufficient depth compensation for the chum redds below Bonneville Dam. Flows of 160 kcfs or greater would additionally lower gas levels and provide more protection against gas supersaturation than the COE model runs using 150 kcfs. Consequently a minimum of 85 Kcfs appears possible under current conditions.

SYSTEM OPERATIONAL REQUEST: #2007-4

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR Oregon Department of Fish and Wildlife, US Fish and Wildlife Service, Shoshone-Bannock Tribes, and the Columbia River Inter-Tribal Fish Commission.

TO:	Brigadier General Gregg F. Martin	COE-NWD
	James D. Barton	COE-Water Management
	Cathy Hlebechuk	COE-RCC
	Witt Anderson	COE-P
	Col. Thomas E. O'Donovan	COE-Portland District
	LTC Anthony Hofmann	COE-Walla Walla District
	J. William McDonald	USBR-Boise Regional Director
	Stephen J. Wright	BPA-Administrator
	Greg Delwiche	BPA-PG-5

FROM: Tom Lorz, Vice Chairperson, Salmon Managers

DATE: March 21, 2007

SUBJECT: Early Spring Dworshak Operations

SPECIFICATIONS:

The Salmon Managers listed above urge the Action Agencies to approach the present operation of Dworshak Dam (increased outflows) with caution to assure that the April 10th shifted Flood Control elevation is met. Outflows may have to be altered to reach the April 10th URC.

JUSTIFICATION:

As stated in the 2000 Biological Opinion, by meeting the April 10th elevations, operator's help to assure a high probability of meeting both reservoir refill and river flow objectives. The Corps of Engineers March final forecast (April-July) at Dworshak Dam is 2192 Kaf, or 82% of average. With this forecast, the shifted end of March Flood Control elevation is 1560.3 feet and the April 15th shifted Flood Control elevation is 1571.6 feet. Interpolating between the COE's end of March and April 15th shifted flood control elevations results in an April 10th elevation of 1567.8 feet. The March 21st midnight elevation was 1556 feet.

The Salmon Managers recognize that inflows to Dworshak Dam have been somewhat high over the last week; however we are concerned that inflows have increased as a result of

melting lower level snowpack. From the NRCS website¹, snowpack in the Clearwater and Salmon Basin has decreased from 86% of average on March 1st, 2007 to a current average of 75% of average on March 20th, 2007. The Salmon Managers are concerned that if snowmelt ceases, inflows will not be sufficient to refill Dworshak Dam from an elevation of 1560.3 feet on March 31st, 2007 to its estimated April 10th elevation of 1567.8 feet. Additionally, diminished snowpack in the Clearwater and Salmon over March indicates that the Water Supply forecast at Dworshak Dam will likely decrease when the COE calculates its April Final Forecast. A decreased April Final forecast at Dworshak Dam will increase flood control elevations at Dworshak Dam. It is important that the COE consider these trends in the water supply forecast when they establish the Dworshak operation.

We recognize that the COE operates Dworshak Dam for multiple purposes which include flood control as well as flow augmentation for fish. Our review of the above information suggests that the COE might consider operating Dworshak Dam more conservatively during the end of March. This operation would not impose undue risk to flood control, while it would allow the COE to better meet the purpose of flow augmentation.

For all of these reasons, the Salmon Managers are requesting that the COE conduct the necessary risk assessments, and if appropriate, operate Dworshak Dam more conservatively to help assure that the current April 10th shifted Flood Control elevation (currently 1567.8 feet but that elevation may increase due to reasons explained above) is achieved at Dworshak Dam.

¹ <ftp://ftp.wcc.nrcs.usda.gov/data/snow/update/>.

SYSTEM OPERATIONAL REQUEST: #2007-5

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Idaho Department of Fish and Game, NOAA Fisheries, US Fish and Wildlife Service, Shoshone-Bannock Tribes, and the Columbia River Inter-Tribal Fish Commission.

TO:	Brigadier General Gregg F. Martin	COE-NWD
	James D. Barton	COE-Water Management
	Cathy Hlebechuk	COE-RCC
	Witt Anderson	COE-P
	Col. Thomas E. O'Donovan	COE-Portland District
	LTC Anthony Hofmann	COE-Walla Walla District
	J. William McDonald	USBR-Boise Regional Director
	Stephen J. Wright	BPA-Administrator
	Greg Delwiche	BPA-PG-5

FROM: Paul Wagner Chairperson, Salmon Managers

DATE: April 26, 2007

SUBJECT: Bonneville Dam Operations for Spring Creek Hatchery Release on May 1, 2007

SPECIFICATIONS:

- 1) The Salmon Managers listed above request the Action Agencies to operate the units at Bonneville Second Powerhouse equipped with gap closure devices, at the low end of the 1% efficiency range. This operation should be implemented beginning at 0001 hours on May 2 and continue for 72 hours, or longer, if the majority (95%) of Spring Creek Hatchery fish continue to pass the project.
- 2) If mortality rates in the sample at any time meet, or exceed 2%, spill should be increased from the 100 Kcfs to the level of the gas cap spill.

JUSTIFICATION:

Thus far this season there have been two releases of subyearling tule fall Chinook from this hatchery. Both releases have been detected at the Bonneville sampling facility with mortality rates significantly higher than normally observed. The last release on April 12 was detected at the monitoring facility beginning at 0645 on April 13th. A sub-sample taken after two hours of collection (7 am to 9 am) found 10% mortality in the 1,232 fish sample. The FPAC met

and requested that the units at Bonneville Second Powerhouse equipped with gap closure devices operate at the low end of the 1% efficiency range. Subsequent to this change, the mortality rates decreased for the remainder of this hatchery group passage.

A third release of 3.5 million subyearling tule fall Chinook is scheduled for May 1, 2007. The survival of this release is of particular concern given the unexpected mortality incurred by the March and April releases. While it is not specifically known that the modifications made to the units equipped with gap closure devices are causing the mortality of the Spring Creek fish, it would be prudent to implement this small change to the project operations prior to the arrival of this third release of fish.

Juvenile Bypass Mortalities for releases from Spring Creek NFH, 2001-2007

	Average Mortality		
	<u>March</u>	<u>April</u>	<u>May</u>
2006	0.2%	0.1%	0.4%
2005	0.4%	0.3%	0.2%
2004	0.1%	1.7%	0.3%
2003	0.7%	0.1%	0.0%
2002	2.0%	0.3%	0.3%
2001	0.1%	0.1%	—
	-----	-----	-----
average	0.6%	0.4%	0.2%
2007	<u>March</u>	range	
	5.1%	(1.6 - 11.7)	
	3.6%	(2.3 - 4.5)	
2007	<u>April</u>		
	2.4%	(0.0 - 7.8)	

SYSTEM OPERATIONAL REQUEST: #2007-6

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, NOAA Fisheries, Nez Perce Tribe, and the Columbia River Inter-Tribal Fish Commission.

TO:	Brigadier General Gregg F. Martin	COE-NWD
	James D. Barton	COE-Water Management
	Cathy Hlebechuk	COE-RCC
	Witt Anderson	COE-P
	Col. Thomas E. O'Donovan	COE-Portland District
	LTC Anthony Hofmann	COE-Walla Walla District
	J. William McDonald	USBR-Boise Regional Director
	Stephen J. Wright	BPA-Administrator
	Greg Delwiche	BPA-PG-5

FROM: Paul Wagner, Chairperson, Salmon Managers

DATE: May 8, 2007

SUBJECT: Spill for Fish Passage According to the Court Order

SPECIFICATIONS: Increase spill to the amounts specified in the Court's Order when TDG levels decrease below the criteria.

JUSTIFICATION: We recognize that implementation of spill under the Court Order is limited by the presently established criteria for total dissolved gas, and that the COE is operating spill within those criteria. However, spill under the Court Order is being provided to benefit fish survival through the hydrosystem, and any unnecessary reductions in spill reduce the survival of these endangered stocks. Consequently, in order to achieve the greatest benefit of spill for fish survival we request the COE to respond more quickly by increasing spill to the amounts specified in the Court's Order when TDG levels decrease below the criteria.

The attached graphs show the provision of spill relative to the Court Order over the past week, as well as the high 12-hour average TDG readings at the tailrace monitor and at the next downstream forebay monitor. Spill is being implemented to the levels specified in the Court's Order at Lower Granite, Ice Harbor (for testing), McNary and The Dalles Dam. At Little Goose Dam the Court's Order calls for an instantaneous spill level of 30%. However, the 2007 Operations Agreement calls for 14 days of spill to the gas cap (120%) during nighttime hours at this project. The fourteen days began on April 29, 2007 and spill has not reached gas cap during nighttime hours at this project since this operation began. While the Lower Monumental Dam forebay readings exceeded the 115% on May 1 to May 3, the 12 hour TDG reading at the tailrace of Little Goose or at the next downstream forebay have not exceeded the TDG criteria in the last

four days. At Lower Monumental Dam spill was decreased to just 13.5 Kcfs on May 3 in response to a downstream forebay monitor at Ice Harbor. That forebay monitor was reading higher TDG levels than were observed at the Lower Monumental tailrace monitor below the dam. John Day Dam has not achieved the Court Order since the first day of spill (on April 18-19 spill averaged the closest to the Court Order at 59.5% during nighttime hours) in spite of the fact that TDG levels in both the tailrace and The Dalles forebay have been below the TDG criteria since April 22. Lastly, at Bonneville Dam spill was reduced on the 29th of April in response to a 115.1% 12 hour average reading at the downstream Camas/Washougal station and was below both the TDG and the Court's Order for several days, with only small increments in spill occurring every few days.

Again, the Salmon Managers recognize the difficulty in managing spill and TDG on a real-time basis. However, since spill is a mitigative measure provided for fish protection, the Salmon Managers request that the COE be more responsive in changing spill levels when TDG falls below criteria.

Flow-Spill Operations – May 1 – May 7, 2007
For FPAC Meeting (05/08/07)

1-May	Court Order: 20 kcfs/20 kcfs; 24-hr Avg Spill = 19.9 kcfs TDG waivers not exceeded (12-hr Avg TDG = 110.7% @ LGR Tailrace and 113.9% @ LGS Forebay)
2-May	Court Order: 20 kcfs/20 kcfs; 24-hr Avg Spill = 20.0 kcfs TDG waivers not exceeded (12-hr Avg TDG = 110.4% @ LGR Tailrace and 112.4% @ LGS Forebay)
3-May	Court Order: 20 kcfs/20 kcfs; 24-hr Avg Spill = 20.0 kcfs TDG waivers not exceeded (12-hr Avg TDG = 109.2% @ LGR Tailrace and 109.1% @ LGS Forebay)
4-May	Court Order: 20 kcfs/20 kcfs; 24-hr Avg Spill = 20.0 kcfs TDG waivers not exceeded (12-hr Avg TDG = 109.4% @ LGR Tailrace and 106.5% @ LGS Forebay)
5-May	Court Order: 20 kcfs/20 kcfs; 24-hr Avg Spill = 19.9 kcfs TDG waivers not exceeded (12-hr Avg TDG = 109.3% @ LGR Tailrace and 104.5% @ LGS Forebay)
6-May	Court Order: 20 kcfs/20 kcfs; 24-hr Avg Spill = 20.0 kcfs TDG waivers not exceeded (12-hr Avg TDG = 110% @ LGR Tailrace and 104.8% @ LGS Forebay)
7-May	Court Order: 20 kcfs/20 kcfs; 24-hr Avg Spill = 19.9 kcfs TDG waivers not exceeded (12-hr Avg TDG = 110.7% @ LGR Tailrace and 105.7% @ LGS Forebay)

Flow-Spill Operations – May 1 – May 7, 2007
For FPAC Meeting (05/08/07)

1-May	Court Order: 30%/30%; 24-hr Avg Spill = 26.9 kcfs (32.4%); Additional spill due to agreement for 14 days of gas cap night-time spill (3rd Day) TDG waiver exceeded @ LMN Forebay (12-hr Avg = 116.2%); Not exceeded @ LGS Tailrace (12-hr Avg = 117.9%)
2-May	Court Order: 30%/30%; 24-hr Avg Spill = 26.6 kcfs (31.9%); Additional spill due to agreement for 14 days of gas cap night-time spill (4th Day) TDG waiver exceeded @ LMN Forebay (12-hr Avg = 118.1%); Not exceeded @ LGS Tailrace (12-hr Avg = 118.3%)
3-May	Court Order: 30%/30%; 24-hr Avg Spill = 25.6 kcfs (28.0%); Additional spill due to agreement for 14 days of gas cap night-time spill (5th Day) TDG waiver exceeded @ LMN Forebay (12-hr Avg = 115.5%); Not exceeded @ LGS Tailrace (12-hr Avg = 116.8%)
4-May	Court Order: 30%/30%; 24-hr Avg Spill = 25.6 kcfs (29.7%); Additional spill due to agreement for 14 days of gas cap night-time spill (6th Day) TDG waivers not exceeded (12-hr Avg TDG = 116.3% @ LGS Tailrace and 114% @ LMN Forebay)
5-May	Court Order: 30%/30%; 24-hr Avg Spill = 24.8 kcfs (31.3%); Additional spill due to agreement for 14 days of gas cap night-time spill (7th Day) TDG waivers not exceeded (12-hr Avg TDG = 115.6% @ LGS Tailrace and 112% @ LMN Forebay)
6-May	Court Order: 30%/30%; 24-hr Avg Spill = 24.1 kcfs (34.6%); Additional spill due to agreement for 14 days of gas cap night-time spill (8th Day) TDG waivers not exceeded (12-hr Avg TDG = 116.1% @ LGS Tailrace and 111.8% @ LMN Forebay)
7-May	Court Order: 30%/30%; 24-hr Avg Spill = 24.3 kcfs (37%); Additional spill due to agreement for 14 days of gas cap night-time spill (9th Day) TDG waivers not exceeded (12-hr Avg TDG = 116.1% @ LGS Tailrace and 111.8% @ LMN Forebay)

Flow-Spill Operations – May 1 – May 7, 2007
For FPAC Meeting (05/08/07)

1-May	Court Order: Gas Cap/Gas Cap; 24-hr Avg Spill = 15.2 kcfs <i>Downstream forebay TDG higher than Tailrace</i> TDG waiver exceeded @ IHR Forebay (12-hr Avg = 115.6%); Not exceeded @ LMN Tailrace (12-hr Avg = 114.1%)
2-May	Court Order: Gas Cap/Gas Cap; 24-hr Avg Spill = 17.5 (4 hours high spill 18:00-21:00 provided to enhance passage of fish in forebay) TDG waiver exceeded @ IHR Forebay (12-hr Avg = 115.6%); Not exceeded @ LMN Tailrace (12-hr Avg = 116.4%)
3-May	Court Order: Gas Cap/Gas Cap; 24-hr Avg Spill = 16.0 kcfs TDG waivers not exceeded (12-hr Avg TDG = 116.4% @ LMN Tailrace and 112.7% @ IHR Forebay) <i>Last exceedance 5/2 @ IHR Forebay</i>
4-May	Court Order: Gas Cap/Gas Cap; 24-hr Avg Spill = 21.4 kcfs TDG waivers not exceeded (12-hr Avg TDG = 117.7% @ LMN Tailrace and 112.2% @ IHR Forebay) <i>Last exceedance 5/2 @ IHR Forebay</i>
5-May	Court Order: Gas Cap/Gas Cap; 24-hr Avg Spill = 21.4 kcfs TDG waivers not exceeded (12-hr Avg TDG = 116.9% @ LMN Tailrace and 111.8% @ IHR Forebay) <i>Last exceedance 5/2 @ IHR Forebay</i>
6-May	Court Order: Gas Cap/Gas Cap; 24-hr Avg Spill = 21.4 kcfs TDG waivers not exceeded (12-hr Avg TDG = 117.3% @ LMN Tailrace and 112.4% @ IHR Forebay) <i>Last exceedance 5/2 @ IHR Forebay</i>
7-May	Court Order: Gas Cap/Gas Cap; 24-hr Avg Spill = 22.8 kcfs TDG waiver exceeded @ LMN Tailrace (12-hr Avg TDG = 120.1%); Not exceeded @ IHR Forebay (12-hr Avg TDG = 113.7%)

Flow-Spill Operations – May 1 – May 7, 2007
For FPAC Meeting (05/08/07)

1-May	Court Order: 45 kcfs/Gas Cap; 24-hr Avg Spill = 61.7 kcfs TDG waivers not exceeded (12-hr Avg TDG = 117.9% @ IHR Tailrace and 114.5% @ MCN Forebay)
2-May	Court Order: 30%/30%; 24-hr Avg Spill = 33.9 kcfs (39.3%) TDG waivers not exceeded (12-hr Avg TDG = 116.8% @ IHR Tailrace and 114% @ MCN Forebay)
3-May	Court Order: 30%/30%; 24-hr Avg Spill = 27.6 kcfs (30.1%) TDG waivers not exceeded (12-hr Avg TDG = 115.7% @ IHR Tailrace and 111.2% @ MCN Forebay)
4-May	Court Order: 45 kcfs/Gas Cap; 24-hr Avg Spill = 47.1 kcfs TDG waivers not exceeded (12-hr Avg TDG = 115.8% @ IHR Tailrace and 109.1% @ MCN Forebay)
5-May	Court Order: 45 kcfs/Gas Cap; 24-hr Avg Spill = 55.3 kcfs TDG waivers not exceeded (12-hr Avg TDG = 115.7% @ IHR Tailrace and 108.9% @ MCN Forebay)
6-May	Court Order: 30%/30%; 24-hr Avg Spill = 29.6 kcfs (41.2%) TDG waivers not exceeded (12-hr Avg TDG = 114.8% @ IHR Tailrace and 110% @ MCN Forebay)
7-May	Court Order: 30%/30%; 24-hr Avg Spill = 19.8 kcfs (29.9%) TDG waivers not exceeded (12-hr Avg TDG = 114.5% @ IHR Tailrace and 113% @ MCN Forebay)

Flow-Spill Operations – May 1 – May 7, 2007
For FPAC Meeting (05/08/07)

1-May	Court Order: 40%/40%; 24-hr Avg Spill = 104.1 kcfs (40.2%) TDG waivers not exceeded (12-hr Avg TDG = 116.0% @ MCN Tailrace and 112.8% @ JDA Forebay)
2-May	Court Order: 40%/40%; 24-hr Avg Spill = 106.8 kcfs (40.1%) TDG waivers not exceeded (12-hr Avg TDG = 115.7% @ MCN Tailrace and 113.3% @ JDA Forebay)
3-May	Court Order: 40%/40%; 24-hr Avg Spill = 108.0 kcfs (39.9%) TDG waivers not exceeded (12-hr Avg TDG = 115.7% @ MCN Tailrace and 111.8% @ JDA Forebay)
4-May	Court Order: 40%/40%; 24-hr Avg Spill = 116.5 kcfs (40.1%) TDG waivers not exceeded (12-hr Avg TDG = 115.8% @ MCN Tailrace and 110.8% @ JDA Forebay)
5-May	Court Order: 40%/40%; 24-hr Avg Spill = 113.8 kcfs (40%) TDG waivers not exceeded (12-hr Avg TDG = 115.6% @ MCN Tailrace and 108.4% @ JDA Forebay)
6-May	Court Order: 40%/40%; 24-hr Avg Spill = 108.8 kcfs (40.3%) TDG waivers not exceeded (12-hr Avg TDG = 115.5% @ MCN Tailrace and 107.2% @ JDA Forebay)
7-May	Court Order: 40%/40%; 24-hr Avg Spill = 101.8 kcfs (39.75%) TDG waivers not exceeded (12-hr Avg TDG = 115.9% @ MCN Tailrace and 108.3% @ JDA Forebay)

Flow-Spill Operations – May 1 – May 7, 2007
For FPAC Meeting (05/08/07)

1-May	Court Order: 0 kcfs/60%; Avg night-time spill April 30 (19:00) to May 1 (06:00) = 127.8 Kcfs (48.4%) TDG waivers not exceeded (12-hr Avg TDG = 119.1% @ JDA Tailrace and 114.7% @ TDA Forebay) <i>Last exceedance 4/22 @ JDA Tailrace</i>
2-May	Court Order: 0 kcfs/60%; Avg night-time spill May 1 (19:00) to May 2 (06:00) = 126.9 kcfs (40.9%) TDG waivers not exceeded (12-hr Avg TDG = 119.2% @ JDA Tailrace and 113.6% @ TDA Forebay) <i>Last exceedance 4/22 @ JDA Tailrace</i>
3-May	Court Order: 0 kcfs/60%; Avg night-time spill May 2 (19:00) to May 3 (06:00) = 128.0 kcfs (45.1%) TDG waivers not exceeded (12-hr Avg TDG = 118.7% @ JDA Tailrace and 113.3% @ TDA Forebay) <i>Last exceedance 4/22 @ JDA Tailrace</i>
4-May	Court Order: 0 kcfs/60%; Avg night-time spill May 3 (19:00) to May 4 (06:00) = 139.9 kcfs (50.5%) TDG waivers not exceeded (12-hr Avg TDG = 118.5% @ JDA Tailrace and 112.4% @ TDA Forebay) <i>Last exceedance 4/22 @ JDA Tailrace</i>
5-May	Court Order: 0 kcfs/60%; Avg night-time spill May 4 (19:00) to May 5 (06:00) = 142.1 kcfs (50.6%) TDG waivers not exceeded (12-hr Avg TDG = 117.9% @ JDA Tailrace and 111.8% @ TDA Forebay) <i>Last exceedance 4/22 @ JDA Tailrace</i>
6-May	Court Order: 0 kcfs/60%; Avg night-time spill May 5 (19:00) to May 6 (06:00) = 140.1 kcfs (44.6%) TDG waivers not exceeded (12-hr Avg TDG = 118% @ JDA Tailrace and 111.6% @ TDA Forebay) <i>Last exceedance 4/22 @ JDA Tailrace</i>
7-May	Court Order: 0 kcfs/60%; Avg night-time spill May 6 (19:00) to May 7 (06:00) = 123.4 kcfs (57.2%) TDG waivers not exceeded (12-hr Avg TDG = 117.6% @ JDA Tailrace and 113.4% @ TDA Forebay) <i>Last exceedance 4/22 @ JDA Tailrace</i>

Flow-Spill Operations – May 1 – May 7, 2007
For FPAC Meeting (05/08/07)

1-May	Court Order: 40%/40%; 24-hr Avg Spill = 98.9 kcfs (39.9%) TDG waivers not exceeded (12-hr Avg TDG = 117.6% @ TDA Tailrace and 113.5% @ BON Forebay)
2-May	Court Order: 40%/40%; 24-hr Avg Spill = 101.3 kcfs (39.6%) TDG waivers not exceeded (12-hr Avg TDG = 116.4% @ TDA Tailrace and 114.7% @ BON Forebay)
3-May	Court Order: 40%/40%; 24-hr Avg Spill = 104.4 kcfs (39.7%) TDG waivers not exceeded (12-hr Avg TDG = 116.1% @ TDA Tailrace and 113.7% @ BON Forebay)
4-May	Court Order: 40%/40%; 24-hr Avg Spill = 108.6 kcfs (39.5%) TDG waivers not exceeded (12-hr Avg TDG = 115.4% @ TDA Tailrace and 112.5% @ BON Forebay)
5-May	Court Order: 40%/40%; 24-hr Avg Spill = 109.1 kcfs (39.9%) TDG waivers not exceeded (12-hr Avg TDG = 114.6% @ TDA Tailrace and 111.3% @ BON Forebay)
6-May	Court Order: 40%/40%; 24-hr Avg Spill = 108.2 kcfs (40.1%) TDG waivers not exceeded (12-hr Avg TDG = 114.2% @ TDA Tailrace and 111.2% @ BON Forebay)
7-May	Court Order: 40%/40%; 24-hr Avg Spill = 93.8 kcfs (39.9%) TDG waivers not exceeded (12-hr Avg TDG = 114.1% @ TDA Tailrace and 112.5% @ BON Forebay)

Flow-Spill Operations – May 1 – May 7, 2007
For FPAC Meeting (05/08/07)

1-May	Court Order: 100 kcfs/100 kcfs; 24-hr Avg Spill = 92.7 TDG waivers not exceeded (12-hr Avg TDG = 118.7% @ CCIS and 115% @ CAMWAS)
2-May	Court Order: 100 kcfs/100 kcfs; 24-hr Avg Spill = 92.8 kcfs TDG waivers not exceeded (12-hr Avg TDG = 118.8% @ CCIS and 113.3% @ CAMWAS)
3-May	Court Order: 100 kcfs/100 kcfs; 24-hr Avg Spill = 93.3 kcfs TDG waivers not exceeded (12-hr Avg TDG = 118.7% @ CCIS and 114% @ CAMWAS)
4-May	Court Order: 100 kcfs/100 kcfs; 24-hr Avg Spill = 94.1 kcfs TDG waivers not exceeded (12-hr Avg TDG = 118.8% @ CCIS and 113.4% @ CAMWAS)
5-May	Court Order: 100 kcfs/100 kcfs; 24-hr Avg Spill = 95.9 kcfs TDG waivers not exceeded (12-hr Avg TDG = 118.6% @ CCIS and 113% @ CAMWAS)
6-May	Court Order: 100 kcfs/100 kcfs; 24-hr Avg Spill = 97.5 kcfs TDG waivers not exceeded (12-hr Avg TDG = 118.3% @ CCIS and 112.7% @ CAMWAS)
7-May	Court Order: 100 kcfs/100 kcfs; 24-hr Avg Spill = 97.2 kcfs TDG waivers exceeded @ CAMWAS (12-hr Avg = 115.1%); Not @ CCIS (12-hr Avg TDG = 118.3%)

SYSTEM OPERATIONAL REQUEST: #2007-7

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

TO:	Brigadier General Gregg F. Martin	COE-NWD
	James D. Barton	COE-Water Management
	Cathy Hlebechuk	COE-RCC
	Witt Anderson	COE-P
	Col. Thomas E. O'Donovan	COE-Portland District
	LTC Anthony Hofmann	COE-Walla Walla District
	J. William McDonald	USBR-Boise Regional Director
	Stephen J. Wright	BPA-Administrator
	Greg Delwiche	BPA-PG-5

FROM: Tom Lorz, Vice-Chairperson, Salmon Managers

DATE: June 26, 2007

SUBJECT: Libby 2007 and Hungry Horse Summer Operations

SPECIFICATIONS: Provide Outflows from Libby and Hungry Horse dams over July and August as estimated in the last (6-26-07) STP to draft these reservoirs to 20 feet below their full pool elevations by August 31, followed by a gradual ramp down of flow through the first week of September. The current STP estimates an outflow from Libby of 17.4 Kcfs while drafting to elevation 2439 feet (20 feet from full) and outflows of 4.4 Kcfs from Hungry Horse while drafting to elevation 3540 feet (20 feet from full). If near term COE water forecast and flow predictions show that these recommended outflow levels will leave these reservoirs above the 20-foot draft level by the end of August, we request that the volume of water predicted to be left in the reservoirs above the 20-foot draft level by August 31, be provided from other storage water releases, such as from Canadian sources, in the July-August migration period. Should Non-Treaty water become available for flow augmentation later in the summer, these recommended releases from Libby and Hungry Horse can be modified to reflect the change in water availability such as was accomplished in 2006.

JUSTIFICATION:

Page 11 of the 2006 SOR (2006 MT-1 Final V2) from Montana contains a graph of the wetted perimeter associated with various Libby Dam outflows from index sites in the Kootenai River. Wetted perimeter is defined as the length of inundated river substrate across the river. This graph provided by Montana shows that the wetted perimeter is greater at flows of 17.4 Kcfs in

comparison to flows recommended by the state of Montana in SOR 2007 MT-1 (15 Kcfs through July 21, 2007 then 12 Kcfs over the rest of July and August). Implementation of this SOR will provide a constant flow level in the Kootenai River, as recommended by the State of Montana and will provide necessary upper basin storage to attempt to meet 2004 FCRPS BiOp flow targets at McNary Dam for migrating anadromous fish in the lower Columbia River, in July and August of 2007.

APPENDIX I

2007 Joint Technical Staff Letters

State, Federal and Tribal Fishery Agencies Joint Technical Staff Memo

To: Rob Lothrop (Columbia River Inter-Tribal Fish Commission)
Sharon Kiefer (Idaho Department of Fish and Wildlife)
Tony Nigro (Oregon Department of Fish and Wildlife)
Bill Tweit (Washington Department of Fish and Wildlife)
Howard Schaller (US Fish and Wildlife Service)

From: Bob Heinith (Columbia River Inter-Tribal Fish Commission)

Russ Kiefer (Idaho Department of Fish and Wildlife)

Ron Boyce (Oregon Department of Fish and Wildlife)

Cindy LeFleur (Washington Department of Fish and Wildlife)

David Wills (US Fish and Wildlife Service)

Date: January 31, 2007

Subject: Technical Comments on the U.S. Army Corps of Engineer's application for a waiver to Oregon's total dissolved gas standard

Contained within this memorandum are our technical comments on the U.S. Army Corps of Engineers' application for a waiver to Oregon's total dissolved gas standard for the purpose of voluntarily spilling water at the four lower Columbia River dams to assist in the passage of out migrating threatened and endangered salmonids (salmon and trout) and other anadromous species such as Pacific lamprey. The spilling of water introduces air into the spilled water and results in total dissolved gas saturation in excess of Oregon's total dissolved gas water quality standard, 110 percent relative to atmospheric pressure.

The applicant requests continuing the current total dissolved gas waiver limits of 120 percent total dissolved gas (TDG) in the tailrace and 115 percent TDG in the forebay. The applicant requests waiver compliance to be measured by fixed monitoring stations located in the

tailwater downstream of the aerated zone below the spillway at each mainstem dam, and in the forebay of the next project downstream.

As in past years we support the applicants' request for a five-year waiver of the total dissolved gas standard to assist fish passage past the Columbia River hydroelectric projects via non-turbine and screen bypass routes. However, DEQ should carefully consider the technical information presented here in their consideration of how and where the total dissolved gas is measured. We believe that lack of accuracy and reliability of TDG monitoring in the forebays of hydroelectric projects and at the Camas/Washougal station downstream of Bonneville Dam may unnecessarily restrict the ability to provide spill in a manner consistent with the original objectives for the waiver. Data collected and studies since that time strongly suggest that it is nearly impossible to obtain valid measurements at the forebay monitoring locations that represent upstream spill total dissolved gas levels or are representative of a mixed water column due to monitor placement problems and confounding effects of environmental conditions (see DeHart. November 16, 2006 Comments on Corps of Engineers 2006 Draft Water Quality Plan. Attachment 1)

The dissolved gas criteria associated with the waiver were to assure that mortality to salmonids and other species occurring from dissolved gas was substantially less than that due to passage through turbines and screen bypass systems at hydroelectric projects. Over the years, the Biological Monitoring Program, which is part of the DEQ waiver requirements for monitoring, has collected data confirming that managing spill to tailrace total dissolved gas levels of 120% in a controlled spill program provides greater protection to the designated and existing beneficial aquatic uses of the river than was anticipated with the original waiver request in 1995.

1. Outline of the Issue

Supersaturation occurs when a solution contains more of the dissolved material than could be dissolved by the solvent under normal circumstances. Dissolved gas supersaturation in the Columbia and Snake rivers routinely occurs during the spring and summer freshet as a result of water spilling over dams (voluntarily or involuntarily). Total Dissolved Gas (TDG) is the measure of the sum total of all gas partial pressures (including water vapor) in water. TDG can be reported as an absolute overall dissolved gas pressure or relative to atmospheric pressure. Gas bubbles can form in the blood and tissues of aquatic organisms when water becomes supersaturated with gas. This results in "Gas Bubble Trauma" (GBT) in the affected organisms. GBT can, in turn if severe enough, cause rapid acute mortality as well as increase long-term mortality in aquatic organisms.

The original waiver criteria for TDG were established in 1994. This was the first time a waiver had been requested from the water quality agencies for variation from the national standard with the intent of providing survival benefits to migrating juvenile salmonids through additional spill passage. A literature review of past experiments (Spill and 1995 Risk Management (WDFW et al., 1995) had suggested that spill to the 125% TDG level might still have provided benefits to the designated and existing fish uses, but to err on the conservative side, a target of 115% TDG in the mixed waters of the forebay and 120% TDG in the tailrace was adopted. These criteria have been in-place since 1994 along with a biological monitoring program to assess the impacts of the controlled spill program.

The goal of the spill program is to provide benefits to migrating juvenile salmonids and other fish as they pass over dams, while not imposing harm from exposure to dissolved gas that outweighs the benefits of spill. The project forebay TDG monitors were originally intended to represent a mixed cross section in the river just upstream of the dam. The tailwater instruments are located immediately downstream of the projects, often in spillway releases downstream of aerated flow, and prior to complete mixing with powerhouse releases. The ability to adequately monitor TDG is extremely important and the question of whether, or not the forebay monitors reflect the actual picture of the potential harm that could occur from TDG has been an uncertainty from the beginning of the monitoring program.¹ While the tailwater instruments are also affected to some degree during periods of non-spill by the same processes that cause errors in forebay readings, the physical process of spilling water sufficiently mixes the water column such that the tailwater monitors adequately represent the mixed water column measurement of TDG due to spill.

In 1994, the Oregon Department of Environmental Quality (DEQ) and the Washington Department of Ecology (DOE) granted variances from the 110% TDG standard for the first time. The waiver allowed TDG to reach 120%, which was defined as the 12 highest hourly readings measured at monitoring sites about a mile downstream of the dams. The maximum instantaneous allowable TDG specified was 125%. At Bonneville Dam the location designated was at Hamilton Island, approximately 1.5 miles downstream of the dam. The monitoring locations were not permanent monitoring sites and data were collected using a manually deployed probe that took readings from 2-4 times in a 24- hour period.

In March of 1995, the National Marine Fisheries Service reissued (NMFS 1995) its 1994-1998 Biological Opinion (BIOP) (NMFS 1994), which included several directives relative to the concentrations and monitoring of total dissolved gas levels that were different from the 1994 program. This BIOP originally developed the 115/120% TDG standard for monitoring that continues to be implemented today. The BIOP states that “until it can be determined how tailrace monitoring stations relate to the river reaches between monitoring sites and how TDG data collected at these sites relate to fish experience, forebay monitoring data will be used for in-season management”... “Spill will be reduced as necessary when the 12 hour average TDG concentration exceeds 115% of saturation (or as limited by state water quality standard modifications) at the forebay monitor of any Snake or lower Columbia river dam or at the Camas/Washougal station below Bonneville Dam or another suitable location to measure accurately chronic exposure levels. Spill will also be reduced when 12-hour average TDG level exceeds 120% of saturation (or as limited by state water quality modifications) at the tailrace monitor at any Snake or lower Columbia river dams.”

It was in this document that the Camas/Washougal site was established to represent a downstream forebay location below Bonneville Dam. The forebay sites were established as a measure of TDG in mixed waters and to represent the long-term exposure levels of migrants throughout the migration corridor. NMFS (NOAA Fisheries) expresses most concern for

¹ Since the original TDG waiver for fish was issued by DEQ, it has been determined by the region's fishery agencies and tribes that forebay monitors measure a host of variables, including but not limited to solar influence, temperature, and biological processes, thus, they are not representative of spill affects at upstream dams. These local process can bias forebay TDG readings.

migrating juvenile salmonids that are delayed in forebay locations for several hours to days at elevated gas levels. The use of a 12- hour average, rather than a 24-hour average, was chosen to provide a conservative measure of total dissolved gas.

Since 1995, the annual monitoring of TDG has been according to the guidelines established in the 1994-1998 Biological Opinion. However, as stated previously, the use of the forebay and Camas/Washougal sites have been problematic since the beginning of the program. In 2000, NOAA Fisheries addressed the concern regarding forebay monitors and included in their Biological Opinion a reasonable and prudent alternative (RPA 132), which states “The Action Agencies shall develop a plan to conduct a systematic review and evaluation of the TDG fixed monitoring stations in the forebays of all the mainstem Columbia and Snake river dams (including the Camas/Washougal monitor)...The Action Agencies shall conduct the evaluation and make changes to the location of the fixed monitoring sites, as warranted, and in coordination with the Water Quality Team.” The COE conducted several tests at project forebay FMS stations in the lower Snake and Columbia rivers and found that several stations experienced thermally induced TDG pressure spikes during the test periods indicating down welling of warm surface waters, resulting in non-representative spiking of TDG (Carroll, 2004).

Based on a study conducted for RPA 132, the COE recommended the relocation of several monitors to address the impact that the daily spike in temperature had on TDG readings. The monitors were relocated upstream of the dam face and the transducers were placed deeper in the water column where daily spikes in temperature were supposed to be minimized. However, based on the three separate analyses that were conducted by the Fish Passage Center (September 29, 2006 memo to Fish Passage Advisory Committee) (Attachment 2), it was concluded that forebay monitors still do not accurately reflect the TDG of mixed waters and continue to be impacted by localized processes. Measures (relocation) taken under RPA 132 to assure that the forebay monitors were representative of mixed water at several of the projects did not achieve that objective.

2. Spill Restriction Based on the Forebay Monitoring Requirement

Spill amounts were included in the 2000 Biological Opinion and reiterated in the 2004 Biological Opinion that were part of a suite of measures designed to meet viability standards under the Endangered Species Act. The following table shows the spill amounts that were modeled for the 2000 BIOP spill measures compared to pre-season spill amounts estimated for 2006 (2006 Water Management Plan) and for 2007 (Draft 2007 Water Quality Plan) using the 115% forebay and 120% tailrace criteria, and to spill amounts that would be provided based on a 120% tailrace criteria using 2006 flow data if the 120% tailrace reading was the point of compliance (FPC memo to FPAC, September 29, 2006). From the table it can be seen that the pre-season estimates of spill amounts in 2006 and 2007 were less than that assumed in the 2000 BIOP especially for Snake River projects. Spill amounts would approach the assumed BIOP amounts if spill was managed based on tailrace 120% TDG criteria.

Table 1. Spill amounts (kcfs) assumed in modeling for 2000 BIOP, estimated spill amounts for 2006 and 2007 to meet 115% forebay/120% tailrace TDG criteria, and estimated spill amount to meet 120% tailrace criteria using 2006 flow data.

Project	2000 BIOP Modeling	2006 Planned Spill to Meet 115/120 TDG Criteria (2006 Water Management Plan)	2007 Spill Planned to Meet 115/120 TDG Criteria (Draft 2007 Water Quality Plan)	Spill to Meet 120 TDG Criteria Based on 2006 Flow Data
LGR	60	42	40	54
LGO	45	32	20	51
LMN	40	40	25	39
IHR	105N/45D	105	95	76
MCN	135 (120-150 range)	155	170	179
JDA	85 Kcfs or 60% (70-100)	95	110	133
TDA	230 or 64%	91	110	147
BVL	135 (120-150)	100	115	101

Over the past several years, (Table 2) there have been several instances where TDG levels were exceeded at the forebay monitors, while the upstream tailrace monitors were in compliance. During spring 2002-06 at Snake River projects and McNary, exceedences of forebay criteria constituted a high proportion of total exceedences and proportion of days where the forebay monitor was in exceedence but the upstream tailrace monitor was not (Table 2). This table includes all days when monitors were exceeded and does not distinguish between controlled and uncontrolled spill. In addition, there were times when actions were taken to decrease spill when possible if forebay monitors exceeded the 115%, while tailrace monitors below the upstream project did not exceed 120%.

Table 2. Total number of exceedences per year and proportion of total where forebay exceeded 115% and tailrace did not exceed 120%.

Project Forebay	Total Number of Exceedences in Spring Spill Season (Apr 3-June 20 - Snake R.; Apr 20-June 30 - Columbia R.)	Number of Days that Forebay was in Exceedence but Upstream Tailrace was Not	Proportion of Total Exceedences where the Forebay was in Exceedence while Tailrace was Not
Lower Granite*			
2002	22	5	0.23
2003	12	3	0.25
2004	1	1	1.00
2006	38	10	0.26
Little Goose*			
2002	41	36	0.88
2003	19	13	0.68
2004	1	1	1.00
2006	54	35	0.65
Lower Monumental*			
2002	24	20	0.83
2003	37	27	0.73
2004	4	3	0.75
2005	6	0	0.00
2006	52	23	0.44
Ice Harbor			
2001	5	5	1.00
2002	31	25	0.81
2003	20	16	0.80
2004	12	10	0.83
2005	15	12	0.80
2006	39	17	0.44
McNary*			
2002	33	3	0.09
2003	22	10	0.45
2004	7	0	0.00
2005	3	2	0.67
2006	40	10	0.25
John Day*			
2002	28	6	0.21
2003	10	10	1.00
2004	5	5	1.00
2005	8	4	0.50
2006	47	14	0.30
The Dalles*			
2002	31	22	0.71
2003	17	13	0.76
2004	1	1	1.00
2005	3	3	1.00
2006	46	37	0.80
Bonneville			
2001	2	2	1.00
2002	48	35	0.73
2003	31	30	0.97
2004	8	8	1.00
2005	14	14	1.00
2006	64	12	0.19

* Data for 2001 and/or 2005 missing for sites where no exceedences were recorded during spring spill season

3. Biological Rationale

A. TDG and Fish Physiology

The potential for adverse effects of dissolved gas to Columbia River aquatic species may seem complex but is fairly easy to understand. The gases of concern are those comprising the atmosphere on earth, i.e., 80% nitrogen, 20% oxygen and a few trace gases. The presence of dissolved gases is measured by the pressure they exert, measured in mm Hg. The measured pressures are compared to atmospheric pressures. If there is more gas in the water due to spill at hydroelectric projects or due to many other causes than the gas pressure (atmospheric) at the surface of the water, then it is referred to as supersaturated and the percentage above the atmospheric pressure is calculated.

Several environmental factors affect the solubility of the composite gases of air. If there are changes in these factors it alters the pressures exerted by those gases, thus, can affect the degree of saturation. Increasing water temperature, falling barometric pressure, and biological activity (respiration) cause an increase in the partial pressures of the individual dissolved gases. Decreasing water temperature, photosynthesis, and a rising barometer have the opposite effect. Wind, although it does not affect gas physics, can decrease the amount of gases in river water by stripping it at the surface. When evaluating the gas level due to one factor, e.g., spill, the other factors must be considered.

Table 3 shows the dramatic influence environmental factors, e.g., water temperature, dissolved oxygen, barometric pressure, wind, photosynthesis, and biological respiration may have on the TDG measurements recorded in a monitoring program. Of great significance to management of voluntary spill is the length of time that elapses from the instant of spill and the TDG measurement. The table portrays the labile nature of TDG measurements. The table information represents changes in measurements that occurred in the 25 mile transit from Bonneville Dam to the Camas/Washougal monitor. The table shows that monitors located miles downstream of the spill site could on a calm warm afternoon during the spill season yield a TDG measurement that has a 5-6% error due to environmental factors. Management to the forebay monitor readings of TDG would result in a reduction of spill, while the tailrace of the upstream project was in compliance.

Table 3. Example of the effect of environmental variables on the concentration of TDG measured downstream of Bonneville Dam.

Factor	Change	Units	TDG Response
Water Temperature	Increase	1 °C	~3.0 °
Barometer	Increase	7-8 mm Hg	~1.0%
Photosynthetic Oxygen	Increase	1 mg/l	~2.0%
Wind	Decrease	18 mph	~5.3%

Aquatic organisms living in a supersaturated river, depending on dissolved oxygen for their metabolic oxygen will tend to come into an equilibrium state with the level of dissolved gases surrounding them. As long as the organism remains in a physical environment that maintains the dissolved gas within its tissue to be equal to the dissolved gases in the water, no gas bubbles can form. For example, as long as the organism remains at adequate depth, benefiting from the hydrostatic pressure, the gases in its tissues will remain at equilibrium. However, if the organism ascends or sounds the gas balance will reflect the pressure change. Ascent will place the organism tissues in an unsteady, supersaturated state. The tissue gases tend to return to a gaseous phase as bubbles and blisters referred to as GBT. Sounding will increase the solubility of the gases and serve to protect the organism.

Dissolved gas affects all aquatic biota similarly, whether salmonids, resident fish or invertebrates. The biological effect is a function of dose response as moderated by hydrostatic pressure, that is, depth. Each meter of depth equates to 10 % of depth compensation. This means that the organisms' depth determines the biological effect of exposure to water supersaturated with atmospheric gas. If the Corps' Fixed Monitoring Station records a gas level of 120% supersaturation, it is referring to a gas level relative to water surface pressure. This same gas content at 1 m is only 110% supersaturated due to the compensatory influence of hydrostatic pressure. At 2 m it is in equilibrium, i.e., it is no longer supersaturated. The same is true of fish or invertebrate tissue levels of gas. If the fish or invertebrate tissues are equilibrated with the ambient level of dissolved gas and the water total dissolved gas is 120% relative to the surface, the organisms cannot develop GBT if they are at 2 meters or more in depth. In short, GBT is the result of uncompensated hyperbaric pressure of TDG (see Figure 1). It is the same for all fish, salmonid or resident species, as well as invertebrates. Beeman and Maule (2006) found that juvenile salmon and steelhead hydrostatic compensation resulting from migration at depth in the water column was sufficient to protect them from gas bubble disease during the controlled fish spill program.

The dose response effect is a function of the difference in gas pressure in the water compared to organism tissue level. If a fish is at equilibrium with water at surface atmospheric pressure (100%) the fish gas physiology is stable. If the fish moves into water with a level of supersaturation the greater the supersaturation the more rapid will be gas uptake by the fish or other aquatic organism. The greater the differential between water TDG and tissue TDG the more rapid will be the tissue uptake of gases. At this point one needs to consider depth compensation, which is the effect of pressure on the potential for development of GBT (Figure 1). A fish with tissue gas levels equal to 130% supersaturation at the surface will not show GBT as long as it stays below 2m from the surface where its tissue will only be 110% supersaturated.

Figure 1. Compensatory effects of depth (hyperbaric pressure) on fish exposed to supersaturated water.

B. Biological Monitoring

Juvenile Salmonids

Since 1995, the biological monitoring program has recorded annually the effects of the FCRPS biological opinion spill program and effects of TDG on incidence of GBT. The data observed over the years through the biological monitoring has consistently shown very low incidence of GBT when gas levels are at the 120% tailrace criteria. When fish are exposed to gas levels greater than 120%, there is an increasing trend in incidence and severity of these signs (Figure 2). For all fish examined through the Smolt Monitoring Program for signs of GBT when tailrace TDG levels were 120% or less the incidence of any fin signs observed in that population was 0.5%. This demonstrates a minimal effect of biological opinion spill levels over the last 11 years with TDG levels managed to 120% in the project tailrace. The percentage of fish with severity of GBT symptoms begins to increase above 120% and then dramatically increases above 125%.

The Independent Scientific Advisory Board's evaluation of gas abatement (ISAB 98-8 *Review of the U.S. Army Corps of Engineers Dissolved Gas Abatement Program*) and the NMFS' 2000 Biological Opinion for the Federal Columbia River Power System (NMFS 2000) found that dissolved gas levels of 120% saturation were conservative and not harmful to salmon in the river. Further, analysis of three years of research from in-river juvenile salmon sampling in the Columbia River indicates that very low incidences of GBT were found in juvenile salmon that were exposed to dissolved gas levels up to 125% saturation Backman et al. 2002a.²

² These researchers found that Gas Bubble Trauma was not detected in most of in-river migrants sampled from 1996-1999. This included fish sampled during two very high flow years where spill was at uncontrolled levels through the Federal Columbia River Power System.

Adult Salmon

Adult salmonids were monitored for signs of GBT through the 1999 spill season. Few signs of GBT were observed at TDG levels within the waivers. Additionally, juveniles are more susceptible to GBT, and if they are being monitored adequately the adults will also be protected (L. Marsh, Oregon Department of Environmental Quality, memorandum to the Environmental Quality Commission, March 27, 2000). Physical handling of adults adds extra stress.

Backman and Evans (2002b) found that in samples of 4,667 adult chinook salmon, fish were rarely observed with gas bubble trauma, despite sampling large numbers when total dissolved gas exceeded 130% saturation. Specifically, Backman and Evans (2002b) found no statistically significant relation between total dissolved gas and gas bubble trauma for chinook salmon. For adult sockeye and steelhead, Backman and Evans (2002b) found that most gas bubble trauma symptoms were minor (>5% fin occlusion) with severe bubbles (>26% fin occlusion) being observed only when total dissolved gas exceeded 126%.

Resident Fish and Invertebrates

The requested TDG variance is expected to have minimal impacts on resident fish or macro invertebrates in the Columbia River. The NMFS monitored resident fishes and aquatic invertebrates in the Columbia River downstream from Bonneville Dam for signs of GBT in 1993, 1994, 1995, and 1996. Organisms sampled included northern pikeminnow, bass, perch, catfish, crappie, sturgeon, shad, suckers, chub, sculpins, sticklebacks, minnows, crayfish and other crustaceans, clams, snails, and insects. Sampling in 1993 revealed a very low incidence of GBT in prickly sculpin (0.6%; 1 of 174 fish); peamouth chub, (0.4%; 1 of 238 fish); and threespine stickleback (0.2%; 2 of 906 fish). No signs of GBD were seen in the three species of invertebrates (crayfish, Asian clam, and dragonfly larvae) that were examined (Toner and Dawley, 1995). In 1994, no signs of GBT were observed in any of the 4,955 resident fish or 3,928 invertebrates that were examined (Toner et al., 1995). During 1995, signs of GBT were noted in five species of resident fish, but never exceeded 1% of those fish examined (Dawley and Schrank, 1995).

In 1997, resident fish were collected and examined for the TDG biological monitoring program in the Columbia River. Fish that were examined included peamouth, largescale sucker, mountain whitefish, northern pikeminnow, stickleback, redbreast shiner, sculpin, sanddollar, pumpkinseed, and carp. A total of 214 individual fish of these resident species were examined for external signs of GBD. No signs of GBT were seen on any of those fish.

In 1998, only largescale suckers and mountain whitefish were examined. No signs of GBT were observed in these fish. In 1999, largescale sucker, northern pikeminnow, stickleback and sculpin were examined. Again, no signs of GBT were observed.

In addition, many of these resident species occupy shallow near shore areas that are out of the main current of the Columbia River. Such areas typically have lower total dissolved gas concentrations than those in the main current. Toner et al. (1995) indicated that the lower TDG levels in the shallow backwater and shoreline areas may be due to the lack of exchange with

higher TDG water in the main river. Faster dissipation of gas from shallow water was also thought to occur because of its higher surface area to volume ratio.

Ryan et al. (2000) found only 3.9% of the almost 40,000 non-salmonid resident fish sampled (27 species) in the mid-Columbia and lower Snake rivers, Washington, showed signs of GBT during spring spill periods in 1994-1997, with TDG reaching above 135%. They concluded that GBT signs were rare in non-salmonid resident fish when TDG levels were less than 120%. Signs of GBT were rare with the invertebrate samples taken.

In work conducted with resident fish behavior relative to TDG supersaturation in the Lower Clark Fork River in Idaho, Weitkamp et al. (2003a) concluded that the fish behavior of the resident fish greatly influenced the degree of supersaturation the fish actually experience. In further work on the Lower Clark Fork River, Weitkamp et al. (2003b) found that the occurrence and severity of GBT was greatly lower than expected for the TDG levels measured (120-150%). Their conclusion was "... the majority of fish are spending sufficient time at depths that avoid or mediate both the incidence and severity of GBT when TDG supersaturation is in the range of 120-130% of saturation."

Figure 2. Percentage of all fish examined for GBT at Little Goose, Lower Monumental, McNary and Bonneville dams from 1995 to 2005 that showed GBT symptoms in fins by severity rank and TDG exposure based on upstream tailwater monitor and fish travel time from that site. Fin ranks are: rank 1 – less than 5% fin area covered with bubbles, rank 2 – 5 to 25%, rank 3 – 26 to 50% and rank 4 – greater than 50%.

C. Fish benefits from maintaining spill at the 120% tailrace level.

Spill is a key measure in NOAA Fisheries Biological Opinions to mitigate for the construction and operation of the Federal Columbia River Power System. Several efforts have been undertaken to provide the benefit of spill in terms of fish survival, however it is impossible to adequately determine the direct and indirect effects of spill on survival with existing tools and data. Most biological models rely on monthly time-steps and average fish numbers that make it extremely difficult to capture the effects of changing daily spill management and other conditions affecting fish survival. In addition, the current state of knowledge of the benefit of spill beyond project passage and delayed effects is continually developing. The benefits of spill include the following:

- Spill provides a non-turbine, non-bypass route of passage past a hydroelectric project that has a higher associated juvenile survival benefit than turbine and screened system passage routes (NOAA 2000a). In addition, recent data suggests there may be some delayed effects of hydrosystem passage especially with bypass routes that are not manifested in juvenile survival. These effects show in smolt to adult survival rates and are due to passage through the hydrosystem. Passage through multiple bypass systems seems to exacerbate the issue reinforcing the positive benefits of spill.
- Since fish transportation does not provide a positive benefit for all species, the agencies and tribes recommend a spread-the-risk management strategy to allow 50% of the fish to migrate in-river primarily through spill and/or other surface passage routes. The effectiveness of the hydro projects at collecting fish and low current spillway passage efficiency makes it difficult to achieve this objective and in most years significantly more than the 50% of fish are transported. In the interim, spill is the primary means to achieve the spread-the-risk management strategy.
- Spill decreases forebay residence time, decreases migration rate (or travel time) and increases survival. Decreasing travel time has been shown to decrease exposure time to in-river predation. Also, survival to adult is increased when travel time is decreased and fish arrive at the estuary during the "optimal" biological window (Marmorek et al. 2004; Williams et al.).
- Turbulence in tailraces from spill disperses predators and improves survival through this area.

While it is impossible to quantify and represent the total benefit of spill, it is possible to estimate improvements that can be made in increasing spillway passage the route of passage that has been shown to provide the highest survival of any passage route at Columbia and Snake River dams. To illustrate this, we compared the number of fish that would be passed via spillways when spill is implemented under the Court Order spill as was done in 2005 and 2006 where spill was managed to 115/120% TDG criteria to that if the Court Order spill was managed only to the 120% tailrace TDG.

The daily fish collections from the smolt monitoring program, the actual spill that occurred in 2006 and the estimates of the spill passage efficiency (SPE) from the NOAA National Marine Fisheries Service COMPASS model (for Snake River Spring Chinook and Steelhead) were used to obtain daily population estimates. Two different spill levels were

applied to the daily population estimates at each project where smolt monitoring data was available from 2006. The first spill level represents the amount of spill that would have occurred in 2006 managing to the 115/120% TDG levels (after involuntary and excess hydraulic capacity were removed, see Attachment 2, September 29, 2006 Spring Spill 2006 memo for a full description of how these numbers were derived) and the second spill level represent an estimated spill that would have occurred if spill were only managed to the 120% tailrace criteria. Again, the SPE used in this portion of the analysis was from the NOAA Fisheries COMPASS model.

As can be seen in the following table, managing spill to a 115% forebay/120% tailrace TDG criteria can result in substantially fewer fish passing over the spillway at many projects as compared to managing spill based on 120% tailrace TDG criteria. The greatest effect would occur at Little Goose Dam with over 18% fewer yearling chinook passing in spill.

Table 4. Estimated percent increase in numbers of fish passing in spill when Court ordered spill is managed to the 120% tailrace TDG.

Project **	Number of Fish Passing Through Spill (under 2006 operations to 115/120% with over-generation and excess hydraulic capacity spill removed) (a)	Number of Fish Passing Through Spill (using spill cap of 120% TDG at tailrace as estimated in Spring 2006 memo) (b)	Percent Change (c)
Lower Granite			
Yearling Chinook	1,996,987	1,996,987	0.00
Steelhead	5,623,601	5,623,601	0.00
Little Goose			
Yearling Chinook	1,233,733	1,459,566	18.30
Steelhead	1,242,498	1,409,044	13.40
Lower Monumental			
Yearling Chinook	2,443,704	2,824,271	15.57
Steelhead	2,287,001	2,563,396	12.09
McNary			
Yearling Chinook	1,159,564	1,163,128	0.31
Steelhead	292,327	292,916	0.20
Bonneville			
Yearling Chinook	1,673,950	1,796,918	7.35
Steelhead	164,399	171,120	4.09

* Ice Harbor and The Dalles are not Smolt Monitoring Program sampling sites and, therefore, fish abundance data were not available for this analysis

† John Day not included in this analysis due to difficulties in estimating spill relative to the court order (see attached Spring Spill 2006 Memo for details)

From the table it is apparent that at some projects there could be significant gain in the number of fish passing over the spillway if TDG management is based on tailrace monitoring. Comparable data for 2006 is not available at John Day due to unreliable fish passage data due to unplanned powerhouse unit outages. However, it should be noted that based on TDG monitoring that spill at all lower Columbia River projects is often constrained by forebay TDG monitoring

and it is highly likely that similar increases in spillway passage would be observed at these projects if spill was managed based only on tailrace monitoring.

The current spill program, limited by forebay monitors, is unable to achieve a spread the risk management strategy with regard to the transportation program for Snake River migrants and in-river migrants. Reductions in the spill program caused by the forebay monitors impacts the ability to keep migrants from being collected and transported. Currently the majority of both Snake River Spring Chinook and Steelhead are transported rather than allowed to migrate in river. Due to concerns with screened bypass systems the default operation is to transport fish that are collected and not return them to the river. The best available scientific information indicates that spillway passage is more likely to increase adult return rates as compared to bypass passage. For example: The 2005 NMFS technical memorandum on the effects of the federal Columbia River power system on salmonid populations contained the following pertinent information. In figures 53 & 54 on pages 112 & 113 this report shows the relative SARs between smolts migrating uncollected (primarily through spill) at collector projects and those bypassed. Smolts with only one bypass history had an average SAR 25% less than those migrating uncollected, and in almost half of these comparisons the difference was significant. Therefore the only way to insure a spread the risk strategy for transported migrants versus in-river occurs, is to pass fish over the spillways and through surface spill routes such as the Removable Spillway weirs. Table 5 indicates the recent percentages of juveniles transported. By using the tailrace monitors to govern the spill program closer to 50% of the migrants will be left to migrate in river. Modeling indicates in years when spill is provided at the collector projects ~5-15% more juveniles would be left to migrate in river than transported. The increase in percent of in river migrants varies from year to year given the different flow years and the shape of the run-off and how it impacts TDG readings.

Table 5. Estimated proportion of fish transported from 1999-2006.

Species Group	Transportation Proportion							
	2006**	2005*	2004*	2003	2002	2001*	2000	1999
Yearling Chinook	.61 (H) .58 (W)	0.92	0.87	0.629	0.683	0.98	0.71	.777 (H) .862 (W)
Steelhead	.76 (H) .79 (W)	0.94	0.964	0.67	0.677	0.986	0.81	0.825
Subyearling Chinook	.56 (H) .52 (W)	0.809	0.972	0.895	0.929	0.962	0.93	0.87

*Spill at the collector projects, (Lower Granite, Little Goose, Lower Monumental, McNary) was not provided in these years.

**Court Ordered Spill Operation

4. Summary

In conclusion, it must be acknowledged that there are problems with managing spill based on forebay monitoring due location of monitors and confounding effects of other environmental variables, therefore, we recommend managing fish spill and total dissolved gas based on 120% TDG measured in dam tailraces as the sole criterion. The fishery agencies and

tribes' "Spill and 1995 Risk Management" assessment originally established a range of 120-125% TDG as the transition zone where the effects of TDG would be increasing, but still very low. This has been reaffirmed by 1) the updated Risk Assessment for the Spill Program in the NOAA 2000 FCRPS Biological Opinion, 2) 12 years of physical and biological monitoring, 3) an independent scientific assessment and, 4) studies in the peer-reviewed literature. Nearly 200,000 salmonids have been evaluated for signs of GBT and less than 2% of those fish were observed with the most minor signs of GBT (less than 5% of a fin covered with bubbles) when spill levels were managed to 120% in the tailraces of dams. This is far less than the biological criteria established for the voluntary spill program of 15% of fish affected with minor signs. This shows that managing spill to 120% TDG criteria in the tailraces is conservative, and best protects the sensitive fishery existing and designated use of the Columbia River.

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State, Federal and Tribal Fishery Agencies Joint Technical Staff Letter

*Columbia River Inter-Tribal Fish Commission
Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife
NOAA National Marine Fisheries Service*

February 28, 2007

Mr. Dennis Schwartz
U.S. Army Corps of Engineers
Fish Passage Team
Robert Duncan Plaza
333 SW First Avenue
Portland, OR 97204

Subject: PNNL Proposed Ives Island Chum Redd Sampling ESA Take Permit Application

Dear Mr. Schwartz,

The System Configuration Team (SCT), Fish Passage Advisory Committee (FPAC) and the Technical Management Team (TMT) are considering studies of chum salmon incubation conditions in the Ives Island area, related to Total Dissolved Gas (TDG) issues and the effects of flow manipulation on egg and fry viability during and after spawning. The study plan proposed by the Pacific Northwest National Laboratory (PNNL) lists two objectives for “redd pumping” (i.e. partial evacuation) of chum redds in the Ives Island area. Objective 3 will “pump” five or more redds to determine TDG Gas Bubble Trauma (GBT) following an unspecified period of average to high spill. Objective 4 will “pump” five dewatered redds to determine if redd dewatering is causing mortality during post-hatch intragravel rearing. Objective 3 is part of a broader study to examine GBT of chum fry in relation to flow operations below Bonneville Dam (SCT study proposal SPE-P-06-1). Objective 4 is an add-on, at the request of the TMT as an attempt to determine if dewatering of redds constructed at higher elevations followed by intermittent rewatering is an effective flow management strategy.

General Comment:

While laboratory work to determine total dissolved thresholds for chum provides good background information, it must be related to actual field like conditions. It is near impossible to simulate field/real life conditions and exposure in the laboratory. Case in point, prior laboratory research showed that smolts held in 110 to 120% TDG levels in the laboratory expressed signs of Gas Bubble Trauma, GBT, throughout a large portion of the test population. However, the field sampling and smolt monitoring program has never recorded levels similar to those reported by the laboratory work at the same gas levels. This is likely related to exposure time, depth compensation, and other factors that occur in the field that the laboratory did not replicate or was unable to replicate. One must always be careful making management decisions based solely on laboratory work without a monitoring/evaluation of field and real life conditions. Therefore we strongly recommend that field measurements and evaluations related to gas levels and GBT need to be completed and compared to the laboratory work to insure a more holistic understanding of how total dissolved gas affects the potential chum redds below Bonneville.

Specific Comments:

The Joint Technical Staff (JTS) has reviewed the PNNL proposal and we have concerns regarding Objective 4:

- Viability criteria, sampling technique, and study design:
 - The proposed study plan does not provide any information on what constitutes viability of incubating eggs, alevins and fry. The TMT has not defined any criteria or objective for evaluating viability of dewatered redds versus non-dewatered redds. The researchers proposing to conduct the studies have not provided any background scientific information regarding egg, alevin and fry survival and mortality that could be used to develop criteria. Without such criteria or some information on what would normally be expected in healthy redds, it will be difficult to interpret findings from the proposed sampling.
 - The study does not include a control group of non-impacted (non-dewatered) redds for comparison with dewatered redds. A lack of a control group will make interpreting results difficult if not impossible. While redds “pumped” for Objective 3 could theoretically serve as controls if properly coordinated and sampled with Objective 4, the sampling periods for the two objectives are disparate and therefore not compatible. Adding the sampling of healthy redds to Objective 4 to serve as a control would require destruction of five additional redds, increasing the detrimental impacts of this objective on the chum population.
 - The technique of redd pumping may not provide useful data on effects of dewatering. When McMichael et al. (2003) used the redd pumping technique proposed in the Wanapum Dam tailrace, they stated that the “sampling efficiency was unknown and thought to be relatively low.” Given this unknown collection efficiency (which likely differs for live versus dead alvins/fry), along with the unknown number of fish in each redd, the redd pumping technique appears unlikely to produce meaningful data for assessing survival.
 - In addition to the problems associated with the redd pumping technique, measuring the effects of dewatering has proven extremely difficult in the field. McMichael et al. (2005)

used redd capping, which is thought to have higher collection efficiency than redd pumping, to assess effects of redd dewatering below Wanapum Dam. McMichael et al. (2005) was unable to demonstrate the effects of redd elevation or dewatering on redd production or fish survival, which was likely due to small sample size ($n = 7$), low statistical power, unknown number of eggs within redds, high variability in fry production among sampled redds, and/or lack of a control group. They also found high variability in estimated survival rates (assuming the unknown number of eggs in each redd of seven redds was equal to 4,272) between selected redds. We expect that chum redds would have similarly high variability in alevin/fry production, making the likelihood of detecting dewatering effects unacceptably low. While not provided by the researchers, this study design likely has low statistical power to detect meaningful differences in survival associated with dewatering.

- Timing of Sampling:
 - Sampling of dewatered redds in the spring may be too late to obtain meaningful information. The proposal does not specify when samples of dewatered redds would occur, other than to say “posthatch”. Addition of this Objective to the PNNL study was suggested with the notion that dewatered redds should be sampled using standard techniques by researchers experienced in their application and in conjunction with other similar sampling (eg. Objective 3). Presumably then, Objective 4 would probably be conducted in the Spring during periods of average or high spill, in conjunction with Obj. 3.
 - However, sampling of chum redds after April 10th, when spill is scheduled to begin in the lower Columbia, may be well after the majority of chum fry have emerged. Sampling of chum fry by seining in the Ives Island area since 1999 has shown that 76% to 92% of chum fry have emerged by April 10th (Figure 1). In only one year, 2001, were more than half of the chum fry still in the gravel. Dewatered redds in the Ives Island area were constructed during high tailwater conditions in November, and thus were some of the first redds constructed. It is likely that these redds, if viable will be the first for fry to emerge. Sampling of redds after emergence could potentially lead to an erroneous conclusion of non-viability of the redd.
 - Sampling late in the incubation period may result in loss of dead eggs and fry due to decomposition and predation over the extended incubation period, potentially leading to an erroneous conclusion of non-viability of the redd.
 - Mobility of post-hatch fry in dewatered/intermittently watered redds may allow the fry to migrate through the gravel to more favorable conditions at lower depths. If fry do migrate deeper in the gravel (or laterally), sampling excavation may find no redds present, potentially leading to an erroneous conclusion of non-viability of the redd.
- Impacts to the chum population:
 - Lower Columbia River chum populations are severely depressed and listed as threatened under the Endangered Species Act (ESA).
 - Recent population levels have been quite low, less than 700 spawning adults, except for 2002.
 - Observed redds (217) in the Ives Island area in 2006 are the second lowest since 1998 when redd surveys began.

-
- A high proportion (81%) of Ives Island 2006 chum redds are at elevations that put them at risk of being dewatered late in the incubation period due to insufficient water in the Columbia system and conflicts with power generation and spring migration flow augmentation needs.
 - Sampling of redds by pumping effectively destroys the redds and the eggs/fry they contain, resulting in an adverse impact to the chum population.
 - Adequate sampling of dewatered redds, which may be lost anyway, requires additional sampling of a comparable number of healthy redds, adding to the adverse impact to the overall chum population.

Recommendations

- To properly evaluate the effects of TDG on chum fry survival, an evaluation with adequate controls would be necessary. One possible means to evaluate this issue would be to place known numbers of hatchery-reared yolk sack fry in containment vessels buried in the gravel and evaluate them for sign of GBT at staged intervals. It would be very important to ensure that the containment vessels experienced conditions similar to natural redds, in terms of their location, depth, shape, upwelling, and substrate composition. This approach would provide a more controlled evaluation and avoid the ambiguity of not knowing whether fish were even present in the redd being evaluated. Further, because this approach would utilize hatchery-reared chum, it would not impact the listed wild chum population below Bonneville Dam.
- We recommend that criteria for evaluating viability of dewatered redds be developed prior to sampling, using available information on viability within un-impacted redds.
- We recommend that researchers proposing to conduct this type of sampling in the future provide information from the scientific literature, both published and unpublished, that describes the proportion of live and dead eggs, alevins and fry that could be expected in a healthy redd and the known effects of dewatering on salmon redds.
- If this sampling proceeds, we recommend that it be conducted earlier during the emergence period to avoid problems associated with decomposition and predation on dead eggs, alevins and fry and to avoid problems that may result from mobility of posthatch fry and early emergence.
- If the above technical issues cannot be resolved, we recommend that Objective 4 of the proposed PNNL study not be conducted due to the high probability of producing non-meaningful and confounded information.
- Given observed high variability in survival rates among redds, sampling enough redds to obtain precise information, including the addition of a control group, will impose losses to the chum spawning population that should be carefully considered in light of the tenuous status of the chum population.

References:

- McMichael, Geist, D.R., Hanrahan, T.P. and others. 2003. Chinook salmon in the Priest Rapids Project. Project Report PNWD-3243 to Public Utility District No. 2, Grant County, WA.
- McMichael, G.A., C.L. Rakowski, B.B. James, and J.A. Lukas. 2005. Estimated fall Chinook salmon survival to emergence in dewatered redds in a shallow side channel of the Columbia River. *North American Journal of Fisheries Management* 25(3):876-884.

Figure 1. Timing of chum salmon fry capture in beach seines in the Ives Island area, 1999 - 2006.

Sincerely,

Thomas K. Lorz
Thomas Lorz
 Columbia River Inter-Tribal Fish Commission

Paul Wagner
Paul Wagner
 NOAA Fisheries

Richard Z. Kruger
Richard Kruger
 Oregon Department of Fish and Wildlife

Cindy LeFleur
Cindy LeFleur
 Washington Department of Fish and Wildlife

State, Federal and Tribal Fishery Agencies Joint Technical Staff Memo

To: Bernard Klatte, COE
Cathy Hlebechuk, COE

From: Bob Heinith (CRITFC)

Richard Kruger (ODFW)

Paul Wagner (NOAA)

Cindy Lefleur (WDFW)

Russell Kiefer (IDFG)

David Wills (USFWS)

Date: April 3, 2007

This memorandum is intended to serve as a formal comment on both the Fall/Winter Update to the 2007 Water Management Plan and the 2007 Fish Passage Plan concerning Winter Count Dates in the Lower Snake River, and the implementation of a zero flow operation in the Snake River from the months of December through February. The January 22, 2007 Draft of the 2007 Fall/Winter Update to the 2007 Water Management Plan provides the following guidance regarding Snake River Zero flow.

Snake River Zero Flow (Non-BiOp Action)

According to the Lower Snake projects operating manuals, "From December to February, "zero" minimum project discharge is permitted on a limited basis. Under an agreement between the Corps of Engineers and the fishery agencies, zero riverflow is allowed for water storage during low power demand periods (at night and on weekends) when there are few, if any, actively migrating anadromous fish present in the Snake River...Water stored under zero riverflow conditions may maximize power production from the Columbia River Basin system, but zero riverflow operations are not recommended at Lower Snake projects when fish are actively migrating in the Snake River." Nighttime zero flow was discussed at the December X TMT meeting and was started December X. The consensus operation is to operate at zero flow no more than 6 hours between 2200 – 0600 hours. Generation at night may be required to provide project heating during cold weather.

In past years, winter video counts at Snake River projects have been the most useful tool in determining if “few, if any, actively migrating anadromous fish are present in the Snake River.” The fisheries agencies are concerned that winter counting in the Lower Snake river have diminished each year (Table 1). Winter counts are especially important as the Water Management Plan indicates that the action agencies can operate the Snake River projects at a zero river flow between the months of December and February when “few, if any, actively migrating anadromous fish are present in the Snake River.” Figure 1 displays both total and wild steelhead daily counts at Lower Monumental Dam from December 1, 2001 through February 28, 2002. This figure shows that adult steelhead can continue to move throughout the December through February period. The fisheries agencies believe that if the Action Agencies intend to use this flexibility in the future, that adult count data should be available to guide its implementation. The fisheries agencies recommend that the Water Management Plan and the Fish Passage Plan be changed in 2008 to state that the Action Agencies will provide adult count data to assure we are following the agreed to protocol. Specifically, we recommend counts be available at all projects until the fish ladders are closed for annual maintenance. Prior to ladder closure, we recommend that the counting data be made available on a weekly basis for in-season review. We also believe that video counting be resumed at Lower Granite Dam when the ladder is reopened, even if a zero flow operation is not planned. This information could potentially allow us to develop a predictive tool for winter steelhead movement.

We appreciate the Action Agencies have limited the use of this authorized flexibility because it is not consistent with the principles of normative river management, and working with the salmon managers to develop an implementation plan to reduce potential impacts when this action is used.

Thank you for the opportunity to comment on this important aspect of the Fall/Winter Update to the 2007 Water Management Plan and the 2007 Fish Passage Plan.

Table 1. Winter video count schedules at the Lower Snake River FCRPS projects, 2004-2007.

Lower Granite Dam

2004: 11/1/03 to 1/22/04 then 3/1/04 through the season

2005: 11/1/04 to 12/31/04 then 3/1/05 through the season

2006: 11/1/05 to 12/16/05 then 3/1/06 through the season

2007: 11/1/06 to 12/16/06

Little Goose Dam

2004: 11/1/03 to 3/31/04 then 4/1/04 through the season

2005: 11/1/04 to 12/31/04 then 4/1/05 through the season

2006: No counts Nov, Dec, Jan, Feb, March then 4/1/06 through the season

2007: No counts Nov, Dec, Jan

Lower Monumental Dam

2004: 11/1/03 to 3/31/04 then 4/1/04 through the season

2005: 11/1/04 to 12/31/04 then 4/1/05 through the season

2006: No counts Nov, Dec, Jan, Feb, March then 4/1/06 through the season

2007: No counts Nov, Dec, Jan

Ice Harbor Dam

2004: 11/1/03 to 1/22/04 then 3/1/04 through the season

2005: 11/1/04 to 12/31/04 (all zeros, questionable data) then 3/1/05 through the season

2006: No counts Nov, Dec, Jan, Feb, and then 3/1/06 through the season

2007: No counts Nov, Dec, Jan

Figure 1. Total and Wild Steelhead daily counts at Lower Monumental Dam from December 1, 2001 through February 28, 2002.

State, Federal and Tribal Fishery Agencies Joint Technical Staff Letter

April 16, 2007

Mr. Mark Bagdovitz, Chairperson MAG
USFWS
911 NE 11th Ave.
Portland, OR 97232-4181

Dear Mr. Bagdovitz:

As requested by individual CBFWA members, the state, federal and tribal fishery managers have reviewed the report entitled, “**Pacific Ocean Shelf Tracking Project (POST): Results from the Acoustic Tracking Study on Survival of Columbia River Salmon, 2006**”, and offer the following review comments for your consideration.

General Comments

This first year of research addressed the use of acoustic telemetry in estimating hydro-system survival and providing additional timing, and survival information into the marine environment. This feasibility study was useful to establish initial data on these acoustic tags in terms of longevity and detection rates at in-river and continental shelf arrays. However, data generated by this study in 2006 should only be considered useful in demonstrating the feasibility of using acoustic telemetry to measure fish passage in-river and along the continental shelf. The results of this feasibility study are not appropriate for developing broad conclusions about transportation benefits, delayed mortality, ocean survival, or ocean migration patterns of Columbia River migrants. The feasibility study has considerable limitations associated with mark groups, such as minimum size, different release and ocean entry timings, methods of marking each group separately, as well as lacking analysis of array detection probabilities in the ocean.

We are concerned that the authors have overlooked the limitations in their feasibility study and have extended their preliminary data on feasibility to address significant hypotheses. Specifically, the report states that telemetry data was used to test two hypotheses:

- 1. Is additional “latent” or “delayed” mortality experienced after Snake River smolts pass the eight dams they encounter as in-river migrants? If so, this would be evidence for the PATH hypothesis that cumulative stress from multiple dam passage is reducing the productivity of important Snake River chinook stocks.*
- 2. Does transporting/barging of chinook smolts improve early marine survival rates over run of river smolts? If so, then transporting smolts down-river should provide a boost to adult return rates, reducing extinction risk.*

We do not believe that the research results from a single year of feasibility investigation (2006) provides meaningful inference about these two hypotheses. There are several issues that need to be resolved with the techniques used in order to make inference to the broader population appropriate and to increase our confidence in the survival estimation methods. We are not confident that methods of calculating survival based on detections at the POST array, are accurate. It is possible that fish swam outside the array or that certain arrays were not operating as some fish passed that may bias results. More traditional methods of detection probability would be useful for comparison, such as mark-recapture methods.

Given our concerns, the following statement from the researchers is troubling;

“We do not find evidence that “delayed” or “latent” mortality has been expressed in the region that we conducted the 2006 pilot study—the upper reaches of the Columbia/Snake River system to the northern tip of Vancouver Island.”

The researchers base this conclusion upon comparisons of survival between Yakama River and Snake River groups in the lower Columbia River and early ocean. However, we do not agree that differences in survival between these two research groups can be applied to the larger populations. (See discussion below about limitation of study design). The above quoted statement implies that these results have broader scope than the techniques and sample size would justify.

The researchers also attempt to generalize from their results regarding transported fish to overall transported population;

“That is, the level of ocean mortality we are measuring is higher than the in-river mortality, so transport places the fish in a higher mortality environment for a longer time period.”

If the ocean mortality rate was as high as they measured, then it would be difficult for anadromous fish to persist. However, this differential in mortality rate could indicate that the tags used in this study may be causing much higher than natural mortality in the ocean. Definitive conclusions cannot be developed based on the information collected to date with this study.

The authors make the following statement “...but the key principle is that the later in the life history that comparative survival can be measured, the better the assessment will be of the merits of transport for Snake River salmon stocks.” We agree with this statement, and that is why we support the NMFS and CSS approach of using SARs to evaluating the benefits of transportation.

In conclusion, we are encouraged that the first year results of this feasibility study shows potential for this methodology to increase our understanding of the early ocean period of Columbia River anadromous fish. However, we want to stress that due

to limitations in the study design that will be discussed in following sections of this memo, broad conclusions cannot be drawn from this one year of feasibility research. The present data should not be used to make inferences in migration timing or survival, or the benefit of the smolt transportation program. The conclusions made by the authors are not justified based on the results obtained to date.

Specific Comments on study design and methods

Size of marked fish

The marking of larger hatchery fish and the unique ways different marked groups were handled, limit inference to the broader hatchery population, let alone listed wild fish. Fish used in this study were minimum 140mm fork length at marking. This is very large compared to average size of even hatchery origin fish at the time of marking. At present, it is likely that the acoustic tags available do not allow the researchers to mark small fish, such that the marked population could represent the unmarked population. In this study, the authors should acknowledge the tag size limitation.

The authors also state that they saw no consistent patterns in survival estimates that would suggest that larger smolts have better survival within the Columbia River, but note there is some slight evidence for this at the northern end of Vancouver Island. From this the authors conclude that the size of the acoustic tag used with the POST array does not seem to have a significant influence on smolt survival over the size range tagged. Once again we believe it is premature to make such a definitive statement on the limited data collected to date. We also note that not only is there an indication of size selective mortality at Lippy Point, but also in the Snake River ROR 1 release group estimated survivals at each receiver array from Lake Wallula through Willapa Bay as shown in Figure 21(a). Hopefully, data collected in the next year or two will provide better insight into the affect of these acoustic tags on size selective mortality. We also hope the trend in tag size reductions continue so that a more representative size range of the population can be evaluated in the future.

Figure 21(a). Comparison of raw survival estimates divided into 5 mm fork length intervals of ROR Snake R chinook smolts to each of the in-river and ocean listening lines.

Mark Group handling

Tagging effects cannot be controlled, given their study design so that comparisons between groups may include differential mortality for different tag groups. The Snake River ROR fish were marked and released a month prior to Snake River Transport releases so that it is impossible to assess potential confounding affects of different tagging operations.

Transport fish were marked and trucked to Lower Granite Dam and then loaded into barges. As a result, survival estimates for these fish may not represent transported fish that migrate from hatcheries, are collected at Lower Granite Dam and then transported. Also their time of release to the estuary is very late for hatchery fish. Using this type of a release group to ascertain information about “D” in actual transported fish is not justified.

The Yakima River smolts were volitionally released from acclimation ponds, recaptured at the Chandler Canal, tagged, and then allowed to continue their migration.

In contrast, the Dworshak fish were marked prior to release from the hatchery. This adds the confounding affect of natural mortality occurring before the Yakima smolts were tagged. Also, data from NMFS research at Lower Granite Dam shows that smolts marked after being collected at a dam have lower SARs than those tagged before release from a hatchery and then subsequently being collected at that same dam. We recommend in the future that handling of study fish be adjusted to mimic what happens to the population at large as much as possible to reduce these confounding affects and make the study more representative of actual conditions.

NMFS research has shown dramatic changes in SARs with different ocean entry timing. Because of this, these researchers chose to include the confounding effect of releasing the different study groups at different times so that they would hopefully arrive at the ocean at the same time and avoid the confounding affect of different ocean entry timing. The researchers unfortunately failed in this goal, with the earlier released Snake River ROR smolts entering the ocean ahead of the Yakima or transported smolts they were to be compared with, resulting in this study now having both confounding effects of different release and ocean entry timings.

Given the delayed mortality hypotheses the authors were trying to address, we also question why they attempted to experimentally time the ocean entry to be identical for the treatment groups. Although Dworshak and Yakima hatchery fish have similar outmigration timing leaving the tributaries, the hydrosystem alters estuary arrival timing for all three groups. The delayed estuary entry timing of in-river migrants is primarily an effect of the hydrosystem, and a likely mechanism for delayed mortality. We recommend in the future that that release timing be the same for each of the different groups so that the potential affects of the hydrosystem and the transportation program on ocean entry timing can be evaluated.

Survival Estimation

The use of the terms “minimum survival” and “survival” are misleading. What the authors call “minimum survival” is simply the number of detections at an array and “survival” is really an expansion of detections based on within array expansion techniques. A more robust survival estimation method requires some estimation of detection probability for each array. The overall array detection efficiency, for ocean arrays, was not directly estimated, instead the authors assumed, based on fish distribution across each array that detection efficiency was 95%. However, the distribution data, particularly for Snake River origin fish, does not justify such an assumption, since many are near the offshore end of the arrays. In fact several detections are from the very last node at the offshore end of the Willapa Bay array, indicating that some of the Snake River fish may have gone undetected by passing the end of the array.

Reported results estimate that transported smolts survived to Lippy Point at about five times the Snake River ROR smolts (Table 3), yet PIT tag SARs consistently show a much lower T/C ratio with the Sandford & Smith or CSS methodology. This indicates that either these arrays do not encompass the area of latent mortality, or the above mentioned concerns with the methodologies caused the results to be erroneous.

Estimated survival to Lippy Point for the Yakima River smolts is lower than

reported SARs from the Yakima River, and they still have several more years of mortality in the ocean. This indicates that true survival of Yakima River smolts is much higher than estimated here. Possible reasons for this low estimate are; the smolts marked were not representative of the population, some smolts migrated beyond the end of the arrays, some smolts rear for a time in the estuary or along the continental shelf, the tags caused higher than natural mortality in the ocean, or a combination of these factors.

The authors report estimated survivals based upon very few detections (2 versus 4) as if they were absolutes; “survival of the Snake River population to Libby Point was double that of the Yakima population”. The number of detections at Libby Point was too few to provide any confidence in estimates, and given the early arrival timing of Snake ROR fish such estimates could be biased low. The array became operational as the first detections occurred. Further, estimates of survival derived by within array estimates are not true survival estimates. The researchers provide no means for estimating true detection probability at this site.

Conclusions

In conclusion, we reiterate, this feasibility study was useful to establish initial data on the performance of acoustic tags, in terms of longevity and detection rates at in-river and continental shelf arrays. However, data generated by this study in 2006 should only be considered useful in developing acoustic telemetry methods with regards to measure fish passage in-river and along the continental shelf. The size of marked fish and the handling of mark groups, determine whether or not the marked study fish are representative. Tagged fish should be the size of the unmarked population, or researchers must recognize the potential bias and constraints upon research results. Also, tagged fish should migrate at the same time and in the same way as unmarked fish to be useful in making study results applicable to the population. Finally, survival estimation should use standard mark-recapture methods unless assumptions of those models cannot be met. Some means of determining whether fish move further off-shore in the near-ocean, beyond the extent of the POST arrays, or delay migration between arrays, would be helpful in determining the feasibility of those arrays for estimating survival.

Sincerely,

Tom Lorz, CRITFC

Jerry McCann, FPC

Rick Kruger, ODFW

Russ Kiefer, IDFG

David Wills, USFWS

Cc: MAG

Brian Lipscomb, CBFWA

State, Federal and Tribal Fishery Agencies Joint Technical Staff Letter

*Columbia River Inter-Tribal Fish Commission
Idaho Fish and Game
Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife
NOAA National Marine Fisheries Service
US Fish and Wildlife Service*

May 4, 2007

Peter Paquet
Acting Director, Fish & Wildlife Division
Northwest Power & Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204-1348

Dear Mr. Paquet:

In response to your request for public comment, the technical staffs of the fishery agencies and tribes have reviewed the Northwest Power Conservation Council document #97-6, entitled, "Consideration of Ocean Conditions in the Columbia River Basin Fish and Wildlife Program" and dated May 29, 1997. In the past decade since completion of the subject NPCC report, data has been collected and many analyses have been completed which advanced our understanding of salmon life cycle effects of the ocean and other factors. Some of these analyses have been conducted under the auspices of the Biological Opinion Remand process. Our overall review conclusions are:

- The subject report no longer provides an adequate technical basis for the upcoming NPCC amendment process in terms of consideration of the impact of ocean conditions.
- The NPCC should base the upcoming amendment process upon the significant body of work that have been conducted since 1997 regarding salmon life cycle analysis and the impact of the interaction of ocean and river conditions.
- The three views described in the document, A, B, C describing the ocean environment and its relationship to freshwater are outdated and should be revised to reflect newer analysis and data.

Specific Comments

The introduction of the report states:

“Consequently , because the two primary ways fish and wildlife managers can influence salmon survival in the ocean are through preserving life-history diversity in salmon and improving estuarine and near-shore conditions, staff proposed to “consider the impact of ocean conditions on fish and wildlife populations” by:

1. Evaluating the impact of projects, strategies and the fish and wildlife program on salmon productivity and diversity; and
2. Evaluating the impact of projects, strategies and the fish and wildlife program on the conditions of estuarine and near-shore ocean habitats.”

This introductory summary statement is out of date and as a result the two potential courses of action identified for the NPCC are also out of date. Analysis conducted since 1997, including Technical Recovery Team analysis, Fish and Wildlife Program projects evaluating fish condition and physiology throughout their downstream migration, Independent Science Advisory Board review of latent mortality, Biological Opinion Remand process analysis, and the Comparative Survival Study workshop and analyses are a portion of the body of more recent work which identifies additional courses of action that the NPCC should pursue to address the requirements of section (4)(h)(10)(D)(vi) to “consider the impact of ocean conditions on fish and wildlife populations.” Much of this work considers the effect of ocean conditions and river conditions together on salmon life cycle survival to adult return. These data and analysis indicate that there are other factors that can be influenced by managers that influence ocean survival and adult return rates such as smolt condition, smolt arrival time to the estuary, and smolt travel time. Although improving near ocean conditions, such as river flows increasing the area of the plume, may influence salmon survival, there is strong empirical basis for the effects of arrival timing to the estuary and travel time impacts on smolt to adult return rates.

The NPPC document describes three views of the possible relationship of the ocean environment and its relationship to the freshwater environment. None of these three views adequately capture the more recent data and analysis regarding salmon life cycle survival. The fishery managers recognize the variable effect of the ocean environment on salmon returns. Recent analysis of salmon life cycle analysis have captured the common year effect of the ocean on stocks of different origins and have explored the variation in recruit per spawner related to ocean indices such as upwelling and the Pacific decadal oscillation and fresh water travel time through the hydrosystem.

To conclude, the subject document should undergo substantial updating before it can provide an adequate basis for the upcoming amendment process to incorporate more recent technical analysis. The technical staffs of the tribes and fishery agencies offer to provide assistance to the Council in updating and reviewing the next draft document.

Sincerely,

Bob Heinith
Columbia River Inter-Tribal Fish Commission

Paul Wagner
NOAA Fisheries

Richard Kruger
Oregon Department of Fish and Wildlife

Cindy LeFleur
Washington Department of Fish and Wildlife

David Wills
US Fish and Wildlife Service

Russ Kiefer
Idaho Department of Fish and Game

State, Federal and Tribal Fishery Agencies Joint Technical Staff Memo

*Columbia River Inter-Tribal Fish Commission
Idaho Fish and Game
Oregon Department of Fish and Wildlife
NOAA National Marine Fisheries Service
US Fish and Wildlife Service
Nez Perce Tribe*

TO: CBFWA Members Advisory Group

FROM: FPAC Chair Paul Wagner

SUBJECT: Review of Corps' Draft Plan for Addressing Pacific Lamprey Passage (2007-2011)

DATE: June 14, 2007

Cc: CBFWA Anadromous Fish Advisory Committee, Lamprey Technical Work Group

The Fish Passage Advisory Committee members, comprising technical staffs of the above fisheries agencies, have reviewed the U.S. Corps Engineers Draft Plan for Addressing Pacific Lamprey Passage (2007-2011) and support the recommended revisions to the document (enclosure). The issue of lamprey passage needs to be addressed expeditiously at the mainstem dams. The fisheries agencies support actions to be taken that are salmon compatible, acknowledging that years of research have determined that it is unlikely that fish ladders can be modified to wholly accommodate both salmonids and lamprey.

A summary of the key features of the lamprey passage plan follows;

- Diffuser grating size in the fish ladders should be reduced from the current size of 1" to a size of 3/4". These changes should be pursued in a methodical manner at the projects and evaluated as the changes are made. A smaller grating size will increase the velocity through the gratings and the effects of those changes must be considered on a project by project basis.
- Screen criteria for juvenile lamprey at corps' projects should be modified to 1.75 open space for the VBS, ESBS, and other screens that encounter juvenile lamprey at the hydro projects.
- Plates along the walls of the adult ladders over floor diffusers should be added to aid in adult lamprey passage in the ladders by providing attachment locations.

-
- The corners of adult ladder facilities should be rounded to better accommodate lamprey passage. This modification should be pursued at a project that has at least two ladders and one should be modified. Once again this modification will have a minor hydraulic effect which should be evaluated before proceeding with this modification to all fish ladders.
 - Flows provided through the auxiliary water system during nighttime hours should be reduced to facilitate lamprey passage. The affect of this change may be the greatest on the passage of sockeye, which have the highest rate of nighttime passage. Once again, this change should be made and evaluated on per project basis.
 - Continued efforts should be made in the development of lamprey adult passage devices. Where applicable, adult lamprey passage systems may offer the best opportunity to avoid any potential passage conflicts among species.
 - A combination of lamprey improvement measures (i.e., structural ladder modifications, ladder velocity adjustments, etc.), rather than a single "fix," is likely to be required to achieved desired dam-specific passage efficiencies.
 - Continued efforts should be made to develop tags to gain more information on the passage behavior of both adult and juvenile lamprey.

The agencies are pleased to see a plan has been developed for lamprey passage and support its timely implementation.

State, Federal and Tribal Fishery Agencies Joint Technical Staff Memo

*Columbia River Inter-Tribal Fish Commission
Idaho Department of Fish and Game
Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife
NOAA National Marine Fisheries Service
US Fish and Wildlife Service
Nez Perce Tribe*

TO: Jim Ruff, NPCC
Lynn Palensky, NPCC

FROM: Paul Wagner, Chairperson
Fish Passage Advisory Committee

SUBJECT: Council's Prospectus for two mainstem issues in a Science Policy Exchange
meeting

DATE: July 2, 2007

We extend our appreciation to both of you for coming to the Fish Passage Advisory Committee (FPAC) with your prospectus for the Council's Science-Policy exchange meeting scheduled for this September, and for being open to input from the FPAC. We are providing the following recommendations regarding the science-policy conference being developed by the NPCC in response to your request for FPAC to summarize their perspectives on the discussion that took place at the June 19, 2007 FPAC meeting. We appreciate your willingness to consider our suggestions and look forward to continuing this dialogue with Council staff on how to advance scientific understanding for improved management actions and for informing Council Members, especially in consideration of the Council's upcoming Fish and Wildlife Program Amendment process.

The draft outline for the upcoming mainstem session in September is focused on only two narrowly-defined issues: Snake River fall Chinook migration behaviors and current juvenile and adult survival rates through the hydrosystem. While only these two topics are currently being

considered in the Council's proposed meeting, it is important to recognize that there are many other important mainstem passage issues that could be given similar consideration (including spill, temperature, dissolved gas, travel time and arrival timing at Bonneville Dam, route of passage and SARs, and RSW effectiveness). We suggest that the Council recognize and consider these additional subjects for future treatment.

At the June 19, 2007 FPAC meeting, members discussed their concerns with you regarding the proposed format for your conference and suggested an alternative format (i.e. weight of evidence approach), the results of which could be used to inform your science-policy meeting and make it a more productive endeavor. A summary of the FPAC concerns discussed are as follows:

- With respect to the two issues the Council has identified for the meeting in September, FPAC members are familiar with the most current research results, the limitations associated with the research, and the breadth of management concerns associated with these two topics. We are also aware that the number of scientists that have conducted work on these issues and that have valuable information to contribute is much larger than the list provided by the agenda. Consequently, FPAC regards the conference as rather limited regarding its scope of scientists included and the information presented.
- Regardless of the scope of this science-policy review conference, that is whether it is designed to address one mainstem science-policy question such as fall Chinook mainstem passage mitigation or whether it is designed to address many other mainstem passage questions, the science-policy conference would benefit from the results produced by a "weight of evidence" workshop. An example of such was a regional review of comparative salmon survival described in Mamorek et al., 2004. This format would include a wide scope of scientists that have data and analysis to contribute. Various hypotheses, and data and evidence supporting these hypotheses, would be presented in formal written proceedings. Neutral scientific facilitation would also be an important part of the proceedings.
- The FPAC has a specific format in mind when they describe a weight of evidence approach. A weight of evidence approach would help inform your proposed science-policy conference format which in its present form consists of individual presentations on ongoing or past research by the researchers themselves. In a weight of evidence approach, a suite of hypotheses are organized in a series of hierarchical impact hypothesis diagrams, with increasingly detailed set of hypotheses and the evidence for and against each of those hypotheses. Scientists presenting data and analysis relative to a particular topic present are all members of the same work group (work groups are typically limited to about 12 people) for that topic, and they each present their evidence for a particular hypothesis.

First, to structure this approach the objectives for the work shop need to be specifically identified and agreed upon. We suggest the following be included in those objectives:

1. Synthesize the results of mainstem passage monitoring and research studies and analysis for Chinook salmon and steelhead...

-
2. Document and assess the evidence relating to various factors that can affect survival rates over different life history stages relating to hydrosystem passage, time of ocean entry and travel time.
 3. Produce a report synthesizing and assessing the evidence for and against hypothesized mechanisms for mainstem juvenile passage and survival related to mainstem hydrosystem operations including water travel time and spill.
 4. Provide the foundation for future implementation of future mitigation measures and future research and monitoring needs.

Second, a workshop oversight group should be established to:

- Develop the overall framework of the conference in terms of a hierarchy of increasingly detailed hypotheses about potential mechanisms linking the hydrosystem to smolt to adult survival rates.
- Define a general hypothesis regarding the operation and development of the hydrosystem.
- Define the hypotheses and assign hypotheses and evidence for each topic area to the appropriate work group. Work group members should be selected for a specific work group on the basis of their expertise in analysis and data.

Third, analysis, reports, and data (i.e., evidence) should be provided to each member of the work group for evaluation against their own hypotheses some time before the actual workshop. A neutral facilitator is assigned to each group and keeps a record of the discussions. The facilitators are charged with summarizing the evidence for and against each hypothesis and these summaries are incorporated into a proceedings document. Each work group develops a set of overall conclusions and recommendations for the hypothesis assigned to them.

At the FPAC meeting you stated that you were receptive to a proposed weight of evidence approach and were going to discuss amongst yourselves specific ways in which the approach could be applied. We are looking forward to working with you to assist in implementing a weight of evidence structure for synthesizing past research and the evidence for and against various management-focused hypotheses. We believe that such an approach would be very useful for advancing scientific understanding for improved management actions, especially for consideration in the Council's upcoming Fish and Wildlife Amendment Process and would help broaden regional support.

Reference:

Marmorek, D.R., M. Porter, I.J. Parnell and C. Peters, eds. 2004. Comparative survival study workshop, February 11-13, 2004. Bonneville Hot Springs Resort. Report compiled and edited by ESSA Technologies, Ltd., Vancouver B.C. for the Fish Passage Center, Portland, OR and the U.S. Fish and Wildlife Service, Vancouver WA. 137 pp.

State, Federal and Tribal Fishery Agencies Joint Technical Staff Letter

*Columbia River Inter-Tribal Fish Commission
Idaho Department of Fish and Game
Oregon Department of Fish and Wildlife
NOAA National Marine Fisheries Service
US Fish and Wildlife Service*

September 25, 2007

Mr. Bill Maslen
Director, Integrated Fish and Wildlife Program
Bonneville Power Administration
P.O. Box 3621
Portland, OR 97208-3621

Dear Mr. Maslen,

The Fish Passage Advisory Committee (FPAC) understands that funding for the Fall Chinook/Chum Spawning below Four Lower Dams Contract (#1999-003-01) is being reduced for the 2007-2009 implementation of this project. We recognize that it is within Bonneville Power Administration's (BPA) authority to make this decision. Nonetheless, the FPAC has concern regarding the funding reduction and would like to take the time to provide their input relative to the elements of this contract that have direct links to making informed in-season management recommendations for chum salmon and other listed and unlisted anadromous fish.

The management of flow from Bonneville Dam during chum spawning and emergence is always a daunting task for the fish and wildlife managers. Decisions made regarding the provision of water for chum salmon can have potentially damaging consequences for the provision of flows for other segments of the spring and summer migrating fish populations. Consequently, it is of utmost importance that solid information is available for consideration when making these management recommendations.

In past years' several different types of information have been made available and utilized when making management recommendations. These include long term climate forecast predictions and water supply forecasts, as well as real time biological and physical monitoring data. The real-time provision of spawning data and redd location is extremely important to management decision pertaining to needed water levels in the fall time period. To provide numbers and locations of redds with sufficient accuracy to allow determination of redd elevation may require weekly or bi-weekly surveys. It is our understanding that redd location data will

continue to be collected, but it is unclear whether the data will be collected at frequent enough intervals to ensure that complete and accurate locations and elevations are determined.

In past years' management decisions have focused between balancing upstream storage releases for maintaining water over redds, and assuring that as much storage as possible is retained in reservoirs to provide target flows for spring migrants and to refill reservoirs for summer migrant flows. In addition to the need for accurate information on the number, location and elevation of chum redds, the fishery managers have relied extensively on the 2-D model developed by the U.S. Fish and Wildlife Service to aid in developing their recommendations. The ability of the model to predict the redds that would be affected at differing water levels was hampered in the past by the lack of resolution associated with the existing information used in the model. The Bonneville Power Administration allocated significant funds in 2006-2007 to obtain the data necessary to improve the accuracy of the 2-D model (approximately \$28,000). We understand that this work element needed to complete this model has been eliminated for the 2007-2008 period. The FPAC believes that given the expenditures already undertaken by BPA, the low cost of completing the model with the already collected data (about \$30,000), and the importance of this tool for making management decisions, this work element warrants reconsideration by BPA for funding this year.

In addition, in past years the emergence timing of these fish during the spring was used to indicate the length of time that protection measures were necessarily implemented. It is FPAC's understanding that with the BPA proposed funding reductions these data will not be collected. There has not been a comprehensive evaluation of the relationship between the measured temperature units the chum redds are exposed to and the physical seining collection data of fry emergence. Consistently, the seining data shows fry emergence timing extending well beyond the expected termination data predicted by the measure of temperature units.

It is our understanding that in the absence of real-time data the in-season management will rely on historic collection data. Consequently, it is our anticipation that protection for emerging chum will be provided as long as possible through the historic emergence period, except where it may reduce flexibility for fish flows and affect total dissolved gas management during the spring and summer migration period, at which time we would enter into discussions with the Region on how best to balance the needs of chum and flows for spring and summer migrants. If this is not an acceptable consequence, then BPA should reconsider their decision to not fund emergence surveys on which salmon managers may rely. At the very least BPA could fund the analysis of the historic seining and thermal data to determine whether the thermal data could be used to effectively predict emergence timing.

Thank you for taking the input of the FPAC regarding this contract. We look forward to working with you to assure that the data collected will provide us with enough information to continue to make informed and important hydrosystem operation decisions.

Sincerely,

Bob Heinith
Columbia River Inter-Tribal Fish Commission

Paul Wagner
NOAA Fisheries

Richard Kruger
Oregon Department of Fish and Wildlife

David Wills
US Fish and Wildlife Service

Russ Kiefer
Idaho Department of Fish and Game

Cc:

Greg Delwiche, BPA
Mark Shaw, BPA
Scott Bettin, BPA

State, Federal and Tribal Fishery Agencies Joint Technical Staff Memo

October 10, 2007

Steve Brown
Grant County Public Utility District
PO Box 878
Ephrata, WA 98823

Dawn Woodward
Grant County Public Utility District
PO Box 878
Ephrata, WA 98823

Dear Steve and Dawn,

The Fish Passage Advisory Committee members and the US v OR Technical Advisory Committee, comprising technical staffs of the below fisheries agencies, are concerned with adult fish counts at both Priest Rapids and Wanapum Dams. There are discrepancies between the number of jack salmon counted at Grant PUD projects and other upper Columbia River projects. Upon investigating this issue we have learned that at both GCPUD projects the count tunnels through which fish pass are 30 inches or greater in dimensional depth, which makes it very difficult to gauge the length of a fish passing through the tunnel. Although total fish counts across GC PUD dams seem to be similar to Rock Island Dam, the adult/jack ratio is different.

Dam counts are used by the fishery managers to track the status of the fish runs through their adult migration, and an accurate accounting of adults versus jacks is necessary to provide confidence in management decisions. Adult dam counts are crucial in reconstructing stock-specific runs and adult and jack counts are necessary for forecasting future runs. Priest Rapids Dam is one of the major counting stations for fishery management on the Columbia River. It is the first dam upstream from the mouth of the Snake River and is used to separate the runs into Upper Columbia and Snake River components. Spring Chinook and steelhead migrating above Priest Rapids Dam are listed under the Endangered Species Act (ESA) as endangered. Under the *U.S. v Oregon* fishery management agreements, Priest Rapids Dam is used in determining the abundance of spring Chinook and steelhead under which certain fisheries can occur, and is used as the measurement of the escapement goal for upper Columbia summer Chinook.

We have been informed that Grant County employees have already been investigating this issue and have preliminarily developed several possible solutions. The fisheries agencies and tribes appreciate the work already conducted by Grant County employees concerning this issue. We recommend that Grant County work with the Agencies and Tribes to develop a solution to the fish counting stations as soon as possible, preferably over the winter of 2007/2008, so as to ensure that adult and jack counts are as accurate as possible at Grant PUD Dams during the 2008 adult migration and in years to follow.

We would like to thank Grant County PUD for all the attention allotted to your adult fishways; your fishways have been very well maintained and appear to provide excellent conditions for passing adult fish. We appreciate your consideration in making these modifications to the adult count stations in a timely fashion.

Sincerely,

Paul Wagner, NOAA Fisheries
Fish Passage Advisory Committee Chairman
Columbia River Inter-Tribal Fish Commission
Idaho Fish and Game
Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife
NOAA National Marine Fisheries Service
US Fish and Wildlife Service

Kathryn Kostow, ODFW
Chair, US v OR Technical Advisory Committee
Idaho Fish and Game
Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife
NOAA National Marine Fisheries Service
US Fish and Wildlife Service
Columbia River Inter-Tribal Fish Commission
Yakima Nation
Confederated Tribes of the Umatilla
Confederated Tribes of the Warm Springs
Nez Perce Tribe

cc:

Tom Dresser
Bryan Bird
Dana Jeske
Ray Ellis
Mike Nicholls
Eric Lauver

State, Federal and Tribal Fishery Agencies Joint Staff Letter

*Columbia River Inter-Tribal Fish Commission
Idaho Fish and Game
Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife
US Fish and Wildlife Service*

Mr. Greg Delwiche
Vice President for Environment, Fish and Wildlife
Bonneville Power Administration
PO Box 3621
Portland, Oregon 97208-3621

Dear Greg,

It has been brought to our attention that the Bonneville Power Administration (BPA) has advised the Fish Passage Center that they will fund a 3 month extension of the Comparative Survival Study contract. However, this extension will not include any new tagging work until the Northwest Power and Conservation Council (NPCC) gives BPA their recommendation for the study.

As you know, the Comparative Survival Study (CSS) Oversight Committee has completed a Ten-Year Retrospective Report, as recommended by the Independent Scientific Advisory Board (ISAB) and the Independent Scientific Review Panel (ISRP) in their 2007 review of the CSS. The Committee completed the report and presented it to the ISAB/ISRP according to the schedule and deadlines established by the NPCC. However, these deadlines were later than originally planned because of the request by BPA to extend the comment period on the report so that its contractor could provide input. The report includes responses to the extensive comments received during the comment period.

We understand that the ISAB/ISRP will present its findings on the report on November 16, 2007. This date is after the November NPCC meeting, likely delaying a recommendation on the study until the December NPCC meeting, rather than at its October meeting as originally planned. This delay is a result of the extended comment period and later deadlines. Because of the delay it is unlikely that the NPCC will develop an FY 2008 recommendation to BPA for the CSS prior to the end of the 2007 contract period. The CSS 2007 contract will expire on November 30, 2007. This timing will preclude the addition of new mark groups to the study, as proposed by the state and tribal fishery managers, and the US Fish and Wildlife Service (USFWS).

The state and tribal fishery managers, and the USFWS have been advocating for the addition to the CSS of mark groups of wild and hatchery steelhead and additional downstream populations of Chinook since 2004. These proposals were in large part based upon ISAB/ISRP recommendations and the management needs of the fishery agencies. The 2008 CSS proposal includes additional marking of wild steelhead, hatchery A and B run steelhead from the Snake River Basin, Warm Springs River wild spring Chinook, and John Day wild steelhead, consistent with past proposals by the managers and the ISAB/ISRP recommendations. The 2008 CSS proposal is a high priority for the state and tribal fishery managers and the USFWS project sponsors.

We appreciate that BPA has extended the 2007 CSS contract to accommodate delays in decision making related to the extended comment period on the Ten-Year Retrospective Report, and resultant delay in the ISAB's report to the NPCC. However failure to include, in the extension, additional funds to mark the additional groups of fish in the FY 2008 proposal, will delay by one-more year, their inclusion in the study. These data are important to the entire region including the FCRPS operators and regulators. The states, tribes, FPC and USFWS have worked diligently to coordinate CSS marking with other marking throughout the region so that the populations of PIT-tagged fish at large can be used to address a broad range of management needs. This approach ensures the project is implemented as cost effectively and efficiently as possible.

Table 1 indicates the mark groups and marking schedule that will be required to implement the 2008 CSS marking proposal. We request that BPA reconsider their decision to not include funds for additional marking in the contract extension. Specifically, we ask that BPA provide the dollars to purchase 322,100 tags for 2008. This total is broken down into 75,000 tags for hatchery steelhead, 213,000 tags for hatchery Chinook, 32,100 tags for wild Chinook, and 2,000 tags for wild steelhead. In the event that BPA's ongoing funding of ODFW to PIT tag 6,000 wild Chinook and 6,000 wild steelhead in the John Day River is not continued into 2008, we also request funds to purchase an additional 12,000 PIT tags to cover that tagging effort.

Table 1. Number of wild and hatchery Chinook and steelhead to be PIT tagged under CSS contract in 2008.

Organization	Tagging Site	Species and rearing type	PIT tags needed	Date tags Needed
IDFG	Magic Valley Hatchery	H Steelhead	13,134 ^A	1/1/08
	Hagerman NFH	H Steelhead	7,666 ^A	1/1/08
	Clearwater Hatchery	H Steelhead	5,200 ^A	1/1/08
	Niagara Springs Hatchery	H Steelhead	28,000	1/1/08
	Rapid R Hatchery	H Chinook	52,000	1/15/08
	McCall Hatchery	H Chinook	52,000	1/15/08
	Salmon R. Trap	W Chinook	5,000	3/5/08
	Snake R. Trap	W Chinook	2,000	3/5/08
	Clearwater R. Trap	W Chinook	3,200	3/5/08
	Clearwater R. Trap	W Steelhead	2,000	3/5/08
	Other IDFG tributary traps	W Chinook	14,500 ^B	2/6/08

ODFW	Irrigon Hatchery	H Steelhead	13,000 ^A	12/1/07
	Lookingglass Hatchery			
	• Imnaha R. release	H Chinook	21,000 ^C	9/3/08
	• Catherine Ck. release	H Chinook	21,000 ^C	9/3/08
	Grande Ronde R. Trap	W Chinook	1,400	3/5/08
	John Day River	W Chinook	[6,000] ^D	
		W Steelhead	[6,000] ^D	
USFWS	Dworshak NFH	H Steelhead	8,000 ^A	12/12/07
	Dworshak NFH	H Chinook	52,000	12/12/07
	Carson NFH	H Chinook	15,000	12/12/07
Warm Springs Tribe	Warms Springs R. Trap (Deschutes River basin)	W Chinook	6,000	2/20/08

^A Fish PIT tagged under CSS contract to complement the LSRCP's proposed steelhead hatchery evaluation (tagging) study.

^B Cost for PIT tags only to complement on-going wild Chinook PIT tagging efforts in Idaho.

^C Fish to be PIT tagged in September 2008 for the 2009 migration.

^D Fish PIT tagged under CSS contract only if not renewed under existing ODFW contract with BPA.

We look forward to working with you to implement this critically important project.

Sincerely,

Anthony Nigro, ODFW

Peter Hassemer, IDFG

Bill Tweit, WDFW

Rob Lothrop, CRITFC

Howard Schaller, USFWS

State, Federal and Tribal Fishery Agencies Joint Staff Letter

***Columbia River Inter-Tribal Fish Commission
Idaho Fish and Game
Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife
US Fish and Wildlife Service***

November 29, 2007

James Ruff
Northwest Power and Conservation Council
851 SW Sixth Ave. #1100
Portland, Oregon 97204

Dear Jim:

We understand that at its December meeting the NPCC will be making funding decisions regarding the Comparative Survival Study (CSS) in response to comments and recommendations from the Independent Science Advisory Board and Review Panel. This is an important funding decision in the Columbia River basin and a decision that should be well informed. Neither we nor our CSS Oversight Committee have had the opportunity to further discuss the comments and recommendations of the ISAB/ISRP with them however; we offer the following comments and recommendations.

We recommend that the NPCC approve marking of all groups as proposed by the fishery managers in the CSS. The ISAB/ISRP review recognized the CSS is successfully implementing a large-scale monitoring program and the review supports the PIT tag marking of additional wild downriver groups to determine SARs and other population metrics for these stocks as part of regional monitoring and evaluation. Many stocks in addition to those of Snake River origin are affected by the operation of the FCRPS and the measures mitigate for those effects, including the downriver steelhead populations proposed for marking that are listed under the ESA. Eliminating these downriver mark groups or delaying the implementation of mark groups will cause critical gaps in these time series. These gaps in SARs will make assessing population status and evaluating restoration and recovery measures difficult and less timely.

More specifically, the ISAB/ISRP indicated that CSS biological objectives (1), (2), and (3) and associated work elements meet scientific review criteria – estimate SARs, in-river survival rates, T/C ratios and make comparisons against hydro goals. The downriver populations proposed for tagging are needed to satisfy these three objectives. The ISAB/ISRP did not recommend eliminating the tagging of downriver groups for these monitoring and evaluation purposes. Building a time series of survival among representative population groups provides important empirical data for assessing the relationship of this survival information to environmental effects and management actions. This monitoring and evaluation approach does not assume that survival differences are only attributable to hydrosystem impacts.

G:\STAFF\DOCUMENT\2007 Documents\2007 Files\JTS\186-07.doc

At an appropriate time, the Oversight Committee would like to have the opportunity to further discuss the comments or address concerns with the ISAB/ISRP. The ISAB/ISRP review of CSS Ten-Year Retrospective Report was overall very positive, finding that the design, implementation and interpretation underpinning the report were very good, and that the CSS successfully implemented a large-scale monitoring program. We believe that had the schedule afforded the fishery managers the opportunity to further discuss technical issues with the ISAB/ISRP, that all issues concerning downriver marking could have been resolved. The CSS Oversight Committee will provide a separate technical response to the ISAB/ISRP comments relative to the downriver and upriver comparisons. We look forward to further discussions on this and other important matters.

Sincerely

Tony Nigro
Oregon Department of Fish and Wildlife

Rob Lothrop
Columbia River Intertribal Fish Commission

Bill Tweit
Washington Department of Fish and Wildlife

Mark Bagdovitz
US Fish and Wildlife Service

Pete Hassemer
Idaho Department of Fish and Game

State, Federal and Tribal Fishery Agencies Joint Technical Staff Letter

Columbia River Inter-Tribal Fish Commission
Idaho Fish and Game
Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife
NOAA National Marine Fisheries Service
US Fish and Wildlife Service

December 12, 2007

Mr. James Adams
U.S. Army Corps of Engineers
Water Quality
1125 NW Couch Street
Portland, OR 97209

Dear Mr. Adams:

The Fish Passage Advisory Committee (FPAC) thanks you for the opportunity to comment on the "Corps of Engineers Plan of Action for Dissolved Gas Monitoring in 2008" (Plan). As communicated by you, the plan is similar to last years' document in format and content. Precisely because of this the finalization of the Plan seems premature given two ongoing processes; the Adaptive Management Team for Columbia River total dissolved gas (TDG) headed by the Washington Department of Ecology (WDOE) and the Oregon Department of Environmental Quality (ODEQ), and the National Oceanic and Atmospheric Administration's (NOAA) 2007 Biological Opinion – Remand Draft on the Operation of the Federal Columbia River Power System, currently out for review. It is possible that the outcome of these two processes may affect the Plan. The FPAC suggests that language be added to the Plan to recognize and accommodate potential changes recommended by these processes.

The comments below refer to specific issues with the current draft of the Plan.

1. The Camas-Washougal monitoring station: The Camas/Washougal monitoring station has been removed from the current ODEQ TDG waiver for gas standards in 2008 and 2009, and hasn't been required by WDOE TDG exemptions for several years. References to this station as a point of monitoring for TDG compliance should be removed from the 2008 plan (Table 1, Phase 2: Instrument Installation, Table 3, and Table 4).
2. There are many monitoring stations operated under the Plan. Some are for TDG waiver/exemption compliance monitoring and some for other management purposes. The purpose of these stations is not stated anywhere in the Plan. We recommend the addition of a column to Table 4 to depict the purpose of each station.

-
3. The order of table references is not consistent with the table numbering. Table 1 is not referenced at all, but it is the first table encountered. This table appears redundant to Table 4 and is not needed. Table 4 in Sect. 3.0 is the first referenced table, prior to all other table references. Table 3 is referenced next in Sect. 4.1, prior to referencing Table 2 in Sect. 4.2. Table 2 is the last of the four tables to be referenced. We recommend that the table numbering should be consistent with their references, which would make Table 4 become Table 1. This seems appropriate as it is a complete listing of all monitoring stations. This also is the appropriate location to list the purpose of each station (item 2 above).
 4. Data quality should be a specified quantitative criterion, rather than relative to a prior year's achievement. There is nothing provided with which to judge the appropriateness of the 2007 data set.
 5. Under Section 4.3.1.1, performance checks (beginning on page 8), there is a difference between the number of data quality criteria (four for the Seattle and Portland districts and three for the Walla Walla district) and their specific implementation. This would seem to imply a difference in reliability between the districts. Why aren't there common standards for the basin as a whole?
 6. The criteria for emergency field visits (page 10) are listed under performance checks for the Walla Walla district. Are there no emergency criteria for the Seattle and Portland districts, or was this section intended for all districts? Please clarify.
 7. A criterion under emergency visits (page 10) states that the gauge has to be malfunctioning for at least 48 hours. This is in contradiction to the previously stated 24-48 hour repair time under Section 4.3.1.1 2 iii, Calibration protocols, Performance Checks (Walla Walla) (page 9). The management of the spill program is critically important to maintaining the successful outmigration of juvenile salmonids listed under the Endangered Species Act. A 24 hour malfunctioning time limit with a repair completed within the next 24 hours should be the criteria, and would compliment the previously stated repair time.

If you have questions or would like further discussion about our comments, please contact Mr. Paul Wagner, NOAA Fisheries, FPAC Chairperson at 503-231-2316.

Sincerely,

Bob Heinith
Columbia River Inter-Tribal Fish Commission

Paul Wagner
NOAA Fisheries

Richard Kruger
Oregon Department of Fish and Wildlife

Cindy LeFleur
Washington Department of Fish and Wildlife

David Wills
US Fish and Wildlife Service

Russ Kiefer
Idaho Department of Fish and Game

APPENDIX J

Maps

Map 1 -- Fishing zones and the spatial distribution of adult dam fish passage facilities in the Columbia River Basin.

Map 2 -- Spring Chinook spatial distribution and 2007 adult dam counts in the Columbia River Basin.

Map 3 -- Summer Chinook spatial distribution and 2007 adult dam counts in the Columbia River Basin.

Map 4 -- Fall Chinook spatial distribution and 2007 adult dam counts in the Columbia River Basin.

Map 6 -- Sockeye spatial distribution and 2007 adult dam counts in the Columbia River Basin.

APPENDIX K

Web Statistics & Data Request Summaries

2007 Fpc.org Web Statistics and Data Requests Summaries

Introduction

The FPC provides technical services to the fish agencies and tribes impacted by the operation of the FCRPS. In doing so, the FPC stores several large databases and documents. Some of the databases include adult passage, water quality (flow, spill, temperature, total dissolved gas, etc.), smolt monitoring program data, comparative survival study data, gas bubble trauma data, and spawning data. Some of the documents include smolt monitoring program documents, comparative survival study documents, gas bubble trauma documents, fishway inspection reports, annual reports, weekly reports and many other miscellaneous documents.

Miscellaneous documents include data request responses. The FPC receives data requests from fish agencies, tribes, and the public. When the data requests are completed by staff members, a copy is sent to the request agency or individual and a copy is kept in the files at the FPC office. Some data request responses are memorandums and are posted on the FPC website.

The FPC provides public access to the former mentioned datasets and documents through its website, fpc.org. This appendix provides a summary of the Fish Passage Center website usage during 2007. It provides general statistics, geographic location of website users, lists the most used web pages, and describes the types of visitors using the FPC website. In addition, this appendix includes a brief summary of the 2007 data requests. The data request summary includes information about the number of annual data requests summarized by general data request categories and the number of data requests summarized by type of requestor. For instance, there were data requests made by various government agencies, individuals, and organizations.

Fpc.org Website Statistics

The FPC website is the primary vehicle for data distribution. In 2007, the Fish Passage Center website (fpc.org) received 7,242,651 successful hits on our website during 2007 with 1,233,785 page views and 978,576 visits or user sessions. Approximately 84.3% of the user sessions were from the United States. About 1.2% of the remaining user sessions were international with about 14.5% of unknown origin. During 2007, we averaged 20,062 hits per day, 3,417 page views per day, and 2,710 user sessions per day. The average user session length was 4 ½ minutes. The number of unique users was 205,056. Of these unique users, 60.3% visited once and 39.7% visited more than once. We log all data requests made via the web. The number of web data requests made in 2007 was 170,381. The top 10 web data requests for each quarter of 2007 totaled 141,357 data requests or about 83% of all of the web data requests in 2007. The top 10 web data requests for each quarter of 2007 can be grouped into 3 general categories including adult salmon, smolts, and river data. Adult salmon counts web data requests comprised about 59% of these web data requests, while smolt comprised 32% and river data comprised about 9%.

In 2007, September had the highest percentage of user sessions with 15%, followed by May with 14% and August and April both with 12%. There were two three month periods during the year with 36% of the user sessions. These were April, May, June August, September, and October (see Figure 1).

The top ten countries with the most fpc.org user sessions in 2007 were the United States (99.04%), Canada (0.13%), Germany (0.11%), China (0.10%), Brazil (0.09%), United Kingdom (0.09%), Japan (0.06%), Netherlands (0.06%), Norway (0.05%), and Poland (0.05%) (see Figure 2). The top seven states with the most user sessions in 2007 were: Colorado (35.56%), California (16.06%), Virginia (12.68%), Massachusetts (11.40%), Oregon (8.88%), Washington (6.45%), and Idaho (3.29%) (see Figure 3).

The top 10 pages with the most hits during 2007 were adult salmon count pages and the FPC.ORG homepage. The top six requested pages were: (1) 7 Day and YTD Adult Counts; (2) 7 Day and YTD Adult Counts (based on historical reporting dates), (3) FPC HomePage, (4) Fish Passage Center's Columbia and Snake River Adult Passage Graph, (5) FPC Adult Salmon Web – Graph Traditional Current Year with last year and 10 year, and (6) Cumulative Adult Ladder Counts. The 11th and 12th most requested pages were (11) Daily Flow and Spill Report and (12) FPC Columbia and Snake River Web. The 14th – 16th most requested pages were (14) FPC Smolt Web, (15) FPC Documents Web, and (16) FPC Weekly Reports (see Figure 4). Users of fpc.org can be categorized into 4 types of users. The types of users of fpc.org during 2007 included network or individual users (60.3%), companies or organizations (31.2%), government or military (6.5%), and educational (1.8%) (see Figure 5).

Figure K-1 2007 Website User Sessions Per Month

Figure K-2 Top Countries Using FPC.ORG

Figure K-3 Top States Using FPC.ORG

Top 21 Requested Pages, 2007

Figure K-4 FPC.ORG 2007 Top Requested Webpages

Figure K-5 FPC.ORG 2007 Hits by User Type

2007 Data Requests Summary

There were a total of 119 data requests during 2007. Of these 51.2% were government requests, 16% were requests from tribes, 16.8% were requests from individuals, 14.3% were requests from organizations, and 1.7% were educational requests. Of the 61 government requests, 49.2% were from states agencies, 34.4% were from federal agencies, and 16.4% were from regional government agencies or groups such as FPAC (see Table 1).

Type of Requestor	Number of Requests	Percentage of Requests
Federal government	21	17.6%
State government	30	25.2%
Regional government	10	8.4%
Tribes	19	16.0%
Individuals	20	16.8%
Organizations	17	14.3%
Education	2	1.7%
Total number of 2007 data requests	119	

Several types of data were requested during 2007 including copies of metadata, questions and requests for data about adult counts, water transit times, survival, spill, total dissolved gas, smolt transportation, smolt mortality and descaling, requests to review management documents (i.e. BIOPs agreements) and many other types of information. The 2007 data requests can be broken down into general categories by subject type. Requests related to adult salmon were most frequent, comprising 29.4% of the yearly total requests. Requests related to river data such as flow, spill, and total dissolved gas were the second most frequent at 28.6% of the data requests. Smolt data requests comprised 16.8% of the 2007 data requests, while requests to review management documents were 5.9%, passage condition requests were 10.1%, hatchery data requests were 5%, and administrative / miscellaneous requests were 5% of the total 2007 data requests (Table 2). Appendix A contains copies of many of these data requests in the form of memorandums of response.

Data Request Category	Number of Requests	Percentage of Requests
Adults	35	29.4%
Smolts	20	16.8%
River data	34	28.6%
Review management documents	7	5.9%
Passage conditions (WTT, TT, Survival, SARS, etc)	12	10.1%
Hatchery data	5	4.2%
Administrative and miscellaneous	6	5.0%
Total	119	

APPENDIX L

April 2007 Court Opinion

and

2007 FCRPS Fish Operations

UNITED STATES DISTRICT COURT

DISTRICT OF OREGON

**NATIONAL WILDLIFE FEDERATION, IDAHO
WILDLIFE FEDERATION, WASHINGTON
WILDLIFE FEDERATION, SIERRA CLUB,
TROUT UNLIMITED, PACIFIC COAST
FEDERATION OF FISHERMEN'S
ASSOCIATIONS, INSTITUTE FOR FISHERIES
RESOURCES, IDAHO RIVERS UNITED, IDAHO
STEELHEAD AND SALMON UNITED,
NORTHWEST SPORT FISHING INDUSTRY
ASSOCIATION, SALMON FOR ALL,
COLUMBIA RIVERKEEPER, AMERICAN
RIVERS, INC., FEDERATION OF FLY FISHERS,
and NW ENERGY COALITION,**

Plaintiffs,

and

STATE OF OREGON,

Intervenor-Plaintiff,

v.

**NATIONAL MARINE FISHERIES SERVICE,
U.S. ARMY CORPS OF ENGINEERS, and U.S.
BUREAU OF RECLAMATION**

Defendants,

PAGE 1 - OPINION AND ORDER

**CV 01-640-RE
OPINION AND ORDER**

and

STATE OF IDAHO, STATE OF MONTANA,
KOOTENAI TRIBE OF IDAHO, NORTHWEST
IRRIGATION UTILITIES, PUBLIC POWER
COUNCIL, WASHINGTON STATE FARM
BUREAU FEDERATION, FRANKLIN COUNTY
FARM BUREAU FEDERATION, GRANT
COUNTY FARM BUREAU FEDERATION, BPA
CUSTOMER GROUP, and CLARKSTON GOLF
& COUNTRY CLUB,

Intervenor-Defendants.

REDDEN, Judge:

On April 10, 2007, the court received an anonymous phone message alleging that Bonneville Power Administration (BPA) intentionally violated biological fish restrictions during "the first part of April, end of March" to satisfy its hydro-power commitments, and sought to declare a system emergency to conceal the variance.¹ I conferred with the parties, and requested written responses to those allegations from Federal Defendants, Plaintiffs, the Treaty Tribes, and the State of Oregon. The responses are public documents and available online. I am concerned by BPA's actions during the early phase of the 2007 spill operations, and the damaging effect that those actions likely had on migrating juvenile salmon. After considering the parties' responses, I find it appropriate to clarify and reiterate Federal Defendants' legal obligations

¹Generally, the Ninth Circuit Court of Appeals has exclusive jurisdiction over claims against BPA relating to its compliance with the Endangered Species Act. 16 U.S.C. § 839f(e)(5); Nw. Res. Info. Ctr. v. Nat'l Marine Fisheries Serv., 818 F. Supp. 1399, 1403-04 (W.D. Wash. 1993). Although not a party to this action, BPA clearly has some ability to order the generation of additional power to meet its marketing requirements. Id.; see also Dec. of Stephen R. Oliver, at 8-9 (If BPA did not supply a balanced schedule for power, "their Automatic Generation Control (AGC) systems likely would simply increase generation from certain projects in the federal hydrosystem in order to force such a balance.").

under the Endangered Species Act (ESA), the 2004 Federal Columbia River Power System Biological Opinion (2004 FCRPS BiOp), and the 2007 Operations Agreement.

Federal dam operations on the Columbia and Snake Rivers are governed primarily by Federal Defendants' 2004 FCRPS BiOp. I granted Plaintiffs' and the Treaty Tribes' requests for injunctive relief in 2005, and again in 2006, ordering the U.S. Army Corps of Engineers to modify its proposed dam operations under the 2004 FCRPS BiOp by increasing spring and summer spill at five Columbia and Snake River dams. The spill was necessary to assist juvenile salmon and steelhead migrating to the ocean, and to avoid irreparable harm to listed juvenile salmon and steelhead that would otherwise occur.

Plaintiffs decided not to file a separate request for injunctive relief after they learned that Federal Defendants entered into a formal agreement with the Treaty Tribes for the 2007 spring and summer spill operations. Under the agreement, Federal Defendants agreed to continue the spring and summer spill operations ordered by the court in 2006.

The agreement also provides, with an exception not relevant here, "[a]ll other operations not specified in the [agreement] will be consistent with the operations identified in the 2004 FCRPS Biological Opinion" The 2004 FCRPS BiOp provides that the action agencies "will continue operating the FCRPS to achieve the hydrosystem standards described in the 2000 BiOp," which requires the Corps and BPA to "operate turbines within 1% peak efficiency during the juvenile and adult migration seasons" The Final 2007 Water Management Plan also requires Federal Defendants to operate Bonneville, The Dalles, and McNary dams "within 1% of best efficiency," for the benefit of listed species.

On April 3, 2007, a combination of required flood control drafts, higher than forecast

demand for power, marketing commitments, and human error, created a situation that made it difficult for BPA to meet both its power commitments and to provide the fish-protection measures enumerated in the 2000 and 2004 BiOps. In the few days before April 3, 2007, BPA overestimated, and consequently oversold the amount of surplus power it expected to generate that day, resulting in a shortfall of power. Colder-than-forecasted regional temperatures also contributed to the energy shortfall. To meet its April 3, 2007 obligations, BPA undertook a diligent, but unsuccessful effort to buy back the needed power. BPA also sought power from Dworshak, Hungry Horse, and the Willamette Project dams to meet the shortfall. BPA even considered declaring a system emergency to avoid violating fish protection measures, but did not do so because there was, in fact, no power system emergency. Having failed to acquire sufficient power to meet its commitments, BPA generated additional power by operating Bonneville, The Dalles, and McNary dams outside the 1% peak turbine efficiency standard for several hours on April 3, 2007. Fortunately, spring spill had not yet started at those dams.

That same day, an unrelated equipment failure caused Little Goose dam to fall below minimum operating pool (MOP). To restore the reservoir to the proper elevation, the Corps reduced power generation and spill discharge at Little Goose dam, which resulted in similar reductions at each of the other Lower Snake River dams.

Federal Defendants acknowledge BPA violated the 1% peak efficiency standard set out in the 2000 and 2004 BiOps. They contend, however, that the biological impact on migrating juvenile salmon was "minimal" because so few smolts were present. But that result is more likely a product of good fortune rather than reasoned decision-making or planning. Moreover, given the dangerously low rate of returning adult fish and the "evidence suggest[ing] that

operations outside of 1% peak efficiency [are] highly detrimental to fish survival," I do not accept Federal Defendants' conclusory assertion that the impact of these violations was "minimal." See Attachment 4 to State of Oregon's Reply, Federal and Tribal Fisheries Agencies Joint Technical Staff letter to U.S. Army Corps of Engineers (April 2, 2004), at 1.

In any event, it is not clear that BPA's actions would have differed substantially even if a similar energy shortfall occurred during peak migration season, when the impacts on ESA-listed species would not have been "minimal." According to Stephen R. Oliver, rather than breaking sales contracts to ensure a balance between power supply and sales commitments, BPA's "Automatic Generation Control (AGC) systems likely would simply increase generation from certain projects in the federal hydro system in order to force such a balance." Dec. of Stephen R. Oliver, at 8-9 (emphasis added). Oliver explained that "only . . . if there were a serious problem with transmission grid reliability" would BPA cut delivery of power to purchasers. Id. (emphasis added). In this case, BPA voluntarily violated fish-protection measures to meet its sales obligations. But if I understand correctly, BPA's AGC systems (*i.e.*, computer system?) will automatically increase power generation to rectify an energy shortfall, regardless of harm to ESA-listed species. Apparently, BPA's sales commitments to customers always trump its obligation to protect ESA-listed species. BPA must realize, however, that the fish-protection measures detailed in the 2000 and 2004 BiOps are not optional. Nor is compliance with the ESA. Nat'l Wildlife Fed'n v. Nat'l Marine Fisheries Serv., 481 F.3d 1224 (9th Cir. 2007).

I recognize that operating the FCRPS is "an incredibly complex task," and that BPA was faced with a "difficult choice" on April 3, 2007. BPA's choice, however, "to operate certain turbines outside the 1% peak efficiency requirement" standard set out in the 2000 and 2004

FCRPS BiOps, and sacrifice the biological needs of listed species to satisfy its sales commitments to customers was wrong. This was not a system emergency. It was a marketing error, and ESA-listed salmon and steelhead paid the price. This, the law does not permit. Under the circumstances here, threatened and endangered species must come before power generation.

There is no evidence that BPA intended to either violate the 2007 Operations Agreement, or harm listed species. I remain concerned, however, that BPA and the Corps do not view their commitments under the current operating agreement as binding legal obligations. To emphasize the point, I find it appropriate to incorporate the terms of the 2007 Operations Agreement into a court order. Federal Defendants do not object. Subject to any further orders, during the remainder of the 2007 spring and summer migration seasons, Federal Defendants shall:

(1) Comply with the terms of the 2007 Operations Agreement for spill. To the extent not specified in that agreement, all FCRPS operations shall be consistent with the 2004 BiOp. As noted above, although the 2004 BiOp does not address turbine efficiency, the 2004 BiOp provides that the action agencies "will continue operating the FCRPS to achieve the hydrosystem performance standards described in the 2000 BiOp." The 2000 BiOp requires the Corps and BPA to operate turbines within 1% of peak efficiency during the juvenile and adult migrating seasons. Therefore, under the 2007 Operations Agreement, Corps and BPA shall operate the FCRPS turbines within the 1% peak efficiency standard.

(2) In the absence of a declared system emergency, BPA and the Corps shall take all reasonable and practicable steps to notify the court and the parties prior to any future departure from the fish-protection requirements set out in the 2007 Operations Agreement, or the 2004 BiOp. If unforeseen circumstances arise that preclude BPA or the Corps from notifying the court

directly to the court as soon as practicable. Federal Defendants shall report to the court any violation of required fish-protection measures, and the mitigation measures that may be appropriate to account for such violation. The other parties shall have an opportunity to respond.

(3) To ensure that BPA is fully aware of its obligations, Federal Defendants shall make this Opinion and Order available to all BPA employees with authority and duties regarding FCRPS operations.

Federal Defendants are commended for their forthright and prompt response to the recent and unfortunate violations of fish-protection measures. This Opinion and Order is not a product of anger, but frustration. The ESA is the law of the land, and has been since it was signed into law by President Richard Nixon in 1973. Its mandate is clear: federal agencies must "afford first priority to the declared national policy of saving endangered species." Tennessee Valley Authority v. Hill, 437 U.S. 153, 185 (1978). It is clearly written because the drafters sought desirable goals, and knew it would require some sacrifice to save our nation's precipitously diminishing species. The duty of federal agencies under ESA has been litigated, and reaffirmed in federal courts across the country. Proposed amendments to the Act have repeatedly failed, and its regulations stand firm. We might as well get it right.

IT IS SO ORDERED.

DATED this 23rd day of May, 2007.

/s/ James A. Redden
James A. Redden
United States District Judge

PAGE 7 - OPINION AND ORDER

**Agreement Regarding
2007 Federal Columbia River Power System Fish Operations**

WHEREAS the Confederated Tribes of the Warm Springs Reservation, the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Colville Indian Reservation and Bonneville Power Administration ("The Parties") and others are actively engaged in remand collaboration pursuant to *National Wildlife Federation v. National Marine Fisheries Service (NWF v. NMFS)*, Cv. 01-640, and in discussions regarding a long term agreement for the operation and mitigation of the FCRPS;

WHEREAS the parties recognize that long term operation of the system is being addressed through the ongoing remand in *NWF v. NMFS* and long term agreement discussions;

WHEREAS the Federal Agencies believe that the FCRPS should be operated in 2007 with respect to spill as required by the Court with respect to 2006 operation except for changes to reflect the anticipated structural improvements at two facilities;

WHEREAS, the Tribes contend that some additional changes to spill and other measures are appropriate;

WHEREFORE, to resolve this disagreement, the Parties agree as follows:

- The Federal Agencies shall operate the FCRPS in 2007 as described in Attachment 1 (which is incorporated herein by reference). To the extent not specified in Attachment 1 the operations shall be consistent with the 2004 Biological Opinion. The Parties agree that these operations provide additional and adequate interim protection for ESA-listed fish for 2007.
- In the event that the District Court requires or desires confirmation of the Tribes' support for these 2007 FCRPS operations and/or the project funding commitments in Attachment 2, the Tribes shall support the above-described operations in any statements to the Court. Even if not required to do so, the Tribes will indicate their support for these operations and project commitments in 2007 to the Court and support their implementation in all forums.
- The Tribes and Columbia River Intertribal Fish Commission, and their staffs, will not provide direct or indirect support for any other party's position in any legal proceeding conducted to determine what 2007 FCRPS operations will be implemented and will not provide support for other parties' efforts to implement operations in 2007 that deviate from those described in Attachment 1.
- Bonneville Power Administration will also provide interim funding for certain tribal projects described in a separate exchange of letters with the tribal chairs, which include actions benefiting ESA-listed fish. The letters setting forth the project funding commitments are, by this reference, part of this agreement and are Attachment 2.

This Agreement addresses 2007 operations only, and does not provide a precedent for any future proceedings or endorsement of these operations for the long term operations of the federal dams.

Agreement Regarding
2007 Federal Columbia River Power System Fish Operations

Dated December 20, 2006

For:
United States Department of Energy
Bonneville Power Administration

By:

Name: Stephen J. Wright

Title: Administrator/CEO

Agreement Regarding
2007 Federal Columbia River Power System Fish Operations

Dated 12-15, 2006

For:
Confederated Tribes of the Warm Springs
Reservation

By: Ron Suppah, Sr.

Name: Ron Suppah

Title: Chair of Tribal Council

Agreement Regarding
2007 Federal Columbia River Power System Fish Operations

Dated 12-15-06, 2006

For:
Nez Perce Tribe

By:

Name: Rebecca Miles

Title: Chair of Executive Committee

Agreement Regarding
2007 Federal Columbia River Power System Fish Operations

Dated December 26, 2006

For:
Confederated Tribes of the Umatilla Indian
Reservation

By:

Name: Antone Minthorn

Title: Chair of Board of Trustees

Agreement Regarding
2007 Federal Columbia River Power System Fish Operations

Dated Dec 21-06, 2006

For:
Confederated Tribes and Bands of the
Yakama Nation

By: Lavina Washines

Name: Lavina Washines

Title: Chair of Tribal Council

Agreement Regarding
2007 Federal Columbia River Power System Fish Operations

Dated Dec. 21, 2006, 2006

For:
Confederated Tribes of the Colville Indian
Reservation

By:

Name: Michael E. Marchand

Title: Chair of Business Council

REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND OR 97208-2870

DEC 15 2006

Planning, Environmental Resources,
and Fish Policy and Support Division

Rebecca Miles, Chairwoman
Nez Perce Tribe
P.O. Box 305
Lapwai, Idaho 83540

Antone Minthorn, Chairman
Confederated Tribes of the Umatilla
P.O. Box 638
Pendleton, Oregon 97801

Lavina Washines, Chairwoman
Confederated Tribes and Bands of
the Yakama Nation
P.O. Box 151
Toppenish, Washington 98948

Ronald Suppah, Sr., Chairman
Confederated Tribes of the Warm
Springs Reservation of Oregon
P.O. Box C
Warm Springs, Oregon 97761

Michael Marchand, Chairman
Confederated Tribes of the Colville Reservation
P.O. Box 150
Nespelem, WA 99155

Dear Tribal Chairs:

I have reviewed the agreement between Bonneville Power Administration and the Colville, Yakama, Umatilla, Warm Springs, and Nez Perce Tribes regarding 2007 Federal Columbia River Power System Fish Operations.

I commit to, and will implement the operations identified in Attachment 1 (copy enclosed herein) to the referenced agreement.

Sincerely,

Gregg F. Martin
Brigadier General, US Army
Division Commander

Enclosure

Agreement Regarding 2007 Federal Columbia River Power System Fish Operations

Page 1 of 2

2007 Operations For Lower Snake and Columbia River projects

The following spill operations assume average water conditions in 2007. Unusually high or low water conditions may require deviations from these operations.

Spring 2007

	Planned Operations for Spring 2007 (Day/Night)	Comments
Transport	Initiate transport at Lower Granite Dam between April 20 – May 1 with staggered transport start dates at Little Goose and Lower Monumental. Criteria for start date and stagger days will be provided to TMT*1	Same as 2006 except potential later start of transport
Lower Granite	20kcfs/20kcfs	Same as 2006 with planned main turbine unit outage
Little Goose	30%/30% Allow for 14 days night Gas Cap spill within the last week of April – second week of May (April 22 – May 15)*. Dates of actual night time spill to be determined by salmon managers within the window of time identified above	Same as 2006 except 14 days of gas cap night spill
Lower Monumental	27 kcfs/27kcfs Gas Cap	Same as 2006 test program (24 hr Gas Cap spill)
Ice Harbor	30%/30% vs 45kcfs/Gas Cap	Same as 2006 test program
McNary	40%/40% (April 10 – June 30)	Same as 2006 except elimination of 0/150 kcfs operation to provide testing of the prototype temporary spillway weir (PTSW)
John Day	0 / 60% Planning for PTSW test with 24 hour spill in 2008	Same as 2006
The Dalles	40%/40%	Same as 2006
Bonneville	100kcfs/100kcfs	Same as 2006

***1 Initiation of Transport**

* The timing of the 14 days of spill to nighttime gas cap levels will be determined in-season through the TMT processes and is intended to coincide with the peak of the wild spring yearling Chinook migration at Little Goose Dam within the window specified.

Attachment 1
Agreement Regarding 2007 Federal Columbia River Power System Fish Operations
Page 2 of 2

In water years when the Snake River projected seasonal average (April 3 – June 20) flow is greater than 70kcf/s, transportation will be initiated at Lower Granite Dam no earlier than April 20 and no later than May 1. The seasonal average flow projection will be based on the Corps' STP model and the April final forecast. The actual start date will be decided through the TMT process as informed by the in-season river conditions (e.g. river flow and temperature) and the status of the juvenile Chinook and steelhead runs (e.g. percent of runs having passed the project). In exceptionally low water years, when the projected seasonal average flow is less than 70kcf/s, the start date of transport would be April 20.

In water years when the projected seasonal average flow is greater than 70kcf/s, transportation will be planned to start 8 days and 11 days after the Lower Granite Dam start date for Little Goose and Lower Monumental dams respectively. The actual start date at those dams will be further considered through the TMT process depending on in-season river conditions and the status of the juvenile Chinook and steelhead runs.

Summer 2007

Project	Planned Operations for Summer 2007 (Day/Night)	Comments
Lower Granite	18 kcf/s / 18 kcf/s	Same as 2006
Little Goose	30% / 30%	Same as 2006
Lower Monumental	17 kcf/s / 17 kcf/s	Same as 2006
Ice Harbor	30%/30% vs 45kcf/s/Gas cap	Same as 2006 test program
McNary	40%/40% vs 60%/60	Same as 2006 test program
John Day	30% / 30%	Same as 2006
The Dalles	40%/40%	Same as 2006
Bonneville	75kcf/s / 120kcf/s	Same as 2006

Studies Review Work Group and Fish Facility Review Work Groups will determine final 2007 biological test program and spill patterns for testing and operation.

All other operations not specified in the table above will be consistent with the operations identified in the 2004 FCRPS Biological Opinion; however, flood control operations at Libby Dam are under review. Concerns about potential risks to public health and safety are currently being assessed, and the Corps may decide an operation in 2007 that differs from the interim VARQ operation is necessary.

Attachment 2
Agreement Regarding 2007 Federal Columbia River Power System Fish Operations
Page 1 of 8

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

In reply refer to: KE-4

Ron Suppah, Chairman
Confederated Tribes of the Warm Springs Reservation
PO Box 1299
Warm Springs, OR 97761

RE: Agreement on 2007 Federal Columbia River Power System Fish Operations and Transition Funding

Dear Chairman Suppah:

On behalf of the Bonneville Power Administration, I would like to thank you for the constructive discussions we have had regarding 2007 hydropower operations and bridge funding for tribal fish mitigation projects. I am pleased to confirm that we have reached agreement in both of these areas. In support of the Agreement regarding 2007 FCRPS fish operations, we are agreeing to extend/provide the contracts and budget amounts for the remainder of FY07 as noted below:

<u>Project #</u>	<u>Project Title</u>	<u>Funding Level</u>
2002-016-00	Evaluation of Lamprey Status	\$108,000
*2007-157-00	Bull Trout Status and Abundance	\$115,000

* This is a new project that will be included within BPA's funding decision letter to the Council for FY07

As we have discussed, this interim agreement covers fiscal year 2007 funding and calendar year 2007 operations only. It does not provide a precedent for any future proceedings or endorsement of these operations or projects for the longer term. We look forward to negotiation of a long term agreement with the Warm Springs Tribe to improve our partnership in fish recovery and to meet our mutual interests in the resources of the Columbia Basin.

Sincerely,

Gregory K. Delwiche
Vice President, Environment, Fish & Wildlife

Attachment 2
Agreement Regarding 2007 Federal Columbia River Power System Fish Operations
Page 2 of 8

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

In reply refer to: KE-4

Rebecca Miles, Chair
Nez Perce Tribe
PO Box 305
Lapwai, ID 83540

RE: Agreement on 2007 Federal Columbia River Power System Fish Operations and Transition Funding

Dear Chair Miles:

On behalf of the Bonneville Power Administration, I would like to thank you for the constructive discussions we have had regarding 2007 hydropower operations and bridge funding for tribal fish mitigation projects. I am pleased to confirm that we have reached agreement in both of these areas. In support of the Agreement regarding 2007 FCRPS fish operations, we are agreeing to extend/provide the contracts and budget amounts for the remainder of FY07 as noted below:

<u>Project #</u>	<u>Project Title</u>	<u>Funding Level</u>
2002-054-00	Protect & Restore Asotin Creek Watershed	\$129,000
1997-038-00	Listed Stock Gamete Preservation	\$228,000
2007-xxx-xx	Conservation Enforcement	\$285,000

In addition, BPA and the Tribe will work together to initiate the work necessary to allow for construction of the Northeast Oregon Hatchery consistent with meeting the summer instream work window which begins on July 1, 2007. This includes reevaluation of cost estimates (e.g. cost escalation due to postponement of the project), and development of a bid package and final design. In addition, the Tribe will prepare a short management plan for the hatchery linked to ESA recovery goals. It is also agreed that the Tribe and BPA will continue to promote the benefits of NEOH in recovering ESA listed species in an effort to gain NOAA concurrence.

As we have discussed, this interim agreement covers fiscal year 2007 funding and calendar year 2007 operations only. It does not provide a precedent for any future proceedings or endorsement

Attachment 2
Agreement Regarding 2007 Federal Columbia River Power System Fish Operations
Page 3 of 8

of these operations or projects for the longer term. We look forward to negotiation of a long term agreement with the Nez Perce Tribe to improve our partnership in fish recovery and to meet our mutual interests in the resources of the Columbia Basin.

Sincerely,

Gregory K. Delwiche
Vice President, Environment, Fish & Wildlife

Attachment 2
Agreement Regarding 2007 Federal Columbia River Power System Fish Operations
Page 4 of 8

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

In reply refer to: KE-4

Antione Minthorn, Chairman
Confederated Tribes of the Umatilla Indian Reservation
P.O. Box 638
Pendleton, OR 97801

RE: Agreement on 2007 Federal Columbia River Power System Fish Operations and Transition Funding

Dear Chairman Minthorn:

On behalf of the Bonneville Power Administration, I would like to thank you for the constructive discussions we have had regarding 2007 hydropower operations and bridge funding for tribal fish mitigation projects. I am pleased to confirm that we have reached agreement in both of these areas. In support of the Agreement regarding 2007 PCRPFS fish operations, we are agreeing to extend/provide the contracts and budget amounts for the remainder of FY07 as noted below:

<u>Project #</u>	<u>Project Title</u>	<u>Funding level</u>
2000-038-00	Walla Walla Hatchery, 3-Step Process	\$30,000 ¹
2000-031-00	John Day Fish Habitat Enhancement	\$249,000 ²
2002-030-00	Progeny Marker Steelhead Supplementation	\$297,000
1994-026-00	Lamprey Research and Restoration	\$296,000 ³
2002-037-00	Freshwater Mussel Research & Restoration	\$233,000
1990-005-01	Umatilla Natural Prod. Temperature M&E	\$25,000
2007-252-00	Assessment of Hyporheic Flow	\$77,000
*2007-xxx-xx	Conservation Enforcement	\$100,000 ⁴
Total		\$1,307,000

* This is a new project that is planned for inclusion in BPA's fish and wildlife project funding decision letter to the Council for Fiscal Year 2007.

¹ This is the initial CTUIR share. It is understood that upon completion and acceptance by BPA of the master plan, BPA commits to future funding in the amount of \$255,000 to non-CTUIR parties (contractors) necessary to complete the project at a total FY07 budget amount of \$285,000.

² This represents the total FY07 project cost. The Northwest Power and Conservation Council has authorized/allotted \$200,000 for this project.

³ This is the budget for FY07 (through September).

⁴ This budgeted amount covers the period through June, 2007, not the entire FY 07.

Attachment 2
Agreement Regarding 2007 Federal Columbia River Power System Fish Operations
Page 5 of 8

As we have discussed, this interim agreement covers fiscal year 2007 funding and calendar year 2007 operations only. It does not provide a precedent for any future proceedings or endorsement of these operations or projects for the longer term. We look forward to negotiation of a long term agreement with the Umatilla Tribe to improve our partnership in fish recovery and to meet our mutual interests in the resources of the Columbia Basin.

Sincerely,

Gregory K. Delwiche
Vice President, Environment, Fish & Wildlife

Attachment 2
Agreement Regarding 2007 Federal Columbia River Power System Fish Operations
Page 6 of 8

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

In reply refer to: KE-4

Lavina Washines, Chair
Yakama Indian Nation
P.O. Box 151
Toppenish, WA 98948-0151

RE: Agreement on 2007 Federal Columbia River Power System Fish Operations and Transition Funding

Dear Chair Washines:

On behalf of the Bonneville Power Administration, I would like to thank you for the constructive discussions we have had regarding 2007 hydropower operations and bridge funding for tribal fish mitigation projects. I am pleased to confirm that we have reached agreement in both of these areas. In support of the Agreement regarding 2007 PCRPS fish operations, we are agreeing to extend/provide the contracts and budget amounts for the remainder of FY07 as noted below:

<u>Project #</u>	<u>Project Title</u>	<u>Funding Level</u>
1992-062-00	*Riparian Wetlands Restoration	\$25,000
1996-035-01	Yakama Reservation Watershed Project	\$650,000
1996-040-00	Mid-Columbia Coho	\$600,000
1988-120-25	YKFP Management, Data, Habitat	\$454,000
1997-056-00	Klickitat Watershed Enhancement	\$261,000

*Note: This project has an O&M component that will continue to receive funding from the fish & wildlife program

As we have discussed, this interim agreement covers fiscal year 2007 funding and calendar year 2007 operations only. It does not provide a precedent for any future proceedings or endorsement of these operations or projects for the longer term. We look forward to negotiation of a long term agreement with the Yakama Tribe to improve our partnership in fish recovery and to meet our mutual interests in the resources of the Columbia Basin.

Sincerely,

Gregory K. Delwiche
Vice President, Environment, Fish & Wildlife

Attachment 2
Agreement Regarding 2007 Federal Columbia River Power System Fish Operations
Page 7 of 8

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

In reply refer to: KE-4

Michael Marchand, Chair
Confederated Tribes of the Colville Reservation
P.O. Box 150
Nespelem, WA 99155

RE: Agreement on 2007 Federal Columbia River Power System Fish Operations and Transition Funding

Dear Chairman Marchand:

On behalf of the Bonneville Power Administration, I would like to thank you for the constructive discussions we have had regarding 2007 hydropower operations and bridge funding for tribal fish mitigation projects. I am pleased to confirm that we have reached agreement in both of these areas. In support of the Agreement regarding 2007 FCRPS fish operations, we are agreeing to extend/provide the contracts and budget amounts for the remainder of FY07 as noted below:

<u>Project #</u>	<u>Project Title</u>	<u>Funding Level</u>
*2000-001-00	Omak Creek Culvert & Land Acquisition	\$271,000
1996-042-00	Salmon Creek	\$300,000
2007-212-00	Locally Adapted SIT Broodstock - Step 1	\$100,000
2003-022-00	Okanogan Basin M&E	\$125,000

*Final land acquisition cost will be based upon a BPA land appraisal that will occur in FY 07

Note: These projects are also planned for inclusion in BPA's new habitat UPA as well as in BPA's fish and wildlife project funding letter to the Council for Fiscal Year 2007.

As we have discussed, this interim agreement covers fiscal year 2007 funding and calendar year 2007 operations only. It does not provide a precedent for any future proceedings or endorsement of these operations or projects for the longer term. We look forward to negotiation of a long term agreement with the Colville Tribe to improve our partnership in fish recovery and to meet our mutual interests in the resources of the Columbia Basin.

Sincerely,

Gregory K. Delwiche
Vice President, Environment, Fish & Wildlife

Attachment 2
Agreement Regarding 2007 Federal Columbia River Power System Fish Operations
Page 8 of 8

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

In reply refer to: KE-4

Olney Patt Jr., Executive Director
Columbia River Inter-Tribal Fish Commission
729 NE Oregon St., Suite 200
Portland, OR 97232

RE: Agreement on 2007 Federal Columbia River Power System Fish Operations and Transition Funding

Dear Mr. Patt:

On behalf of the Bonneville Power Administration, I would like to thank you for the constructive discussions we have had regarding 2007 hydropower operations and bridge funding for tribal fish mitigation projects. I am pleased to confirm that we have reached agreement in both of these areas. In support of the Agreement regarding 2007 FCRPS fish operations, we are agreeing to provide the contract and budget amount for the remainder of FY07 as noted below:

<u>Project #</u>	<u>Project Title</u>	<u>Funding Level</u>
*2007-xxx-xx	Conservation Enforcement	\$225,000

* This is a new project that will be included within BPA's funding decision letter to the Council for FY07

As we have discussed, this interim agreement covers fiscal year 2007 funding and calendar year 2007 operations only. It does not provide a precedent for any future proceedings or endorsement of these operations or projects for the longer term. We look forward to negotiation of a long term agreement with the Columbia River Inter-Tribal Fish Commission to improve our partnership in fish recovery and to meet our mutual interests in the resources of the Columbia Basin.

Sincerely,

A handwritten signature in blue ink that reads "Gregory K. Delwiche".

Gregory K. Delwiche
Vice President, Environment, Fish & Wildlife

APPENDIX M

Acronyms

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
CSS	Comparative Survival Study
CWT	Coded wire tag
DEQ	Oregon Department of Environmental Quality
DOE	Washington Department of Ecology
ESA	Endangered Species Act
ESP	Extended stream flow prediction model
FCE	Flood control elevation
FCRPS	Federal Columbia River Power System
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
Kaf	Thousand acre feet
Maf	Million acre feet
NFH	National Fish Hatchery
NOAA Fisheries	Fisheries National Oceanic and Atmospheric Administration
NPT	Nez Perce Tribe
NTS	Non-treaty storage
NPCC	Northwest Power and Conservation Council
ODFW	Oregon Department of Fish and Wildlife
Opinion	NOAA Fisheries 2000 Biological Opinion
PIT Tag	Passive Integrated Transponder Tag
PSMFC	Pacific States Marine Fisheries Commission

PUD	Public Utility District
RFC	River Forecast Center
RPA	Reasonable and prudent alternative
RSW	Removable spillway weir
RT	Radio tag
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 (in regressions AVTEMPC is used)
TMT	Technical Management Team
TREATY	Columbia River Treaty
TRVTIME	Smolt Travel Time
TSR	Treaty storage regulation
USFWS	United States Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WSF	Water Supply Forecast
WTT	Water particle transit time
WY	Water year