CENWW-OD-EL HOLDREN February, 2018

MEMORANDUM THRU:
Marty Mendiola, Operations Project Manager, Lower Granite Dam

FOR Chief, Operations Division
ATTN: Eric Hockersmith / Ann Setter

SUBJECT: Submission of 2017 Juvenile Fish Collection and Bypass Report, Lower Granite Dam Juvenile Fish Facility.

1. Enclosed find the 2017 Juvenile Fish Collection and Bypass Report for Lower Granite Dam as requested.

2. If you have any questions contact Elizabeth Holdren at Lower Granite Dam, (509) 843-2263.

ELIZABETH A. HOLDREN
Supervisory Fisheries Biologist, Lower Granite Dam

Enclosure

2017 Juvenile Fish Collection and Bypass Report
Lower Granite Dam Juvenile Fish Facility

Prepared by

Elizabeth Holdren

U.S. Army Corps of Engineers

and

Shawn Rapp Anchor QEA

February, 2018

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TRANSPORT OPERATIONS - LOWER GRANITE DAM

Introduction

The 2017 collection season at Lower Granite was characterized by above average flow and spill conditions. Water temperatures were below average in June, above average in April and July, and average in May. Debris levels were high throughout the season. ESBSs (Extended Length Submersible Bar Screens) were installed March 21 through March 23. The bypass system and juvenile collection facility were watered up in secondary bypass mode at 0915 hours March 20. Operation of the JFF (Juvenile Fish Facility) in secondary bypass continued until collection for transport began at 0700 hours May 1. Daily twenty-four hour collection for condition monitoring began at 0700 hours March 25 with the first sample being worked up March 26. Collection for condition monitoring continued until collection for transport began May 1. Early season transport of Snake River yearling anadromous salmonids as part of the ongoing study to compare in-river verses transported SARs (Smolt Adult Return Ratios) occurred April 13, 20, and 27. Four agencies conducted six research projects and handled a total of 568,280 smolts at the Lower Granite juvenile collection facility this season in addition to smolt monitoring, gas bubble trauma (GBT) sampling, and kelt collection for Nez Perce Tribe reconditioning program.

Collection for transport began at 0700 hours May 1 and ended at 0700 hours August 2. The juvenile bypass and collection facilities were dewatered early due to construction activities associated with the juvenile fish bypass system upgrade. Total smolt collection for 2017 season was 5,430,419 fish compared to 8,454,280 collected in 2016. Of the 5,430,419 fish collected in the 2017 season 2,612,019 were barged and 2,811,096 were bypassed.

Pacific States Marine Fisheries Commission (PSMFC) technicians examined 1,596 fish for GBT between March 30 and July 27. Smolts examined prior to May 1 were bypassed to the river and smolts examined after April 30 were transported. There were 21 fish with symptoms of GBT observed during the 2017 season.

The passive integrated transponder (PIT) tag system detected 120,561 PIT-tagged fish coming through the JFF during the 2017 season. Of the PIT tagged fish detected 85,106 were diverted to the river, 34,259 were diverted to the raceways for transport, 1,024 were diverted to the sample holding tank, and 172 failed to be detected moving to bypass, raceways, or the sample.

Historically Snake River Basin hatchery salmonids were distinguished from wild salmonids by clipped adipose fins (occasionally pectoral or ventral fins). Before 1998, Idaho Fish and Game (IDFG) was the only agency that released sizeable numbers of unclipped hatchery fish. Starting in 1998, increasing numbers of unclipped hatchery fish were released by state, federal, tribal, or other agencies (such as the Fish Passage Center (FPC)). Thus salmonids collected, sampled, bypassed, and transported from Lower Granite facilities are designated as clipped/unclipped not hatchery/wild. Snake River Basin Coho were reintroduced by the tribes and are all of hatchery origin.

Corps of Engineers personnel included: Project Supervisory Fisheries Biologist Elizabeth Holdren, Assistant Biologists Robert Horal and Suzette Frazier (acting), Lead Biological

Technician Stephen Hampton, Biological Technicians: Bob Traufer, Geno Sprofera, Henry Kei, Marlene Fisher, David Philips, Tyler Janasz and Biological Interns Kevin Ross, and Joshua Moore, truck driver/maintenance personnel: Raymond Cooper, Chuck Krasselt, Jeremy Krewer, and Tomas Dickinson. Representing Pacific States Marine Fisheries Commission (PSMFC) were biologists Allan Martin and Jenna Davis. Anchor QEA was represented by biologists Shawn Rapp and Paul Burke, and Washington Department of Fish and Wildlife (WDF&W) biologist Charles Morrill. PSMFC technicians Bill Fitzgerald, Praxy McIntyre, Jennifer Warner, and Scott Cron conducted fish sampling, and were responsible for the numerous quality control and data keeping tasks.

Facility Modifications

The following modifications were made to the JFF prior to or during the 2017 fish collection season:

1. Juvenile bypass upgrade Phase 1a is ongoing.
2. Refurbished the sample diversion slide gates per PSMFC guidelines.
3. Replaced large PVC separator bars with fabricated aluminum bars at the same spacing to reduce adult passage through the sample and transport system.
4. Sea chest and flapper seals replaced/installed on fish transport barge 8108.
5. Replaced balls in six aerators on fish transport barge 8108.
6. Refurbished separator box and supply lines.
7. Improved separator exit gate design.
8. Installed a direct loading line dewatering box flush valve to eliminate fish stranding on screens
9. Replaced old mesh on raceway 4 head box screen to prevent fry and juvenile lamprey passage into supply box.
10. Installed sample holding tank jump barrier.
11. Overhauled raceway 1-5 canal gates.
12. Replaced raceway 6-10 evacuation valve cylinders.
13. Installed new barge loading dock chain hoists.
14. Installed battery disconnects on fish transport barges 4382, 4394, 8105, and 8106
15. Sea chest and flapper seals replaced/installed on fish transport barge 8107.
16. Replaced all aerator balls on fish transport barge 8107.
17. Painted aerators, above deck fish holds, and engine room exteriors of fish transport barges 8108, 8107, and 8105.
18. Replaced winch cable on right rear of fish transport barge 8105.

River Conditions

The average daily river flow exceeded 100 kcfs on 93 days during the 2017 season. Highest daily average flow for the March 26-August 2 collection season was 181.0 kcfs May 14. Lowest daily average flow for the season was 38.1 kcfs July 28. The seasonal average flow was 116.4 kcfs. Lower Granite began spilling due to high river flows March 8. The maximum spill during the March 8-April 3 period was 107.8 kcfs. Spill for the fish passage season occurred for 152 days from April 3 through midnight on August 31 with a maximum daily average spill of 89.8

kcfs May 14, a minimum daily spill of 14.7 kcfs August 19, and a seasonal average of 39.2 kcfs. Several emergency debris spills with the RSW closed and spill shifted primarily through spillway 3 were required due to heavy debris loads this season. Spill volume remained the same during emergency spill operations May 15, 24, and June 3, 4, 8, 19, and 22. Lower Granite operated with the RSW closed in accordance with Fish Passage Plan Table LWG-9 1313 July 12 through August 31 due to increased forebay surface water temperatures. Spill operations were extended from 0600-1800 hours September 1 through December 15 to provide fish passage during juvenile bypass system construction. River temperatures averaged 57.2 ^{o} F for the season and ranged from 46.4° F March 26 to 70.0° F August 2. A comparison of daily powerhouse flow and spill is shown in Figure 1. Average monthly flow and spill for the 2013-2017 collection seasons are provided in Table 1.

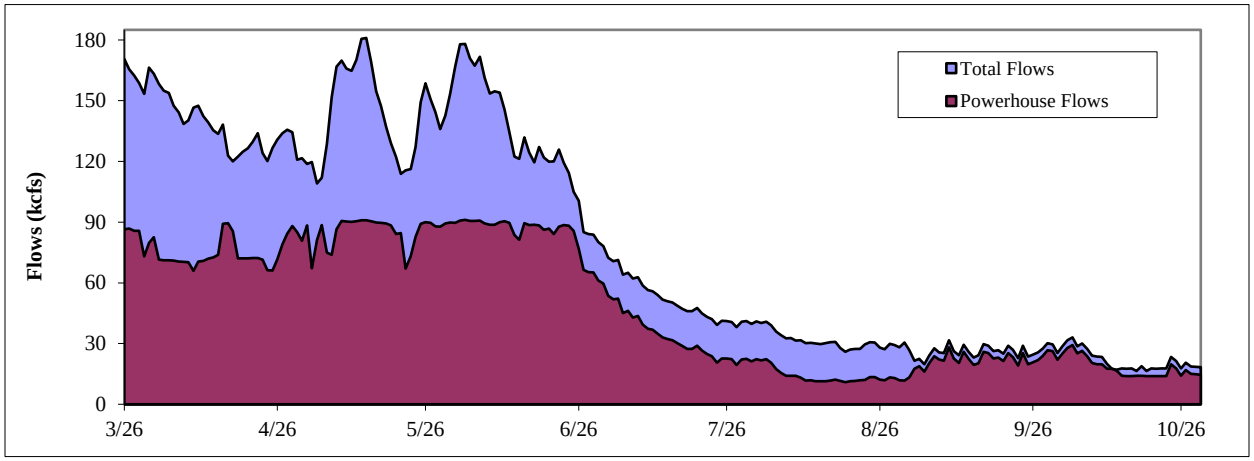

Figure 1. Daily average total flow and powerhouse flow at LWG, 2017.

Table 1. Comparison of average monthly river flow and spill at LWG, 2013-2017.

Flow (kcfs)	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-16 Ave.**
April[1]	52.58	73.67	52.11	85.12	140.76	65.87
May	82.19	104.08	60.89	90.79	142.82	84.49
June	56.31	88.09	43.08	55.58	131.44	60.76
July	33.31	46.64	28.47	34.41	51.98	35.71
August	22.08	26.06	21.72	24.96	31.31	23.71
September	20.42	21.54	19.26	20.06	26.08	20.32
October	23.30	18.86	16.36	22.06	21.42	20.15
Spill (kcfs)						
April[1]	15.56	16.79	15.34	17.23	64.33	16.23
May	21.45	31.10	20.30	21.53	56.98	23.59
June	19.71	23.22	19.60	19.88	46.24	20.60
July	16.71	18.77	12.22	17.73	18.26	16.36
August	11.52	14.19	8.75	12.46	17.05	11.73
September	1.99	0.47	0.15	0.20	3.74	0.70
October	0.00	0.00	0.00	0.00	3.17	0.00

Fish Collection

Migration and Collection

Pre-transport secondary bypass occurred from March 20 through March 25. Daily collection for condition sampling began March 26 and continued until transportation began at 0700 hours on May 1. Collection for transport continued until 0700 hours August 2. An estimated 5,430,419 juvenile salmonids were collected during the 2017 season compared to 8,454,280 in 2016 (Table 2). Within each species group, the number collected, and percent of the total collection was: 1,789,880 clipped yearling Chinook (33.0%), 572,818 unclipped yearling Chinook (10.5%), 225,787 clipped subyearling Chinook (4.2%), 402,606 unclipped subyearling Chinook (7.4%), 1,798,556 clipped steelhead (33.1%), 530,958 unclipped steelhead (9.8%), 15,750 clipped sockeye (0.3%), 19,839 unclipped sockeye/kokanee (0.4%), and 74,225 Coho (1.4%). Daily collection and bypass numbers are provided in Appendix Table 1.

Table 2. Annual collection, bypass, transportation and mortality at LWG, 2013-2017.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
Collection										
2013	1,362,720	502,542	173,989	319,566	1,058,688	386,214	27,395	15,377	48,078	3,894,569
2014	2,431,937	1,010,410	242,870	415,002	1,856,040	548,219	18,902	112,122	52,724	6,688,226
2015	902,798	247,380	188,552	500,858	674,434	152,383	8,350	2,572	26,330	2,703,657
2016	3,405,400	1,104,727	262,101	512,157	2,385,586	600,528	28,700	4,665	150,416	8,454,280
2017	1,789,880	572,818	225,787	402,606	1,798,556	530,958	15,750	19,839	74,225	5,430,419
Bypass										
2013	184,931	123,327	12,212	1,485	303,992	52,616	0	54	210	678,827
2014	895,654	605,721	3,013	8,991	920,228	156,884	0	59,640	3,722	2,653,853
2015	512,884	163,586	0	8,366	407,393	55,764	0	160	3,499	1,151,652
2016	2,263,433	842,120	596	31,941	1,564,652	311,329	258	655	33,079	5,048,063[1]
2017	980,750	401,216	3,517	18,985	1,158,305	221,673	104	15,631	10,915	2,811,096[1]
Truck										
2013	0	130	456	40,474	3	16	0	112	1	41,192
2014	5	4	486	20,690	0	2	2	64	2	21,255
2015	28	9	145	22,184	28	16	0	7	15	22,432
2016	13	107	784	21,607	2	3	0	11	2	22,529
2017	0	0	0	0	0	0	0	0	0	0
Barge										
2013	1,176,085	378,497	161,004	276,789	754,419	333,510	27,386	15,188	47,807	3,170,685
2014	1,535,098	404,342	238,763	383,774	935,573	391,283	18,889	51,966	48,991	4,008,679
2015	389,616	83,675	188,023	468,810	266,752	96,530	8,091	2,392	22,805	1,526,694
2016	1,140,972	262,241	260,025	457,228	820,839	289,171	27,868	3,981	117,278	3,379,603
2017	807,461	171,227	220,591	380,436	640,117	309,241	15,613	4,086	63,247	2,612,019
Total Transport										
2013	1,176,085	378,627	161,460	317,263	754,422	333,526	27,386	15,300	47,808	3,211,877
2014	1,535,103	404,346	239,249	404,464	935,573	391,285	18,891	52,030	48,993	4,029,934
2015	389,644	83,684	188,168	490,994	266,780	96,546	8,091	2,399	22,820	1,549,126
2016	1,140,985	262,348	260,809	478,835	820,841	289,174	27,868	3,992	117,280	3,402,132
2017	807,461	171,227	220,591	380,436	640,117	309,241	15,613	4,086	63,247	2,612,019
2017 Mortalities										
Facility	1,669	375	1,679	3,185	134	44	33	122	63	7,304
NMFS	535	120	246	322	51	17	26	39	15	1,371
Res/Sac	0	26	3	9	18	4	0	0	0	60

[1] Includes Res/Sac fish and NMFS raceway mortalities.

By the end of May, 90.9% of the total yearly collection had occurred. The percent of total collection arriving by the end of June and the end of July was 97.4% and 100.0%, respectively. The remaining 0.02% of juvenile salmonids was collected during the two days of August collection. The peak daily collection total and date for each species group were: clipped yearling Chinook 114,800 (May 2), unclipped yearling Chinook 27,400 (April 15), clipped subyearling Chinook 17,900 (June 1), unclipped subyearling Chinook 26,500 (May 29), clipped steelhead 138,642 (April 21), unclipped steelhead 43,600 (May 9), clipped sockeye 2,400 (May 11), unclipped sockeye/kokanee 1,800 (April 17), and Coho 5,200 (May 12). Total daily collection in 2017 peaked at 224,300 (April 21). Daily collection of all species combined versus total flow is shown in Figure 2. Peak collection date and daily collection total by species group are listed in Table 3.

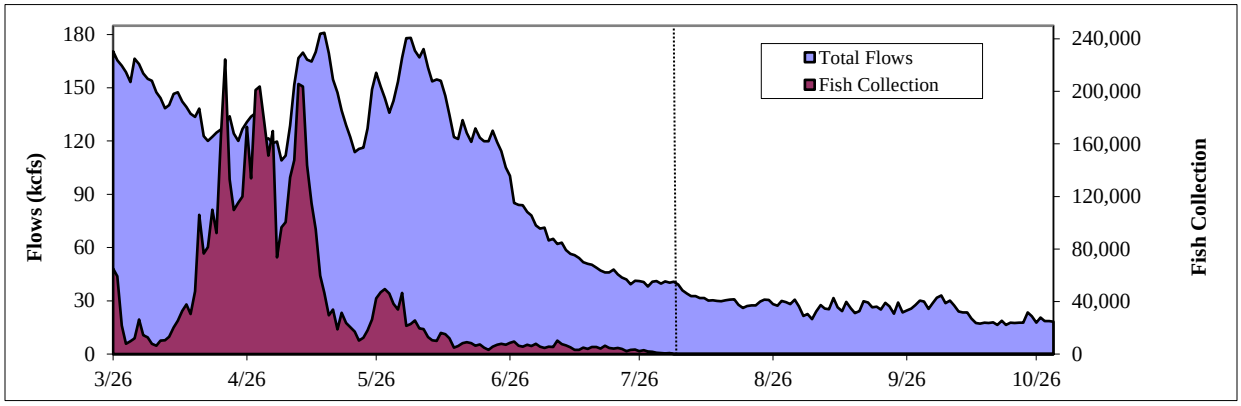

Figure 2. Fish collection and daily average flows at LWG, 2017. The vertical line in early August is when the JFF was dewatered early to facilitate construction for system upgrades.

Table 3. Annual peak collection days at LWG, 2013-2017.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
2013	8-May	13-May	9-Jun	9-Jun	13-May	13-May	16-May	17-May	14-May	13-May
	129,641	37,800	20,100	16,225	89,200	42,400	13,000	4,600	9,400	244,000
2014	6-May	24-Apr	3-Jun	3-Jun	27-Apr	8-May	18-May	5-May	19-May	6-May
	287,000	48,000	12,900	18,600	126,200	31,000	8,900	10,800	5,600	438,800
2015	25-Apr	25-Apr	5-Jun	5-Jun	26-Apr	7-May	19-May	9-May	7-May	26-Apr
	66,400	28,200	24,900	44,100	64,200	10,200	1,750	400	2,600	150,800
2016	26-Apr	15-Apr	10-Jun	10-Jun	24-Apr	26-Apr	20-May	9-May	9-May	26-Apr
	208,800	99,046	18,100	25,900	197,000	52,000	4,600	400	21,200	492,000
2017	2-May	15-Apr	1-Jun	29-May	21-Apr	9-May	11-May	17-Apr	12-May	21-Apr
	114,800	27,400	17,900	26,500	138,642	43,600	2,400	1,800	5,200	224,300

Adult Fallbacks

A total of 1,659 adult salmonids fell back through the juvenile bypass system and were bypassed from the separator between March 26 and August 2, 2017 (Table 4). The total includes 91 clipped adult and 101 unclipped adult chinook, 19 clipped and 16 unclipped jack Chinook, 611

clipped steelhead, 820 unclipped steelhead, 1 sockeye, and no Coho. Steelhead kelts are included in the total though they are not technically fallbacks. Fallbacks that went through the separator bars entered the raceways and were transported, were sent to the sample system, or bypassed to the river. These fish were not counted by the separator technician. The 2017 season had the lowest number of fallbacks in the last five years. Another 278 fallbacks were bypassed from March 20 to March 25 including 166 clipped and 112 unclipped steelhead. Mortalities during this time period included 10 clipped and 5 unclipped steelhead. Daily adult fallbacks and daily fallback mortalities can be found in Appendix Table 4.

Table 4. Annual totals of adult salmonids released from the separator at LWG (March 26-August 2) 2013-2017.

	Adult Chinook		Jack Chinook		Steelhead		Sockeye	Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip			Totals
2013	1,160	963	1,058	768	1,242	1,058	5	11	6,265
2014	951	992	455	393	2,662	2,546	26	79	8,104
2015	558	483	290	201	1,180	1,472	16	5	4,205
2016	534	784	328	568	2,118	2,728	15	16	7,091
2017	91	101	19	16	611	820	1	0	1,659
13-16 avg.	801	805	533	483	1,800	1,951	15	28	6,416

Steelhead were the most common adult salmonid species removed from the separator in 2017. April and May accounted for 91.3% of adult steelhead removed from the separator. The remaining 8.7% of steelhead fallbacks were removed from the separator in June and July. The total number of steelhead fallbacks removed from the separator include out migrating kelts. The majority of Chinook adults (89.6%) were removed from the separator during June and July (spring/summer Chinook). One clipped Sockeye fallback was removed from the separator July 9 and there were no Coho fallbacks in 2017 (Table 5).

Table 5. Monthly totals of adult salmonids released from the separator at LWG (March 26-August 2), 2017.

	Adult Chinook		Jack Chinook		Steelhead		Sockeye	Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip			Totals
April[1]	1	1	0	0	417	404	0	0	823
May	14	2	2	0	173	312	0	0	503
June	52	57	12	14	19	99	0	0	253
July	24	39	5	2	2	5	1	0	78
August	0	2	0	0	0	0	0	0	2
Totals	91	101	19	16	611	820	1	0	1,659

[1] Includes March 26-31

Adult salmonid condition was classified as good, fair, poor, or dead prior to being released from the separator (Table 6). Overall 89.1% of fallback condition was classified as good to fair. Condition ratings of adult salmonids examined were as follows: 1,084 good (65.3%), 394 fair (23.7%), 158 poor (9.5%), and 23 mortalities (1.4%). Adult salmonid mortalities included: 2 clipped Chinook, 1 unclipped Chinook, 15 clipped steelhead, and 5 unclipped steelhead. Adult Chinook had a higher percentage of good/fair fish (91.7%) than steelhead (88.6%). A total of 26 adult lamprey were collected at the fish facility including 14 from the separator, 6 from raceways and 6 from the sample tank. Lamprey were transported and released into the Snake River upstream of Lower Granite Dam at Offield Landing boat ramp.

Table 6. Condition of adult salmonids released from the separator at LWG (March 26-August 2), 2017.

	Adult Chinook		Jack Chinook		Steelhead		Sockeye	Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip			Totals
Good	59	86	14	15	351	558	1	0	1,084
Fair	19	12	3	1	178	181	0	0	394
Poor	11	2	2	0	67	76	0	0	158
Dead	2	1	0	0	15	5	0	0	23
Total	91	101	19	16	611	820	1	0	1,659

Sampling

Consistent with the 2017 Fish Operations Plan (FOP) Appendix B and guidance provided by the Technical Management Team (TMT), the juvenile fish transportation program allows for a variable start date, based on expected river flows. Years when Snake River spring seasonal average river flow is expected to equal or exceed 65 kcfs transport operations will begin on staggered start dates between April 21 and May 1 at Lower Granite, Little Goose, and Lower Monumental Dams. All fish collected that are not needed for research will be bypassed to the river prior to collection. In years when the spring seasonal average river flow is expected to be below 65 kcfs transport operations at Lower Granite Dam will start on April 1. This year TMT put out a system operational request (SOR) for transportation collection at Lower Granite, Little Goose, and Lower Monumental to begin at 0700 hours May 1. All fish sampled prior to transport were bypassed to the river with the exception of research fish. Sampling is diverting and segregating groups of fish in a consistent fashion so that data collected from those segregated groups will accurately represent the sum total of the fish being collected in real time. Sampling is not the act of evaluating those groups. Lower Granite fish sampling began at 0700 hours March 26 and ended at 0700 hours August 2. A total of 130 daily samples were processed this season. The sample rate was set at 5% March 26 and lowered to 1% about 5 hours later due to higher than expected fish passage. The sample rate fluctuated throughout the season based on guidelines provided by the Fish Passage Center (FPC) according to daily fish numbers and to accommodate research needs. During 2017, the smolt monitoring staff sampled 47,740 smolts or 0.9% of the total collection compared to 85,493 smolts (1.0%) in 2016. This is the lowest percent of juvenile salmonids sampled in the last five years (Table 7).

Table 7. Annual percentage of smolts sampled at LWG, 2013-2017.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
2013	1.1	1.3	5.8	15.4	1.3	1.2	0.6	1.6	0.8	2.6
2014	0.6	0.8	2.9	8.5	0.6	0.6	0.8	1.1	0.5	1.2
2015	0.9	1.0	2.1	5.9	0.9	1.1	1.7	1.8	1.2	1.9
2016	0.6	0.6	2.2	6.9	0.6	0.6	1.2	1.0	0.6	1.0
2017	0.6	0.8	2.0	2.4	0.7	0.8	0.9	0.9	1.0	0.9
13-16 Ave.	0.7	0.8	3.1	8.6	0.7	0.8	1.0	1.1	0.7	1.5

The total number of smolts sampled in 2017 by species and percent of each species included: 10,678 clipped yearling Chinook (22.4%), 4,319 unclipped yearling Chinook (9.0%), 4,620 clipped subyearling Chinook (9.7%), 9,825 unclipped subyearling Chinook (20.6%), 12,993 clipped steelhead (27.2%), 4,272 unclipped steelhead (8.9%), 146 clipped sockeye (0.3%), 180 unclipped sockeye/kokanee (0.4%), and 707 Coho (1.5%) (Table 8). The sample rate was raised

above FPC guidelines June 12 to collect an additional 320 subyearling Chinook needed for USGS/USFWS PIT tag detection efficiency evaluation.

Table 8. Weekly sample totals at LWG, 2017.

Week	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
Ending	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
30-Mar	182	79	0	6	1,436	201	0	5	1	1,910
6-Apr	616	351	0	3	873	259	0	14	13	2,129
13-Apr	710	894	0	5	1,364	183	0	36	2	3,194
20-Apr	979	805	0	6	1,552	259	0	36	6	3,643
27-Apr	1,845	583	0	6	2,264	311	0	21	14	5,044
4-May	2,991	559	0	4	1,360	386	0	13	49	5,362
11-May	2,190	357	0	5	1,821	768	23	5	83	5,252
18-May	641	207	0	13	700	537	59	1	152	2,310
25-May	417	223	70	42	796	735	58	9	218	2,568
1-Jun	84	142	906	1,479	368	353	6	9	109	3,456
8-Jun	10	34	563	595	93	104	0	1	20	1,420
15-Jun	7	39	755	834	131	77	0	2	14	1,859
22-Jun	5	40	549	993	108	62	0	2	20	1,779
29-Jun	0	5	593	1,321	108	31	0	6	6	2,070
6-Jul	1	0	428	1,234	11	3	0	5	0	1,682
13-Jul	0	0	279	880	1	1	0	7	0	1,168
20-Jul	0	1	274	1,062	5	1	0	7	0	1,350
27-Jul	0	0	147	860	2	1	0	1	0	1,011
3-Aug	0	0	56	477	0	0	0	0	0	533
Total	10,678	4,319	4,620	9,825	12,993	4,272	146	180	707	47,740

Transportation

An estimated 2,612,019 juvenile salmonids (48.1% of fish collected) were barged from Lower Granite Dam in 2017. There was no truck transport from Lower Granite in 2017 due to the early facility dewatering for bypass upgrade construction activities. The number of fish and the percentage of collection that was transported of each species group from Lower Granite included 807,461 (45.1%) clipped and 171,227 (29.9%) unclipped yearling Chinook, 220,591 (97.7%) clipped and 380,436 (94.5%) unclipped subyearling Chinook, 640,117 (35.6%) clipped and 309,241 (58.2%) unclipped steelhead, 15,613 (99.1%) clipped and 4,086 (20.6%) unclipped sockeye/kokanee, and 63,247 (85.2%) Coho. Early season transport occurred April 13, 20, and 27 as part of National Marine Fisheries Service (NMFS) study to compare transport versus in-river yearling Chinook smolt to adult return (SARs). Daily barge transportation numbers are provided in Appendix Table 2.

Collection for barge transport occurred May 1 through August 2 from Lower Granite and through August 14 at Little Goose and Lower Monumental Dams. The facility was in secondary bypass from 1815 hours July 20 to 0800 hours July 24 due to a railroad bridge failure at RM 323 blocking river traffic on the Columbia River. Every day barging operations occurred May 2 through May 26. Every-other-day barging from Lower Granite occurred May 28 through August 2 with the exception of July 21 and July 23 due to a railroad bridge failure. About 24,972 smolts were loaded on the barge from Lower Granite, Little Goose, and Lower Monumental July 19 and later released at river mile 324 when the railroad bridge failure was identified. During 2017 season 6,162,042 smolts were transported by barge from Lower Granite, Little Goose, and Lower Monumental combined.

Point Four oxygen monitoring systems were used on 4000 and 8000 series barges this season. YSI portable oxygen monitoring units continue to be kept on barges as backup systems. Fish evacuation plungers were replaced on 8000 and 2000 series barges during the 2014-2017 maintenance seasons. Plunger installation on 4000 series was completed during the maintenance season. Barge 4382 has two original plungers due to new plungers not seating with abnormalities on the hold floor. Generators and air compressors and generator upgrades on 8000s and 4000s were completed during the 2015-2017 maintenance season. Reusable air compressors and generators were installed on 2000 series barges during the 2016-2017 maintenance season.

There was no late season fish transport by truck from Lower Granite in 2017 due to early dewatering for the juvenile bypass upgrade construction.

Bypass

An estimated 2,811,096 juvenile salmonids were bypassed during the 2017 collection season. The facility was operated in secondary bypass mode March 20 through May 1. Bypassed fish were enumerated during the daily condition sample period from 0700 hours March 25 to 0700 hours May 1 an estimated 2,751,607smolts or 50.7% of the total 2017 season facility collection were bypassed. During the May 2 through August 2 collection for transport season 59,489 smolts were bypassed. The total number bypassed during collection season and percent of each species collected included 980,750 clipped yearling Chinook (54.8%), 401,216 unclipped yearling Chinook (70.0%), 3,517 clipped subyearling Chinook (1.6%), 18,985 unclipped subyearling Chinook (4.7%), 1,158,305 clipped steelhead (64.4%), 221,673 unclipped steelhead (41.7%), 104 clipped sockeye (0.7%), 15,631 unclipped sockeye/kokanee (78.8%), and 10,915 coho (14.7%). Facility bypass estimates include all fish bypassed to the tailrace during secondary bypass operation before collection for transport, GBT fish prior to May 2, and fish collected and provided for research needs. Fish provided for research needs are recorded as bypassed including research mortalities. There were 60 research mortalities reported during 2017 included 26 unclipped yearling Chinook, 3 clipped subyearling Chinook, 9 unclipped subyearling Chinook, 18 clipped steelhead, and 4 unclipped steelhead. The facility was operated in secondary bypass from 0700 hours August 2 until 0930 hours August 3 when the last ESBS was removed and the facility was dewatered for bypass upgrade construction. During this time all PIT tagged fish were diverted directly back to the river. An additional 1,371 mortalities were removed from the east raceways that held NMFS transport research fish including 535 clipped yearling Chinook, 120 unclipped yearling Chinook, 246 clipped subyearling Chinook, 322 unclipped subyearling Chinook, 51 clipped steelhead, 17 unclipped steelhead, 26 clipped sockeye, 39 unclipped sockeye/kokanee, and 15 Coho. East raceway mortalities are included in Lower Granite facility mortality when raceways were also used for standard transport collection in addition to NMFS studies. The facility bypassed fish estimate does not include fish bypassed by the PIT tag diversion system. Juvenile salmonids were bypassed rather than transported for the following purposes this season.

1. Secondary bypass occurred from March 20 through May 1. Sampling occurred March 26 through May 1 for fish condition monitoring (COE). Fish sampled during this period are included in the facility bypass total. The facility was operated in

secondary bypass from 0700 hours August 2 until 0930 hours August 3 when the last ESBS was removed and the facility was dewatered for bypass upgrade construction. These fish are not included in the number of fish collected or bypassed this season.

2. GBT inspections during the period of March 30 through May 1 accounted for a total of 519 fish bypassed. Within each species group the number bypassed was: 137 clipped yearling Chinook, 75 unclipped yearling Chinook, 260 clipped steelhead, and 47 unclipped steelhead.
3. As part of research projects 64,566 fish were collected and bypassed (See; Research Section). There were 1,371 fish mortalities removed from the east raceways used exclusively for research that were recorded as bypassed. These fish are included in the bypass numbers of this report.
4. The PTAGIS database revealed that 85,106 PIT-tagged fish of different species were bypassed through the PIT tag system. These fish are not included in the facility bypass total.

According to the PTAGIS database, 120,561 PIT-tagged fish were detected at LWG in 2017. Of these, 85,106 (70.6%) were bypassed to the LWG tailrace through the PIT-tag diversion system, 34,259 (28.4%) were diverted to the raceways to be transported, 1,024 (0.9%) were diverted to the sample tank, and 172 (0.1%) were not detected at any of the bypass, raceway, or sample exit monitors, and their disposition was unknown. From March 20 through May 1 and August 2 through August 3 all PIT-tagged fish were bypassed to the river.

Incidental Species

Non-target fish species that were too large to pass through the separator bars were recorded and bypassed through the adult release flume at the separator. Those small enough to pass through the separator bars were either sampled and bypassed, or held in raceways and transported with juvenile salmonids. Sample fish from each incidental species were counted and their total numbers were calculated using the sample rate. These numbers were then added with separator counts of the same group to estimate the total collection for each species. An estimated 36,215 non-salmonid incidental fish were collected at the fish facility during the March 26 to August 2 passage period (Table 9). This is less than half of the 89,569 incidental species collected in 2016. The reduction of incidental species collected can be contributed in part to the shorter collection season. Pacific lamprey ammocoetes were the most abundant incidental species with an estimated 9,520 collected compared to 3,581 in 2016. Sand rollers were the second most abundant incidental species with 5,282 collected compared to 10,599 in 2016. Pacific Lamprey macrophthalmia were the third most abundant incidental species with an estimated 5,142 collected compared to 27,521 in 2016. Siberian prawns were the fourth most abundant incidental species with an estimated 4,148 collected compared to 25,848 in 2016. Siberian prawns were euthanized rather than released to the LWG tailrace per Washington Department of Fish and Wildlife (WDFW) instructions and were disposed of in landfills instead of the river.

Table 9. Estimated collection of incidental fish species at LWG, 2017.

Common Name	*Scientific Name*	Separator	Expanded Sample	Total Collection[1]
American Shad (Adult)	*Alosa sapidissima*	75	20	95
American Shad (Juvenile)	*A. sapidissima*			
Banded Killifish	*Fundulus diaphanus*		125	125
Bass, Largemouth	*Micropterus salmoides*			
Bass, Smallmouth	*M. dolomieui*	8	1,596	1,604
Bullhead (misc.)	*Amierus sp.*		125	125
Catfish, Channel	*Ictalurus punctatus*	28		28
Catfish, Flathead	*Pylodictis olivaris*			
Chiselmouth	*Acrocheilus alutaceus*		225	225
Common Carp	*Cyprinus carpio*	217		217
Crappie (misc)	*Pomoxis sp.*	2	125	127
Dace, Longnose	*Rhinichthys cataractae*		25	25
Dace, Speckled	*R. osculus*			
Kokanee[2]	*Oncorhynchus nerka*		650	650
Northern Pikeminnow	*Ptychocheilus oregonensis*		200	200
Pacific Lamprey (Adult)	*Entosphenus tridentatus*	14	115	129
Pacific Lamprey (Ammocoete)	*E. tridentatus*		9,520	9,520
Pacific Lamprey (Macrophthalmia)	*E. tridentatus*		5,142	5,142
Peamouth	*Mylocheilus caurinus*	7	2,657	2,664
Redside Shiner	*Richardsonius balteatus*			
Sand Roller	*Percopsis transmontana*		5,282	5,282
Sculpin	*Cottus sp.*		50	50
Siberian Prawn	*Exopalaemon modestus*		4,148	4,148
Sucker (misc.)	*Catostomus sp.*	412	1282	1,694
Sunfish (misc.)	*Lepomis sp.*		850	850
Trout, Bull	*Salvelinus Malma*			
Trout, Cutthroat	*Oncorhynchus clarkii*			
Trout, Rainbow	*O. mykiss*	383[3]	50[4]	433
Walleye	*Stizostedion vitreum*	1		1
Warmouth	*Lepomis gulosis*			
White Sturgeon	*Acipenser transmontanus*	1		1
Whitefish	*Prosopium sp.*		2854	2854
Yellow Perch	*Perca flavescens*	1	25	26
Total		1,149	35,066	36,215

[1]Separator count plus expanded sample count equals estimated total facility collection.
[2]Unclipped *Oncorhynchus nerka* not CWT or PIT-tagged and >200mm
[3]Large steelhead smolts that cannot fit through the narrower spaced separator bars.
[4]Steelhead lacking smoltification characteristics and/or fish under 140mm, per FPC guidelines.

Fish Condition

Descaling

The standard descaling criteria is based on a fish with 20% or greater scale loss on one side of its body. If scale loss is less than 20% on one side of the fishes body it is not considered descaled. PSMFC smolt monitoring personnel collected descaling data from all live sample fish (full sample) rather than just a portion (subsample).

The descaling rate for all fish sampled in 2017 was 1.85% which is slightly lower than the 2013-2016 average of 1.94%. The annual descaling rate by species group was: clipped yearling Chinook 1.8%, unclipped yearling Chinook 0.8%, clipped subyearling Chinook 1.3%, unclipped subyearling Chinook 1.5%, clipped steelhead 2.7%, unclipped steelhead 1.8%, clipped sockeye 5.6%, unclipped sockeye/kokanee 4.7%, and Coho 1.1%. Annual descaling rates are summarized in Table 10.

Table 10. Annual full-sample descaling rates (>20%) by species at LWG, 2013-2017.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
2013	3.1	1.6	2.0	3.0	2.6	2.5	1.9	7.4	2.7	2.7
2014	0.9	0.6	0.7	1.8	1.3	1.2	0.0	2.6	1.0	1.3
2015	1.6	1.2	0.7	2.6	2.2	3.3	5.1	0.0	0.9	2.2
2016	0.9	0.5	1.0	2.0	1.1	1.3	1.2	2.2	1.1	1.4
2017	1.8	0.8	1.3	1.5	2.7	1.8	5.6	4.7	1.1	1.9
13-16 Ave.	1.6	0.9	1.2	2.4	1.8	1.9	1.8	3.2	1.4	1.9

The highest weekly descaling rate for all species combined was 3.7% for the week ending May 18. The highest weekly descaling rates are normally observed in late August, September, and October when the sample size decreases. Heavy debris load early in the season likely contributed to increased descaling rates in May. The lowest descaling rates are generally during June and July when small subyearling Chinook salmon dominate the collection. In 2017 descaling rates were lowest during the first three weeks of the fish passage season (Table 11). Clipped sockeye collected at the juvenile fish facility in late May and early June exhibited descaling, caudal fin rot, and fungus. IDFG determined these maladies were due to hatchery related fish transport and release conditions not Lower Granite operation. This probably led to higher descaling rates on clipped sockeye observed and the overall facility descaling rate this season. Daily descaling rates are provided in Appendix, Table 3.

Table 11. Weekly descaling rates in percent for fish sampled at LWG, 2017.

Week	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
Ending	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
30-Mar	1.10%	1.32%	--	--	0.49%	1.01%	--	20.00%	0.00%	0.69%
6-Apr	1.46%	0.57%	--	--	0.81%	0.39%	--	0.00%	0.00%	0.90%
13-Apr	1.42%	0.45%	--	--	0.81%	0.00%	--	0.00%	0.00%	0.79%
20-Apr	2.26%	0.75%	--	--	1.29%	0.39%	--	2.78%	0.00%	1.38%
27-Apr	1.69%	0.52%	--	--	1.68%	1.61%	--	0.00%	0.00%	1.53%
4-May	1.75%	1.26%	--	--	1.11%	1.30%	--	7.69%	0.00%	1.50%
11-May	1.65%	1.41%	--	0.00%	5.84%	1.83%	0.00%	0.00%	1.22%	3.10%
18-May	2.83%	0.49%	--	0.00%	6.00%	3.18%	6.78%	0.00%	1.33%	3.66%
25-May	1.92%	0.45%	1.49%	0.00%	6.18%	2.05%	7.14%	0.00%	1.38%	3.18%
1-Jun	3.57%	1.42%	0.22%	0.14%	8.97%	2.56%	0.00%	12.50%	0.93%	1.56%
8-Jun	0.00%	0.00%	0.54%	0.35%	5.38%	1.92%	--	0.00%	5.00%	0.93%
15-Jun	0.00%	2.56%	1.08%	0.50%	8.40%	3.90%	--	0.00%	0.00%	1.49%
22-Jun	0.00%	7.50%	1.29%	1.41%	0.93%	1.61%	--	50.00%	0.00%	1.53%
29-Jun	--	0.00%	2.21%	1.79%	0.00%	6.67%	--	33.33%	0.00%	1.97%
6-Jul	0.00%	--	3.34%	2.76%	0.00%	0.00%	--	0.00%	--	2.87%
13-Jul	--	--	1.09%	1.27%	0.00%	0.00%	--	14.29%	--	1.31%
20-Jul	--	0.00%	2.97%	2.49%	0.00%	0.00%	--	0.00%	--	2.56%
27-Jul	--	--	0.68%	2.01%	0.00%	0.00%	--	0.00%	--	1.81%
3-Aug	--	--	1.82%	2.15%	--	--	--	--	--	2.12%
# Descaled	191	36	61	141	345	77	8	8	8	875
# Sampled	10,612	4,295	4,547	9,488	12,955	4,257	144	171	702	47,171
% Descaled	1.80%	0.84%	1.34%	1.49%	2.66%	1.81%	5.56%	4.68%	1.14%	1.85%

Injuries and Disease

Injury data was gathered from a sub sample of 100 of the dominant species and not more than 100 each of the non-dominant species. There were 19,897 fish examined for injury and disease and 3,004 fish (15.1%) were afflicted with an injury or disease symptom in 2017. The overall affliction rate, body injury rate, predator injury rate, head injury rate and disease symptom rates reported are the actual rates observed for 2013 to 2017. In previous years, these rates were reported with the caveat that the actual injury rates are lower than reported due to individual fish having more than one symptom or injury. The body injuries associated with dam passage that were recorded this season included a generic body injury category and a generic fin injury category. Head injuries that were associated with dam passage include generic head injuries, eye injuries, operculum injuries and "pop" or bulging eye. Fish were also examined for external symptoms of fungus, columnaris, bacterial kidney disease, and parasites.

Body injuries were observed on 11.8% of the smolts examined in the detailed subsample. Blood pooling is defined as the vasodilatation of the capillaries in fins (also referred to as fin pinkness). It seems to be a symptom of anesthetic use during higher water temperatures and is mostly found on subyearling Chinook. Fin hemorrhaging is the discharge of blood outside the body and is a sign of trauma. Of the smolts examined from the sample that had body injuries, the most common symptom observed in 2017 was general fin injury (51.6%), followed by fin discoloration (28.2%), pink fin (11.1%), body injury (4.9%), and body deformities (4.2%). Clipped sockeye exhibited the highest percent of body injuries at 48.2% (68 of 141 examined) followed by unclipped yearling Chinook at 14.8% (302 of 2,047 examined).

Head injuries were recorded on 0.5% of the smolts examined in the detailed subsample. Unclipped steelhead had the highest incidence of head injury at 1.0% (19 of 1,936 examined), followed by clipped steelhead at 0.7% (32 of 4,724 examined). Injuries to the operculum comprised the majority of observed head injuries at 43.0%, followed by eye injuries at 25.2%, eye hemorrhage at 16.8%, "pop" eye at 8.4%, and general head injuries at 6.5%.

Injuries associated with predators include wounds inflicted by other fish, birds, and lamprey. Predator wounds were observed on 0.9% of the smolts examined. Predator marks caused by birds, characterized by a distinct V-shaped descaling pattern on both sides of a fish were the most common predator mark at 53.7% compared to 40.6% caused by fish and 5.7% caused by lamprey. Predator marks were highest on clipped steelhead at 1.4% (65 of 4,724 examined), unclipped steelhead at 1.3% (25 of 1,936 examined), and clipped yearling Chinook at 1.2% (43 of 3,545 examined).

External symptoms of disease were observed on 2.9% of the smolts examined in the detailed subsample compared to 5.6% in 2016, 3.5% in 2015, 3.3% in 2014, and 4.1% in 2013. Symptoms of disease were most common on clipped sockeye (11.3%). Of the fish afflicted, fin hemorrhages comprised the majority of disease symptoms (49.2%), followed by parasites (31.4%), fungus (9.4%), columnaris (6.1%), and bacterial kidney disease (3.9%).

Fin hemorrhage was found on 1.5% of all fish examined and on all species and rearing types. Fin hemorrhage was the primary disease afflicting clipped sockeye and was observed on 7.8% of sockeye examined. Corps biological staff and Smolt Monitoring Program staff observed that

clipped sockeye salmon arriving at the fish facility were in poor condition. Idaho Department of Fish and Game (IDFG) determined the poor condition of clipped sockeye salmon was due to hatchery release conditions and not related to dam passage.

Columnaris is caused by the bacterium *Flavobacterium columnare* that becomes more virulent when water temperatures exceed 60º F. Summer and subyearling migrants are more susceptible to infection summer and subyearling Chinook migrants are more susceptible to infection due to increased water temperatures during their outmigration. Columnaris can be recognized by the presence of yellowish lesions on the belly, damage to the gills, pelvic fins, snout, and caudal fins. SMP at Lower Granite only classify fish as being infected with columnaris if there is some tissue loss on the snout or body (fish with only red mouth edges are not classified as infected). Columnaris was identified at Lower Granite in 1996 and symptoms observed on sample fish have been recorded since 1999. Typically the first incidence of columnaris is observed in July after the majority of subyearling Chinook have passed the Project. The first symptoms of columnaris this season were observed July 3 which is about 15 days earlier than first observed in 2016 (July 18). The 2017 columnaris infection rate for subyearling Chinook was 0.3% (36 of 14,035) compared to 2.2% (905 of 40,433) in 2016, 0.8% (276 of 32,815) in 2015, 1.8% (736 of 41,386) in 2014, and 1.4% (796 of 58,510) in 2013.

Mortality

Facility mortality includes fish removed from the barges or trucks before departure, sample mortalities, recovery tank mortalities, separator mortalities and raceway mortalities, not including the east raceways when used to hold NMFS research fish. Mortalities removed from east raceways when used exclusively for NMFS studies were included in bypassed fish and not considered facility mortalities. Annual facility mortality for all groups combined was 0.13% in 2017 and totaled 7,304 fish (Table 12). All species group mortality rates were higher than those observed for the 2013-2016 average except for clipped and unclipped steelhead, and clipped sockeye. Within each species group the number of facility mortalities and percent of those collected in that group was: 1,669 clipped yearling Chinook (0.09%), 375 unclipped yearling Chinook (0.07%), 1,679 clipped subyearling Chinook (0.74%), 3,185 unclipped subyearling Chinook (0.79%), 134 clipped steelhead (0.01%), 44 unclipped steelhead (0.01%), 33 clipped sockeye (0.21%), 122 unclipped sockeye/kokanee (0.61%), and 63 coho (0.08%).

Table 12. Annual facility mortality in percent by species group at LWG, 2013-2017.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
2013	0.12	0.11	0.16	0.26	0.02	0.02	0.03	0.15	0.12	0.10
2014	0.05	0.03	0.25	0.37	0.01	0.01	0.06	0.40	0.02	0.06
2015	0.03	0.04	0.20	0.29	0.04	0.04	3.03	0.47	0.04	0.10
2016	0.03	0.02	0.27	0.27	<0.01	<0.01	2.00	0.39	0.04	0.05
2017	0.09	0.07	0.74	0.79	0.01	0.01	0.21	0.61	0.08	0.13
13-16 Ave.	0.05	0.04	0.23	0.30	0.01	0.01	1.02	0.37	0.05	0.07

Weekly facility mortality rates were low during April and May and increased during June and July as the sample size decreased, water temperatures increased, and river flows decreased. The

weekly facility mortality rate increased to over 1% the week ending July 6 compared to August 18 in 2016 with a maximum weekly mortality rate of 1.64% the week ending July 13 (Table 13).

Table 13. Weekly facility mortality in percent by species group at LWG, 2017.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
Week Ending	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
30-Mar	0.01%	0.05%	--	0.54%	0.01%	0.02%	--	0.00%	0.00%	0.01%
6-Apr	0.00%	0.01%	--	0.00%	0.01%	0.01%	--	0.44%	0.00%	0.01%
13-Apr	0.01%	0.01%	--	0.00%	0.00%	0.00%	--	0.20%	0.00%	0.01%
20-Apr	0.00%	0.00%	--	0.00%	0.00%	0.00%	--	0.00%	0.00%	0.00%
27-Apr	0.00%	0.00%	--	0.17%	0.00%	0.00%	--	0.02%	0.00%	0.00%
4-May	0.09%	0.07%	--	0.25%	0.01%	0.00%	--	0.69%	0.03%	0.06%
11-May	0.17%	0.13%	--	0.20%	0.01%	0.00%	0.02%	3.50%	0.04%	0.09%
18-May	0.26%	0.14%	--	0.57%	0.01%	0.01%	0.24%	44.00%	0.09%	0.12%
25-May	0.36%	0.42%	0.34%	0.48%	0.01%	0.01%	0.34%	0.67%	0.08%	0.14%
1-Jun	1.21%	0.80%	0.57%	0.62%	0.09%	0.05%	0.75%	1.33%	0.26%	0.51%
8-Jun	0.00%	0.16%	0.67%	0.56%	0.01%	0.03%	--	1.00%	0.00%	0.50%
15-Jun	0.36%	0.13%	0.78%	0.82%	0.00%	0.03%	--	9.33%	0.52%	0.70%
22-Jun	0.00%	0.00%	0.49%	0.44%	0.04%	0.00%	--	2.00%	0.00%	0.40%
29-Jun	--	0.00%	0.86%	0.67%	0.11%	0.13%	--	1.33%	0.00%	0.68%
6-Jul	0.00%	--	1.59%	1.50%	0.71%	0.00%	--	4.80%	--	1.52%
13-Jul	--	--	1.86%	1.57%	0.00%	0.00%	--	1.50%	--	1.64%
20-Jul	--	8.00%	0.90%	1.08%	2.34%	0.00%	--	4.00%	--	1.07%
27-Jul	--	--	0.33%	0.46%	0.00%	10.00%	--	0.00%	--	0.45%
3-Aug	--	--	1.65%	1.42%	--	--	--	--	--	1.45%
# morts	1,669	375	1,679	3,185	134	44	33	122	63	7,304
# collected	1,789,880	572,818	225,787	402,606	1,798,556	530,958	15,750	19,839	74,225	5,430,419
% mortality	0.09%	0.07%	0.74%	0.79%	0.01%	0.01%	0.21%	0.61%	0.08%	0.13%

Sample mortalities include dead fish removed from the sample tank prior to sampling and those from the sorting trough in the sample lab. Annual sample mortality for all groups combined was 0.86% in 2017 (Table 14) and totaled 410 fish. The number of sample mortalities and mortality rate by species group was: 66 clipped yearling Chinook (0.62%), 24 unclipped yearling Chinook (0.56%), 73 clipped subyearling Chinook (1.58%), 178 unclipped subyearling Chinook (1.81%), 38 clipped steelhead (0.29%), 15 unclipped steelhead (0.35%), 2 clipped sockeye (1.37%), 9 unclipped sockeye/kokanee (5.00%), and 5 Coho (0.71%). Sample mortality for all groups combined has ranged from a high of 1.05% in 2014 to a low of 0.74% in 2016.

Table 14. Annual sample mortality by species group in percent at LWG, 2013-2017.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
2013	0.74	0.90	1.88	1.12	0.22	0.22	1.27	6.15	0.81	0.97
2014	0.61	0.68	1.38	1.41	0.40	0.46	0.00	4.06	0.35	1.05
2015	0.40	0.52	0.7	1.13	0.48	0.23	4.17	4.35	0.31	0.86
2016	0.38	0.36	0.95	1.18	0.23	0.16	4.57	6.25	0.12	0.74
2017	0.62	0.56	1.58	1.81	0.29	0.35	1.37	5.00	0.71	0.86
13-16 ave	0.54	0.63	1.37	1.20	0.30	0.27	3.00	4.47	0.33	0.91

Barge mortalities are salmonids removed from barge holds after the barges depart LWG. The total number of smolts barged in 2017 included: 2,612,019 fish from LWG, 1,454,673 from LGS, and 2,088,322 fish from LMN. The barge mortality rate of 0.07% (4,119 of 6,155,014) is the second highest observed in the last five years (Table 16). Barge mortalities by species group included: 1,729 clipped yearling Chinook, 534 unclipped yearling Chinook, 405 clipped subyearling Chinook, 693 unclipped subyearling Chinook, 456 clipped steelhead, 243 unclipped steelhead, 33 clipped sockeye, 9 unclipped sockeye/kokanee, and 17 Coho (Table 15). According to IDFG increased mortality of sockeye was probably the result of poor fish health related to hatchery transport and release conditions and not related to operations at Lower Granite or downstream collection facilities or barge transport conditions.

Table 15. Total barge mortalities from LWG 2013-2017.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Unknown	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Others	Total
2013	2,410	576	123	149	637	225	24	1	137	0	4,282
2014	1,562	427	217	404	476	159	4	328	100	0	3,677
2015	563	247	719	1462	599	258	84	19	13	1,720	5,684
2016	591	198	596	343	323	134	338	4	51	30	2,608
2017	1,729	534	405	693	456	243	33	9	17	0	4,119
13-16 ave	1,282	362	414	589	509	194	113	88	75	437	4,063

There was no truck transport from Lower Granite in 2017.

Table 16. Annual percent truck mortality at LWG, 2013-2017.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
2013	--	0.77	0.00	0.23	0.00	0.00	--	3.57	0.00	0.24
2014	0.00	0.00	0.00	0.18	--	0.00	0.00	1.56	0.00	0.18
2015	0.00	0.00	0.69	0.14	0.00	0.00	--	0.00	0.00	0.14
2016	0.00	0.00	0.38	0.07	0.00	0.00	--	0.00	0.00	0.08
2017	--	--	--	--	--	--	--	--	--	--
13-16 Ave.	0.00	0.40	0.21	0.17	0.00	0.00	0.00	2.58	0.00	0.17

--no fish trucked

Gas Bubble Trauma Monitoring (PSMFC)

Juvenile salmonids were sampled for GBT from March 30 through July 27 in 2017. PSMFC personnel examined up to 100 clipped and unclipped yearling Chinook and steelhead each week for evidence of bubbles in paired and unpaired fins, and in the eye, as per Fish Passage Center GBT protocols. GBT sampling historically has ended early to mid-June. This season GBT sampling was extended due to concerns about increased total dissolved gas related to above average flows and addition spill from Dworshak during unit 3 outage. Subyearling Chinook sampling for GBT began June 15. This season 1,596 fish were sampled for GBT: 239 clipped yearling Chinook, 98 unclipped yearling Chinook, 167 clipped subyearling Chinook, 356 unclipped subyearling Chinook, 563 clipped steelhead, and 173 unclipped steelhead. During GBT sampling 26 PIT-tagged smolts were handled, not examined and returned to the separator

including: 6 clipped yearling Chinook, 3 unclipped yearling Chinook, 1 clipped subyearling Chinook, 1 unclipped subyearling Chinook, 12 clipped steelhead, and 3 unclipped steelhead. An additional 23 fish were handled and released into the separator including: 1 clipped yearling Chinook, 2 unclipped yearling Chinook, 1 clipped subyearling Chinook, 4 unclipped subyearling Chinook, 2 clipped steelhead, 2 clipped sockeye, 2 unclipped sockeye/kokanee and 9 Coho. There was 1 unclipped subyearling Chinook mortality. Prior to May 1, smolts examined for GBT were released in the sample recovery tank and bypassed. Smolts examined for GBT after May 1 were returned to the raceways and transported. A total of 519 smolts were bypassed including: 137 clipped yearling Chinook, 75 unclipped yearling Chinook, 260 clipped steelhead, and 47 unclipped steelhead. A total of 1,126 smolts were transported including: 109 clipped yearling Chinook, 28 unclipped yearling Chinook, 169 clipped subyearling Chinook, 361 unclipped subyearling Chinook, 317 clipped steelhead, 129 unclipped steelhead, 2 clipped sockeye, 2 unclipped sockeye/kokanee, and 9 coho. There were 21 fish observed with symptoms of GBT while no fish were observed with symptoms in 2016.

Research

Four agencies participated in six research projects at LWG juvenile facility that impacted 568,280 smolts, which is 10.5% of the total collection or 21.8% of the 2017 facility collection for transport. By comparison 458,051 were handled in 2016, 451,816 were handled in 2015, 471,305 were handled in 2014, and 458,554 in 2013. The 568,280 smolts taken from the collection included: 164,375 clipped yearling Chinook, 36,997 unclipped yearling Chinook, 57,876 clipped subyearling Chinook, 66,864 unclipped subyearling Chinook, 177,051 clipped steelhead, 37,583 unclipped steelhead, 4,088 clipped sockeye, 1,323 unclipped sockeye/kokanee, 21,649 Coho, and 474 subyearling Chinook mortalities that COE and SMP personnel collected for the United States Geological Survey (USGS) feeding ontogeny study. Lower Granite biological staff collected 477 clipped and 643 unclipped steelhead kelts from the juvenile facility this season for Nez Perce Tribe (NPT) and Columbia River Intertribal Fisheries Commission (CRITFC).

National Marine Fisheries Service (NMFS)-Study to Compare the Adult Returns of In-river Migrating versus Barged Juvenile Anadromous Salmonids (Transportation Study)

Corps biological technicians collected smolts in the east raceways for NMFS tagging April 11 to June 17. Raceway flows, fish behavior, and mortalities were monitored by Corps biological staff 24 hours per day. NMFS handled 501,955 smolts in the marking trailers at Lower Granite fish facility as part of this transportation study. Of these 34,553 smolts were PIT tagged and transported including 10,895 unclipped yearling Chinook, 7,347 clipped steelhead, and 16,311 unclipped steelhead. There were 467,313 smolts handled that were not selected for tagging. All fish were held overnight in the east raceways prior to transport. There were 89 smolt mortalities reported including 37 clipped yearling Chinook, 9 unclipped yearling Chinook, 15 clipped subyearling Chinook, 12 unclipped subyearling Chinook, 12 clipped steelhead, 1 unclipped steelhead, 1 clipped sockeye, and 2 unclipped sockeye/kokanee. There were an additional 1,371 mortalities removed by Corps biological staff from the east raceways while these raceways were used exclusively for holding NMFS research. Unclipped yearling Chinook with fork lengths less than 124 mm were targeted. Unclipped steelhead with fin erosion were not PIT tagged. All

smolts handled and PIT-tagged for this study were collected in the east raceways and tagged in the NMFS marking trailer adjacent to the east raceways.

National Marine Fisheries Service (NMFS)-Study to Estimate Juvenile Salmonid Reach Survival
Corps biological technicians collected smolts in the east raceways for this in-river survival study April 4 to June 17 in conjunction with the NMFS Transportation Evaluation study. NMFS handled 61,382 smolts as part of this study including 54,770 fish that were PIT-tagged and bypassed, and 6,564 not tagged and bypassed. Tagged fish including 14,269 unclipped yearling Chinook, 21,479 clipped steelhead, and 19,022 unclipped steelhead. There were 48 post tagging mortalities including 26 unclipped yearling Chinook, 18 clipped steelhead, and 4 unclipped steelhead. There were 1,371 mortalities removed from the east raceways while used exclusively for NMFS as described above.

National Marine Fisheries Service (NMFS)-Monitoring the Migrations of Wild Snake River Spring/Summer Chinook
This study to monitor the migration behavior and survival of Snake River Basin wild spring/summer Chinook salmon aims to characterize migration timing, estimate individual wild population parr-to-smolt survival to LWG, and the influence of environmental factors on migration patterns. Fish PIT-tagged in natal streams during the summer of 2016 were diverted to the SByC tanks at LWG April 7 to June 7 during 2017. Corps biological technicians monitored tanks for flow, fish behavior, and mortalities. A total of 828 fish were impacted by this study. NMFS handled and bypassed 567 targeted unclipped yearling Chinook as part of this study. An additional 138 untagged smolts and 123 non-target PIT-tagged fish were incidentally diverted to the SBC tanks handled and bypassed.

Idaho Fish and Game (IDFG)-Genetic Stock Identification
The goal of this study is to develop detailed genetic profiles for natural origin salmon and steelhead, develop genetic stock identification (GSI) techniques to estimate stock-specific escapement over LWG, monitor abundance, productivity and distribution of naturally produced adult and juvenile steelhead and salmon and to research and monitor stock-specific life history characteristics. The objective of the study is to enumerate and characterize the natural production of spring/summer Chinook salmon and steelhead above LWG with regards to age composition and genetic stock identification. Lower Granite biological staff and SMP biologists provided IDFG 3,319 smolts for this study March 27 to June 30. Scale samples and fin clips were taken from 1,502 non-fin eroded unclipped steelhead and fin clips only were taken from 1,817 non-coded wire tag (CWT) unclipped yearling Chinook. Fish bypassed prior to transport collection (March 27-May 1) included 344 unclipped steelhead without fin erosion and 1,231 yearling Chinook without CWT.

University of Idaho/Columbia River Intertribal Fisheries Commission (CRITFC)/Nez Perce Tribe (NPT)-Evaluate Reproductive Success of Natural-Origin, Hatchery-Origin, and Kelt Steelhead in the Columbia River Basin
This project studies steelhead kelt physiology and endocrinology to evaluate strategies for rehabilitating and handling steelhead kelts captured at Lower Granite. Lower Granite biological technicians diverted 1,120 steelhead kelts to the holding tanks from March 27 to June 28. NPT/CRITFC personnel collected genetic samples, PIT-tagged, and returned to the tailrace 804 steelhead, including 463 clipped and 341 unclipped steelhead. Another 291 steelhead kelts were

transported to Dworshak National Fish Hatchery for acclimation and feeding studies, 2 clipped steelhead were handled and returned to the tailrace and 23 were mortalities. Mortalities included 12 clipped and 11 unclipped steelhead.

U.S. Geological Survey (USGS)/U.S. Fish and Wildlife Service (USFWS)- Evaluating Detection Efficiency of Subyearling Chinook Salmon Tagged with 8-, 9-, and 12-mm PIT-tags and released into the Juvenile Bypass System at LWG

Lower Granite biological staff and SMP biologists raised the sample rate above SMP guidelines June 12 to target collection of 320 additional subyearling Chinook to facilitate USGS research to evaluate 8-, 9-, or 12-mm PIT-tags detection efficiency. Tagged fish were released into the upwell at the south end of the juvenile collection facility. PIT tag detection efficiency of each group was measured as fish volitionally egressed from the separator through facility PIT tag detection systems. USGS personnel PIT-tagged a total of 310 subyearling Chinook salmon, including 148 clipped and 162 unclipped. Mortalities included 3 clipped and 9 unclipped subyearling Chinook mortalities.

USGS-Feeding Ontogeny in the Hydrosystem

USGS personnel are collecting information on stable isotopes to determine signatures specific to hatchery and naturally produced subyearling fall Chinook and on signatures specific to which hatchery the fish were released from. The results will be used to explore the possibility of using stable isotopes to distinguish hatchery from natural origin subyearling fall Chinook. SMP personnel collected and froze up to 50 subyearling fall Chinook mortalities a week, from the sample and/or raceways. From May 22 to July 27 a total of 474 subyearling fall Chinook mortalities were collected for this study.

Operation and Maintenance

Turbine Operations

Efforts were made to operate all turbine units within one percent of the peak efficiency from April 1 to October 31. Deviations were infrequent and brief or required by BPA (table 17).

Table 17. Lower Granite turbine unit outages, 2017.

Unit	Date OOS	Reason out of service
Units 2 – 6	**Monthly**	**ESBS/VBS inspection**
Units 2 – 6	**March 20 – 24**	**ESBS installation**
Units 2 – 6	**March 29 - 30**	**Trash rack raking**
Units 2 – 6	**June 20**	**Index Testing**
Units 2 - 6	**June 21**	**Remedial action scheme trip**
Units 2 - 6	**August 1 - 3**	**ESBS removal**
Unit 1		
	January 1-December 31	**Blade/runner repair**
Unit 2		
	December 21 - April 13	**Blade seal repair**
	May 6	**Tripped offline**
	June 6	**Governor pressure device failure resulting in full load rejection**
	July 14 - 15	**Turbine thrust bearing temperature trip**
	September 5	**AC turbine bearing oil pump failure**
	October 31 – November 30	**Annual Maintenance**
	December 5	**Caisson Removal**
Unit 3		
	May 31	**Excessive oil in fly ball assembly case**
	August 3 - 9	**ESBS stuck in gatewell slot 3A**
	September 25 – October 31	**Annual Maintenance**
	November 2	**Caisson Movement**
	December 12	**Unit run relax not picking up in time**
Unit 4		
	July 31 – August 17	**Annual Maintenance**
	August 29	**Caisson Installation**
	November 16	**Caisson Movement**
Unit 5		
	May 21 - 22	**Debris lodged on flow vein in gatewell slot 5B**
	July 3 - 19	**Annual Maintenance**
	August 28	**NPE gates repair dive operations**
Unit 6		
	April 17 - 27	**Wicket gate repacking**
	August 28	**NPE gates repair dive operations**
	August 28 – October 4	**Annual maintenance**

Debris/Trash Racks

Unit 2 trashracks were raked March 1 with about 33 cubic yards of debris removed from the forebay and trashracks. Trashracks were raked again March 29-30 with about 23.4 cubic yards of debris removed. Between May 26 and June 8 the powerhouse mechanical crew removed about 438 cubic yards (15 truckloads) of debris from the powerhouse forebay.

Extended-length Submersible Bar Screens (ESBSs)

ESBSs were inspected and tested on the week of March 12. Screens were installed from March 20 through March 23. Video inspection took place May 21-23, and June 25-26. No problems with the ESBSs were detected during video inspections. ESBSs were removed August 1-3 due to bypass upgrade construction. Brush cleaning cycle was set to operate every two hours this season.

Vertical Barrier Screens (VBSs)

VBSs were video inspected in conjunction with ESBSs during the 2017 fish passage season. Detailed inspections were performed during the June ESBS inspection. VBS screen panel mesh has the potential to deteriorate and become brittle over time. VBS panels for screens that pass underwater camera inspection but showed potential for deterioration will continue to be replaced during unit annual outages or during winter maintenance as time permits.

Gatewells

Gatewells were normally less than 1% covered with debris and did not exceed the 50% debris surface coverage criterion. Turbulence in gatewells with ESBSs causes debris to tumble around and exit through the orifices rather than accumulate on the gatewell surfaces. Surface debris was removed from individual gatewells with a hand dipping basket during initial water-up in late March and continued throughout the season. Occasional oil sheens were dealt with by floating oil absorbent pads in the affected gatewells.

Orifices/Collection Channel

During the 2017 season the number of open orifices usually varied from 18 to 21 dependent on forebay elevation. With the Lower Granite reservoir at minimum operating pool, water discharge through an orifice is reduced. Orifices were cycled and back-flushed with air to remove debris every three hours from March 20 through August 3 when the collection channel was dewatered. Heavy debris loads resulted in orifice obstructions throughout the spring until June. Beginning May 15 an extra biological technician was necessary to manage orifice debris that included monitoring and back flushing orifices hourly to prevent obstruction and clear debris. May 25 the debris load increased with river flows and high winds. The powerhouse mechanical crew removed about 438 cubic yards (15 truckloads) of debris from the powerhouse forebay between May 26 and June 8. Orifice lights were checked daily. Orifices with burnt out lights were switched to the other orifice in the slot until the bulb was replaced.

Primary Dewaterer

Lower Granite's primary dewatering structure is an inclined screen just upstream from the porosity control perforated plate for the separator. Debris is removed from the screen with a long handled brush every half hour to once a shift depending on debris level. When the inclined screen becomes severely clogged the facility is put in primary bypass mode to take pressure off the top of the inclined screen. Debris then either floats off or is brushed off. This cleaning procedure takes about 20-30 minutes to complete. During 2017 it was necessary to go to primary bypass due to accumulated debris on the incline screen from 1100-1130 hours March 21.

Wet Separator/Distribution and Sampling Systems

Water levels in the separator also varied with the forebay elevation requiring adjustment in the number of orifices operating and adjustments of the 42-inch valve to maintain proper water level. The separator water levels also fluctuated due to the south shore makeup water valve being unable to adjust automatically. Separator personnel manually operated orifice valves to maintain collection channel and separator water levels.

Historical PVC separator bar spacing at Lower Granite allowed kelts, Chinook jacks, shad, and other adults to be collected into the sample, raceways, and barges for transport. Jack bars positioned on the standard PVC bars to keep larger fish out resulted in debris accumulating between the bars. Aluminum separator bars were designed, fabricated, and installed during the 2016-2017 winter outage. The distance between the aluminum bars remains the same as the distance between the PVC bars.

Barge Loading Operations

Barge loading operations occurred from May 2 through August 2. Both direct loading and loading from the raceways went smoothly this season.

Truck Loading Operations

Truck transport did not occur due to early dewatering for bypass upgrade construction.

Recommendations

1. Replace mesh tailscreens with porosity plates to allow lamprey passage.
2. Cover upstream raceways to provide shade.
3. Improve flow/elevation in the sample recovery truck loading pipe to eliminate fish being stranded in the pipe.
4. Continue rebuilding motors on the 2000 series barges.
5. Install bumper system to replace cable and tire system on barges.
6. Paint hulls on 8000 series barges.
7. Install ballast material in voids of barge 4394 and barge 4382 to eliminate the need to use river water.

8. Purchase a 1000 gallon fish tank and truck, a 3500 gallon tank and semi, and a service truck dedicated to trap and transport truck/barge maintenance.
9. Install electronic operators for raceway supply knife gate valves at east end of raceways to improve control of water supply during barge and truck loading.
10. Improve juvenile collection facility pneumatic system air compressors and air lines to ensure adequate supply for gate operation and eliminate air pressure deficiencies.
11. Replace sample holding tank fish exit release manual valves with pneumatic valves.
12. Improve/modify anesthetic chamber door operation.

APPENDIX TABLES

Appendix Table 1. Daily collection and bypass numbers and river conditions at Lower Granite Dam, 2017.

Appendix Table 2. Percent descaling and daily facility mortality numbers at Lower Granite Dam, 2017.

Appendix Table 3. Daily number of fish trucked and barged from Lower Granite Dam, 2017.

Appendix Table 4. Daily number of adult fallbacks and fallback mortality at Lower Granite Dam, 2017.