CENWW-OD-EL HOLDREN January 2021

MEMORANDUM THRU:
Rob Lustig, Operations Project Manager, Lower Granite Dam

FOR Chief, Operations Division
ATTN: Christopher Peery

SUBJECT: Submission of 2020 Juvenile Fish Collection and Bypass Report, Lower Granite Dam Juvenile Fish Facility.

1. Enclosed find the 2020 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

2020 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

January 2021

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Introduction

The 2020 collection season at Lower Granite Dam (LWG) was characterized by below average flow and above average spill throughout the season. Spring spill volume was managed based on the total dissolved gas (TDG) cap of 125% saturation per the 2019 - 2021 Flex Spill Operation Agreement. Operation under this agreement requires LWG to spill up to the 125% gas cap for 16 hours and 8 hours of Performance Standard spill of 20 kcfs split into two blocks over the 24 hours day. Involuntary spill occurred when spring flows exceeded 20 kcfs during the spring Performance Standard spill operations. Summer spill volume requirements remained at the historical level of 18 kcfs. Water temperatures were below average during the season with the exception of October. Debris levels were higher than average during early spring migration and in September and October.

At the request of regional fisheries managers, the juvenile system was watered up early to obtain information on juvenile salmonid outmigration from March 1-25. The juvenile collection channel was watered up in primary bypass mode at 1130 hours February 20. ESBSs (Extended Length Submersible Bar Screens) were installed February 25-27 except for unit 2 that were installed March 13. Juvenile collection facility operation was changed to 24 hours condition sample collection in secondary bypass mode at 0700 hours March 1. The juvenile collection facility was operated in secondary bypass mode for condition sampling from 0700 hours June 21 to 0700 hours August 1. Early season transport of Snake River anadromous salmonids as part of the ongoing study to compare in-river verses transported SARs (Smolt Adult Return Ratios) did not occur in 2020. Two agencies conducted three research projects and handled a total of 886 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.

Secondary bypass occurred from 0700 hours March 1 through 0700 hours April 23 and again from 0700 hours June 21 through 0700 hours August 1. Collection for barge transport occurred from 0700 hours April 23 through 0700 hours June 21. Collection resumed for truck transport at 0700 hours August 1 through 0700 hours November 1. The facility was operated in primary bypass November 1 through December 21. Facility smolt collection totaled 1,495,940 during the 2020 season compared to 5,164,205 in 2019. Distribution of the 2020 total collection was 329,111 bypassed, 1,144,545 barged, and 21,009 trucked.

Pacific States Marine Fisheries Commission (PSMFC) technicians handled 798 and examined 738 juvenile salmonids for GBT between April 9 and June 11. Smolts examined were bypassed or sent to the raceway depending on transport operations. No symptoms of GBT were observed during the 2020 season.

The passive integrated transponder (PIT) tag system detected 34,379 PIT-tagged fish at the JFF during the 2020 season. Facility PIT tagged fish distribution was 16,998 diverted to the river, 16,457 diverted to raceways for transport, 795 diverted to sample holding tank, and 129 failed to be detected in secondary bypass, raceways, or the sample systems. Installation of the RSW PIT

tag array was completed during the 2019-2020 winter maintenance season. Another 160,021 PIT-tagged fish were detected at the RSW PIT-tag detector from March 1-November 15 (PTAGIS) and remained in the river past LWG dam.

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)). Salmonids collected, sampled, bypassed, and transported from Lower Granite facilities are designated as clipped or unclipped not hatchery or wild. Snake River Basin coho were reintroduced by the tribes and are all of hatchery origin.

Corps of Engineers personnel included: Lead Project Supervisory Fisheries Biologist Elizabeth Holdren, Assistant Supervisory Fisheries Biologist David Miller, Maintenance Lead Jeremy Krewer, Lead Biological Technician Steven Lee; Biological Technicians: Tyler Janazs, David Philips, Taylor Lance, David Riley, Kenneth McIntyre, Shelby Wallace, and Ken Millar; Biological Pathway Intern Cetia Dawson; and Maintenance personnel/truck transport drivers: Chuck Krasselt, Ryan Bonivert, Jeff Kuhn, Tyler Potts, and David Hernandez. Anchor QEA was represented by Biologists Shawn Rapp and Environmental Assessment Services was represented by Paul Burke. Pacific States Marine Fisheries Commission (PSMFC) was represented by Biologists Allan Martin and Dylan Tauzer. PSMFC technicians conducting fish sampling, quality control, data collection, and GBT sampling included Jackie Ambrose, Taylor Truett and Praxy McIntyre. Washington Department of Fish and Wildlife (WDF&W) was represented by Biologist Charles Morrill.

Facility Modifications

The following modifications were made to the JFF prior to or during the 2020 fish collection season:

1. Installed safety guards on PDW overflow weirs operating shafts.
2. Upgraded shop pneumatic system to provide emergency supply to collection facility.
3. Completed facility air compressor installation.
4. Eliminated void and installed additional flow fin at the downstream end of the porosity control unit to improve entrance into the separator.
5. Received 3500 gallon semi-truck, 1000 gallon flatbed truck, and service truck. Installed 1000 gallon tank on flatbed and prepared service truck. The 3500 gallon tank is scheduled to be received April, 2021.
6. Modified the JFF sample anesthetic system and procedure to minimize volume of MS-222 waste and developed a disposal system for LWG JFF lab waste.
7. Provided anesthetic disposal route for NOAA tagging trailer.
8. Fabricated and installed sample recovery tank exit barge and truck loading diversion gate.
9. Refurbished the sample diversion slide gates per PSMFC guidelines.
10. Purchased and received additional fish hold water supply pumps for 4000 and 8000 series barges.
11. Installed and tested upgraded supply valve with electronic operator in raceway 2. Improved

water control during truck and barge loading.
12. Completed front void structural support repairs in 8000 series barges.
13. Continued replacing aerators biological balls on fish transport barges.
14. Continued upgrading facility pneumatic system including adding condensation drains, new air lines, valves, and valve operators.
15. Continued replacing old mesh on raceway supply headbox screens to prevent fry and juvenile lamprey passage.
16. Continued to install anodes to prevent corrosion on barge fish hold supply pump to prevent electrolysis.
17. Continued rebuilding ESBSs and replacing VBS mesh as time permits.

River Conditions

The average daily river flow exceeded 100 kcfs on 31 days during the 2020 season. Total river flow averaged 52.0 kcfs this season. Highest daily average flow for the March 2-November 1 collection season was 163.3 kcfs June 2. Lowest daily average flow for the season was 17.9 kcfs October 18. Spill for fish passage occurred for 152 days from April 3 through midnight on August 31. LWG spilled up to the 125% gas cap for 16 hours a day and performance standard spill (20 kcfs) for up to 8 hours per day during the spring spill season (April 3-June 20). Summer spill of 18 kcfs began at 0001 hours on June 21 and ended at 2400 hours August 31. To facilitate spillway PIT tag detection the RSW remained in operation after average total outflow dropped below 30 kcfs (August 16-31). Spill was distributed according to FPP Table LWG-7 and LWG-8. Average season flow through spillways was 36.5 kcfs with a maximum daily average of 75.7 kcfs May 23 and a minimum daily average of 6.9 kcfs August 26. The RSW was open from 0500-0900 hours on Sundays, Tuesdays and Thursdays from October 1 to November 15 for passage of adult steelhead overshoot. River temperatures collected as part of the daily condition sample averaged 56.7° F for the season and ranged from 39.7° F March 3 to 66.7° F July 28. A comparison of daily powerhouse flow and spill is shown in Figure 1. Average monthly flow and spill for the 2016-2020 collection seasons are provided in Table 1.

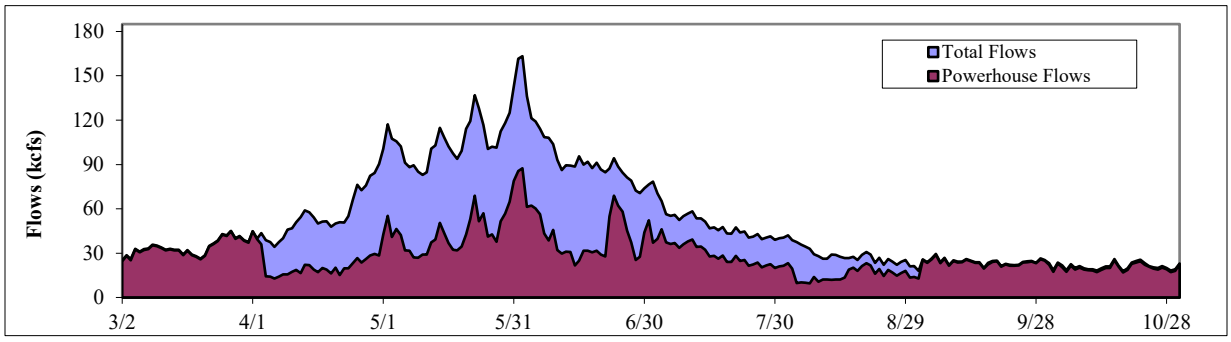

Figure 1. Daily average total flow and powerhouse flow at LWG, 2020.

Table 1. Comparison of average monthly river flow (kcfs) and spill (kcfs) at LWG, 2016-2020.

Flow (kcfs)	2016	2017	2018	2019	2020	2016–19 Ave.
March	61.81	162.83	58.80	76.68	33.82	90.03
April	89.79	136.35	94.33	121.47	54.67	110.48
May	90.79	142.82	139.11	122.06	106.17	123.70
June	55.58	131.44	82.92	92.71	98.06	90.66
July	34.41	51.98	38.22	38.54	50.77	40.79
August	24.96	31.31	29.48	28.92	28.63	28.67
September	20.06	26.08	22.97	25.75	24.01	23.72
October	22.06	21.42	18.70	22.13	20.95	21.08
Spill (kcfs)						
March	0.01	79.58	6.85	0.02	0.00	21.61
April	20.67	61.29	40.61	46.18	32.40	42.19
May	21.53	56.98	42.76	42.73	62.02	41.00
June	19.88	46.24	30.94	35.66	53.73	33.18
July	17.73	18.26	17.48	18.62	19.87	18.02
August	12.46	17.05	16.12	16.18	12.37	15.45
September	0.20	3.74	0.42	0.29	0.16	1.16
October	0.00	3.17	0.00	0.00	0.49	0.79

Fish Collection

Migration and Collection

Daily collection for condition sampling in secondary bypass mode occurred from 0700 hours March 1 through April 23 and again from 0700 hours June 21 through 0700 hours August 1. Collection for condition sample and barge transport occurred from 0700 April 23 through 0700 June 21. Collection for condition sampling and truck transport occurred from 0700 hours August 1 through 0700 hours November 1. An estimated 1,495,940 juvenile salmonids were collected during the 2020 season compared to 5,164,205 in 2019 (Table 2). The percent of the total collection for each species was: 30.1% clipped and 8.9% unclipped yearling Chinook salmon, 6.7% clipped and 12.4% unclipped subyearling fall Chinook salmon, 29.4% clipped and 8.0% unclipped steelhead, 1.1% clipped sockeye salmon, 0.1% unclipped sockeye salmon/kokanee, and 3.3% coho salmon. Daily collection and bypass numbers are provided in Appendix Table 1.

By the end of May, 84.3% of the total season collection had occurred. The percent of total collection arriving by the end of June and the end of July was 94.9% and 98.5%, respectively. The remaining 1.5% of juvenile salmonids was collected August through October (technically November 1). Daily collection of all species combined versus total flow is shown in Figure 2. Total daily collection in 2020 peaked at 92,200 (May 4). The peak daily collection total and date for each species group for 2016-2020 are listed in Table 3.

Table 2. Annual collection, bypass, transportation and mortality at LWG, 2016-2020.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
Collection										
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
2018	2,342,198	698,954	208,584	329,159	1,877,057	645,906	165,786	22,959	182,829	6,473,432
2019	1,470,467	396,127	176,608	263,341	2,190,548	540,061	44,450	5,207	77,396	5,164,205
2020	449,966	133,693	100,061	185,432	439,343	120,302	16,890	1,021	49,232	1,495,940
Bypass[1]										
2016	2,263,433	842,120	596	31,941	1,564,652	311,329	258	655	33,079	5,048,063
2017	980,750	401,216	3,517	18,985	1,158,305	221,673	104	15,631	10,915	2,811,096
2018	353,084	257,945	1,075	13,690	599,397	112,054	12	4,483	3,543	1,345,283
2019	453,214	153,562	3,285	41,108	1,160,105	210,169	9	154	20,630	2,042,236
2020	61,015	28,661	29,125	66,140	126,779	16,408	0	20	963	329,111
Truck										
2016	13	107	784	21,607	2	3	0	11	2	22,529
2017	0	0	0	0	0	0	0	0	0	0
2018	0	7	665	12,387	0	2	0	40	9	13,110
2019	4	258	1,906	17,377	3	2	0	28	8	19,586
2020	1	73	580	19,788	1	3	0	550	13	21,009
Barge										
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
2018	1,988,387	440,782	206,504	302,296	1,277,515	533,803	165,687	18,378	179,217	5,112,569
2019	1,016,004	242,036	171,023	204,217	1,030,304	329,833	44,341	5,005	56,679	3,099,442
2020	388,550	104,847	70,172	99,141	312,488	103,871	16,834	414	48,228	1,144,545
Total Transport										
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
2018	1,988,387	440,789	207,169	314,683	1,277,515	533,805	165,687	18,418	179,226	5,125,679
2019	1,016,008	242,294	172,929	221,594	1,030,307	329,835	44,341	5,033	56,687	3,119,028
2020	388,551	104,920	70,752	118,929	312,489	103,874	16,834	964	48,241	1,165,554
2020 Mortalities										
Facility	400	112	184	363	75	20	56	37	28	1,275
NMFS	0	0	0	0	0	0	0	0	0	0
Res/Sac	0	0	0	0	0	0	0	0	0	0

Figure 2. Fish collection and daily average flows at LWG, 2020.

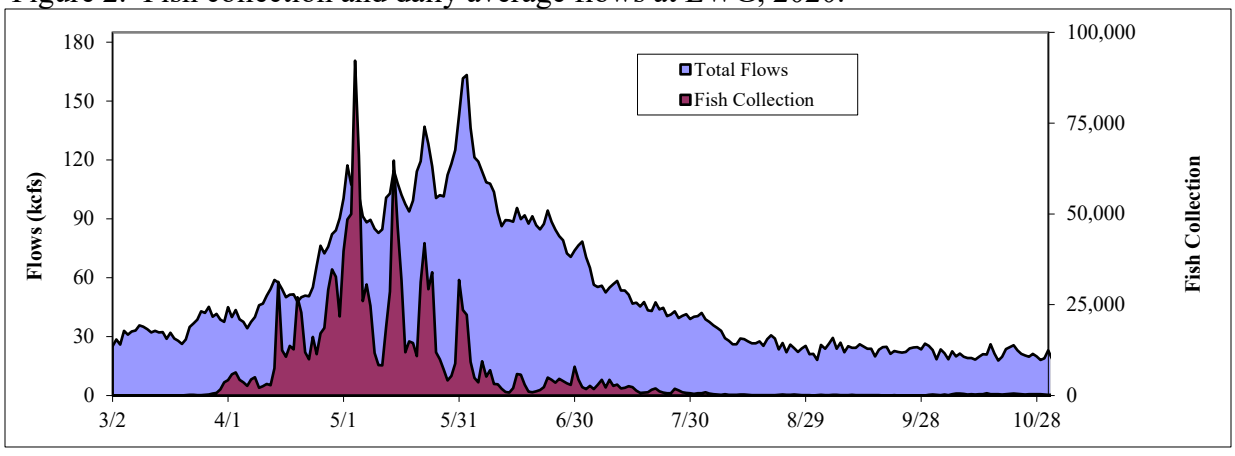

Table 3. Annual peak collection days at LWG, 2016-2020.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
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
2018	9-May	1-May	29-May	27-May	14-Apr	10-May	17-May	17-May	10-May	10-May
	196,200	33,600	19,400	26,800	93,403	49,400	40,800	1,600	18,800	383,600
2019	30-Apr	30-Apr	5-Jun	5-Jun	10-Apr	27-Apr	18-May	18-May	12-Apr	10-Apr
	76,200	17,600	16,650	18,250	159,600	31,400	13,000	1,000	8,000	245,802
2020	5-May	14-May	31-May	31-May	4-May	4-May	14-May	15-May	22-May	4-May
	37,600	8,129	8,934	13,012	47,400	16,000	8,290	200	4,800	92,200

Adult Fallbacks

A total of 2,393 adult salmonids fell back through the juvenile collection facility and were bypassed directly back to the river from the separator between March 1 and November 1. The total number of each species of adult fallbacks are listed in Table 4. Steelhead kelts are included in the total though they are not technically fallbacks. Fallbacks that went through the separator bars and entered the raceways were transported and were not counted by separator technicians. Fallbacks that went through the separator bars and entered the sample tank were counted and bypassed by SMP personnel. No fallbacks were bypassed through the fish facility before March 1 or after November 1 due to the facility being in primary bypass operation. Daily adult fallbacks and fallback mortalities are in Appendix Table 4.

Table 4. Annual totals of adult salmonids released from the separator at LWG, 2016-2020.

	Adult Chinook		Jack chinook		Steelhead		Sockeye		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Totals
2016	534	784	328	568	2,118	2,728	12	3	16	7,091
2017	91	101	19	16	611	820	1	0	0	1,659
2018	297	350	124	252	762	616	4	3	17	2,425
2019	222	293	147	142	814	713	0	7	19	2,357
2020	161	227	458	307	567	567	6	56	44	2,393
16-19 avg.	286	382	155	245	1,076	1,219	4	3	13	3,383

Steelhead were the most common adult salmonid species removed from the separator in 2020 (Table 5). March through May accounted for 50.3% of adult steelhead removed from the separator. The remaining 49.7% of steelhead fallbacks were removed from the separator June through October. The total number of steelhead fallbacks removed from the separator include out migrating kelts. The majority of Chinook adults, 92.2% were removed from the separator during September and October (fall Chinook). There were 6 clipped and 56 unclipped sockeye fallbacks released back to the river July through October. A total of 44 coho fallbacks were released to the river from the separator with 38 (86.4%) removed in October.

Table 5. Monthly totals of adult salmonids released from the separator at LWG, 2020.

	Adult Chinook		Jack Chinook		Steelhead		Sockeye		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Totals
March	1	0	0	0	142	93	0	0	0	236
April	0	0	0	0	51	40	0	0	0	91
May	11	6	1	2	105	139	0	0	0	264
June	10	10	2	4	2	63	0	0	0	91
July	3	8	2	3	1	4	0	4	0	25
August	7	10	3	7	9	16	2	24	0	78
September	71	130	170	119	147	128	2	20	6	793
October	58	63	280	172	110	84	2	8	38	815
Totals	161	227	458	307	567	567	6	56	44	2,393

Adult salmonid condition was classified as good, fair, poor or dead prior to being released from the separator (Table 6). Overall, 94.9% of fallback condition was classified as good to fair. Condition ratings of adult salmonids examined were as follows: 84.8% good, 10.1% fair, 4.1% poor, and 1.0% mortalities. Adult salmonid mortalities included: 1 unclipped Chinook, 13 clipped and 9 unclipped steelhead (mostly steelhead kelts). Chinook Jack had the highest percent of good/fair fish (99.2%) followed by adult Chinook of good/fair fish (95.9%) and steelhead (91.4%). There were 10 adult lamprey (*Entosphenus tridentatus*) collected at the juvenile facility and released at Offield Landing boat ramp (1 separator, and 9 sample tank).

Table 6. Condition of adult salmonids released from the separator at LWG, 2020.

	Adult Chinook		Jack chinook		Steelhead		Sockeye		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Totals
Good	136	206	447	305	389	450	6	51	39	2,029
Fair	17	13	5	2	112	85	0	4	4	242
Poor	8	7	6	0	53	23	0	1	1	99
Dead	0	1	0	0	13	9	0	0	0	23
Total	161	227	458	307	567	567	6	56	44	2,357

Sampling

Consistent with the 2020 Fish Operations Plan (FOP), Appendix E of the 2020 Fish Passage Plan, and guidance provided by the Regional Implementation Oversight Group (RIOG) through the Technical Management Team (TMT), the juvenile fish transportation program allows for a variable start date based on fish survival, adult returns, current in-river conditions, and water supply forecasts data. All fish collected that are not needed for research will be bypassed to the river prior to the start of collection for transportation. This year TMT requested collection for transport at Lower Granite, Little Goose, and Lower Monumental to begin at 0700 hours April 23. All fish sampled prior to transport were bypassed to the river. NOAA did not perform juvenile research this season due to their agencies COVID-19 restrictions. Lower Granite collection for fish sampling began at 0700 hours March 1 and ended at 0700 hours November 1. Sampling at Lower Granite Dam 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 and is not the act of evaluating those groups. A total of 245 daily samples were processed this season. The sample rate was set at 20% March 1 and fluctuated from a minimum of 0.5% to a maximum of 100% based on guidelines provided by the

Fish Passage Center (FPC), according to daily fish numbers, and to accommodate research needs. The smolt monitoring staff sampled 63,608 smolts or 4.3% of the total facility collection during 2020 compared to 64,765 smolts or 1.3% of the total facility collection in 2019 (Table 7).

Table 7. Annual percentage of smolts sampled at LWG, 2016-2020.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
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
2018	0.6	0.7	3.1	7.9	0.6	0.6	0.5	1.1	0.6	1.1
2019	0.6	0.9	4.7	9.1	0.7	0.7	0.6	1.6	1.2	1.3
2020	1.9	2.8	6.8	15.9	2.4	2.3	1.3	59.1	1.9	4.3
16-19 Ave.	0.6	0.7	2.9	6.3	0.6	0.7	0.6	1.1	0.7	1.0

The percent of the total smolts sampled in 2020 by species included: 13.6% clipped and 5.8% unclipped yearling Chinook, 10.7% clipped and 46.4% unclipped subyearling Chinook, 16.3% clipped and 4.4% unclipped steelhead, 0.4% clipped and 0.9% unclipped sockeye/kokanee, and 1.5% coho (Table 8).

Transportation

An estimated 1,165,554 juvenile salmonids were transported from Lower Granite Dam in 2020 by barge and truck combined. The number transported was 77.9% of the total facility collection. The percentage of the total collection that was transported of each species group from Lower Granite included; 86.4% clipped and 78.5% unclipped yearling Chinook, 70.7% clipped and 64.1% unclipped subyearling Chinook, 71.1% clipped and 86.3% unclipped steelhead, 99.7% clipped and 94.4% unclipped sockeye/kokanee, and 98.0% coho. Early season transport as part of National Marine Fisheries Service (NMFS) study to compare transport and in-river yearling Chinook smolt to adult returns (SARs) did not occur in 2020 due to COVID-19 restrictions. Daily barge transportation numbers are provided in Appendix Table 2.

Collection for barge transport occurred 0700 hours April 23 through 0700 hours June 21 from Lower Granite. Everyday barging operations occurred April 24 through May 18. Every other day barging from Lower Granite occurred May 20 through June 21. An estimated 1,144,545 juvenile salmonids were transported by barge from Lower Granite Dam in 2020. The number transported by barge was 76.5% of the total facility collection and included; 86.4% clipped and 78.4% unclipped yearling Chinook, 70.1% clipped and 53.5% unclipped subyearling Chinook, 71.1% clipped and 86.3% unclipped steelhead, 99.7% clipped and 40.5% unclipped sockeye/kokanee, and 97.0% coho. A total of 2,953,722 smolts were barged from LWG, LGO, and LMN by Lower Granite staff as part of the Walla Walla District trap and transport program.

Point Four oxygen monitoring systems were used on 4000 and 8000 series barges. YSI portable oxygen monitoring units continue to be kept on barges as backup systems.

Juvenile fish were trucked by pickup, flatbed, or semi-truck August 3 through November 1. The majority of truck trips were made with the 300-gallon pickup mounted tank. Lower Granite piggy backed with Little Goose using the 3500-gallon trailer August 23 and October 22 and on August 21 using the new 1,000-gallon flatbed truck mounted tank on August 21, due to Little

Goose exceeding their midi-tank capacity. The 1,000-gallon flatbed truck mounted tank was used on August 3 and October 8 due to increased collection at LWG. Lower Granite transported 21,009 smolts by truck which is 1.4% of the total juvenile collection. There were 9,515 fish collected at Little Goose that were transported with Lower Granite smolts on August 21, August 23 and October 22. The number of smolts trucked from Lower Granite by species included: 1 clipped and 73 unclipped yearling Chinook, 580 clipped and 19,788 unclipped subyearling Chinook, 1 clipped and 3 unclipped steelhead, 550 unclipped sockeye/kokanee, and 13 coho. The number of smolts trucked from Little Goose with Lower Granite smolts by species included: 859 clipped and 8,655 unclipped subyearling Chinook, and 1 coho. Water temperatures and oxygen levels were monitored to ensure acceptable levels. River water or river water ice is added to temper truck transport tanks when needed to ensure temperature are within 1-2ºF of Bonneville tailrace.

Table 8. Weekly sample totals at LWG, 2020.

Week	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
Ending	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
5-Mar	0	3	0	0	0	4	0	0	0	7
12-Mar	2	30	0	0	4	32	0	1	1	70
19-Mar	54	61	0	2	9	78	0	2	0	206
26-Mar	572	279	0	3	21	113	0	1	1	990
2-Apr	774	717	0	4	1,293	492	0	7	9	3,296
9-Apr	585	205	0	3	812	174	0	0	2	1,781
16-Apr	1,171	364	0	8	1,881	208	0	0	0	3,632
23-Apr	759	429	0	19	1,721	198	0	0	8	3,134
30-Apr	874	309	0	18	923	222	0	0	68	2,414
7-May	1,055	216	0	6	862	268	0	0	36	2,443
14-May	1,818	342	109	111	548	195	157	1	110	3,391
21-May	578	236	118	116	442	212	66	3	170	1,941
28-May	220	156	146	274	491	192	0	0	202	1,681
4-Jun	144	160	907	1,435	970	276	0	3	208	4,103
11-Jun	15	37	1,008	1,382	164	89	0	1	33	2,729
18-Jun	6	37	1,427	1,330	71	29	0	0	19	2,919
25-Jun	8	41	702	923	107	23	0	0	35	1,839
2-Jul	1	8	708	869	20	2	0	0	13	1,621
9-Jul	1	2	430	1,135	6	1	0	0	4	1,579
16-Jul	0	1	340	1,261	2	0	0	0	0	1,604
23-Jul	1	0	309	1,544	3	1	0	0	2	1,860
30-Jul	0	0	101	1,208	0	1	0	0	1	1,311
6-Aug	0	0	35	965	0	0	0	0	0	1,000
13-Aug	0	1	78	1,537	0	0	0	0	0	1,616
20-Aug	0	1	46	742	0	0	0	0	0	789
27-Aug	0	0	77	1,385	1	1	0	0	2	1,466
3-Sep	0	2	36	627	0	0	0	3	2	670
10-Sep	1	0	38	873	1	2	0	1	1	917
17-Sep	0	3	18	782	0	2	0	1	0	806
24-Sep	0	1	10	317	0	0	0	9	0	337
1-Oct	0	0	11	706	0	2	0	8	1	728
8-Oct	0	0	38	1,784	0	1	0	29	2	1,854
15-Oct	0	3	55	2,596	0	0	0	88	2	2,744
22-Oct	0	1	35	2,529	0	0	0	183	0	2,748
29-Oct	0	30	34	2,394	0	2	0	199	1	2,660
1-Nov	0	31	9	615	0	1	0	63	3	722
Total	8,639	3,706	6,825	29,503	10,352	2,821	223	603	936	63,608

Bypass

An estimated 329,111 juvenile salmonids, 22.0% of the total collection, were bypassed during the 2020 collection season. The facility was operated in secondary bypass mode March 1 through April 23 and from June 22 through August 1. Bypassed fish were enumerated during the daily condition sample period from 0700 hours March 1 to 0700 hours April 23 with 231,511 juvenile salmonids, 15.5% of the total collection, bypassed during this time period. Another 96,695 juvenile salmonids, 6.5% of the total collection, were bypassed from 0700 hours June 21 to 0700 hours on August 1. During collection for transport season 905 juvenile salmonids were bypassed. The percent of the total collection bypassed during the season of each species collected included 13.6% clipped and 21.4% unclipped yearling Chinook, 29.1% clipped and 35.7% unclipped subyearling Chinook, 28.9% clipped and 13.6% unclipped steelhead, 2.0% unclipped sockeye/kokanee, and 2.0% coho. Facility bypass estimates include all fish bypassed to the tailrace during secondary bypass operation when collection for transport did not occur, GBT fish prior to April 24, and fish collected and provided for research needs. Fish provided for research needs are recorded as bypassed including research mortalities. There were no research mortalities reported during 2020. There were no mortalities removed from the east raceways that held NMFS transport research fish. 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 1 through April 23 and from June 22 to August 1 Sampling occurred during these time periods for fish condition monitoring (COE). Fish sampled during this period are included in the facility bypass total. The facility was operated in primary bypass from 0700 hours November 1 until the bypass was dewater for winter maintenance at 1045 hours December 21.
2. GBT inspections during the period of April 9 through April 23 accounted for a total of 269 fish bypassed. Within each species group the number bypassed was: 117 clipped and 22 unclipped yearling Chinook, 119 clipped and 11 unclipped steelhead.
3. As part of research projects 886 fish were collected and bypassed (See; Research Section).
4. The PTAGIS database revealed that 16,998 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, 34,379 PIT-tagged fish were detected at LWG in 2020. Of the detected fish 49.4% were bypassed to the LWG tailrace through the PIT-tag diversion system, 47.9% were diverted to the raceways to be transported, 2.3% were diverted to the sample tank, and 0.4% were not detected at an exit monitor and their disposition was unknown. Another 160,021 PIT-tagged fish were detected at the new RSW PIT-tag detectors, and presumably bypassed. All PIT tagged fish were bypassed to the river from March 1 through April 23 and June 21 to August 1.

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. Incidental fish small enough to pass through the separator bars were either sampled and bypassed back to the river or held in raceways and transported with juvenile salmonids. The number of incidental species counted in the daily sample were expanded based on the sample rate to calculate collection. Incidental fish recorded at the separator were added to the expanded collection from the sample to estimate the total collection for each incidental species. An estimated 354,863 non-salmonid incidentals were collected at the fish facility during the March 2 to November 1 passage period compared to 142,936 in 2019 (Table 9). This is the highest collection of incidental species since at least 1999. Siberian prawns, Pacific Lamprey ammocoetes and Pacific Lamprey macrophthalmia had their highest number collected at the fish facility since 1999. Siberian prawns were the most abundant incidental species during the 2020 season with an estimated 145,030 collected compared to 71,565 in 2019. Siberian Prawn collection has increased every year since they were first observed in the LWG sample in 2004. Siberian prawns were euthanized per Washington Department of Fish and Wildlife instructions and disposed of in landfills according to the Washington Department of Fish and Wildlife permit requirements. Pacific lamprey ammocoetes were the second most abundant incidental species with an estimated 99,399 collected compared to 4,411 in 2019. Pacific Lamprey macrophthalmia were the third most abundant incidental species with an estimated 81,810 collected compared to 29,448 in 2019.

Table 9. Estimated collection of incidental fish species at LWG, 2020.

Common Name	*Scientific Name*	Separator	Expanded Sample	Total Collection[1]
American Shad (Adult)	*Alosa sapidissima*	61	15	76
American Shad (Juvenile)	*A. sapidissima*	0	882	882
Banded Killifish	*Fundulus diaphanus*	0	2	2
Bass, Largemouth	*Micropterus salmoides*	0	15	15
Bass, Smallmouth	*M. dolomieui*	9	3,028	3,037
Bullhead (misc.)	*Amierus sp.*	4	526	530
Catfish, Channel	*Ictalurus punctatus*	28	309	337
Catfish, Flathead	*Pylodictis olivaris*	0	0	0
Chiselmouth	*Acrocheilus alutaceus*	2	159	161
Common Carp	*Cyprinus carpio*	10	41	51
Crappie (misc)	*Pomoxis sp.*	9	9,406	9,415
Dace, Longnose	*Rhinichthys cataractae*	0	106	106
Dace, Speckled	*R. osculus*	0	0	0
Kokanee[2]	*Oncorhynchus nerka*	0	4	4
Northern Pikeminnow	*Ptychocheilus oregonensis*	3	25	28
Pacific Lamprey (Adult)	*Entosphenus tridentatus*	0	13	13
Pacific Lamprey (Ammocoete)	*E. tridentatus*	0	99,399	99,399
Pacific Lamprey (Macrophthalmia)	*E. tridentatus*	0	81,810	81,810
Peamouth	*Mylocheilus caurinus*	12	2,547	2,559
Redside Shiner	*Richardsonius balteatus*	0	0	0
Sand Roller	*Percopsis transmontana*	2	766	768
Sculpin	*Cottus sp.*	0	265	265
Siberian Prawn	*Exopalaemon modestus*	0	145,030	145,030
Sucker (misc.)	*Catostomus sp.*	582	4,545	5,127
Sunfish (misc.)	*Lepomis sp.*	0	357	357
Trout, Bull	*Salvelinus Malma*	0	0	0
Trout, Cutthroat	*Oncorhynchus clarkii*	0	0	0
Trout, Rainbow	*O. mykiss*	119[3]	1[4]	120
Walleye	*Stizostedion vitreum*	4	1	5

Warmouth	*Lepomis gulosis*	0	0	0
White Sturgeon	*Acipenser transmontanus*	9	1	10
Whitefish	*Prosopium sp.*	2	4,753	4,755
Yellow Perch	*Perca flavescens*	1	0	1
Total		857	354,006	354,863

[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 classified as a fish with scale loss of 20% or greater scale on one side of the body. Scale loss less than 20% on one side of the body is not considered descaled. PSMFC and Anchor QEA and EAS smolt monitoring personnel collected descaling data from the full live fish sample rather than the portion of the sample used for condition monitoring.

The descaling rate for all fish sampled in 2020 was 1.1% compared to 1.0% in 2019 and 1.4% for the 2016 to 2019 average (Table 10). The annual descaling rate by species group was: clipped yearling Chinook 1.4%, unclipped yearling Chinook 0.9%, clipped subyearling Chinook 0.5%, unclipped subyearling Chinook 0.5%, clipped steelhead 2.2%, unclipped steelhead 2.5%, clipped sockeye 0.0%, unclipped sockeye/kokanee 4.4%, and Coho 1.1%.

Table 10. Annual full-sample descaling rates (>20%) by species at LWG, 2016-2020.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
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
2018	1.3	0.8	0.6	0.8	3.6	2.7	1.0	3.3	1.4	1.5
2019	1.2	0.7	0.6	0.7	1.6	1.8	1.2	6.0	1.1	1.0
2020	1.4	0.9	0.5	0.5	2.2	2.5	0.0	4.4	1.1	1.1
16-19 Ave.	1.3	0.7	0.8	1.3	2.2	1.9	1.5	4.0	1.2	1.4

The highest weekly descaling rate for all species combined was 3.1% for the week ending November 1 (Table 11). Typically, the highest weekly descaling rates are observed in late August, September, and October when temperatures increase, flows decrease, and the sample size decreases. Descaling increased slightly in September and October in 2020. Heavy debris load 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. Clipped sockeye collected at the juvenile fish facility in late May and early June exhibited caudal fin rot and fungus but not descaling like in previous years. IDFG determined these maladies were due to rearing and release conditions and not Lower Granite operation as is evident in the fish sampled. Daily descaling rates are provided in Appendix, Table 3.

Table 11. Weekly descaling rates in percent for fish sampled at LWG, 2020.

Week Ending	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	
5-Mar	--	0.00%	--	--	--	0.00%	--	--	--	0.00%
12-Mar	0.00%	0.00%	--	--	0.00%	6.45%	--	0.00%	0.00%	2.90%
19-Mar	5.56%	1.69%	--	--	0.00%	1.28%	--	0.00%	--	2.48%
26-Mar	2.48%	4.69%	--	--	0.00%	0.89%	--	0.00%	0.00%	2.87%
2-Apr	1.17%	0.98%	--	--	0.62%	1.43%	--	0.00%	0.00%	0.95%
9-Apr	0.51%	0.98%	--	--	0.25%	4.02%	--	--	0.00%	0.79%
16-Apr	0.69%	0.00%	--	--	1.97%	2.40%	--	--	--	1.38%
23-Apr	0.66%	0.23%	--	--	0.99%	2.53%	--	--	0.00%	0.90%
30-Apr	0.46%	0.00%	--	--	1.30%	0.45%	--	--	0.00%	0.71%
7-May	1.61%	0.93%	--	--	4.07%	3.36%	--	--	0.00%	2.59%
14-May	2.37%	0.29%	0.00%	0.00%	2.92%	4.10%	0.00%	0.00%	0.91%	2.05%
21-May	1.91%	0.00%	0.00%	0.00%	5.66%	3.79%	0.00%	33.33%	1.18%	2.43%
28-May	1.37%	0.65%	0.00%	0.38%	4.48%	2.60%	--	--	1.49%	2.10%
4-Jun	1.41%	0.00%	0.33%	0.15%	4.02%	2.90%	--	0.00%	0.98%	1.40%
11-Jun	0.00%	2.70%	0.20%	0.23%	5.56%	2.25%	--	0.00%	3.03%	0.68%
18-Jun	0.00%	0.00%	0.84%	0.71%	1.41%	0.00%	--	--	0.00%	0.77%
25-Jun	12.50%	0.00%	0.86%	0.93%	2.80%	4.35%	--	--	0.00%	1.07%
2-Jul	0.00%	0.00%	0.42%	0.47%	0.00%	0.00%	--	--	0.00%	0.44%
9-Jul	0.00%	0.00%	0.47%	0.54%	16.67%	0.00%	--	--	0.00%	0.58%
16-Jul	--	0.00%	0.89%	0.56%	0.00%	--	--	--	--	0.63%
23-Jul	100.00%	--	0.65%	0.59%	66.67%	0.00%	--	--	0.00%	0.76%
30-Jul	--	--	1.01%	0.17%	--	0.00%	--	--	0.00%	0.23%
6-Aug	--	--	0.00%	0.21%	--	--	--	--	--	0.20%
13-Aug	--	0.00%	0.00%	0.39%	--	--	--	--	--	0.37%
20-Aug	--	0.00%	0.00%	0.68%	--	--	--	--	--	0.64%
27-Aug	--	--	1.30%	0.29%	0.00%	0.00%	--	--	0.00%	0.34%
3-Sep	--	0.00%	0.00%	0.48%	--	--	--	0.00%	50.00%	0.60%
10-Sep	0.00%	--	0.00%	0.35%	0.00%	0.00%	--	0.00%	0.00%	0.33%
17-Sep	--	0.00%	5.56%	0.51%	--	0.00%	--	0.00%	--	0.62%
24-Sep	--	0.00%	0.00%	1.27%	--	--	--	0.00%	--	1.19%
1-Oct	--	--	0.00%	0.28%	--	0.00%	--	12.50%	0.00%	0.41%
8-Oct	--	--	0.00%	0.73%	--	0.00%	--	3.85%	0.00%	0.76%
15-Oct	--	0.00%	0.00%	0.58%	--	--	--	7.06%	0.00%	0.77%
22-Oct	--	0.00%	0.00%	0.40%	--	--	--	2.89%	--	0.55%
29-Oct	--	6.67%	0.00%	0.42%	--	0.00%	--	4.37%	0.00%	0.76%
1-Nov	--	3.23%	11.11%	2.80%	--	0.00%	--	4.92%	0.00%	3.09%
# Descaled	124	32	37	149	229	70	0	25	10	676
# Sampled	8,612	3,691	6,802	28,972	10,337	2,815	220	568	932	62,949
% Descaled	1.44%	0.87%	0.54%	0.51%	2.22%	2.49%	0.00%	4.40%	1.07%	1.07%

Injuries and Disease

Injury and disease data gathered from a sub sample of 100 of the dominant species and not more than 100 each of the non-dominant species. There were 31,114 fish examined for injury and disease and 8,018 fish (25.8%) were afflicted with an injury or disease symptom in 2020. The overall affliction rate, body injury rate, predator injury rate, head injury rate and disease

symptom rates reported are the actual rates observed for 2014 to 2020. 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 21.5% 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 may 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 2020 was fin discoloration (36.7%), followed by general fin injury (33.0%), pink fin (26.9%), body injury (1.8%), and body deformities (1.5%). Unclipped subyearling Chinook exhibited the highest percent of body injuries at 27.4% (3,462 of 12,638 examined) followed by clipped subyearling Chinook at 20.1% (571 of 2,845 examined).

Head injuries were recorded on 0.6% of the smolts examined in the detailed subsample. Unclipped yearling Chinook had the highest incidence of head injury at 1.9% (43 of 2,320 examined), followed by clipped yearling Chinook at 1.2% (55 of 4,609 examined). Injuries to the eyes comprised the majority of observed head injuries at 35.7%, followed by operculum injuries at 25.4%, eye hemorrhage at 20.5%, general head injuries at 11.9%, "pop" eye at 6.5%.

Injuries associated with predators include wounds inflicted by other fish, birds, and lamprey. Predator wounds were observed on 0.7% 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 52.6% compared to 44.6% caused by fish and 2.8% caused by lamprey. Predator marks were highest on unclipped steelhead at 1.4% (25 of 1,804 examined), followed by clipped sockeye salmon at 1.2% (2 of 169 examined), and clipped steelhead 1.2% (62 of 5,260 examined).

External symptoms of disease were observed on 4.7% of the smolts examined in the detailed subsample compared to 6.5% in 2019, 5.9% in 2018, 2.9% in 2017, and 5.6% in 2016. Symptoms of disease were most common on clipped sockeye salmon (8.3%), followed by unclipped subyearling Chinook (7.3%). Of the fish afflicted, fin hemorrhages comprised the majority of disease symptoms (77.2%), followed by columnaris (8.7%), parasites (7.1%), fungus (5.1% and bacterial kidney disease (1.9%).

Fin hemorrhage was found on 3.7% of all species and rearing types examined. Fin hemorrhage was the primary disease afflicting subyearling Chinook and was observed on 6.3% of unclipped subyearling Chinook examined and 5.0% of clipped subyearling Chinook examined.

Columnaris is caused by the bacterium *Flavobacterium columnare* that becomes more virulent as water temperatures increase. Summer and subyearling migrants are more susceptible to infection as water temperatures increase 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 18. The 2020 columnaris infection rate for subyearling Chinook was 0.4% (138 of 35774) compared to 2016-2019 average of 1.3%.

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 are included in bypassed fish and not considered facility mortalities. Annual facility mortality for all groups combined was 0.09% in 2020 and totaled 1,275 fish (Table 12). Within each species group the number of facility mortalities were 400 clipped and 112 unclipped yearling Chinook, 184 clipped and 363 unclipped subyearling Chinook, 75 clipped and 20 unclipped steelhead, 56 clipped and 37 unclipped sockeye/kokanee, and 28 coho.

Table 12. Annual facility mortality in percent by species group at LWG, 2016-2020.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
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
2018	0.03	0.03	0.16	0.24	0.01	0.01	0.05	0.25	0.03	0.04
2019	0.08	0.07	0.22	0.24	0.01	0.01	0.22	0.38	0.10	0.06
2020	0.09	0.08	0.18	0.20	0.02	0.02	0.33	3.62	0.06	0.09
16-19 Ave.	0.05	0.04	0.04	0.04	0.01	0.01	0.31	0.41	0.05	0.07

Weekly facility mortality rates are provided in Table 13. During September and October facility mortality rates were higher than in 2019 and peaked at 1.69% the week ending on October 29.

Table 13. Weekly facility mortality in percent by species group at LWG, 2020.

Week	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
Ending	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
5-Mar	--	0.00%	--	--	--	0.00%	--	--	--	0.00%
12-Mar	0.00%	0.00%	--	--	0.00%	3.13%	--	0.00%	0.00%	1.43%
19-Mar	0.00%	3.28%	--	0.00%	0.00%	0.00%	--	0.00%	--	0.97%
26-Mar	1.22%	0.72%	--	0.00%	0.00%	0.88%	--	0.00%	0.00%	1.01%
2-Apr	0.11%	0.12%	--	5.88%	0.04%	0.14%	--	0.00%	0.00%	0.09%
9-Apr	0.01%	0.03%	--	0.00%	0.01%	0.00%	--	--	0.00%	0.01%
16-Apr	0.02%	0.03%	--	0.83%	0.01%	0.00%	--	--	--	0.02%
23-Apr	0.00%	0.02%	--	0.48%	0.00%	0.00%	--	--	0.00%	0.01%
30-Apr	0.15%	0.11%	--	0.08%	0.03%	0.01%	--	--	0.05%	0.09%
7-May	0.08%	0.03%	--	0.13%	0.02%	0.00%	--	--	0.04%	0.05%
14-May	0.09%	0.09%	0.99%	1.02%	0.03%	0.04%	0.15%	0.00%	0.04%	0.13%

21-May	0.10%	0.11%	0.24%	0.28%	0.01%	0.02%	0.51%	0.00%	0.08%	0.11%
28-May	0.07%	0.13%	0.16%	0.16%	0.01%	0.01%	--	--	0.02%	0.06%
4-Jun	0.15%	0.15%	0.13%	0.12%	0.03%	0.10%	--	3.57%	0.12%	0.10%
11-Jun	0.53%	0.84%	0.14%	0.21%	0.17%	0.00%	--	0.00%	0.24%	0.19%
18-Jun	0.00%	0.00%	0.39%	0.27%	0.00%	0.00%	--	--	0.00%	0.32%
25-Jun	0.00%	0.00%	0.06%	0.04%	0.00%	0.00%	--	--	0.00%	0.04%
2-Jul	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	--	--	0.00%	0.01%
9-Jul	0.00%	0.00%	0.04%	0.03%	0.00%	0.00%	--	--	0.00%	0.03%
16-Jul	--	0.00%	0.06%	0.04%	0.00%	--	--	--	--	0.04%
23-Jul	0.00%	--	0.23%	0.12%	0.00%	0.00%	--	--	0.00%	0.14%
30-Jul	--	--	0.40%	0.06%	--	0.00%	--	--	0.00%	0.09%
6-Aug	--	--	1.49%	0.22%	--	--	--	--	--	0.26%
13-Aug	--	0.00%	0.00%	0.55%	--	--	--	--	--	0.52%
20-Aug	--	0.00%	0.00%	1.08%	--	--	--	--	--	1.01%
27-Aug	--	--	0.00%	0.36%	0.00%	0.00%	--	--	0.00%	0.34%
3-Sep	--	0.00%	0.00%	0.16%	--	--	--	33.33%	0.00%	0.30%
10-Sep	0.00%	--	0.00%	0.92%	0.00%	0.00%	--	0.00%	0.00%	0.87%
17-Sep	--	0.00%	0.00%	0.13%	--	0.00%	--	0.00%	--	0.12%
24-Sep	--	0.00%	0.00%	0.32%	--	--	--	0.00%	--	0.30%
1-Oct	--	--	0.00%	0.42%	--	0.00%	--	0.00%	0.00%	0.41%
8-Oct	--	--	0.00%	0.39%	--	0.00%	--	8.82%	50.00%	0.56%
15-Oct	--	0.00%	1.82%	0.73%	--	--	--	3.41%	0.00%	0.84%
22-Oct	--	0.00%	2.86%	0.83%	--	--	--	5.46%	--	1.16%
29-Oct	--	0.00%	0.00%	1.21%	--	0.00%	--	8.04%	0.00%	1.69%
1-Nov	--	0.00%	0.00%	1.14%	--	0.00%	--	3.17%	0.00%	1.25%
# Morts	400	112	184	363	75	20	56	37	28	1,275
# Collected	449,966	133,693	100,061	185,432	439,343	120,302	16,890	1,021	49,232	1,495,940
% Mortality	0.09%	0.08%	0.18%	0.20%	0.02%	0.02%	0.33%	3.62%	0.06%	0.09%

Sample mortalities include fish removed from the sample holding tank prior to being handled in the lab and mortalities removed from the sorting trough in the wet lab. Annual sample mortality for all groups combined was 0.47% in 2020 (Table 14) and totaled 296 fish. This is the second lowest sample mortality rate on record since 1996. The number of sample mortalities and mortality rate by species group was: 27 clipped and 15 unclipped yearling Chinook, 23 clipped and 168 unclipped subyearling Chinook, 15 clipped and 6 unclipped steelhead, 3 clipped and 35 unclipped sockeye/kokanee, and 4 Coho. All species groups sample mortality rates were lower than the 2016 to 2019 average except for unclipped sockeye salmon/kokanee and coho salmon. Sample mortality for all groups combined since 2016 has ranged from a high of 0.86% in 2017 to a low of 0.45% in 2019.

Barge mortalities are salmonids removed from barge holds after the barges depart LWG. The total number of smolts barged in 2020 included: 1,144,545 fish from LWG, 1,013,683 from LGS, and 795,494 fish from LMN. The seasonal barge transport program mortality rate was 0.01% (360 of 2,953,722) (Table 16). Barge mortalities by species group included: 220 clipped and 34 unclipped yearling Chinook, 8 clipped and 4 unclipped subyearling Chinook, 61 clipped and 11 unclipped steelhead, 20 clipped and 1 unclipped sockeye salmon/kokanee, and 1 coho salmon (Table 15).

Table 14. Annual sample mortality by species group in percent at LWG, 2016-2020.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
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
2018	0.32	0.31	0.85	0.87	0.30	0.27	0.72	1.99	0.00	0.58
2019	0.29	0.49	0.53	0.74	0.12	0.18	0.39	2.35	0.22	0.45
2020	0.31	0.40	0.34	0.57	0.14	0.21	1.35	5.80	0.43	0.47
16-19 ave	0.40	0.42	0.90	1.05	0.23	0.24	1.57	3.37	0.22	0.65

Table 15. Total annual transport program barge mortalities 2016-2020.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Unknown	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Others	Total
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
2018	2,945	782	270	311	690	283	50	47	15	1	5,394
2019	1,345	302	55	48	590	211	21	0	0	0	2,572
2020	220	34	8	4	61	11	20	1	1	0	360
16-19 ave	1,652	454	331	349	515	218	110	15	21	8	3,673

The truck transport fish mortality rate in 2020 was 0.19% (40 of 21,009) (Table 16). All trips were made by pickup truck mounted with a 300-gallon tank, except for the August 3, August 21 and October 8 trips that were made with the new 1,000 gallon tank, and the trips on August 23 and October 22 when the 3,500 gallon semi-truck was used. The trips on August 21, August 23 and October 22 also picked up fish from LGS. Fish transported from LGS with LWG fish totaled 9,515 smolts. A total of 21,009 fish were collected and transported by truck from LWG. Truck mortality number and percent by species included: 6 clipped and 12 unclipped subyearling Chinook, 21 unclipped sockeye/kokanee, and 1 coho salmon.

Table 16. Annual percent truck mortality at LWG, 2016 -2020.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	Clipped	No Clip	All	Total
2016	0.00	0.00	0.38	0.07	0.00	0.00	--	0.00	0.00	0.08
2017	--	--	--	--	--	--	--	--	--	--
2018	--	14.30	0.60	0.10	--	0.00	--	17.50	0.00	0.19
2019	0.00	1.16	0.19	0.07	0.00	0.00	0.00	3.57	0.00	0.10
2020	0.00	0.00	1.03	0.06	0.00	0.00	--	3.82	7.69	0.19
16-19 Ave.	0.00	1.08	0.48	0.09	0.00	0.00	0.00	10.13	0.00	0.14

--no fish trucked

Gas Bubble Trauma Monitoring (PSMFC)

Juvenile salmonids were sampled for GBT from April 9 through June 11 in 2020. 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. This season 798 salmonids were netted off the separator and handled by PSMFC technicians. Salmonids examined for GBT symptoms totaled 738 fish and included: 381 clipped and 64 unclipped yearling Chinook and 257 clipped and 36 unclipped steelhead. During GBT sampling 20 PIT-tagged smolts were handled, not examined and returned to the separator including: 10 clipped and 4 unclipped yearling Chinook, 6 clipped steelhead. An additional 40 fish were handled and released into the separator included: 2 clipped and 1 unclipped yearling Chinook, 5 clipped and 5 unclipped subyearling Chinook, 1 clipped steelhead, 1 clipped sockeye, and 25 Coho. Smolts examined for GBT prior to April 23 were released in the sample recovery tank and bypassed. Smolts examined for GBT after April 23 were returned to the raceways and transported. A total of 269 smolts were bypassed including 117 clipped yearling Chinook, 22 unclipped yearling Chinook, 119 clipped steelhead, and 11 unclipped steelhead. A total of 529 smolts were transported including: 276 clipped and 47 unclipped yearling Chinook, 5 clipped and 5 unclipped subyearling Chinook, 145 clipped and 25 unclipped steelhead, 1 clipped sockeye, and 25 coho. There were no fish observed with symptoms of GBT in 2020 or 2019. New for this season was the intent to examine non-salmonid fish for symptoms of GBT. Only 3 non-salmonid fish were netted off the separator, 1 Pacific Lamprey ammocoete and 1 chiselmouth that did not have GBT symptoms, and 1 sucker that was not examined.

Research

Research projects were limited due to COVID-19 restrictions. Two agencies participated in three research projects with juvenile fish collected at LWG juvenile facility and one project collecting adults off the separator. A total of 886 smolts (0.1% of the total collection) was handled during the 2020 season compared to 466,556 smolts (9.0% of total collection) in 2019. The 2016-2019 average number of fish handled as part of LWG research projects was 505,844 smolts. The 886 smolts taken from the 2020 collection season included: 50 unclipped yearling Chinook, 249 clipped and 464 unclipped subyearling Chinook, and 123 clipped steelhead. Corps biological staff collected a 177 clipped and 254 unclipped adult steelhead kelts from the LWG juvenile separator for the Nez Perce Tribe (NPT) and Columbia River Inter-Tribal Fisheries Commission (CRITFC) this season.

National Marine Fisheries Service (NMFS)-Study to Compare the Adult Returns of In-river Migrating versus Barged Juvenile Anadromous Salmonids (Transportation Study)
This research did not occur due to NOAA agency restrictions related to COVID-19.

National Marine Fisheries Service (NMFS)-Study to Estimate Juvenile Salmonid Reach Survival
This research did not occur due to NOAA agency restrictions related to COVID-19.

National Marine Fisheries Service (NMFS)-Monitoring the Migrations of Wild Snake River Spring/Summer Chinook
This research did not occur due to NOAA agency restrictions related to COVID-19.

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 collected 173 fish that were sorted by SMP biologists and provided to IDFG for this study March 2 to March 24 Scale samples and fin clips were taken from 123 non-fin eroded unclipped steelhead and fin clips only were taken from 50 non-coded wire tag (CWT), unclipped yearling Chinook. Sampled fish for this study were bypassed prior to transport collection (April 23) and included 123 unclipped steelhead without fin erosion and 50 yearling Chinook without CWT. Collection for this study is normally scheduled to end in June but ended early due to COVID-19 restrictions.

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

Corps biological staff collected 431 steelhead kelts from the Lower Granite juvenile separator from March 11 to June 26. The purpose of the study is to evaluate steelhead kelt physiology and endocrinology for rehabilitating. NPT/CRITFC personnel took genetic samples, PIT-tagged, and returned to the tailrace 329 steelhead, including 173 clipped and 156 unclipped steelhead kelts collected at LWG that did not meet their criteria. Of the kelts collected, 89 steelhead kelts were transported to Dworshak National Fish Hatchery for acclimation and feeding studies. Eleven steelhead died before handling including 4 clipped and 7 unclipped steelhead kelts, 1 unclipped steelhead died after handling and 1 unclipped steelhead was not sampled and returned to the river.

USGS-Emerging Issues to Recover the Snake River Fall Chinook Salmon Evolutionary Significant Unit

The goal of this research project was to collect previously PIT-tagged subyearling fall Chinook salmon from the Clearwater River basin to measure and determine growth. From September 10 to October 30 USGS personnel used the SBC system to collect previously PIT-tagged subyearling Chinook salmon from the Clearwater River basin. There was 1 clipped and 190 unclipped subyearling Chinook salmon evaluated to measure growth that were bypassed to the river and 1 clipped and 1 unclipped subyearling Chinook mortalities.

USGS-Detection Efficiency of 8-mm PIT Tags Over the RSWD

The goal of this research project was to evaluate the detection efficiency of the new PIT array in the RSW at LWG with 8-mm PIT-tags. On June 10, subyearling fall Chinook salmon were collected from the sample, tagged with 8-mm PIT-tags, and released into the top of the RSW. PIT-tagged fish released included 239 clipped and 262 unclipped subyearling fall Chinook, and another 8 clipped and 11 unclipped subyearling fall Chinook were not needed for this study and were transported.

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

contains unit outages during 2020.

Table 17. Lower Granite turbine unit outages, 2020.

Unit	Date OOS	Reason out of service
Units 1 – 6	**Monthly**	**ESBS/VBS inspection**
Units 1 – 6	**Feb 18-19**	**Trash rack raking**
Units 1 &3 – 6	**Feb 24-27**	**ESBS Installation**
Unit 2	**Mar 13**	**ESBS Installation**
Units 1-6	**Aug 3-Aug 8**	**Doble Testing**
Units 1 & 3	**Dec 2**	**ESBS Removal**
Units 2 & 4-6	**Dec 16-17**	**ESBS Removal**
Units 1-6	**Feb 11-12**	**Digital governor network switch upgrade**
Unit 1	**Feb 11**	**Digital governor network switch upgrade**
	Sept 29	**Nexus Meter Replacement**
	Nov 30-Dec 17	**Annual Maintenance**
Unit 2	**Nov 4, 2019-Mar 19, 2020**	**Overhaul, Blade packing wear ring failure**
Unit 3	**Feb 11**	**Digital governor network switch upgrade**
	June 4	**Sheared bolts on governor system repair**
	Oct 19-Dec 18	**Annual Maintenance**
Unit 4	**Feb 11**	**Digital governor network switch upgrade**
	May 22	**Swapped fish screen due to oil in gatewell slot**
	Aug 24-Sept 30	**Annual Maintenance**
Unit 5	**Jan 27-29**	
	Feb 11-19	**Digital governor network switch upgrade and keeper pin with the blade MLDT and restoring cable**
	Mar 17	**TO1 outage**
	Jun 20-July 23	**Annual Maintenance**
Unit 6	**Dec 5, 2019-Jan 14, 2020**	**Suspected source of oil in tailrace**
	Feb 12	**Digital governor network switch upgrade**
	Feb 16	**Digital Exciter Problems**
	July 27-Aug 19	**Annual Maintenance**

Debris/Trash Racks

Trashracks were raked February 25-27. Trashrack raking was not required during the fish passage season.

Extended-length Submersible Bar Screens (ESBSs)

ESBSs were inspected and tested prior to installation. ESBSs (Extended Length Submersible Bar Screens) were installed March 18-21. 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 2020 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 continue to be replaced/repaired 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

The orifice gallery was watered up at 1130 hours February 20 to support early juvenile collection facility operation. Orifices operation was determined by collection channel flow and forebay elevation during the 2020 season. When the forebay is raised above MOP 10" orifices in gatewells of non-priority units (typically units 4 & 5) are used to maintain acceptable flow to the PDW. Orifices were inspected every three hours and back-flushed with air as needed to remove debris March 1-May 25. Orifices were inspected and back flushed twice a shift May 25-November 1 when river debris loads were minimal. Orifice operation programming issues continue to be a problem. The facility was operated by two biological technicians to monitor the orifice gallery and the operation of the relatively new system during the spring freshet. Orifice lights were checked during daily inspections.

Primary Dewaterer

The primary bypass system was watered up in bypass mode at 1130 hours February 20 to support the request of regional fisheries managers to obtain information on early juvenile salmonid outmigration. Primary dewaterer floor screen brushes, side screen brushes, and the pneumatic screen cleaners were intermittently operated in auto and manual mode by powerhouse operators and JFF staff due to mechanical and programing issues with the system. Operational changes in response to programming, mechanical, and structural issues with the PDW continue as needed.

Wet Separator/Distribution and Sampling Systems

Water levels in the separator varied with the forebay elevation and PDW operations requiring adjustment in porosity control valves and separator exit gates. Adjustments in flume flow were made to reduce fish holding in the transport flume and under the separator. Porosity control valve modifications made during the 2018-2019 winter outage distributed flow evenly across the porosity. These modifications to the porosity control unit balanced water across the plate and

enabled adequate dewatering prior to entering the separator however they did not address all the issues. An additional modification was added to the porosity control unit during the 2019-2020 outage to smooth the downstream flow. Biological technicians adjusted porosity dewatering valves and exit gate positions in response to separator water elevation changes related to PDW weir operation. Separator exit gates were adjusted to improve PIT tag detection efficiencies as coordinated with PSMFC technicians. Debris obstructions became an issue as debris load increased late in the season and seemed to be more prevalent during steelhead overshoot spill operational hours.

Barge Loading Operations

Barge loading operations occurred from April 24 through June 21. Loading from the raceways went smoothly this season. Direct loading did not occur.

Truck Loading Operations

Truck transport occurred from August 1 through November 1. LWG transported fish from LGS August 21, August 23, and October 22.

Recommendations

1. Complete Phase 1a modifications and resolve programming issues.
2. Operate the PDW flume outflow between 35-40 cfs to reduce delays in system.
3. Rebuild raceway tailscreens to reduce weight for personnel safety.
4. Improve sample recovery truck loading pipe slope to eliminate fish stranding in pipe.
5. Continue rebuilding motors on the 2000 series barges.
6. Replace barge bumper cable and tire system with bumpers.
7. Paint hulls on 8000 series barges.
8. Install ballast material in barges 4394 and 4382 voids to eliminate use of river water.
9. Install electronic operators for all raceway supply knife gate valves.
10. Replace sample holding tank fish exit release manual valves with pneumatic valves.
11. Improve/modify anesthetic chamber door operation.
12. Install cabinet for all raceway supply and exit valve operating controls.
13. Permanently close the collection channel 5A research weir that is becoming a safety concern.
14. Ensure all researcher working at LGW are accountable for anesthetic waste disposal in compliance with the EPA Clean Water Act.
15. Floor screen cleaner modification to allow backward movement that would eliminate continuous operational issues.
16. Modify side screen cleaners for reliability and ability to operate system in auto mode.
17. Replace temporary chain hoist on emergency bypass hatch with a permanent system that will enable the hatch to be operated as designed and reduce personnel safety concerns during fish rescues/dewatering.
18. Replace electrical cables, control, and hoist for upstream raceway fish crowder.

APPENDIX TABLES

Appendix Table 1. Daily collection and bypass numbers and river conditions at Lower Granite Dam, 2020.

Appendix Table 2. Percent descaling and daily facility mortality numbers at Lower Granite Dam, 2020.

Appendix Table 3. Daily number of fish trucked and barged from Lower Granite Dam, 2020.

Appendix Table 4. Daily number of adult fallbacks and fallback mortality at Lower Granite Dam, 2020.