CENWW-ODE HOLDREN March 2022

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

FOR Chief, Operations Division
ATTN: Christopher Peery

SUBJECT: Submission of 2021 Juvenile Fish Collection and Bypass Report, Lower Granite Dam Juvenile Fish Facility.

1. Enclosed find the 2021 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

# 2021 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 2022

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# TRANSPORT OPERATIONS - LOWER GRANITE DAM

## Introduction

The 2021 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 thousand cubic feet per second (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 except for June 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 1028 hours February 22. Extended Length Submersible Bar Screens (ESBSs) were installed February 23-25. Juvenile fish facility (JFF) operation was changed to 24 hours collection for condition sampling 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 20 through 1110 hours July 2. Emergency truck transport began at 1110 hours July 2 due to deteriorating river conditions as a result of record high regional temperatures. The first truck departed LWG July 4. Research fish were transported by barge April 15 as part of the ongoing study to compare in-river verses transported Smolt-to-Adult Return Ratios (SARs). Three agencies conducted five research projects and handled a total of 147,635 smolts at the Lower Granite juvenile collection facility this season in addition to the Smolt Monitoring Program (SMP), 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 20 through 1110 hours July 2. Collection for barge transport occurred from 0700 hours April 23 through 0700 hours June 20. Collection resumed for truck transport at 1110 hours July 2 through 0700 hours November 1. The facility was operated in primary bypass November 1 through December 6. Facility smolt collection totaled 771,088 during the 2021 season compared to 1,495,940 in 2020. Distribution of the 2021 total collection excluding mortalities was 281,269 bypassed, 366,654 barged, and122,356 trucked.

Pacific States Marine Fisheries Commission (PSMFC) technicians handled 581 and examined 495 juvenile salmonids for GBT between April 8 and June 17. Smolts examined were bypassed or sent to the raceway depending on transport operations. Two fish were observed with symptoms of GBT during the 2021 season.

The passive integrated transponder (PIT) tag system detected 23,719 PIT-tagged fish at the JFF during the 2021 season. Facility PIT tagged fish distribution was 9,191 diverted to the river, 13,724 diverted to raceways for transport, 745 diverted to sample holding tank, and 59 failed to be detected in secondary bypass, raceways, or the sample systems. Another 251,434 PIT-tagged

fish were detected at the RSW PIT-tag detectors 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, Supervisory Fisheries Biologist David Miller, Acting Maintenance Lead Ryan Bonivert Lead Biological Technician Steven Lee; Biological Technicians: Tyler Janasz, David Phillips, David Riley, Kenneth McIntyre, Shelby Wallace, Kenneth Millar, and Cetia Dawson; and Maintenance personnel/truck transport drivers: 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 and Matt Paulson. Pacific States Marine Fisheries Commission (PSMFC) was represented by Biologists Allan Martin, Paul Burke and Dylan Tauzer. PSMFC technicians conducting fish sampling, quality control, data collection, and GBT sampling included Matt Dwyer, Nina Flack 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 2021 fish collection season:

1. Installed safety guards on primary dewaterer (PDW) overflow weirs operating shafts.
2. Completed facility air compressor installation.
3. Received 3500-gallon tank semi-trailer.
4. Replaced fish hold water supply pumps for barges 4394 and 8105.
5. Completed front void structural support repairs in barge 8105.
6. Replaced aerators biological balls on all barges except 8105.
7. Completed upgrading facility pneumatic system including adding condensation drains, new air lines, valves, and valve operators.
8. Install electronic operators for all raceway release knife gate valves.
9. Install cabinet for all raceway supply and exit valve operating controls.
10. Improved sample recovery truck loading pipe slope to eliminate fish stranding in pipe.
11. Installed TDG monitoring equipment on all barges.
12. Installed air conditioning unit in facility air compressor conex to reduce excess heat during summer months.
13. Installed pneumatic release valves on the sample holding tank.
14. Installed backflush air valve and slide gate on the sample transport line for dislodging debris.
15. Replace hydraulic system for the barge loading boom.

16. Continued replacing old mesh on raceway supply headbox screens to prevent fry and juvenile lamprey passage.
17. Continued to install anodes on barge fish hold supply pump to prevent electrolysis corrosion.
18. Continued rebuilding ESBSs and replacing VBS mesh as time permits.
19. Installed PIT tag detection array on the barge load line.

## River Conditions

The average daily river flow did not exceed 100 kcfs during the 2021 season. Total river flow averaged 37.3 kcfs this season. Highest daily average flow for the March 2-November 1 collection season was 89.4 kcfs May 19. Lowest daily average flow for the season was 14.2 kcfs October 22. 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 the Fish Passage Plan (FPP) Table LWG-7 and LWG-8. Average season flow through spillways was 25.7 kcfs with a maximum daily average of 57.9 kcfs May 19 and a minimum daily average of 5.7 kcfs August 29. The RSW was open for four hours between 0500-1100 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 57.0° F for the season and ranged from 39.0° F March 2-4 to 67.5° F August 4. A comparison of daily powerhouse flow and spill is shown in Figure 1. Average monthly flow and spill for the 2017-2021 collection seasons are provided in Table 1.

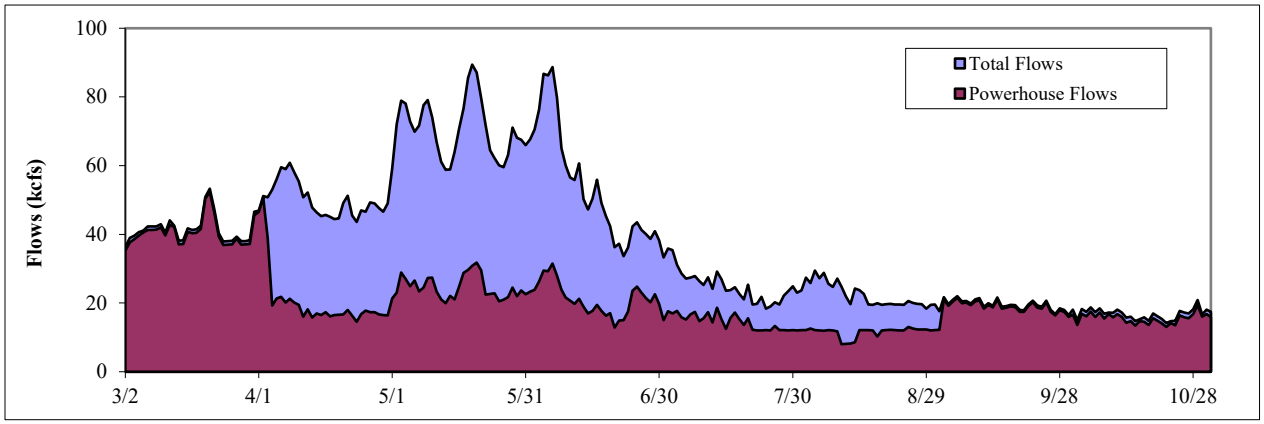


**Figure 1. Daily average total flow and powerhouse flow at LWG, 2021.**

Table 1. Comparison of average monthly river flow (kcfs) and spill (kcfs) at LWG, 2017-2021.

| Flow (kcfs) | 2017 | 2018 | 2019 | 2020 | 2021 | 2017–20 Ave. |
|---|---|---|---|---|---|---|
| March | 162.83 | 58.80 | 76.68 | 33.82 | 41.43 | 83.03 |
| April | 136.35 | 94.33 | 121.47 | 54.67 | 49.91 | 101.70 |
| May | 142.82 | 139.11 | 122.06 | 106.17 | 70.51 | 127.54 |

| | | | | | | |
|---|---|---|---|---|---|---|
| June | 131.44 | 82.92 | 92.71 | 98.06 | 54.10 | 101.28 |
| July | 51.98 | 38.22 | 38.54 | 50.77 | 25.13 | 44.88 |
| August | 31.31 | 29.48 | 28.92 | 28.63 | 22.28 | 29.59 |
| September | 26.08 | 22.97 | 25.75 | 24.01 | 19.50 | 24.70 |
| October | 21.42 | 18.70 | 22.13 | 20.95 | 16.80 | 20.80 |
| **Spill (kcfs)** | | | | | | |
| March | 79.58 | 6.85 | 0.02 | 0.00 | 0.51 | 21.61 |
| April | 61.29 | 40.61 | 46.18 | 32.40 | 28.99 | 45.12 |
| May | 56.98 | 42.76 | 42.73 | 62.02 | 45.48 | 51.12 |
| June | 46.24 | 30.94 | 35.66 | 53.73 | 32.29 | 41.64 |
| July | 18.26 | 17.48 | 18.62 | 19.87 | 10.02 | 18.56 |
| August | 17.05 | 16.12 | 16.18 | 12.37 | 10.17 | 15.43 |
| September | 3.74 | 0.42 | 0.29 | 0.16 | 0.16 | 1.15 |
| October | 3.17 | 0.00 | 0.00 | 0.49 | 0.75 | 0.92 |

## Fish Collection

Migration and Collection

Lower Granite juvenile facility operations started March 1 in 2020 and 2021 to support the regions request to gain information on early out migration. During the early start up period from March 1 through March 25 there was a total of 1,092 smolts collected in 2020 and 581 smolts collected in 2021. Daily collection for condition sampling in secondary bypass mode occurred from 0700 hours March 1 through April 23 and again from 0700 hours June 20 through 1110 hours July 2. Collection for condition sample and barge transport occurred from 0700 April 23 through 0700 June 20. One research barge departed LWG as part of the ongoing National Marine Fisheries Service (NMFS) seasonal effects transportation study on April 15. Collection for emergency truck transport began on July 2, instead of August 1, due to deteriorating river conditions as a result of record high regional temperatures. Collection for condition sampling and truck transport occurred from 1110 hours July 2 through 0700 hours November 1. An estimated 771,088 juvenile salmonids were collected during the 2021 season compared to 1,495,940 in 2020 (Table 2). The percent of the total collection for each species was: 18.4% clipped and 4.2% unclipped yearling Chinook salmon *Oncorhynchus tschawytscha*, 9.9% clipped and 28.9% unclipped subyearling fall Chinook salmon, 29.7% clipped and 6.0% unclipped steelhead *O. mykiss*, 0.4% clipped sockeye salmon *O. nerka*, 0.2% unclipped sockeye salmon/kokanee, and 2.3% coho salmon *O. kisutch*. Daily collection and bypass numbers are provided in Appendix Table 1.

Table 2. Annual collection, bypass, transportation and mortality at LWG, 2017-2021.

| | Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |
| **Collection** | | | | | | | | | | |
| 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 |
| 2021 | 141,518 | 32,735 | 76,606 | 222,821 | 229,147 | 45,926 | 2,722 | 1,757 | 17,856 | 771,088 |
| **Bypass** | | | | | | | | | | |
| 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 |
| 2021 | 21,753 | 12,441 | 17,635 | 57,070 | 153,371 | 18,123 | 40 | 52 | 784 | 281,269 |
| **Truck** | | | | | | | | | | |
| 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 |
| 2021 | 2 | 180 | 13,271 | 108,192 | 217 | 104 | 0 | 22 | 368 | 122,356 |
| **Barge** | | | | | | | | | | |
| 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 |
| 2021 | 119,594 | 20,087 | 45,588 | 57,172 | 75,517 | 27,687 | 2,666 | 1,662 | 16,681 | 366,654 |
| **Total Transport** | | | | | | | | | | |
| 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 |
| 2021 | 119,596 | 20,267 | 58,859 | 165,364 | 75,734 | 27,791 | 2,666 | 1,684 | 17,049 | 489,010 |
| **2021 Mortalities** | | | | | | | | | | |
| Facility | 169 | 27 | 112 | 387 | 42 | 12 | 16 | 21 | 23 | 809 |
| NMFS | 146 | 32 | 9 | 17 | 79 | 7 | 36 | 3 | 14 | 343 |
| Res/Sac | 0 | 10 | 0 | 0 | 64 | 4 | 0 | 0 | 0 | 78 |

By the end of May, 62.0% of the total season collection had occurred. The percent of total collection arriving by the end of June and the end of July was 82.7% and 94.2%, respectively. The remaining 5.8% of juvenile salmonids were collected August through November 1. Daily collection of all species combined versus total flow is shown in Figure 2. Total daily collection in 2021 peaked at 38,400 (April 17). This was the lowest peak collection day recorded at LWG and the second earliest peak collection day since 1985. The peak daily collection total and date for each species group for 2017-2021 are listed in Table 3.

Figure 2. Fish collection and daily average flows at LWG, 2021.

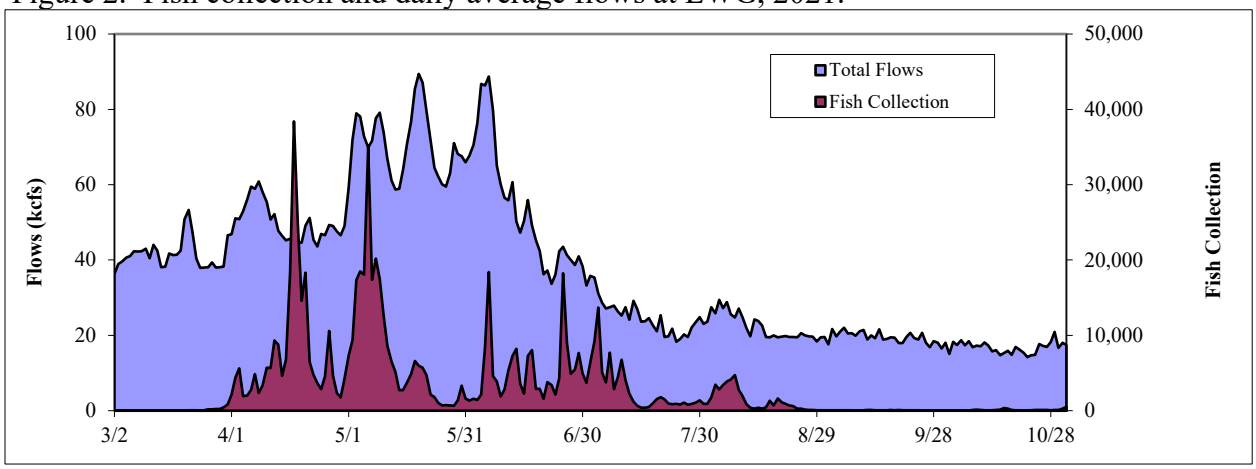

Table 3. Annual peak collection days at LWG, 2017-2021.

| | Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |
| **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 |
| **2021** | 6-May | 6-May | 6-Jun | 25-Jun | 17-Apr | 6-May | 9-May | 3-May | 7-May | 17-Apr |
| | 14,950 | 2,200 | 6,869 | 13,172 | 34,900 | 4,400 | 850 | 400 | 1,800 | 38,400 |

## Adult Fallbacks

A total of 2,070 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 during primary bypass operation prior to March 1 or after November 1. Daily adult fallbacks and fallback mortalities are in Appendix Table 4.

Table 4. Annual totals of adult salmonids released from the separator at LWG, 2017-2021.

| | Adult Chinook | | Jack chinook | | Steelhead | | Sockeye | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Totals |
| 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 |
| 2021 | 185 | 271 | 634 | 243 | 310 | 303 | 10 | 11 | 103 | 2,070 |
| 17–20 Ave. | 193 | 243 | 187 | 180 | 689 | 679 | 3 | 15 | 20 | 2,209 |

Steelhead were the most common adult salmonid species removed from the separator in 2021 (Table 5). March through May accounted for 60.1% of adult steelhead removed from the separator. The remaining 39.9% of steelhead fallbacks were removed from the separator June through November 1. The total number of steelhead fallbacks removed from the separator include out migrating kelts. Most of the Chinook adults (86.8%) were removed from the separator during September and October (fall Chinook). There were 10 clipped and 11 unclipped sockeye fallbacks released back to the river July through November 1. A total of 103 coho fallbacks were released to the river from the separator with 93 (90.3%) removed in October.

Table 5. Monthly totals of adult salmonids released from the separator at LWG, 2021.

| | Adult Chinook | | Jack Chinook | | Steelhead | | Sockeye | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Totals |
| March | 0 | 0 | 0 | 0 | 92 | 48 | 0 | 0 | 0 | 140 |
| April | 0 | 0 | 0 | 0 | 66 | 66 | 0 | 0 | 0 | 132 |
| May | 4 | 3 | 4 | 1 | 33 | 68 | 0 | 0 | 0 | 113 |
| June | 7 | 5 | 2 | 4 | 0 | 6 | 0 | 0 | 0 | 24 |
| July | 13 | 14 | 18 | 7 | 2 | 1 | 3 | 4 | 0 | 62 |
| August | 5 | 9 | 9 | 11 | 6 | 14 | 6 | 1 | 0 | 61 |
| September | 82 | 133 | 212 | 96 | 49 | 56 | 1 | 6 | 10 | 645 |
| October | 74 | 107 | 389 | 124 | 62 | 44 | 0 | 0 | 93 | 893 |
| Totals | 185 | 271 | 634 | 243 | 310 | 303 | 10 | 11 | 103 | 2,070 |

Adult salmonid condition was classified as good, fair, poor or dead prior to being released from the separator (Table 6). Overall, 96.1% of fallback condition was classified as good to fair. Condition ratings of adult salmonids examined were as follows: 86.4% good, 9.7% fair, 3.5% poor, and 0.4% mortalities. Adult salmonid mortalities included: 2 unclipped Chinook, 5 clipped and 1 unclipped steelhead (mostly steelhead kelts) and 1 coho. Jack Chinook had the highest percent of good/fair fish (99.5%) followed by adult Chinook of good/fair fish (97.4%) and steelhead (90.2%). There were 18 adult lamprey (*Entosphenus tridentatus*) collected at the juvenile facility and released at Offield Landing boat ramp (6 raceway, and 12 sample tank).

Table 6. Condition of adult salmonids released from the separator at LWG, 2021.

| | Adult Chinook | | Jack chinook | | Steelhead | | Sockeye | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Totals |
| Good | 168 | 253 | 619 | 235 | 191 | 235 | 5 | 9 | 74 | 1,789 |
| Fair | 11 | 12 | 12 | 7 | 77 | 50 | 2 | 2 | 27 | 200 |
| Poor | 6 | 4 | 3 | 1 | 37 | 17 | 3 | 0 | 1 | 72 |
| Dead | 0 | 2 | 0 | 0 | 5 | 1 | 0 | 0 | 1 | 9 |
| Total | 185 | 271 | 634 | 243 | 310 | 303 | 10 | 11 | 103 | 2,070 |

## Sampling

Consistent with the 2021 Fish Operations Plan (FOP), Appendix E of the 2021 FPP, and guidance provided by the Regional Implementation Oversight Group (RIOG) through the Technical Management Team (TMT), the juvenile fish transportation program allows for variable start and end dates based on fish survival, adult returns, current in-river conditions, and water supply forecasts data. All fish collected that are not needed for research are 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. NMFC performed juvenile research for their seasonal effects transportation and survival studies this season after not conducting it in 2020 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 of 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 50% 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. An unusually large number of unclipped sockeye salmon/kokanee were observed in the daily sample when collection began March 2 and continued through April. Initially these fish in the condition sample were classified as unclipped sockeye salmon per FPC guidelines although they were assumed to be kokanee from Dworshak Reservoir. Discussions occurred between the management agencies, and the decision was made March 12 to begin classifying these fish as kokanee and not wild sockeye salmon. Fish collected prior to March 12 were also reclassified as kokanee. These fish averaged 93.4 millimeters (mm), with lengths between 66 mm and 120 mm long. This season there were 5,744 unclipped sockeye salmon/kokanee collected in the condition sample March 2 through April 30 compared to 11 in 2020 and 55 for the 2015-2019 average. Genetic samples were taken from 138 unclipped sockeye salmon/kokanee confirming that these fish were kokanee and not unclipped sockeye salmon from the Salmon River's Stanley Basin. The smolt monitoring staff sampled 49,737 smolts or 6.5% of the total facility collection during 2021 compared to 63,608 smolts or 4.3% of the total facility collection in 2020 (Table 7).

Table 7. Annual percentage of smolts sampled at LWG, 2017-2021.

| | Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |
| 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 |
| 2021 | 4.3 | 6.1 | 7.9 | 10.0 | 4.1 | 5.9 | 3.8 | 6.7 | 5.7 | 6.5 |
| 17–20 Ave. | 0.7 | 0.9 | 3.7 | 7.6 | 0.8 | 0.8 | 0.6 | 2.3 | 1.0 | 1.3 |

The percent of the total smolts sampled in 2021 by species included: 12.2% clipped and 4.0% unclipped yearling Chinook, 12.1% clipped and 44.9% unclipped subyearling Chinook, 18.8% clipped and 5.5% unclipped steelhead, 0.2% clipped and 0.2% unclipped sockeye/kokanee, and 2.0% coho (Table 8).

Table 8. Weekly sample totals at LWG, 2021.

| Week | Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ending | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |
| 4-Mar | 0 | 14 | 0 | 4 | 6 | 16 | 0 | 0 | 5 | 45 |
| 11-Mar | 2 | 25 | 0 | 18 | 13 | 42 | 0 | 0 | 3 | 103 |
| 18-Mar | 1 | 24 | 0 | 8 | 7 | 29 | 0 | 0 | 4 | 73 |
| 25-Mar | 5 | 27 | 0 | 40 | 8 | 62 | 0 | 0 | 0 | 142 |
| 1-Apr | 485 | 406 | 0 | 49 | 769 | 399 | 2 | 0 | 1 | 2,111 |
| 8-Apr | 1,063 | 359 | 0 | 18 | 1,118 | 155 | 0 | 0 | 0 | 2,713 |
| 15-Apr | 333 | 144 | 0 | 26 | 1,509 | 244 | 0 | 0 | 2 | 2,258 |
| 22-Apr | 158 | 108 | 0 | 8 | 2,276 | 211 | 0 | 0 | 3 | 2,764 |
| 29-Apr | 528 | 126 | 0 | 13 | 667 | 126 | 0 | 0 | 2 | 1,462 |
| 6-May | 1,563 | 315 | 0 | 17 | 1,063 | 295 | 0 | 31 | 113 | 3,397 |
| 13-May | 776 | 114 | 23 | 33 | 394 | 183 | 50 | 7 | 88 | 1,668 |
| 20-May | 839 | 107 | 71 | 101 | 437 | 270 | 29 | 14 | 303 | 2,171 |
| 27-May | 183 | 78 | 152 | 252 | 505 | 286 | 8 | 17 | 86 | 1,567 |
| 3-Jun | 82 | 45 | 780 | 931 | 366 | 228 | 6 | 17 | 119 | 2,574 |
| 10-Jun | 35 | 36 | 1,517 | 2,164 | 169 | 109 | 8 | 3 | 178 | 4,219 |
| 17-Jun | 2 | 12 | 1,336 | 1,436 | 12 | 11 | 0 | 4 | 30 | 2,843 |
| 24-Jun | 0 | 3 | 740 | 1,172 | 14 | 9 | 1 | 3 | 19 | 1,961 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1-Jul | 0 | 4 | 385 | 1,352 | 6 | 3 | 0 | 1 | 14 | 1,765 |
| 8-Jul | 0 | 6 | 276 | 1,332 | 3 | 2 | 0 | 0 | 8 | 1,627 |
| 15-Jul | 0 | 2 | 110 | 784 | 5 | 2 | 0 | 0 | 3 | 906 |
| 22-Jul | 0 | 1 | 136 | 1,151 | 6 | 11 | 0 | 1 | 3 | 1,309 |
| 29-Jul | 0 | 0 | 125 | 1,141 | 6 | 0 | 0 | 0 | 7 | 1,279 |
| 5-Aug | 0 | 0 | 221 | 2,084 | 0 | 3 | 0 | 0 | 2 | 2,310 |
| 12-Aug | 0 | 0 | 49 | 1,181 | 0 | 0 | 0 | 0 | 0 | 1,230 |
| 19-Aug | 0 | 2 | 25 | 1,627 | 0 | 1 | 0 | 0 | 2 | 1,657 |
| 26-Aug | 0 | 0 | 13 | 678 | 0 | 0 | 0 | 0 | 2 | 693 |
| 2-Sep | 0 | 1 | 1 | 338 | 1 | 0 | 0 | 0 | 2 | 343 |
| 9-Sep | 0 | 0 | 5 | 328 | 2 | 1 | 0 | 1 | 0 | 337 |
| 16-Sep | 1 | 4 | 12 | 405 | 2 | 2 | 0 | 1 | 5 | 432 |
| 23-Sep | 0 | 1 | 6 | 464 | 2 | 1 | 0 | 1 | 1 | 476 |
| 30-Sep | 0 | 1 | 3 | 135 | 1 | 2 | 0 | 0 | 3 | 145 |
| 7-Oct | 0 | 1 | 4 | 81 | 3 | 0 | 0 | 1 | 0 | 90 |
| 14-Oct | 0 | 0 | 10 | 519 | 2 | 7 | 0 | 4 | 1 | 543 |
| 21-Oct | 0 | 0 | 9 | 964 | 1 | 3 | 0 | 1 | 2 | 980 |
| 28-Oct | 0 | 0 | 5 | 547 | 1 | 1 | 0 | 5 | 0 | 559 |
| 1-Nov | 1 | 18 | 17 | 942 | 0 | 1 | 0 | 6 | 0 | 985 |
| Total | 6,057 | 1,984 | 6,031 | 22,343 | 9,374 | 2,715 | 104 | 118 | 1,011 | 49,737 |

Transportation

An estimated 489,010 juvenile salmonids were transported from Lower Granite Dam in 2021 by barge and truck combined. This is 15.8% of the five-year average number of fish transported from LWG. The number transported was 63.4% of the total facility collection. The percentage of the total collection that was transported of each species group from Lower Granite included 84.5% clipped and 61.9% unclipped yearling Chinook, 76.8% clipped and 74.2% unclipped subyearling Chinook, 33.3% clipped and 60.5% unclipped steelhead, 97.9% clipped and 95.8% unclipped sockeye/kokanee, and 95.5% coho. Daily barge transportation numbers are provided in Appendix Table 2.

Collection for the NMFS seasonal effects study to compare transport and in-river smolt to adult returns (SARs) occurred on April 13 and April 14. These fish were transported on a research barge April 15. Collection for general barge transport occurred 0700 hours April 23 through 0700 hours June 20 from Lower Granite. Everyday barging operations occurred April 24 through May 17. Every other day barging from Lower Granite occurred May 19 through June 20. An estimated 366,654 juvenile salmonids were transported by barge from Lower Granite Dam in 2021. The percentage transported by barge was 47.6% of the total facility collection and for each species group included 84.5% clipped and 61.4% unclipped yearling Chinook, 59.5% clipped and 25.7% unclipped subyearling Chinook, 33.0% clipped and 60.3% unclipped steelhead, 97.9% clipped and 94.6% unclipped sockeye/kokanee, and 93.4% coho. A total of 831,861 smolts were barged from Lower Granite, Little Goose (LGO), and Lower Monumental (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.

Emergency collection for truck transport began July 2 due to deteriorated river conditions due to extreme regional temperatures. Lower Granite transported 122,356 smolts by truck which is 15.9% of the total juvenile collection. Fish were trucked in a 300-gallon tank mounted on a

pickup, 1000-gallon tank mounted on a flatbed, or in a 3500-gallon semi-truck trailer July 4 through November 1. There were 61 truck trips this season with 5 using the semi-truck, 23 using the flatbed, and 33 using the pickup. Lower Granite transported 36,531 fish collected at LGO on 6 separate trips in July and August. The number of smolts trucked from LWG by species included: 2 clipped and 180 unclipped yearling Chinook, 13,271 clipped and 108,192 unclipped subyearling Chinook, 207 clipped and 104 unclipped steelhead, 22 unclipped sockeye/kokanee, and 368 coho. The number of smolts trucked from Little Goose with Lower Granite smolts by species included: 5,287 clipped and 30,844 unclipped subyearling Chinook, 258 clipped and 112 unclipped steelhead and 30 coho. Water temperatures and oxygen levels were monitored to ensure acceptable levels in transport tanks. River water at the release site or river water ice is added to temper truck transport tanks when needed to ensure temperature are within 1-2ºF of Bonneville tailrace.

Bypass

Lower Granite juvenile system was watered up in primary bypass February 23 with fish being returned directly to the river through the outfall pipe. Collection for condition sampling began at 0700 hours March 1. The facility was operated in secondary bypass mode for condition sampling March 1 through April 23 and again from June 21 to 1110 hours July 2. An estimated 281,269 juvenile salmonids, 36.5% of the total collection, were bypassed directly back to the river from the juvenile collection facility during the 2021 season. The number of bypassed fish was estimated based on the 0700-0700 daily sample. There were 184,098 juvenile salmonids, 23.9% of the total collection, bypassed March 1 to April 23. Another 74,531 juvenile salmonids, 9.7% of the total collection, were bypassed from June 20 to July 2. During collection for transport season 22,640 juvenile salmonids were bypassed from the collection facility. The percent of the total collection of each species bypassed included 15.4% clipped and 38.0% unclipped yearling Chinook, 23.0% clipped and 25.6% unclipped subyearling Chinook, 66.9% clipped and 39.5% unclipped steelhead, 1.5% clipped and 3.0% unclipped sockeye/kokanee, and 4.4% coho. Facility bypass estimates include all fish bypassed to the tailrace during secondary bypass operation when collection for transport did not occur. Bypassed fish include, GBT fish prior to April 24, fish collected and provided for research needs, and steelhead during late season trucking operations. Fish provided for research needs are recorded as bypassed including research mortalities. There were 78 research mortalities reported during 2021. There were 343 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. The juvenile system was operated in primary bypass mode November 1-December 21.

1. The facility was operated in primary bypass from 0700 hours November 1 until the juvenile bypass was dewater for winter maintenance December 6. ESBSs were installed February 23-25 and removed December 1-3.
2. Secondary bypass occurred from March 1 through April 23 and from June 21 to 1110 hours on July 2. Sampling occurred during these time periods for fish condition monitoring (COE). Fish sampled during this period are included in the facility bypass

total.

3. GBT inspections during the period of April 8 through April 22 accounted for a total of 224 fish bypassed. Within each species group the number bypassed was 57 clipped and 34 unclipped yearling Chinook, 122 clipped and 11 unclipped steelhead.
4. As part of research projects 28,666 fish were collected and bypassed (See; Research Section).
5. The PTAGIS database revealed that 9,191 PIT-tagged fish of different species were bypassed through the PIT tag system at the fish facility. These fish are not included in the facility bypass total.

According to the PTAGIS database, 23,719 PIT-tagged fish were detected in the LWG juvenile collection facility in 2021. Of the detected fish 38.7% were bypassed to the LWG tailrace through the PIT-tag diversion system, 57.9% were diverted to the raceways to be transported, 3.1% were diverted to the sample tank, and 0.2% were not detected at an exit monitor and their disposition was unknown. There were also 251,434 PIT-tagged fish detected passing over the 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, except for fish collected on April 13, April 14, April 22, and April 23 for the NMFS transportation study.

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 1,281,744 incidental species were collected at the fish facility during the March 1 to November 1 passage period compared to 354,863 in 2020 (Table 9). This is the highest collection of incidental species since at least 1999. Siberian prawns, smallmouth bass, and bullhead catfish had their highest number collected at the fish facility since 1999. Siberian prawns were the most abundant incidental species during the 2021 season with an estimated 1,179,365 collected compared to 145,030 in 2020. 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 their agencies permit requirements. Juvenile shad collection was the second highest since at least 1999 at 3,639. Pacific lamprey ammocoete collection was 11,996 compared to 99,399 in 2020 but is still the second highest since at least 1999. Pacific Lamprey macrophthalmia collection decreased from 81,810 in 2020 to 40,159 this season and is the fourth highest since 1999.

Table 9. Estimated collection of incidental fish species at LWG, 2021.

| Common Name | *Scientific Name* | Separator | Expanded Sample | Total Collection [1] |
|---|---|---|---|---|
| American Shad (Adult) | *Alosa sapidissima* | 88 | 43 | 131 |
| American Shad (Juvenile) | *A. sapidissima* | | 3,639 | 3,639 |
| Banded Killifish | *Fundulus diaphanus* | | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| Bass, Largemouth | *Micropterus salmoides* | | 0 | 0 |
| Bass, Smallmouth | *M. dolomieui* | 4 | 15,376 | 15,380 |
| Bullhead (misc.) | *Amierus sp.* | | 750 | 750 |
| Catfish, Channel | *Ictalurus punctatus* | 37 | 270 | 307 |
| Catfish, Flathead | *Pylodictis olivaris* | | 0 | 0 |
| Chiselmouth | *Acrocheilus alutaceus* | 1 | 36 | 37 |
| Common Carp | *Cyprinus carpio* | 4 | 11 | 15 |
| Crappie (misc) | *Pomoxis sp.* | 4 | 1,481 | 1,485 |
| Dace, Longnose | *Rhinichthys cataractae* | | 26 | 26 |
| Dace, Speckled | *R. osculus* | | 0 | 0 |
| Kokanee[2] | *Oncorhynchus nerka* | | 18,226 | 18,226 |
| Northern Pikeminnow | *Ptychocheilus oregonensis* | 1 | 274 | 275 |
| Pacific Lamprey (Adult) | *Entosphenus tridentatus* | 0 | 20 | 20 |
| Pacific Lamprey (Ammocoete) | *E. tridentatus* | | 11,996 | 11,996 |
| Pacific Lamprey (Macrophthalmia) | *E. tridentatus* | | 40,159 | 40,159 |
| Peamouth | *Mylocheilus caurinus* | 5 | 2,053 | 2,058 |
| Redside Shiner | *Richardsonius balteatus* | | 0 | 0 |
| Sand Roller | *Percopsis transmontana* | | 2,032 | 2,032 |
| Sculpin | *Cottus sp.* | | 277 | 277 |
| Siberian Prawn | *Exopalaemon modestus* | | 1,179,365 | 1,179,365 |
| Sucker (misc.) | *Catostomus sp.* | 349 | 3,432 | 3,781 |
| Sunfish (misc.) | *Lepomis sp.* | | 377 | 377 |
| Trout, Bull | *Salvelinus Malma* | 2 | 0 | 2 |
| Trout, Cutthroat | *Oncorhynchus clarkii* | | 0 | 0 |
| Trout, Rainbow | *O. mykiss* | 80[3] | 16[4] | 96 |
| Walleye | *Stizostedion vitreum* | 11 | 3 | 14 |
| Warmouth | *Lepomis gulosis* | | 0 | 0 |
| White Sturgeon | *Acipenser transmontanus* | 3 | 0 | 3 |
| Whitefish | *Prosopium sp.* | 11 | 1,275 | 1,286 |
| Yellow Perch | *Perca flavescens* | 3 | 1 | 4 |
| Total | | 603 | 1,281,141 | 1,281,744 |

[1]Separator count plus expanded sample count equals estimated total facility collection.
[2]Unclipped *Oncorhynchus nerka* not CWT or PIT-tagged and >200mm, and those sampled from March 2 to May 1.
[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 sample rather than the portion of the sample used for condition monitoring.

The descaling rate for all fish sampled in 2021 was 1.5% compared to 1.1% in 2020 and 1.3% for the 2017 to 2020 average (Table 10). The annual descaling rate by species group was 1.5% clipped and 1.6% unclipped yearling Chinook salmon, 0.9% clipped and 0.7% unclipped subyearling Chinook, 2.8% clipped and 2.8% unclipped steelhead, 9.9% clipped and 7.3% unclipped sockeye/kokanee and 2.0% Coho

Table 10. Annual full-sample descaling rates (>20%) by species at LWG, 2017-2021.

| Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | |
|---|---|---|---|---|---|---|---|---|---|
| Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 2021 | 1.5 | 1.6 | 0.9 | 0.7 | 2.8 | 2.8 | 9.9 | 7.3 | 2.0 | 1.5 |
| 17–20 Ave. | 1.4 | 0.8 | 0.7 | 0.8 | 2.5 | 2.2 | 1.3 | 4.3 | 1.2 | 1.3 |

The highest weekly descaling rate for all species combined was 4.6% for the week ending March 18 (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 only slightly in September and October in 2021. The highest descaling rates were observed in early March, May, and early June this season. The lowest descaling rates are generally during June and July when small subyearling Chinook salmon dominate the collection. This season the lowest weekly descaling rates were observed from the last two weeks of June through September. Clipped sockeye collected at the juvenile fish facility in late May and early June exhibited high rates of caudal fin rot, fungus and descaling. IDFG determined these maladies were due to rearing and release conditions related to differences in water hardness levels between the hatchery and release locations, and not Lower Granite operation. Daily descaling rates are provided in Appendix, Table 3.

Table 11. Weekly descaling rates in percent for fish sampled at LWG, 2021.

| | Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| Week Ending | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |
| 4-Mar | -- | 0.00% | -- | -- | 0.00% | 6.25% | -- | -- | 0.00% | 2.44% |
| 11-Mar | 0.00% | 0.00% | -- | -- | 0.00% | 4.76% | -- | -- | 0.00% | 2.35% |
| 18-Mar | 0.00% | 8.33% | -- | -- | 0.00% | 3.45% | -- | -- | 0.00% | 4.62% |
| 25-Mar | 20.00% | 3.70% | -- | -- | 0.00% | 0.00% | -- | -- | -- | 1.96% |
| 1-Apr | 1.93% | 1.49% | -- | -- | 0.26% | 2.27% | 0.00% | -- | 0.00% | 1.28% |
| 8-Apr | 1.14% | 1.97% | -- | -- | 0.99% | 1.29% | -- | -- | -- | 1.19% |
| 15-Apr | 1.52% | 0.70% | -- | -- | 1.26% | 1.64% | -- | -- | 0.00% | 1.30% |
| 22-Apr | 1.90% | 1.85% | -- | -- | 0.75% | 0.00% | -- | -- | 0.00% | 0.80% |
| 29-Apr | 1.34% | 0.81% | -- | -- | 3.00% | 0.79% | -- | -- | 0.00% | 2.01% |
| 6-May | 0.97% | 0.96% | -- | -- | 5.47% | 4.41% | -- | 0.00% | 0.89% | 2.68% |
| 13-May | 1.55% | 1.75% | 0.00% | 0.00% | 8.18% | 3.85% | 12.50% | 14.29% | 2.27% | 3.79% |
| 20-May | 1.92% | 0.00% | 0.00% | 0.00% | 6.90% | 3.33% | 3.57% | 7.69% | 1.99% | 2.96% |
| 27-May | 3.87% | 3.90% | 1.37% | 1.95% | 6.55% | 2.80% | 0.00% | 0.00% | 4.76% | 4.05% |
| 3-Jun | 3.66% | 0.00% | 0.64% | 1.15% | 6.56% | 5.29% | 33.33% | 12.50% | 0.00% | 2.31% |
| 10-Jun | 2.86% | 0.00% | 2.38% | 2.02% | 7.14% | 5.50% | 12.50% | 0.00% | 1.70% | 2.45% |
| 17-Jun | 0.00% | 0.00% | 0.23% | 0.37% | 8.33% | 18.18% | -- | 0.00% | 0.00% | 0.40% |
| 24-Jun | -- | 33.33% | 0.54% | 0.70% | 7.14% | 0.00% | 0.00% | 0.00% | 10.53% | 0.83% |
| 1-Jul | -- | 0.00% | 0.52% | 0.22% | 0.00% | 0.00% | -- | 0.00% | 0.00% | 0.29% |
| 8-Jul | -- | 16.67% | 1.09% | 0.53% | 0.00% | 0.00% | -- | -- | 12.50% | 0.74% |
| 15-Jul | -- | 0.00% | 0.00% | 0.77% | 0.00% | 0.00% | -- | -- | 0.00% | 0.67% |
| 22-Jul | -- | 0.00% | 0.00% | 0.35% | 0.00% | 0.00% | -- | 0.00% | 0.00% | 0.31% |
| 29-Jul | -- | -- | 0.00% | 0.26% | 0.00% | -- | -- | -- | 0.00% | 0.24% |
| 5-Aug | -- | -- | 0.45% | 0.19% | -- | 0.00% | -- | -- | 0.00% | 0.22% |
| 12-Aug | -- | -- | 2.08% | 0.51% | -- | -- | -- | -- | -- | 0.57% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 19-Aug | -- | 0.00% | 0.00% | 0.31% | -- | 0.00% | -- | -- | 0.00% | 0.30% |
| 26-Aug | -- | -- | 0.00% | 0.45% | -- | -- | -- | -- | 0.00% | 0.44% |
| 2-Sep | -- | 0.00% | 0.00% | 0.89% | 0.00% | -- | -- | -- | 0.00% | 0.88% |
| 9-Sep | -- | -- | 0.00% | 0.61% | 0.00% | 0.00% | -- | -- | -- | 0.60% |
| 16-Sep | 0.00% | 25.00% | 0.00% | 0.99% | 0.00% | 0.00% | -- | 0.00% | 0.00% | 1.16% |
| 23-Sep | -- | 0.00% | 0.00% | 0.65% | 0.00% | 0.00% | -- | 0.00% | 0.00% | 0.63% |
| 30-Sep | -- | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | -- | -- | 33.33% | 0.69% |
| 7-Oct | -- | 0.00% | 0.00% | 2.47% | 0.00% | -- | -- | 0.00% | -- | 2.22% |
| 14-Oct | -- | -- | 0.00% | 2.33% | 0.00% | 0.00% | -- | 25.00% | 0.00% | 2.41% |
| 21-Oct | -- | -- | 0.00% | 1.15% | 0.00% | 0.00% | -- | 0.00% | 0.00% | 1.13% |
| 28-Oct | -- | -- | 0.00% | 1.10% | 0.00% | 0.00% | -- | 0.00% | -- | 1.07% |
| 1-Nov | 0.00% | 0.00% | 0.00% | 0.64% | -- | 0.00% | -- | 50.00% | -- | 0.92% |
| # Descaled | 91 | 31 | 57 | 159 | 260 | 77 | 10 | 8 | 20 | 713 |
| # Sampled | 6,001 | 1,969 | 6,004 | 21,693 | 9,353 | 2,710 | 101 | 110 | 1,003 | 48,944 |
| % Descaled | 1.52% | 1.57% | 0.95% | 0.73% | 2.78% | 2.84% | 9.90% | 7.27% | 1.99% | 1.46% |

## Injuries and Disease

Injury and disease data gathered from a subsample of 100 of the dominant species and not more than 100 each of the non-dominant species. There were 26,055 fish examined for injury and disease and 6,202 fish (23.8%) were afflicted with an injury or disease symptom in 2021. 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 2021. 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 19.3% 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 2021 was fin discoloration (40.5%), followed by general fin injury (37.6%), pink fin (17.7%), body injury (2.7%), and body deformities (1.5%). Clipped sockeye salmon had the highest incidence of body injuries (33.0%), followed by unclipped yearling Chinook salmon (27.0%), clipped yearling Chinook salmon (25.1%), and clipped subyearling fall Chinook salmon (19.6%).

Head injuries were recorded on 0.6% of the smolts examined in the detailed subsample. Clipped sockeye salmon had the highest incidence of head injury (1.9%), followed by unclipped sockeye salmon/kokanee (1.9%) and clipped (1.6%) and unclipped (1.2%) yearling Chinook salmon. Operculum injuries (34.5%) were the most frequently observed type of head injury, followed by eye injuries (24.4%), eye hemorrhages (19.6%), general head injuries (12.5%), and "pop" eye (8.9%).

Injuries associated with predators include wounds inflicted by other fish, birds, and lamprey. Predator wounds were observed on 1.0% 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 51.9% compared to 28.0% caused by lamprey and 20.1% caused by fish. Predator marks were highest on clipped sockeye salmon (2.0%), unclipped steelhead (1.8%), clipped steelhead (1.5%) and unclipped subyearling fall Chinook salmon (1.0%). Injuries caused by lamprey were observed on 0.02% of all condition sampled smolts in the sample in 2020 compared to 0.53% of smolts this season.

External symptoms of disease were observed on 4.5% of the smolts examined in the detailed subsample compared to 4.7 in 2020, 6.5% in 2019, 5.9% in 2018 and 2.9% in 2017. Symptoms of disease were most common on clipped sockeye salmon (16.0%), followed by unclipped subyearling Chinook (6.2%) and clipped subyearling Chinook (4.7%). Of the fish afflicted, fin hemorrhages comprised the majority of disease symptoms (72.5%), followed by fungus (15.5%), parasites (7.7%), Columnaris (2.7%), and bacterial kidney disease (1.5%).

Fin hemorrhage was found on 3.3% of all species and rearing types examined. Fin hemorrhage was the primary disease afflicting subyearling Chinook and was observed on 5.6% of unclipped and 4.2% 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 all 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 4. The 2021 Columnaris infection rate for subyearling Chinook was 0.1% (33 of 27,697) compared to 2017-2020 average of 0.6%.

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 only NMFS research fish. Mortalities removed from east raceways when used exclusively for NMFS studies are included in bypassed fish and are considered research mortalities not facility mortalities. Annual facility mortality for all groups combined was 0.10% in 2021 and totaled 809 fish (Table 12). Within each species group the number of facility mortalities were 169 clipped and 27 unclipped yearling Chinook, 112 clipped and 387 unclipped subyearling Chinook, 42 clipped and 12 unclipped steelhead, 16 clipped and 21 unclipped sockeye/kokanee, and 23 coho.

Table 12. Annual facility mortality in percent by species group at LWG, 2017-2021.

| | Yearling Chinook | Subyearling Chinook | Steelhead | Sockeye/Kokanee | Coho |
|---|---|---|---|---|---|

| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 2021 | 0.12 | 0.08 | 0.15 | 0.17 | 0.02 | 0.03 | 0.59 | 1.20 | 0.13 | 0.10 |
| 17-20 Ave. | 0.07 | 0.05 | 0.37 | 0.42 | 0.01 | 0.01 | 0.11 | 0.48 | 0.06 | 0.08 |

Weekly facility mortality rates were highest during March and October and peaked at 3.88% the week ending on March 11. Weekly facility mortality rates are provided in Table 13.

Table 13. Weekly facility mortality in percent by species group at LWG, 2021.

| | Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| Week Ending | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |
| 4-Mar | -- | 0.00% | -- | 25.00% | 0.00% | 0.00% | -- | -- | 0.00% | 2.00% |
| 11-Mar | 0.00% | 0.00% | -- | 22.22% | 0.00% | 0.00% | -- | -- | 0.00% | 3.88% |
| 18-Mar | 0.00% | 0.00% | -- | 6.25% | 0.00% | 0.00% | -- | -- | 0.00% | 0.69% |
| 25-Mar | 0.00% | 0.00% | -- | 1.25% | 0.00% | 0.00% | -- | -- | -- | 0.35% |
| 1-Apr | 1.86% | 0.49% | -- | 9.18% | 0.07% | 0.25% | 0.00% | -- | 0.00% | 0.81% |
| 8-Apr | 0.11% | 0.10% | -- | 1.88% | 0.02% | 0.07% | -- | -- | -- | 0.08% |
| 15-Apr | 0.08% | 0.08% | -- | 0.61% | 0.01% | 0.00% | -- | -- | 0.00% | 0.03% |
| 22-Apr | 0.00% | 0.00% | -- | 0.00% | 0.00% | 0.00% | -- | -- | 0.00% | 0.00% |
| 29-Apr | 0.07% | 0.19% | -- | 0.37% | 0.01% | 0.04% | -- | -- | 0.00% | 0.05% |
| 6-May | 0.10% | 0.08% | -- | 0.69% | 0.03% | 0.00% | -- | 0.37% | 0.14% | 0.07% |
| 13-May | 0.13% | 0.06% | 0.21% | 0.28% | 0.02% | 0.01% | 0.51% | 0.57% | 0.04% | 0.10% |
| 20-May | 0.13% | 0.00% | 0.40% | 0.47% | 0.08% | 0.00% | 0.75% | 0.95% | 0.09% | 0.13% |
| 27-May | 0.41% | 0.33% | 0.73% | 0.66% | 0.19% | 0.00% | 1.43% | 2.94% | 0.43% | 0.35% |
| 3-Jun | 0.00% | 0.00% | 0.43% | 0.45% | 0.00% | 0.10% | 0.00% | 4.05% | 0.20% | 0.34% |
| 10-Jun | 0.42% | 0.00% | 0.36% | 0.32% | 0.16% | 0.43% | 2.63% | 0.00% | 0.21% | 0.33% |
| 17-Jun | 0.00% | 0.00% | 0.03% | 0.07% | 0.56% | 0.59% | -- | 0.00% | 0.43% | 0.06% |
| 24-Jun | -- | 0.00% | 0.02% | 0.04% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.03% |
| 1-Jul | -- | 0.00% | 0.04% | 0.02% | 0.49% | 0.92% | -- | 0.00% | 0.00% | 0.03% |
| 8-Jul | -- | 0.00% | 0.05% | 0.13% | 0.00% | 0.00% | -- | -- | 0.43% | 0.11% |
| 15-Jul | -- | 0.00% | 0.08% | 0.06% | 0.00% | 0.00% | -- | -- | 0.00% | 0.07% |
| 22-Jul | -- | 0.00% | 0.36% | 0.38% | 0.00% | 0.00% | -- | 40.00% | 4.17% | 0.43% |
| 29-Jul | -- | -- | 0.00% | 0.37% | 0.00% | -- | -- | -- | 0.00% | 0.33% |
| 5-Aug | -- | -- | 0.07% | 0.20% | -- | 6.67% | -- | -- | 0.00% | 0.19% |
| 12-Aug | -- | -- | 0.27% | 0.19% | -- | -- | -- | -- | -- | 0.20% |
| 19-Aug | -- | 0.00% | 0.00% | 0.12% | -- | 0.00% | -- | -- | 8.33% | 0.14% |
| 26-Aug | -- | -- | 0.00% | 0.26% | -- | -- | -- | -- | 0.00% | 0.25% |
| 2-Sep | -- | 0.00% | 0.00% | 0.80% | 0.00% | -- | -- | -- | 0.00% | 0.79% |
| 9-Sep | -- | -- | 20.00% | 0.61% | 0.00% | 0.00% | -- | 100.00% | -- | 1.19% |
| 16-Sep | 0.00% | 0.00% | 0.00% | 0.74% | 0.00% | 0.00% | -- | 100.00% | 0.00% | 0.93% |
| 23-Sep | -- | 0.00% | 0.00% | 0.43% | 0.00% | 0.00% | -- | 0.00% | 0.00% | 0.42% |
| 30-Sep | -- | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | -- | -- | 0.00% | 0.00% |
| 7-Oct | -- | 0.00% | 0.00% | 0.00% | 0.00% | -- | -- | 0.00% | -- | 0.00% |
| 14-Oct | -- | -- | 0.00% | 1.54% | 0.00% | 0.00% | -- | 25.00% | 0.00% | 1.66% |
| 21-Oct | -- | -- | 0.00% | 0.62% | 0.00% | 0.00% | -- | 100.00% | 0.00% | 0.71% |
| 28-Oct | -- | -- | 0.00% | 0.55% | 0.00% | 0.00% | -- | 0.00% | -- | 0.54% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1-Nov | 0.00% | 0.00% | 0.00% | 0.21% | -- | 0.00% | -- | 0.00% | -- | 0.20% |
| # mortalities | 169 | 27 | 112 | 387 | 42 | 12 | 16 | 21 | 23 | 809 |
| # collected | 141,518 | 32,735 | 76,606 | 222,821 | 229,147 | 45,926 | 2,722 | 1,757 | 17,856 | 771,088 |
| % mortality | 0.12% | 0.08% | 0.15% | 0.17% | 0.02% | 0.03% | 0.59% | 1.20% | 0.13% | 0.10% |

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 0.57% in 2021 (Table 14) and totaled 284 fish. This is the highest sample mortality rate since 2018. The number of sample mortalities and percent mortality by species group included 56 clipped (0.92%) and 15 unclipped (0.76%) yearling Chinook salmon, 27 clipped (0.45%) and 141 (0.63%) unclipped subyearling fall Chinook salmon, 21 clipped (0.22%) and 5 unclipped (0.18%) steelhead, 3 clipped sockeye salmon (2.88%), 8 unclipped sockeye salmon/kokanee (6.78%), and 8 coho salmon (0.79%). All species groups sample mortality rates were higher than the 2017 to 2020 average except for clipped and unclipped subyearling Chinook and unclipped steelhead. Sample mortality for all groups combined since 2017 has ranged from a high of 0.86% in 2017 to a low of 0.45% in 2019.

Table 14. Annual sample mortality by species group in percent at LWG, 2017-2021.

| | Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |
| 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 |
| 2021 | 0.92 | 0.76 | 0.45 | 0.63 | 0.22 | 0.18 | 2.88 | 6.78 | 0.79 | 0.57 |
| 17–20 Ave. | 0.39 | 0.44 | 0.74 | 0.84 | 0.21 | 0.26 | 0.82 | 4.56 | 0.30 | 0.57 |

Barge mortalities are salmonids removed from barge holds after the barges depart LWG. The total number of smolts barged in 2021 included: 366,654 fish from LWG, 256,026 from LGS, and 209,181 fish from LMN. The seasonal barge transport program mortality rate was 0.03% (211 of 823,861) (Table 16). Barge mortalities by species group included: 96 clipped and 14 unclipped yearling Chinook, 4 clipped and 2 unclipped subyearling Chinook, 82 clipped and 12 unclipped steelhead, and 1 unclipped sockeye salmon/kokanee (Table 15).

Table 15. Total annual transport program barge mortalities 2017-2021.

| | Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | Unknown | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Others | Total |
| 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 |
| 2021 | 96 | 14 | 4 | 2 | 82 | 12 | 0 | 1 | 0 | 0 | 211 |
| 17–20 Ave. | 1,560 | 413 | 185 | 264 | 449 | 187 | 31 | 14 | 8 | 0 | 3,111 |

The truck transport fish mortality rate in 2021 was 0.05% (67 of 122,356) (Table 16). The 3500-gallon semi-truck was used for the July 4, August 5, August 7, and August 9 trips. The 1000-

gallon tank was used for all trips from July 6 through August 27, except for the August 5, August 7, and August 9 semi-truck trips. The 300-gallon tank was used for all trips from August 29 through November 1. The trips on July 14, July 16, July 18, August 5, August 7 and August 9 also picked up fish from LGS. Fish transported from LGS with LWG fish totaled 36,531 smolts. A total of 122,356 fish were collected and transported by truck from LWG. Truck mortality number and percent by species included: 15 clipped (0.11%) and 48 unclipped (0.04%) subyearling fall Chinook salmon, 2 unclipped steelhead (1.92%) and 2 unclipped sockeye salmon/kokanee (9.09%).

Table 16. Annual percent truck mortality at LWG, 2017 -2021.

| | Yearling Chinook | | Subyearling Chinook | | Steelhead | | Sockeye/Kokanee | | Coho | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | Clipped | No Clip | All | Total |
| 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 |
| 2021 | 0.00 | 0.00 | 0.11 | 0.04 | 0.00 | 1.92 | -- | 0.00 | 0.00 | 0.05 |
| 17-20 Ave. | 0.00 | 1.18 | 0.60 | 0.09 | 0.00 | 0.00 | -- | 4.69 | 3.33 | 0.18 |

--no fish trucked

Gas Bubble Trauma Monitoring (PSMFC)

Juvenile salmonids were sampled for GBT from April 8 through June 17 in 2021. 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 581 salmonids were netted off the separator and handled by PSMFC technicians. Salmonids examined for GBT symptoms totaled 495 fish and included: 175 clipped and 43 unclipped yearling Chinook and 238 clipped and 39 unclipped steelhead. During GBT sampling 8 PIT-tagged smolts were handled, not examined, and returned to the separator, including 4 clipped yearling Chinook salmon, 3 clipped and 1 unclipped steelhead. An additional 78 smolts were handled and released to the separator without examination, including 1 clipped and 1 unclipped yearling Chinook salmon, 45 clipped and 28 unclipped subyearling fall Chinook salmon, 2 clipped sockeye salmon, and 1 coho salmon. 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 224 smolts were bypassed including 57 clipped and 34 unclipped yearling Chinook salmon, and 122 clipped and 11 unclipped steelhead. A total of 357 smolts were transported including: 123 clipped and 10 unclipped yearling Chinook, 45 clipped and 28 unclipped subyearling Chinook, 119 clipped and 29 unclipped steelhead, 2 clipped sockeye, and 1 coho. There were 2 fish observed with symptoms of GBT in 2021 and no fish observed with symptoms in 2020 or 2019.

## Research

Ongoing annual research projects were not limited due to COVID-19 restrictions this season as

they were in 2020. Each federal, state, and tribal agency has different COVID requirements. To support the collaborative efforts at LWG facilities, other agencies COVID policies were considered during the access request and coordination process to ensure guidelines were followed at LWG. All researchers were required to follow USACE guidelines and restrictions along with administrative and engineered controls to satisfy additional requirements of other agencies. This included access approval for minimal staff, social distancing, and wearing masks. Six agencies participated in six research projects with juvenile fish collected at LWG juvenile facility and one project collecting adults off the separator. A total of 147,635 smolts (19.1% of the total collection) were handled by research groups during the 2021 season compared to 886 smolts (0.1% of total collection) in 2020. The 2017-2020 average number of fish handled as part of LWG research projects was 391,553 smolts. The 147,635 smolts taken from the 2021 collection season included: 50,169 clipped and 4,801 unclipped yearling Chinook salmon, 9,407 clipped and 11,772 unclipped subyearling fall Chinook salmon, 54,721 clipped and 10,436 unclipped steelhead, 1,044 clipped sockeye salmon and 433 unclipped sockeye salmon/kokanee and 4,852 coho salmon. Corps biological staff collected 118 clipped and 131 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)

LWG Corps biological technicians collected smolts in the east raceways for NMFS tagging April 13 to June 11. Raceway flows, fish behavior, and mortalities were monitored by Corps biological staff 24 hours per day. Corps biological technicians collected 118,170 smolts for NMFS that were handled in their marking trailers at LWG fish facility as part of the annual transportation study. Of these 12,271 smolts were PIT tagged and transported including 1,668 unclipped yearling Chinook, 6,464 clipped steelhead, and 4,139 unclipped steelhead. There were 105,865 smolts handled that were not selected for tagging. All fish were held overnight in the east raceways prior to transport. There were 34 smolt mortalities reported by NMFS including 24 clipped and 2 unclipped yearling Chinook, 1 clipped subyearling Chinook, 4 clipped steelhead and 3 clipped sockeye. There were an additional 343 mortalities removed by Corps biological staff from the east raceways while being used exclusively for holding NMFS research fish. Unclipped yearling Chinook with fork lengths less than 124 mm were targeted. Unclipped steelhead with fin erosion were not PIT tagged.

National Marine Fisheries Service (NMFS)-Study to Estimate Juvenile Salmonid Reach Survival

Corps biological technicians collected smolts in the east raceways for the continuing in-river survival study April 6 to June 11 in conjunction with the NMFS Transportation Evaluation study, except fish collected April 6 and April 7 were only collected for the survival study. NMFS handled 26,817 smolts as part of this study, 24,855 that were PIT-tagged and bypassed including 1,848 unclipped yearling Chinook salmon, 18,236 clipped steelhead trout, and 4,771 unclipped steelhead. There were 78 post tagging mortalities including 10 unclipped yearling Chinook salmon, 64 clipped and 4 unclipped steelhead. Another 1,884 fish were handled but not utilized for the survival study including 1,184 clipped and 36 unclipped yearling Chinook salmon, 1 unclipped subyearling Chinook salmon, 649 clipped and 10 unclipped steelhead and 4 coho salmon. There were 343 mortalities removed from the east raceways while used exclusively for

NMFS as described above.

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 2,329 fish that were sorted by SMP biologists and provided to IDFG for this study March 2 to June 30. Scale samples and fin clips were taken from 1,343 non-fin eroded unclipped steelhead. Fin clips only were taken from 845 non-coded wire tag (CWT), unclipped yearling Chinook salmon, 1 non-fin eroded unclipped steelhead, 2 non-CWT or PIT-tagged unclipped subyearling Chinook salmon and 138 unclipped, untagged sockeye salmon/kokanee. Sampled fish for this study were bypassed prior to transport collection (April 23) and from June 20 to June 30 and included 636 unclipped steelhead without fin erosion and 572 yearling Chinook salmon 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

Corps biological staff collected 249 steelhead kelts from the Lower Granite juvenile separator from March 9 to June 23. 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 203 steelhead, including 117 clipped and 86 unclipped steelhead kelts collected at LWG that did not meet their criteria. Of the kelts collected, 44 steelhead kelts were transported to Dworshak National Fish Hatchery for acclimation and feeding studies. Two steelhead died before handling including 1 clipped and 1 unclipped steelhead kelts.

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 31, USGS personnel used the sort-by-code system to collect previously PIT-tagged subyearling Chinook salmon from the Clearwater River basin. There were 19 unclipped subyearling Chinook salmon evaluated to measure growth that were bypassed to the river.

NMFS Salmon Ocean Behavior and Distribution in the Columbia River Estuary

Due to the low abundance of smolts being captured in the estuary for an estuary and ocean tracking study, 300 clipped yearling Chinook salmon were taken from the NMFS Transportation Study on May 11. These fish were held overnight and trucked to Hammond, Oregon. They were acoustic tagged and released into the Columbia River estuary to determine survival, migration routes and timing to marine waters.

## 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 2021.

Table 17. Lower Granite turbine unit outages, 2021.

| Unit | Date OOS | Reason out of service |
|---|---|---|
| Units 1 – 6 | Monthly Mar-Nov | ESBS/VBS inspection |
| Units 1 – 6 | Feb 8-10 | Trash rack raking |
| Units 1– 6 | Feb 23-25 | ESBS Installation |
| Units 1-4 | Aug 5 | Line Outage |
| Units 1 - 6 | Aug 9-12 & Aug 17 | Doble Testing |
| Units 2 - 6 | Nov 30-Dec 2 | ESBS Removal |
| Unit 1-6 | May 4 | 300G Line Relay Program Settings |
| | | |
| Unit 1 | Mar 3 | Swap direct current busses |
| | Oct 4 | DC feed swap to bus 2 |
| | Nov 29-Feb 2022 | Annual Maintenance |
| | | |
| Unit 2 | Feb 9 | 300 G Relay Issues |
| | Mar 17 | PSS Model Validation Testing |
| | May 20-26 | Governor Processing Card Failure |
| | July 1-14 | Oil/Water Separator Install |
| | Nov 1-17 | Annual Maintenance |
| | | |
| Unit 3 | Mar 3 | Swap direct current busses |
| | Mar 16 | PSS Model Validation Testing |
| | Mar 17 | PSS Model Validation Testing |
| | Apr 7-8 | Regulator issues – Will not build voltage |
| | May 12 | Turbine Guide Bearing Control Circuit Failure |
| | June 24 | Exciter Breaker Circuit Issues |
| | Oct 4-20 | Annual Maintenance |
| | Nov 22 | SQ1 Switchgear Change out |
| | | |
| Unit 4 | Sept 13-29 | Annual Maintenance and Bearing Indication Work |
| | Nov 22 | SQ1 Switchgear Change out |
| | | |
| Unit 5 | April 1 | Replace ESBS/VBS |
| | Apr 12-May 6 | SU5/S5/Gov Oil Pump Replacement |
| | June 3 | Turbine Bearing Oil Low Device Failure |
| | July 12-20 | SQ2 Wire Upgrade |
| | Oct 25-28 | 5A Prototype Weir Decommissioning Prework |
| | | |
| Unit 6 | Mar 1-Apr 8 | Replace SU6 |
| | July 26-Sept 21 | 6 Year Maintenance Overhaul |
| | | |

Debris/Trash Racks

Trashracks were raked February 8-10. Trashrack raking was not required during the fish passage season.

Extended-length Submersible Bar Screens (ESBSs)

ESBSs were inspected and tested prior to installation on February 23-25. Brush cleaning cycle was set to operate automatically every two hours this season.

Vertical Barrier Screens (VBSs)

VBSs were video inspected in conjunction with ESBSs during the 2021 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 1028 hours February 22 to support early juvenile collection facility operation. Orifice operation was determined by collection channel flow and forebay elevation during the 2021 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 1028 hours February 22 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 20. Loading from the raceways went smoothly this season. Direct loading did not occur.

Truck Loading Operations

Truck transport started July 4 due to high in-river temperatures combined with record high air temperatures. Truck transport continued through November 1. LWG transported fish from LGS July 14, July 16, July 18, August 5, August 7, and August 9.

## Recommendations

1. Complete Phase 1a modifications and resolve programming issues.
2. Replace PDW emergency bypass exit hatch.
3. Operate the PDW flume outflow between 35-40 cfs to reduce delays in system.
4. Rebuild raceway tailscreens to reduce weight for personnel safety.
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 electronic operators for all raceway supply knife gate valves.
9. Install ballast material in barges 4394 and 4382 voids to eliminate use of river water.
10. Improve/modify sample holding tank anesthetic chamber separation door operation.
11. Permanently close the collection channel 5A research weir that is becoming a safety concern.
12. Ensure all researcher working at LGW are accountable for anesthetic waste disposal in compliance with the EPA Clean Water Act.
13. Modify PDW side screen cleaners for reliability and ability to operate system in auto mode.
14. 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, 2021.

Appendix Table 2. Percent descaling and daily facility mortality numbers at Lower Granite Dam, 2021.

Appendix Table 3. Daily number of fish trucked and barged from Lower Granite Dam, 2021.

Appendix Table 4. Daily number of adult fallbacks and fallback mortality at Lower Granite Dam, 2021.