CENWW-ODG BARNES 4 April 2022

MEMORANDUM THRU:
Justin Stegall, Operations Project Manager, Little Goose Dam

FOR Chief, Operations Division
ATTN: Chris Peery and Scott St. John

SUBJECT: Submission of 2021 Juvenile and Adult Fish Passage Report, Little Goose Dam.

1. Enclosed find the 2021 Juvenile and Adult Fish Passage Report for Little Goose Dam as requested.

2. If you have any questions contact Chuck Barnes at Little Goose Dam, (509) 399-2233 ext. 263.

CHARLES A. BARNES
Supervisory Fisheries Biologist, Little Goose Dam

Enclosure

2021 Juvenile and Adult Fish Passage Report
Little Goose Dam

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and

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Environmental Assessment Services

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Introduction

Little Goose Lock and Dam (LGS), located at river mile (RM) 70.3, is the third of four hydroelectric dams impounding the lower Snake River. Little Goose Dam is 2,655 feet long and impounds Lake Bryan, a 10,025-acre reservoir with normal operating elevations ranging from 633-638 feet above mean sea level (msl). Lower Monumental Dam impounds the Snake River below LGS, forming Lake Herbert G. West, creating tailwater elevations at LGS ranging from 537-544 feet msl. LGS is comprised of five major components: the powerhouse, navigation lock, earthen embankment, spillway and adult and juvenile fish passage facilities.

Adult Fish Passage

This report summarizes the operation and maintenance of the adult fish passage facility from March 01, 2021 to December 31, 2021. The adult fishway was in service from February 10, 2021 to January 3, 2022. Fish counting activities took place from March 01 to December 31, 2021. A total of 133 fishway inspections were conducted by U.S. Army Corps of Engineers (USACE), Environmental Assessment Services (EAS) and Oregon Department of Fish and Wildlife (ODFW) biologists and technicians.

The adult fishway includes a north shore entrance and a channel under the spillway that connects to the powerhouse collection system. The powerhouse collection system has a north powerhouse entrance and a channel under the tailrace deck that connects with the fish ladder. This section also includes an adult fallout fence near the north powerhouse entrance. Ten floating orifice gates along the powerhouse channel were removed and closed off with bulkheads between 1996 and 2000. A south shore entrance also connects to the fish ladder. The ladder rises about 100' on a 1:10 slope and exits into the forebay above the dam. Gravity provides adequate water flows for the fish ladder. For the rest of the system, however, auxiliary water is needed to attract fish into the various entrances. Auxiliary water is supplied by three turbine-driven pumps that pump water from the tailrace to the pump chamber which gravity feeds various floor diffusers in the powerhouse channel and at the bottom of the fish ladder. Additional gravity-fed water is provided by diverting excess water from the primary dewaterer (a juvenile fish facility component) to the pump chamber and floor diffusers.

Additionally, the fish ladder includes a fish viewing room which is not only popular for visitors but is utilized to provide adult fish count data. Fish counting by Four Peaks Environmental, under contract with the USACE, took place from March through December.

Juvenile Fish Passage

This report summarizes activities and results associated with the collection, transportation and bypass of out-migrating juvenile steelhead *Oncorhynchus mykiss*; Chinook salmon *O. tschawytscha*; sockeye salmon *O. nerka*; and coho salmon *O. kisutch* at LGS in 2021. The data represented in this report was collected from April 01 through November 01, 2021 by USACE, EAS and ODFW Smolt Monitoring Program (SMP) and transportation biologists and technicians.

The juvenile fish collection and bypass system at LGS extends from the upstream face of the dam downstream to the Juvenile Fish Facility (JFF) and tailwater area. System components include 18 extended length submersible bar screens (ESBS), 18 vertical barrier screens (VBS), 36 gatewell orifices, a collection channel, a dewatering structure, and a corrugated flume which

routes fish diverted from the forebay to the JFF. The JFF consists of a fish separator, routing flumes, fish holding raceways, a sampling and marking laboratory, truck and barge loading facilities, and a passive integrated transponder (PIT) tag detection and diversion system.

The objective of the transport program is to improve survival of out-migrating smolts, resulting in increased adult salmon and steelhead returns. Operating parameters are set forth annually in the Fish Passage Plan (FPP) and Fish Operations Plan (FOP).

River Conditions

River Flows

Below average winter and spring precipitation and warm temperatures in early spring resulted in flows that were 59.0% of the 5-year average. Monthly flows were well below the 5-year average during April, May, June and July and slightly below average August, September and October (Table 1). During the 2021 fish passage season—April 1 to November 1—the average daily flow was 34.81 kilo cubic feet per second (kcfs). The maximum average daily flow of 85.1 kcfs occurred on May 19, and the minimum average daily flow of 12.3 kcfs occurred on October 16 (Figure 1).

Table 1. Comparisons of average monthly flow and spill in kcfs at Little Goose Dam JFF 2016-2021.

Month	2016	2017	2018	2019	2020	2021	2016 to 2020 Average
Flows (kcfs)							
March	--	--	57.34	--	--	--	--
April	87.05	132.84	91.81	116.99	54.50	45.55	96.64
May	87.36	139.59	133.80	118.34	105.15	61.67	116.85
June	52.30	127.97	80.76	93.20	93.33	52.56	89.51
July	32.11	50.02	37.57	38.51	46.88	26.81	41.02
August	23.70	29.96	28.49	28.26	28.58	22.49	27.80
September	18.90	25.79	21.84	24.47	22.47	18.66	22.69
October	20.74	22.81	17.82	21.30	19.53	15.92	20.44
Spill (kcfs)							
March	--	--	0.02	--	--	--	--
April	24.70	43.41	31.78	48.25	31.32	23.99	35.89
May	25.77	76.33	50.73	49.30	64.34	39.04	53.29
June	15.68	50.41	27.89	39.47	49.96	30.53	36.68
July	10.42	14.94	11.43	11.55	14.33	8.29	12.53
August	8.51	10.34	10.47	10.58	9.02	7.18	9.78
September	0.18	0.21	0.24	0.44	0.80	0.97	0.37
October	0.00	0.00	0.31	0.01	0.54	0.56	0.17

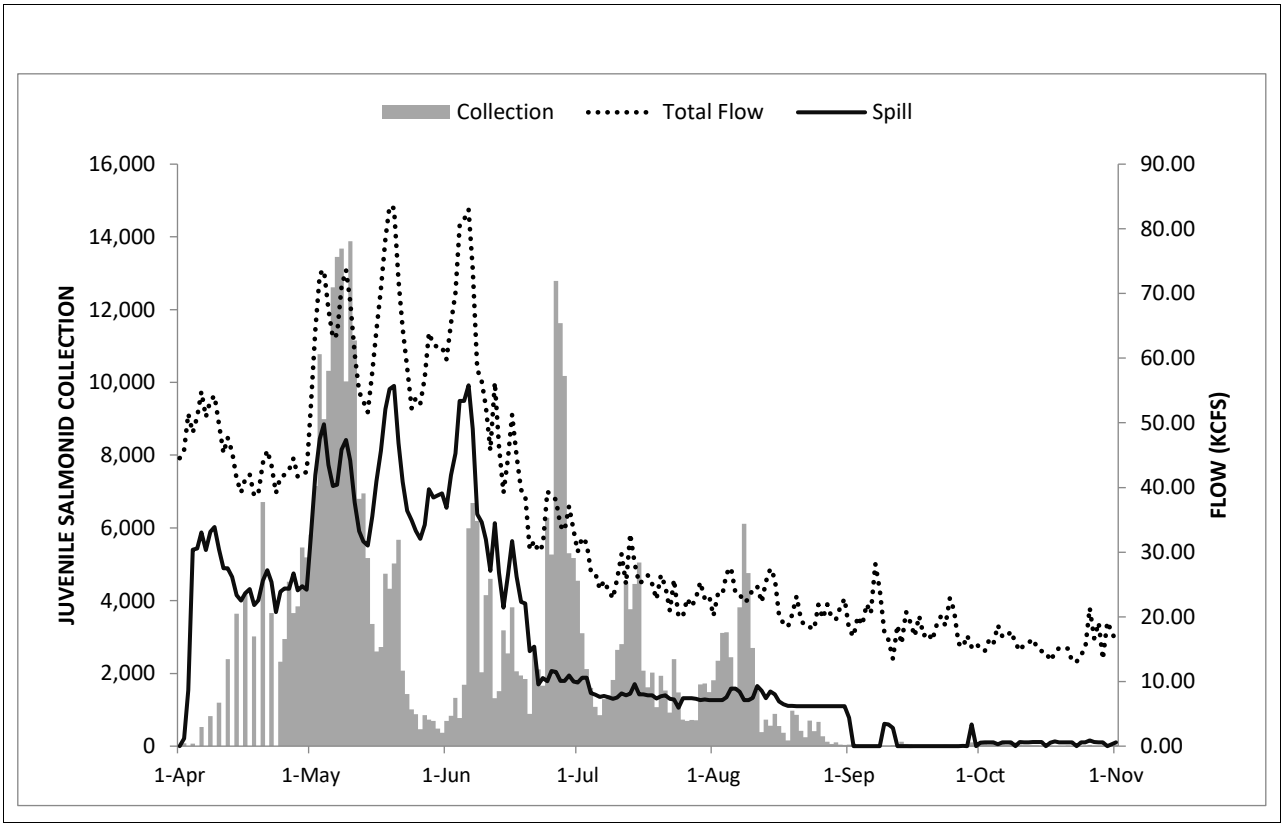

Figure 1. Total river flow, spill, and number of juvenile salmonids collected at Little Goose Dam during the fish collection and transport season, 2021.

Spill to aid juvenile fish passage occurred from April 3 to August 31, in accordance with the 2021 FOP. In the years before 2018, the spill target was 30% of total flow from April 3 to August 31. Starting in 2018, and continuing through 2021, during the spring passage season (April 3 to June 20) spill at all four projects on the lower Snake River increased due to either court mandates or regional coordination under the Flex Spill Agreement (NWF, et al. v. NBFS, et al. 2018). In 2020, the spring spill total dissolved gas concentration allowed by State of Washington (Gas Cap) was increased from 120% in the tailrace to 125%. The same spill operation continued in 2021; 16 hours per day of Gas Cap spill and the remaining 8 hours of spill per day could be reduced to 30%. Target spill remained 30% of total flow during the summer passage season (June 22 to August 31). The target of 30% was not met for 13 days between June 24 and August 31. The Adjustable Spillway Weir (ASW) was operated in Spillbay 1 on April 3 and removed on July 9 due to daily average spill falling below 35 kcfs. Spill through the ASW started up again October 1 through November 15 for adult steelhead overshoots, in compliance with the 2020 National Oceanic and Atmospheric Administration Fisheries Columbia River System Biological Opinion (NOAA 2020). Spill through the ASW occurred at least three times each week on non-consecutive days for 4 hours in the morning (between 05:00 a.m. and 11:00 a.m.).

To enhance fish migration and comply with the 2020 Columbia River System Biological Opinion, the forebay elevation was at Minimum Operating Pool (633 to 634 feet MSL) from April 3 to August 31. The forebay elevation was increased to Minimum Operating Pool +2 (634 to 636 feet MSL) after September 1, 2020, when spill to aid fish passage ended. Beginning in late September, operations were under compliance with the 2020 Columbia River System Biological Opinion (NOAA 2020). All deviations from the FPP were coordinated through the Fish Passage Operations and Maintenance (FPOM) workgroup, as necessary, to meet real-time operational requirements.

River Temperature

River temperature was recorded daily at approximately 0700 hours in the JFF. The average daily river temperature during the 2021 fish passage season was 62.0°F. Average monthly water temperatures were cooler than the 5-year average in June and September, but warmer than the 5-year average for all other months (Table 2). The maximum river temperature of 72.0°F was recorded on August 10 and was 1.4°F higher than the 5-year average maximum of 70.6°F. The 2021 minimum river temperature of 47.7°F was recorded April 1 and April 2 and is 1.5°F above the 5-year average minimum of 46.2°F.

As per the Water Management Plan, summer river temperatures were tempered by cool-water releases from Dworshak Reservoir. Supplemental flow from Dworshak Reservoir started June 23 and ended September 23, averaging 12.4 kcfs at 43.0°F from June 23 to June 30, 7.9 kcfs at 43.6°F for the month of July, 7.9 kcfs at 45.5°F for the month of August, and 4.7 kcfs at 47.5°F from September 1 to September 23 (Columbia Basin Research 2021). Water temperatures recorded daily in the LGS JFF averaged 68.7°F in July, 69.4°F in August, and 65.8°F in September.

Table 2: Average Monthly River Temperatures (ºF) at Little Goose Dam, 2016 to 2021.

Month	2016	2017	2018	2019	2020	2021	2016 to 2020 Average
Temperature (°F)							
April	50.2	48.9	49.2	48.2	49.4	50.6	49.2
May	54.7	53.4	53.7	53.3	52.5	57.1	53.5
June	62.7	58.6	61.6	61.7	59.4	60.3	60.8
July	67.6	68.4	68.1	67.6	66.8	68.7	67.7
August	67.1	68.9	69.3	69.0	69.4	69.4	68.7
September	64.8	68.1	66.2	68.3	67.8	65.8	67.0
October	60.5	61.2	60.7	59.6	63.7	61.4	61.1
Minimum	46.4	46.7	44.7	45.4	46.4	47.7	45.9
Maximum	69.5	70.3	70.9	70.0	70.7	72.0	70.3

Total Dissolved Gas

Total dissolved gas (TDG) data are automatically collected and transmitted hourly to the Columbia River Operational and Hydromet Management System to provide information for spill and gas saturation management. TDG was monitored in the forebay from April 2 to September

2, and year-round in the tailwater.

The USACE Reservoir Control Center coordinates efforts to maintain TDG saturation levels in accordance with the Washington State TDG Level Variance Standard of 125.0% saturation in the project tailwater in the spring, as measured throughout 12 consecutive hours. The summer TDG criteria is at or below 120% in the immediate tailrace and 115% in the forebay of Lower Monumental Dam.

The average daily TDG level in the LGS forebay, from April 1 to August 31, was 110.7% saturation. TDG saturation ranged from 101.9% on April 2 to 119.9% on June 3.

The TDG level in the LGS tailrace was 101.9% on April 2 (low) and 121.4% on June 1 (high), averaging 114.2% during the spill to aid fish passage season (April 3 to August 31). Tailwater TDG levels never exceeded 125% saturation in 2021.

Turbidity

Water clarity was measured during adult fish passage facility inspections. Measurements were taken in the adult fish ladder using a Secchi disc lowered to a maximum depth of 6 feet. The fish ladder water supply is gravity fed from the forebay and is representative of river conditions. The lowest Secchi disk readings occurred during periods of high outflow from April 1 to 11, with measurements ranging between 3.7 and 4.0 feet and averaging 3.5 feet. The highest Secchi disk readings occurred from May 20 to November 1, with measurements ranging from 5.1 to 6.0 feet and averaging 5.8 feet. The average Secchi disk reading for all facility inspections was 5.4 feet.

Adult Fish Facility

Facility Description

The adult fish facility is located on the downstream side of the dam and functions to attract and pass adult migrating fish upstream over the dam. The facility consists of a fish ladder and a collection channel. The collection channel acts to attract and route fish from across the tailrace to the fish ladder. Components of the collection channel system include two South Shore Entrances (SSE), two North Powerhouse Entrances (NPE), two North Shore Entrances (NSE), the collection channel itself, a fallout fence, an auxiliary water supply system, and an electronic monitoring and control system.

The pool-and-weir fish passage ladder is located on the south shore. It is approximately 1,000 feet long and rises a vertical distance of about 100 feet. The ladder begins at the junction pool near the SSE and leads upstream westward approximately 400 feet and switches back with a curve south and then east. It continues another 550 feet to the east where it passes under the dam's intake deck and exits into the forebay.

The viewing room and fish counting windows are located approximately 300 feet from the start of the ladder at the junction pool. The fish counting slot is fixed at a width of no less than 18" deep by 36" high by 48" wide. Underwater vertical fences called "Picketed Leads" guide and confine fish to pass through the counting slot.

The two SSE (SSE1 and 2) have overflow weirs that are normally open. The two NPE (NPE1 and 2) have overflow weirs and are normally open. NPE3, a lift gate entrance, was permanently closed with a concrete bulkhead in February 2011. The two north shore entrances (NSE1 and 2) are also overflow weirs and were normally open. NSE3, a lift gate entrance, was also permanently closed with a concrete bulkhead in 2011.

Additionally, ten floating orifice gates located in front of the powerhouse have been removed and permanently sealed with bulkheads. Floating orifice gates 1, 4, 6, and 10 have been closed since the 2000 fish passage season and floating orifice gates 2, 3, 5, 7, 8, and 9 have been closed since January 1996. Research has shown that adult fish attraction into the adult fish channel improved with these gates closed.

The adult collection channel begins at the NSE, passes under the spillway, past the NPE and fallout fence then continues along the base of the powerhouse, and terminates in the junction pool near the base of the ladder. A separate short channel connects the SSE to the junction pool and ladder. The fallout fence, consisting of a steel tube framework and wire mesh panels, is located in the channel near NPE1 and 2. It functions to prevent fish in the channel from leaving the channel and re-entering the tailrace via NPE.

The collection channel water is supplied from three sources. First, the fish ladder coupled with a diffuser (diffuser 13) supplies approximately 75 cubic feet per second (cfs) of water and flows via gravity into the channel. Second, three turbine-driven pumps (fish pumps) supply approximately 1,700-2,000 cfs of auxiliary water. The fish pumps move water from the tailrace into a head channel for which gravity forces water through 21 sluice gates and up through 20 diffusers located on the floor of the collection channel in front of the powerhouse, near the junction pool and lower end of the ladder. Third, 175-230 cfs of excess water from the primary dewatering unit of the juvenile fish collection system also flows into the head channel and up through the floor diffusers.

An electronic computer interface system for operating and monitoring the adult fishway was put in service in March 1994. The Fishway System Control (FSC) includes water elevation sensors for the fishway channel and tailrace near each entrance and elevation sensors and controls for each of the 6 entrance weirs.

An electronic water velocity meter (flow meter) was added to the collection channel near the SSE in November 1997. The meter was programmed to measure subsurface water velocities near the junction pool and diffuser 2. Diffuser 2 (the largest of the water supplying diffusers) produced upwelling and non-laminar flows making measurements unreliable. The flow meter failed in spring of 2011 and was replaced with a hydrologic current meter. In 2019, subsurface water flow velocities were measured near the NPE approximately midpoint of collection channel where flows are more representative of the entire collection channel.

Adult Fish Passage and Fishway Activities

Monitoring Activities

In 2021, a total of 152,531 salmonids were visually counted passing upstream through the adult fish ladder. The species counts were: 67,908 adult Chinook salmon; 21,871 jack Chinook salmon; 41,646 steelhead; 713 sockeye salmon; 18,010 adult coho salmon; 2,376 jack coho salmon; and 7 adult pink salmon. Additionally, 31 adult lamprey and 3 bull trout were counted migrating upstream at the adult fish counting window.

Several monitoring activities involving the use of the adult fishway were in progress in 2021. These included:

- From 0400 hours to 2000 hours Four Peaks Environmental conducted video counting activities from March 1 – March 31, visual fish counting activities April 1 – October 31[1], and resumed video counting from November 1 – December 31.

- Water temperature within the adult ladder was recorded on an hourly basis in an ongoing trend study in support of safe fish passage.

- Invasive species were monitored with particular attention to zebra and quagga mussels. Reports were submitted weekly to District biologists.

Operations and Maintenance

The adult fishway was in service from February 10, 2021 to January 3, 2022. The in-water work maintenance period occurred from January 21 to February 3, 2021.

The fish ladder functioned adequately throughout the season. The air bubbler located at the ladder exit to push back debris performed well all season. Diffuser 13 functioned without incident and water level over the weirs were maintained within criteria. Picketed leads remained clear of debris and the counting window backboard was routinely cleaned throughout the season.

Water clarity and temperature were measured during adult fish passage facility inspections near the fish counting window area. Water clarity was measured using a Secchi disc that was lowered to a maximum depth of just over 6 feet (see River Conditions).

The packing material in expansion joints in the fishway has decomposed over the years and when water temperatures fall below 50°F, the ladder contracts and water leaks through these joints. When temperatures drop below freezing, large icicles form overhead and large patches of ice form on the ground below. Both are hazards to safe working conditions. Incremental repairs took place in 2018 and 2019 with remaining sections planned for future winter maintenance periods.

An electronic computer interface system for operating and monitoring the adult fishway was put in service in March 1994. The original Fishway System Control (FSC) includes water elevation sensors for the fishway channel and tailrace near each entrance and elevation sensors and controls for each entrance weir (6). The FSC system that monitors and controls the fishway

[1] 0500 to 2100 Hours during daylight savings time. No nighttime counts are made at Little Goose Dam.

failed in March, 2012. A new control panel and updated software were installed during the winter of 2015. The updated software was placed into service for 2016, however the system failed to maintain fishway criteria and was placed back into manual mode.

The Rickly hydrologic current meter was used again in 2021 to determine subsurface velocities in the adult collection channel. Measurements were taken monthly just downstream of the NPE before the channel enters under the spillway, approximately mid-point of the length of the channel. This position best measures laminar flows that represent the overall flow rates of the channel. Subsurface velocities were measured just below the surface, at mid-depth, and just above bottom and averaged. The subsurface velocities were measured once per month and submitted in weekly reports. Average subsurface velocity measurements ranged from 1.8 to 3.3 feet per second (fps) with an average of 2.6 fps. Collection channel surface water velocities were measured using a floating stick or bubble that was timed over a distance and calculated into feet per second. Measurements ranged from 1.5 to 4.0 fps near the NPE's and 1.5 to 3.3 fps near the NSE's. Auxiliary water supply (AWS) system operated with three fish pumps for the majority of 2021.

The adult fishway was removed from service on January 20, 2021, when the ladder was dewatered. Fish ladder maintenance included inspecting weirs, removing debris, cleaning the picketed leads, cleaning lamp lenses, cleaning viewing windows and removal of metal grating upstream of adult counting window. Collection channel maintenance included inspecting diffuser grating and supporting beams, removing debris and repairing the fallout fence from the powerhouse section of the adult channel. Sluice gates that function to pass auxiliary supply water to the fish channel are in poor or non-operating condition. These gates are adjusted to position using a mobile electric operator. Many of the sluice gate indicator rods are bent and need replacing/repair. These gates and indicators need to be in good operational working condition to maintain correct gate position to provide the optimum water supply and flow criteria for adult fish passage.

Adult Fishway Inspections

Adult fishway inspections during the 2021 fish passage season were conducted by USACE, EAS and ODFW biologists and technicians. Inspections by the ODFW were done once a month from April through October, generally on designated days. Inspections by USACE and EAS were conducted three times a week from March through December. Problems observed during an inspection were reported to the Project Biologist and/or the Dam Operator for appropriate action. Adult fishway criteria are detailed below in the results section. All inspection data were entered into a computer spreadsheet that provided an indication as to whether operating criteria were met.

Inspection Results

The adult fish ladder section of the adult fishway includes differentials at the ladder exit, ladder weirs and counting station. The ladder and counting station weirs met criteria throughout the entire season (Table 3). The ladder exit trash rack and picketed leads remained relatively clean throughout the season. The air bubbler at the ladder exit was in service during the season and kept debris from collecting in front of exit area.

The collection channel continued to have mechanical and electrical problems but for the most part performed adequately throughout the season. Channel to tailwater elevation criteria (1-2 ft) was met 88.0% or better at all locations throughout the season. Weir depth criteria (6-8 ft) was met at least 80.3% of the time at NSE, 23.5% of the time at NPE and 88.6% of the time at SSE. NPE weirs were on sill for at least 75.8% of all inspections (Table 3). Low tailwater elevations will cause NPE weirs to bottom-out on its sill elevation at 532 feet.

Surface water velocities met criteria (1.5 – 4.0 fps) 100.0% of the time near the NPE and 97.4% of the time near the NSE (Tables 3 and 4).

Table 3. Summary of results from adult fishway inspections at Little Goose Dam, 2021. [1]

LITTLE GOOSE	No. in		Not Enough Depth				Too Much Depth		
Criteria and	Criteria/	% In	No./%	No./%	No./%	No./%	No./%	No./%	No./%
Locations	No. on Sill/	Criteria/	Weir Raised	Within	Within	>0.2	Within	Within	>0.2
	No. of	% On	Or Closed	0.01-0.1	0.11-0.2	Foot	0.01-0.1	0.11-0.2	Foot
	Inspections	Sill		Foot	Foot		Foot	Foot	
Channel Velocities (NPE)	133	100.0	***	***	***	***	***	***	***
	***	***	***	***	***	***	***	***	***
	133								
Channel Velocities (NSE)	76	97.4	***	***	***	***	***	***	***
	***	***	***	***	***	***	***	***	***
	78								
Differentials									
Ladder Exit	128	99.2	***	***	***	***	0	0	1
	***	***	***	***	***	***	0.0	0.0	0.7
	129								
Ladder Weirs	133	100.0	***	0	0	0	0	0	0
	***	***	***	0.0	0.0	0.0	0.0	0.0	0.0
	133								
Counting Station	133	100.0	***	***	***	***	0	0	0
	***	***	***	***	***	***	0.0	0.0	0.0
	133								
South Shore	132	99.2	***	0	1	0	0	0	0
	***	***	***	0.0	0.8	0.0	0.0	0.0	0.0
	133								
North Powerhouse	132	99.2	***	0	0	0	0	1	0
	***	***	***	0.0	0.0	0.0	0.0	0.8	0.0
	133								
North Shore	117	88.0	***	10	2	0	0	2	1
	***	***	***	7.5	1.5	0.0	0.0	1.5	0.8
	133								
Weir Depths									
SSE-1	117	88.6	0	3	3	9	***	***	***
On Sill[2]	0	0.0	0.0	2.3	2.3	6.8	***	***	***
	132								
SSE-2	118	89.4	0	4	1	9	***	***	***
On Sill[2]	0	0.0	0.0	3.0	0.8	6.8	***	***	***
	132								
NPE-1	32	24.2	0	0	0	0	***	***	***
On Sill[2]	100	75.8	0.0	0.0	0.0	0.0	***	***	***
	132								
NPE-2	31	23.5	0	0	0	0	***	***	***
On Sill[2]	101	76.5	0.0	0.0	0.0	0.0	***	***	***
	132								
NSE-1	106	80.3	0	4	3	19	***	***	***
On Sill[2]	0	0.0	0.0	3.0	2.3	14.4	***	***	***
	132								
NSE-2	107	81.1	0	3	3	19	***	***	***
On Sill[2]	0	0.0	0.0	2.3	2.3	14.4	***	***	***
	132								

[1] Data are from Appendix 1.[2] "On sill" means the weir gate was bottomed out on its sill and within criteria at this location.

Table 4. LGS collection channel in-criteria rates 2017-2021.[1]

Location	Collection Channel Success Rates (%) - Annual Comparison				
	2017	2018	2019	2020	2021
Channel Surface Water Velocities					
North Powerhouse Entrance (NPE)	97.4	99.2	96.0	97.1	100.0
North Shore Entrance (NSE)	99.1	99.2	98.1	98.5	97.4
Channel Head Differentials					
SSE	97.4	98.5	96.1	97.8	99.2
NPE	97.4	100.0	100.0	100.0	99.2
NSE	95.7	92.3	88.4	84.8	88.0
Channel Weir Depths					
SSE1	96.6	96.9	92.1	91.3	88.6
SSE2	93.1	97.7	92.9	91.3	89.4
NPE1 without on-sill criteria	51.7	35.4	46.5	57.2	24.2
NPE1 with on-sill criteria	100.0	100.0	98.4	99.3	100.0
NPE2 without on-sill criteria	33.3	49.1	33.8	55.8	23.5
NPE2 with on-sill criteria	90.5	100.0	100.0	99.3	100.0
NSE1	46.0	92.2	95.4	89.0	80.3
NSE2	45.2	91.4	94.6	82.7	81.1

[1] Data compiled from Appendix 1, previous monitoring report appendixes and inspection forms for the years 2016-2021.

Average tailrace elevations in 2021 were lower than the 5-year average at all locations (Table 5). To enhance fish migration, reservoirs were drafted down to minimum operating pool (MOP) elevations from April through August. During MOP, Lake Herbert G. West was operated between 537.0 and 538.0 as measured at Lower Monumental Dam.

During inspections, tailrace water elevations were simultaneously collected at the FSC for the SSE, NPE and NSE locations. These readings usually varied from 0 to 3 tenths of a foot in height difference. The variations are caused by the upwelling of water being released from the turbine draft tube and the number of and/or sequence of turbine units operating.

Table 5. LGS average tailrace water elevations, 2016-2021.[1]

Location	Average Tailrace Water Elevations						
	2016	2017	2018	2019	2020	2021	2016 – 2020 Average
SSE	538.43	538.83	538.50	538.71	538.83	538.45	538.66
NPE	538.34	538.65	538.40	538.59	538.73	538.37	538.54
NSE	538.44	538.76	538.46	538.61	538.75	538.32	538.60

[1] Data compiled from Appendix 1 and previous monitoring report appendixes for years 2016-2020.

Average channel to tailwater head differentials in 2021 were slightly lower than the 5-year average at SSE, NPE and NSE locations. NPE3 and NSE3 were permanently sealed with concrete in February 2011.

Average entrance weir depths at SSE and NSE were in criteria for 2021 (Table 6). The NPE entrance was on-sill or in criteria for the majority of 2021. Average entrance weir depths at SSE and NSE locations were close to the 5-year average while the NPE average dropped further below the 7 foot over weir criteria. In 2016, NSE weir depths were lower than average due to electrical limits within the FSC software. Project staff were only able to lower weirs to approximately 532.7 feet for the majority of the passage season. New FSC software was placed into operation in 2016 but continued to fail maintaining fishway criteria while operating in automatic mode and the system was returned to manual operation. The 2021 season FSC board issues were attributed to a faulty hydro-ranger component. Impacts included lack of NSE weir, channel, and tailwater readings in 38 of 133 inspections, lack of NSE-1 weir readings in 72 of 133 inspections, and 1 instance of total FSC board data failure during inspection activities. Manual operations utilized physical measurements in conjunction with electronic data for maintenance, reporting, and inspection purposes.

Table 6. LGS adult fishway average differentials and weir depths 2016-2021.[1]

Location	Average Differential or Depth in Feet						
Channel to Tailwater Differential	2016	2017	2018	2019	2020	2021	2016 – 2020 Average
SSE	1.41	1.40	1.42	1.42	1.41	1.39	1.41
NPE	1.67	1.65	1.62	1.57	1.51	1.57	1.60
NSE	1.32	1.29	1.16	1.21	1.19	1.22	1.23
Weir Depth							
SSE-1	8.44	8.73	8.72	8.72	8.60	8.65	8.64
SSE-2	8.38	8.68	8.71	8.78	8.60	8.68	8.63
NPE-1	6.47	6.99	6.50	6.93	7.02	6.47	6.78
NPE-2	6.45	6.94	6.50	6.77	6.99	6.47	6.73
NSE-1	5.74	6.63	6.85	6.59	6.61	6.43	6.48
NSE-2	5.62	6.60	6.77	6.55	6.57	6.44	6.42

[1] Data compiled from Appendix 1 and previous monitoring report appendixes for years 2016-2021.

Fishway Modifications and Improvements

Fishway System Control (FSC) panel and software was installed in 2016. The new software was installed to automatically adjust adult fish entrance weirs and ensure the adult fishway remained in criteria. Unfortunately, improper data was programmed, and the automatic controls did not function as expected. Therefore, the control system was operated in manual for the 2021 season.

An adult fish ladder cooling pump was installed during the 2017-2018 winter maintenance period. The adult ladder cooling pump was started on June 12 and shut off on September 16. The adult ladder cooling pump was also temporarily off to support line outage switching in support of Transformer – 2 repairs on September 8 – 10.

Other improvements included adult channel fallback fence panel rebuilds, fish ladder metal grating removal, orifice opening of first upstream weir from the adult counting window, and installation of adult fish counting window supplementary lighting.

Adult Fish Facility Recommendations

1. Continue to repair and/or replace ladder expansion joint seals.
2. Repair and/or replace collection channel sluice gates and indicator rods.

3. Continue to replace diffuser grating and supporting beams.
4. Replace the North Shore Rip Rap jetty that protects the NSE entrance from turbulent water forces created by the north shore clockwise eddy.
5. Repair or replace the automatic adult Fishway Control System.
6. Repair and/or replace picketed leads.

Juvenile Fish Facility

Facility Description

The Little Goose Juvenile Fish Facility was designed to bypass juvenile salmon and steelhead to the tailrace, or to collect for transport below Bonneville Dam by truck and barge. The bypass system includes extended length submersible bar screens in the turbine intakes, vertical barrier screens, 12-inch diameter gatewell orifices, a 14-inch diameter gatewell orifice, a collection channel running the length of the powerhouse, a dewatering structure, two emergency bypass routes, and a corrugated metal flume.

The transport system includes a fish separator, fish distribution system, raceways, a sampling and marking building, truck and barge loading areas, and a passive integrated transponder (PIT) tag detection and diversion / bypass system. Untagged fish (without PIT tags) may also be bypassed from the transport system.

Juvenile Fish Collection and Bypass

Migration and Collection

The juvenile fish bypass and collection facility was placed into primary bypass operations on March 12. Every other day collection for sampling began at 0700 on April 01. A total of 453,587 smolts were collected during the 2021 season (Table 7). Of those, 351,854 were transported, 100,724 were bypassed, and 1,009 were facility mortalities (separator, raceway, or sample).

Table 7. Annual collection, bypass, and transport activity at Little Goose Dam JFF, 2016-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Coho		Sockeye		Total
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	
Collection											
2016	1,873,536	564,588	203,981	414,605	1,261,259	339,520	29,781	74,575	18,868	4,032	4,784,745
2017	957,932	380,014	236,813	386,867	812,224	252,851	17,941	25,257	7,164	6,618	3,083,681
2018	1,358,654	498,442	233,371	336,373	1,518,859	450,840	16,892	120,257	56,863	17,830	4,608,381

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Coho		Sockeye		Total
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	
2019	909,931	248,210	126,440	196,296	1,335,165	367,506	12,697	43,213	27,714	3,236	3,270,408
2020	319,868	94,808	134,826	221,775	325,285	73,310	17,900	29,511	8,044	531	1,225,858
2021	80,728	18,119	61,200	160,352	97,559	23,131	2,100	6,121	1,255	3,022	453,587
Bypass											
2016	1,032,728	382,708	1	2,876	766,337	163,410	3,600	10,000	6	1	2,361,667
2017	554,485	282,676	3,282	15,172	612,738	138,805	1,200	2,001	0	3,322	1,613,681
2018	163,625	142,644	342	1,387	534,670	77,151	7	447	9	7,711	927,993
2019	147,664	65,018	3,190	13,055	574,953	99,844	10	3,052	10	30	906,826
2020	6,435	2,265	45,796	79,884	38,475	4,418	471	128	4	4	177,880
2021	1,486	665	24,725	48,070	22,128	2,954	484	88	0	124	100,724
Truck											
2016	0	0	1,345	10,576	23	3	0	0	0	0	11,947
2017	0	0	435	6,156	5	3	0	0	5	41	6,645
2018	0	0	370	4,163	2	6	0	2	4	13	4,560
2019	1	1	3,888	18,583	122	17	10	2	20	1	22,645
2020	1	0	2,642	30,354	3	2	1	10	1	1	33,015
2021	9	3	12,625	82,224	429	315	140	73	1	9	95,828
Barge											
2016	840,410	181,791	202,183	400,476	494,818	176,078	26,140	64,542	18,645	4,024	2,409,107
2017	399,531	96,175	232,159	363,553	199,312	113,958	16,726	23,230	7,099	2,930	1,454,673
2018	1,191,502	354,645	230,891	328,304	983,890	373,576	16,843	119,534	56,450	9,684	3,665,319
2019	760,457	182,729	119,157	164,092	759,935	267,573	12,644	40,086	27,537	3,187	2,337,397
2020	313,202	92,482	86,278	110,924	286,712	68,866	17,413	29,342	7,941	523	1,013,683
2021	79,094	17,431	23,749	29,497	74,904	19,850	1,451	5,939	1,245	2,866	256,026
Total Transport											
2016	840,410	181,791	203,528	411,052	494,841	176,081	26,140	64,542	18,645	4,024	2,421,054
2017	399,531	96,175	232,594	369,709	199,317	113,961	16,726	23,230	7,104	2,971	1,461,318
2018	1,191,502	354,645	231,261	332,467	983,892	373,582	16,843	119,536	56,454	9,697	3,669,879
2019	760,458	182,730	123,045	182,675	760,057	267,590	12,654	40,088	27,557	3,188	2,360,042
2020	313,203	92,482	88,920	141,278	286,715	68,868	17,414	29,352	7,942	524	1,046,698
2021	79,103	17,434	36,374	111,721	75,333	20,165	1,591	6,012	1,246	2,875	351,854

Transportation

Collection for daily barging and direct loading operations started April 23, transitioned from daily to every other day barging on May 18 and concluded on June 21. The JFF operated in secondary bypass between June 22 and July 4, and collection for transport by truck occurred from July 5 through November 1. An estimated total of 427,251 smolts were collected between April 23 and November 1. Of this total, 256,026 smolts were barged, 95,828 were trucked, 74,410 were bypassed, and 987 were facility mortalities.

Juvenile salmonids collected for transport by barge or truck were held in raceways, wet-lab holding tanks, or directly loaded into barges or trucks. Maximum fish holding time prior to transport varied from 24 to 48 hours, depending on the transportation schedule. Transport time from LGS to the approved release point was approximately 2 days by barge or 6 hours by truck. Fish transported by truck were transported in a mild saline solution of 1 to 2 grams per liter to treat presumed Columnaris disease. All fish transport operations were performed without incident in 2021.

A total of 351,854 juvenile salmonids were transported from LGS in 2021; 256,026 of them, or 72.76%, were transported by barge (Table 7). The estimated species composition and clip type of the fish transported by barge was as follows: 30.9% clipped yearling Chinook salmon, 6.8% unclipped yearling Chinook salmon, 9.3% clipped subyearling Chinook salmon, 11.5% unclipped subyearling Chinook salmon, 29.3% clipped steelhead, 7.8% unclipped steelhead, 0.5% clipped sockeye salmon, 1.1% unclipped sockeye salmon and 2.8% coho salmon.

Of the 351,854 juvenile salmonids transported from LGS, 95,828 of them, or 27.24% of the total, were transported by truck. The notable increase in truck transport in 2021was due to the TMT decision to start trucking on July 6th due to high water temperatures throughout the system. The species composition of salmonids transported by truck was as follows: <0.1% clipped and unclipped yearling Chinook salmon, 13.2% clipped subyearling Chinook salmon, 85.8% unclipped subyearling Chinook salmon, 0.5% clipped steelhead, 0.3% unclipped steelhead, <0.1% clipped sockeye salmon, <0.1% unclipped sockeye salmon, and 0.2% coho salmon. A total of 639 mortalities occurred during truck transport. Of those, 525 were unclipped subyearling Chinook salmon, 86 were clipped subyearling Chinook salmon, 8 were steelhead and 16 were coho salmon.

In previous years, due to high numbers of fish collected, Lower Granite Fish Facility trucked Little Goose Fish using the 3,500 gallon tanker. This “piggyback” operation delayed transport time for those fish transported from Lower Granite by approximately one hour. In 2021, Little Goose conducted 6 piggyback operations with Lower Granite.

The maximum daily estimated collection of 13,881 fish occurred on May 10 and accounted for 3.1% of total collection (Table 8). The composition of the collection for that date was as follows: clipped yearling Chinook salmon (59.2%), unclipped yearling Chinook salmon (9.1%), unclipped subyearling Chinook salmon (<0.1%), clipped steelhead (20.1%), unclipped steelhead (8.2%), clipped coho salmon (0.4%), unclipped coho salmon (2.0%), clipped sockeye salmon (0.2%), and unclipped sockeye salmon (0.9%).

Table 8. Peak passage dates and totals by species group at Little Goose Dam JFF, 2016-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	Season
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		
2016	30-April	18-April	11-June	11-June	24-April	30-April	21-May	12-May	9-May	28-April
	180,800	62,401	15,750	25,750	183,201	28,400	4,400	400	1,320	432,007
2017	28-April	16-April	6-June	2-June	28-April	28-April	20-May	26-April	18-May	28-April
	115,678	50,001	16,772	16,208	119,203	27,601	803	1,209	3,200	298,107
2018	10-May	21-April	29-May	29-May	9-April	3-May	20-May	19-May	13-May	9-April
	87,294	26,408	28,966	34,245	167,390	19,400	8,712	1,009	10,404	212,443
2019	24-April	16-April	7-June	7-June	24-April	24-April	19-May	19-May	18-May	24-April
	57,647	19,209	9,355	14,212	244,404	76,801	7,022	402	3,801	394,474
2020	16-May	16-May	15-June	15-June	26-April	2-May	16-May	26-May	1-June	16-May
	25,103	6,802	16,544	16,993	32,901	6,801	1,803	100	3,175	44,508
2021	10-May	11-May	26-Jun	27-Jun	6-May	7-May	12-May	3-May	6-May	10-May
	8,217	1,325	6,460	8,003	6,216	1,625	200	380	645	13,881

Bypass

From April 1 to April 23, the facility was rotated between primary bypass (fish are routed directly to the river) and secondary bypass (fish are routed through the fish facility) every 24 hours for every-other-day condition sampling and gas bubble trauma (GBT) monitoring. Fish were routed to the river without being sampled on non-sample days. An estimated total of 26,336 smolts entered the facility on sampling days between April 1 and April 23. Of this total, 26,314 were bypassed and 22 were facility mortalities. There are no passage estimates for the 12 non-sample days during the month of April.

From June 22 through July 4 no transport occurred as recommended by the Technical Management Team (TMT) and the facility operated in secondary bypass. During that time an estimated total of 71,769 smolts entered the facility. Of this total the estimated species composition consisted of 8 clipped yearling Chinook salmon, 43 unclipped yearling Chinook salmon, 23,621 clipped subyearling Chinook salmon, 46,657 unclipped subyearling Chinook salmon, 523 clipped steelhead, 287 unclipped steelhead, 111 unclipped sockeye salmon and 519 coho salmon.

Adult Fallbacks

Fallbacks are adult salmonids that have migrated above the dam and have "fallen back" into the downstream juvenile fish collection and bypass system. Fallbacks collected at the separator were usually too large to pass between the separator bars and were released back to the river. Fallbacks were identified by species and fin clip and assessed for condition prior to being released.

A total of 1,219 adult salmon and steelhead fallbacks occurred in 2021 (Table 9). No small adult salmon fallbacks were collected in the sample and released back to the river.

There were 106 steelhead fallbacks in April, May and June (Table 10). In previous years, USACE classified out-migrating kelts due to their post spawned condition; kelts collected during

this period accounted for the majority of fish in fair, poor, and dead condition. In April of 2018, FPOM asked that steelhead fallbacks be classified as adult steelhead rather than steelhead kelts. Table 11 lists the numbers of fish by species and condition.

Table 9. Total annual adult salmonid fallbacks at Little Goose Dam JFF, 2016-2021.

Year	Adult Chinook	Jack/mini Chinook	Clip Steelhead	Unclip Steelhead	Sockeye	Coho	Total
2016	643	452	1049	1272	17	9	3,442
2017	1,345	455	583	528	4	47	2,962
2018	374	210	923	667	3	0	2,177
2019	435	175	525	425	16	28	1,604
2020	485	913	324	338	87	31	2,178
2021	358	425	126	149	31	130	1,219

Table 10. Monthly totals of fallbacks bypassed from separator at Little Goose Dam, 2021.

	Chinook		Chinook Jack		Steelhead		Sockeye		Coho	
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Total
April	0	0	2	0	7	18	0	0	0	27
May	5	1	0	0	23	41	0	0	0	70
June	3	4	0	0	5	12	0	0	0	24
July	42	44	12	6	4	10	15	7	0	140
August	3	13	4	6	6	5	3	4	0	44
September	44	83	118	52	40	37	0	2	43	419
October[1]	44	72	173	52	39	28	0	0	87	495
Total	141	217	309	116	126	149	18	13	130	1,219

[1]Includes fallbacks on the last sample day, November 1.

Table 11. Condition of adult salmonids released at Little Goose Dam, 2021.

Fish	Chinook		Chinook Jack		Steelhead		Sockeye		Coho	
Condition[1]	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Total
Good	118	176	292	107	101	114	13	10	100	1,031
Fair	19	31	16	9	16	32	5	1	26	155
Poor	4	10	0	0	7	5	0	2	4	32
Dead	0	0	1	0	0	0	0	0	0	1
Total	141	217	309	116	126	149	18	13	130	1,219

[1] Condition ratings for live fish were determined subjectively based on the presence/absence and severity of fungus, headburn, fin wear, and other injuries.
Note: Table 11 does not separate post spawned "kelt" steelhead from pre-spawned healthier steelhead.

Separator Efficiency

Separator efficiency is a measure of how fish entering the facility are separated by size. Smaller fish, primarily salmon smolts, are expected to enter through the narrower bars on the upstream end of the separator (A-side). Larger fish, primarily steelhead, are expected to enter through the wider bars on the downstream end of the separator (B-side). Table 12 gives efficiency expressed as the percentage of each group, passing through the desired side of the separator, for 2016 to 2021. Efficiency rates are based on expanded sample counts.

Separator efficiency was highest for clipped steelhead and unclipped steelhead, with 81.2% of clipped steelhead and 70.9% of unclipped steelhead entering on B-side. Separator efficiency was lowest for clipped sockeye salmon and unclipped sockeye salmon, with 19.7% of clipped sockeye salmon and 17.3% of unclipped sockeye salmon entering on A-side. (Table 11).

Table 12. Annual juvenile salmonid separator efficiency (%) at Little Goose Dam JFF, 2016-2021.

	Yearling Chinook		Subyearling Chinook		Steelhead		Coho		Sockeye	
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip
Year	A-side	A-side	A-side	A-side	B-side	B-side	A-side	A-side	A-side	A-side
2016	65.4%	64.0%	57.3%	56.1%	88.6%	68.7%	36.0%	32.2%	23.9%	27.3%
2017	62.0%	56.5%	45.6%	46.9%	85.8%	69.6%	24.9%	22.0%	11.2%	34.8%
2018	69.7%	71.5%	55.8%	52.0%	81.1%	62.6%	31.8%	33.2%	24.0%	13.7%
2019	69.1%	72.0%	61.5%	60.6%	84.9%	55.7%	21.3%	31.2%	34.3%	25.4%
2020	52.0%	54.9%	43.1%	43.2%	88.3%	78.4%	15.0%	21.3%	11.2%	10.2%
2021	50.5%	46.8%	39.5%	37.3%	81.2%	70.9%	19.5%	42.9%	19.7%	17.3%

Note: Counts do not include sample mortalities.

Sampling

The fish sampling system was operated without incident throughout the 2021 season. Sampling procedures followed the smolt monitoring guidelines developed by the Fish Passage Center and USACE. The resulting data were used for management of facility and fish transport operations. Collection and fish condition data were also transmitted daily by ODFW personnel to the Fish Passage Center electronic database in support of the Smolt Monitoring Program (SMP).

Sample rates were set by USACE project biologists to obtain the target sample of 300 to 500 smolts. Sample rates were varied between 2.0% and 100.0% as fish migration numbers fluctuated. The percentage of each species sampled was dependent on their migration timing and the overall sample rate in effect at that time (Table 13).

Table 13. Annual sample rate percentages of juvenile salmonids collected per species and clip type that were sampled at Little Goose Dam JFF, 2016-2021[1].

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	Total
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	All	
2016	0.5%	0.5%	3.1%	5.0%	0.5%	0.7%	1.3%	1.1%	1.3%	1.6%
2017	0.5%	0.5%	3.3%	6.4%	0.5%	0.7%	1.3%	1.9%	1.2%	1.5%
2018	0.5%	0.7%	3.1%	5.8%	0.7%	0.7%	0.8%	1.9%	0.7%	1.1%
2019	0.7%	0.7%	8.4%	14.3%	0.6%	0.6%	1.3%	1.9%	1.5%	1.8%
2020	1.2%	1.3%	6.8%	16.3%	1.9%	1.6%	0.7%	1.7%	1.3%	4.8%
2021	5.9%	6.7%	11.1%	11.6%	7.2%	7.6%	6.9%	7.6%	8.0%	9.1%

[1]All research fish and sample mortality are included in percentages.

All fish in the sample were examined to determine species, clip type, and prevalence of descaling. In addition, Chinook salmon age class was determined as subyearling or yearling. All yearling Chinook salmon in the sample were examined for characteristics typical of holdover or Lyons Ferry Hatchery fall Chinook salmon. All unclipped salmon were scanned for coded wire tags. Chinook, sockeye and coho salmon fry were defined by length, under 60 mm, and were bypassed for continued growth. None of the 2021 hatchery releases above LGS were marked with elastomer eye tags.

Fish condition data were collected from a random subsample of 100 fish from the dominant species in the daily sample. Data collected included weight, length, descaling, injury, disease, predation, and "other" monitored conditions including pink fin, fin hemorrhage, fin discoloration, popeyes (exophthalmos), and eye hemorrhage. Injury and descaling data were used by managers to assess passage conditions at the dam.

Number of fish per pound was calculated from the weights taken during fish condition sampling, and the species composition from the entire sample, and was provided to USACE from April 2 to November 1.

A total of 41,162 fish were sampled during the 2021 season. Of these, 39,672 were examined for descaling, 51 were salmonid fry, 198 were sample mortalities, and 1,241 were removed from the separator during GBT monitoring (Table 14).

Table 14. Weekly sample as percent of collection total and sample totals at LGS JFF, 2021.

Week Ending	Weekly Sampled (percent)	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	Totals[1]
		Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	All	
8-Apr	28.3%	37	28	0	0	308	51	0	0	0	424
15-Apr	17.4%	68	24	0	0	1,000	169	0	0	0	1,261
22-Apr	7.7%	91	33	0	0	1,114	115	0	0	0	1,353
29-Apr	5.7%	329	135	0	0	691	138	0	0	3	1,296
6-May	6.0%	1,262	302	0	0	1,603	284	0	75	112	3,638
13-May	3.8%	1,530	273	0	5	688	251	19	26	85	2,877

Week Ending	Weekly Sampled (percent)	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	Totals[1]
		Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	All	
20-May	7.3%	842	165	13	19	634	203	38	26	107	2,047
27-May	11.6%	426	131	86	90	393	195	7	14	97	1,439
3-Jun	43.5%	159	69	650	704	308	173	18	56	93	2,230
10-Jun	14.8%	28	34	1,498	2,187	134	94	3	7	73	4,058
17-Jun	14.1%	4	5	1,214	1,387	27	25	1	5	14	2,682
24-Jun	12.8%	1	4	982	1,175	27	17	0	9	27	2,242
1-Jul	5.1%	0	0	1,016	1,748	24	10	0	4	16	2,818
8-Jul	6.5%	1	1	155	570	4	2	0	0	11	744
15-Jul	6.1%	0	1	279	1,208	14	8	0	0	9	1,519
22-Jul	6.1%	0	1	87	583	5	6	0	0	0	682
29-Jul	19.4%	0	1	205	1,408	11	7	0	0	0	1,632
5-Aug	15%	0	0	332	2,067	3	3	0	0	0	2,405
12-Aug	5.4%	0	0	94	1,031	0	0	0	0	0	1,125
19-Aug	21%	0	0	49	842	1	0	0	1	0	893
26-Aug	39.6%	0	0	63	1,346	0	3	0	0	4	1,416
2-Sep	86.2%	0	0	20	389	3	1	0	0	4	417
9-Sep	100%	0	0	3	135	0	0	0	0	0	138
16-Sep	100%	0	0	5	338	1	0	0	0	2	346
23-Sep	100%	0	0	7	132	0	1	1	0	0	141
30-Sep	100%	0	0	8	345	1	0	0	3	0	357
7-Oct	100%	0	0	12	396	0	0	0	0	0	408
14-Oct	100%	0	0	6	287	1	0	0	3	0	297
21-Oct	100%	0	0	2	94	0	0	0	0	1	97
28-Oct	100%	0	0	4	105	0	0	0	1	0	110
1-Nov	100%	0	0	2	71	0	0	0	0	2	75
Total Sampled		**4,778**	**1,207**	**6,791**	**18,658**	**6,995**	**1,756**	**87**	**230**	**660**	**41,162**
Total Sample Collection[2]		4,819	1,215	6,812	18,755	7,022	1,759	89	238	663	**41,372**
Percent of Sample		11.7%	3.0%	16.5%	45.6%	17.1%	4.3%	0.2%	0.6%	1.6%	**100%**
Percent of Collection		1.06%	0.27%	1.50%	4.13%	1.55%	0.39%	0.02%	0.05%	0.15%	**9.12%**

[1]All research fish, GBT fish and sample mortality included in species group and clip type numbers.
[2]Separator mortalities are included in collection totals but are not sampled.

Fish Condition

Fish condition was monitored daily by EAS and ODFW biologists. "The primary role of the condition monitoring is to identify the proportion of each species of migrant juvenile salmonid and larval and juvenile lamprey (where applicable) that are descaled (salmonids only) or have significant injuries indicative of problems in fish passage at dams such as debris in fish bypass apparatus. Secondarily, the data collected on disease, predation, and other injuries will provide a relative indication of the health of fish passing at the dams." (Condition Sampling Protocol, 2019 Smolt Monitoring Season).

Injuries

Prior to 2009, recorded injuries were based solely on the presence of an injury, with no attempt made to determine the age or origin of the injury. From 2009 to date, only fresh injuries presumed to have occurred during passage through Little Goose Dam, have been recorded.

The highest rates of injury this year were observed in clipped sockeye salmon (16.9%), followed by unclipped sockeye salmon (10.7%) and unclipped subyearling Chinook salmon (10.6%; Table 15).

Table 15. Annual injury rates (%) for salmonids examined at Little Goose Dam, 2016-2021.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	
Years	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	All	Total
2016	10.2%	12.2%	19.5%	23.5%	0.1%	6.4%	5.6%	13.5%	14.8%	17.9%
2017	9.9%	10.6%	12.3%	16.6%	5.4%	4.9%	11.8%	7.8%	7.1%	13.0%
2018	10.0%	13.3%	14.0%	14.1%	3.3%	4.7%	10.1%	15.1%	7.3%	10.7%
2019	9.0%	13.3%	17.1%	16.4%	3.9%	3.9%	9.9%	8.5%	7.5%	12.1%
2020	9.3%	10.8%	10.3%	11.5%	2.8%	4.1%	9.1%	11.1%	7.4%	9.4%
2021	7.8%	6.7%	8.6%	10.6%	2.2%	2.4%	16.9%	10.7%	4.9%	7.6%

A total of 20,749 smolts from the condition subsample were examined for injuries. Of the fish examined, 1,584 (7.6%) individual smolts were observed with one or more injuries. A total of 1,599 individual injuries were observed this year. The majority of injuries involved damage to fins (86.9%) followed by operculum injury (5.8%), body injury (3.2%), eye injury (2.5%), and head injury (1.7%). A detailed list of individual injury types and injury rates by species and clip type is provided in Table 16.

Table 16. Percent of fish examined that were injured, had predation marks, or had signs of disease by species and clip type at Little Goose Dam, 2021.

	Yearling Chinook		Subyearling Chinook		Steelhead		Coho		Sockeye		
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Total[1]
Injuries											
Eye	0.8%	0.4%	0.1%	0.0%	0.1%	0.1%	0.4%	0.2%	0.0%	0.9%	0.2%
Operculum	0.4%	0.4%	0.3%	0.2%	0.9%	0.8%	0.4%	0.2%	3.6%	0.9%	0.4%
Head	0.2%	0.3%	0.0%	0.1%	0.1%	0.1%	0.0%	0.2%	1.2%	0.0%	0.1%
Body	0.2%	0.0%	0.0%	0.3%	0.3%	0.3%	0.0%	0.0%	2.4%	0.4%	0.2%
Fin	6.3%	5.6%	8.2%	10.0%	0.8%	1.0%	7.2%	2.4%	12.0%	8.4%	6.7%
Total Injury	**7.8%**	**6.7%**	**8.6%**	**10.6**	**2.2%**	**2.4%**	**8.1%**	**3.1%**	**16.9%**	**10.7%**	**7.6%**
Disease											
Fungus	1.2%	0.4%	0.0%	0.0%	1.3%	1.2%	1.7%	0.7%	4.8%	1.8%	0.6%
Columnaris	0.0%	0.0%	0.5%	1.7%	0.1%	0.1%	0.0%	0.2%	0.0%	0.4%	0.8%
BKD	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Parasites	0.1%	0.4%	0.5%	0.2%	0.2%	1.9%	0.0%	0.5%	0.0%	0.4%	0.4%
Deformity	0.6%	0.7%	0.3%	0.1%	0.3%	0.3%	0.4%	0.2%	1.2%	0.4%	0.3%
Disease Other	0.7%	0.0%	0.2%	0.2%	0.1%	0.3%	0.4%	0.0%	1.2%	0.0%	0.3%
Total Disease	**2.8%**	**1.5%**	**1.6%**	**2.2%**	**1.9%**	**3.8%**	**2.6%**	**1.7%**	**7.2%**	**3.1%**	**2.3%**
Predation											
Bird	1.3%	1.4%	0.3%	0.4%	2.9%	2.7%	1.3%	0.5%	1.2%	0.4%	1.1%
Fish	1.3%	0.3%	0.9%	0.9%	0.9%	1.1%	3.0%	1.7%	1.2%	0.0%	1.0%
Lamprey	0.0%	0.0%	0.3%	1.1%	0.1%	0.2%	0.4%	0.2%	0.0%	0.0%	0.5%
Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Predation	**2.7%**	**1.6%**	**1.5%**	**2.3%**	**3.9%**	**4.0%**	**4.7%**	**2.4%**	**2.4%**	**0.4%**	**2.7%**
Miscellaneous Conditions											
Popeye	0.2%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.5%	1.2%	0.0%	0.1%
Fin Hemorrhage	2.4%	3.7%	11.7%	15.2%	0.8%	0.7%	1.7%	0.7%	3.6%	3.6%	8.6%
Pink Fin	2.5%	4.4%	16.1%	22.9%	0.7%	0.7%	0.4%	1.2%	2.4%	0.0%	12.4%
Fin Discoloration	3.1%	1.5%	7.9%	7.3%	0.1%	0.3%	2.1%	1.2%	0.0%	1.3%	4.6%
Eye Hemorrhage	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.9%	0.2%	0.0%	0.0%	0.1%
Total Miscellaneous Conditions	**7.9%**	**8.5%**	**29.8%**	**37.3%**	**1.7%**	**1.7%**	**5.1%**	**3.1%**	**7.2%**	**4.9%**	**21.4**
Total Sample Size	**2,605**	**731**	**2,291**	**9,006**	**3,624**	**1,533**	**235**	**416**	**83**	**225**	**20,749**

[1] Overall disease and injury rates are less than the sum of the individual categories because some individual fish had more than one injury or disease.

BKD = bacterial kidney disease

Descaling

All live smolts in the sample were examined for descaling. A smolt was considered descaled if more than 20% of the scales were missing from either side of the fish. Only descaling that appeared fresh enough to have occurred at LGS was recorded. Prior to 2009, all descaling, old or new, was recorded.

A total of 39,672 smolts were examined for descaling in 2021. Smolts examined for descaling include live smolts in the sample and do not include smolts examined for GBT, sample mortalities, or fry. The overall rate of descaling was 1.2% (460 descaled), which is slightly lower than the 5-year average of 1.3% (Table 17). Of the 39,672 smolts examined for descaling, 52.3% (20,749) were examined as part of condition subsampling. During condition subsampling, fish with descaling greater than or equal to 20.0% were differentiated into two categories: 1) descaling associated with dam passage, and 2) descaling on fish with bite marks indicative of predation attempts by birds, fish, or lamprey. The rate of descaling observed in the condition subsample was 1.5% (319 descaled smolts). Of the 319 descaled smolts observed in the condition subsample, descaling associated with dam passage was 69.0% of the condition descale total, and the rate of descaling on fish with predation marks present was 31.0% of the condition descale total. The rate of descaling observed in the non-condition sample was 0.7% (141 descaled smolts) from a sample size of 18,923 salmon. Note that all descaling recorded from the non-condition sample does not differentiate between descaling as a result of passage and descaling as a result of predators.

Table 17. Annual descaling rates for salmonids examined at Little Goose Dam JFF, 2016-2021.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	
Year	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	All	Totals
2016	1.1%	0.7%	1.0%	1.5%	1.2%	1.2%	1.3%	2.4%	1.8%	1.3%
2017	2.2%	1.5%	1.2%	1.4%	1.5%	0.8%	3.1%	6.5%	1.7%	1.5%
2018	1.7%	0.8%	1.2%	1.0%	1.3%	1.9%	1.1%	4.6%	1.9%	1.2%
2019	2.3%	1.7%	1.5%	1.2%	2.0%	1.7%	2.3%	3.4%	3.1%	1.5%
2020	1.5%	2.0%	0.6%	0.9%	1.0%	1.9%	3.6%	0.0%	1.5%	1.0%
2021	1.5%	1. 7%	0.5%	0.9%	1.9%	2.1%	1.2%	1.8%	2.2%	1.2%

Note: GBT sample numbers not included in descaling rate calculations.

For fish in the condition subsample, in addition to descaling of 20% or greater, partial descaling of 3% to 19% above background levels was also recorded. The rate of partial descaling was 2.8% of the 20,749 smolts examined for condition in 2021.

Weekly descaling rates per species and clip types are listed in Table 18. The average weekly descaling rate ranged from 0.0% to 4.3%.

Table 18. Weekly descaling rates for salmonids examined at Little Goose Dam JFF, 2021.

Week Ending	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	Total
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	All	
1-Apr	--	--	--	--	--	--	--	--	--	--
8-Apr	0.00%	11.11%	--	--	0.67%	4.17%	--	--	--	1.70%
15-Apr	0.00%	8.70%	--	--	2.98%	5.59%	--	--	--	3.31%
22-Apr	0.00%	0.00%	--	--	0.58%	0.93%	--	--	--	0.56%
29-Apr	2.40%	2.86%	--	--	1.06%	3.08%	--	--	--	1.76%
6-May	0.66%	0.69%	--	--	1.02%	0.72%	--	0.00%	0.00%	0.79%
13-May	1.44%	1.89%	--	--	2.26%	0.41%	5.26%	0.00%	2.35%	1.63%
20-May	2.58%	1.84%	0.00%	7.14%	2.46%	2.63%	0.00%	3.85%	3.77%	2.54%
27-May	1.67%	0.78%	1.16%	0.00%	3.25%	2.11%	0.00%	0.00%	2.11%	1.94%
3-Jun	2.92%	0.00%	1.40%	0.44%	5.32%	2.33%	0.00%	3.64%	1.10%	1.80%
10-Jun	0.00%	0.00%	0.14%	0.66%	4.58%	2.17%	0.00%	0.00%	4.17%	0.68%
17-Jun	0.00%	0.00%	0.51%	0.91%	14.81%	4.17%	0.00%	0.00%	7.14%	0.93%
24-Jun	0.00%	0.00%	0.53%	1.59%	0.00%	6.25%	--	0.00%	3.70%	1.16%
1-Jul	--	--	0.20%	0.18%	5.26%	0.00%	--	0.00%	0.00%	0.22%
8-Jul	--	0.00%	0.68%	1.14%	0.00%	0.00%	--	--	0.00%	1.02%
15-Jul	--	--	0.77%	0.62%	8.33%	0.00%	--	--	0.00%	0.71%
22-Jul	--	--	1.22%	1.43%	0.00%	0.00%	--	--	--	1.38%
29-Jul	--	--	0.00%	0.43%	0.00%	0.00%	--	--	--	0.37%
5-Aug	--	--	1.20%	0.49%	0.00%	0.00%	--	--	--	0.58%
12-Aug	--	--	0.00%	0.88%	--	--	--	--	--	0.81%
19-Aug	--	--	2.04%	1.33%	0.00%	--	--	100.00%	--	1.48%
26-Aug	--	--	0.00%	1.43%	--	0.00%	--	--	0.00%	1.36%
2-Sep	--	--	5.00%	1.55%	0.00%	0.00%	--	--	0.00%	1.68%
9-Sep	--	--	0.00%	0.76%	--	--	--	--	--	0.74%
16-Sep	--	--	0.00%	0.90%	0.00%	--	--	--	0.00%	0.88%
23-Sep	--	--	0.00%	1.00%	0.00%	--	--	0.00%	--	0.97%
30-Sep	--	--	0.00%	0.00%	--	--	--	0.00%	--	0.00%
7-Oct	--	--	0.00%	1.61%	0.00%	--	--	0.00%	--	1.60%
14-Oct	--	--	0.00%	1.96%	--	--	--	--	0.00%	1.90%
21-Oct	--	--	0.00%	3.21%	--	--	--	0.00%	0.00%	3.05%
28-Oct	--	--	0.00%	4.55%	--	--	--	--	0.00%	4.30%
1-Nov	--	--	0.00%	1.41%	--	--	--	--	0.00%	1.33%
Total Exam.	**4,529**	**1,141**	**6,601**	**18,118**	**6,635**	**1,689**	**83**	**225**	**651**	**39,672**
Percent Desc.	**1.50%**	**1.67%**	**0.53%**	**0.86%**	**1.93%**	**2.13%**	**1.20%**	**1.78%**	**2.15%**	**1.16%**
Median	**0.33%**	**0.69%**	**0.51%**	**0.90%**	**0.85%**	**0.83%**	**0.00%**	**0.00%**	**0.00%**	**1.16%**

[1] Descaling figures do not include sample mortalities or fish examined for GBT.
[2] "-----" means species group not present in sample during this week.

Disease

Data on the presence of disease symptoms were collected from fish in the condition subsample to provide relative information about fish health. Disease classifications included fungus, Columnaris, BKD, body parasites, deformity, and other disease such as cysts or tumors. 2014 was the first season parasites were identified and documented to genus which included fish louse (*Argulus*), gill lice (*Salmincola*), and leech (*Piscicola*). Types of deformity including spinal curvatures such as scoliosis and lordosis, and dwarfism or truncated body were also documented.

A total number of 473 smolts (2.3%) of the total condition subsample were observed with one or more symptoms of disease (See Table 16 above). Of the 473 individual signs of disease observed this year, Columnaris disease was the most prevalent at 36.0% of the total, followed by fungus (24.9%), parasite (15.3%), deformity (11.9%), other disease (10.9%), and presumed BKD (1.0%). Almost all the other diseases this season consisted of observations of smolts with rotted caudal fins or smolts with symptoms of abdominal distention similar to BKD. In 2015, several subyearling fall Chinook salmon smolt mortalities were observed with these symptoms which prompted ODFW to collect a specimen for the ODFW Fish Health Laboratory in La Grande, Oregon. Preliminary results were positive for the intestinal protozoan parasite (*Ceratomyxa shasta*). As a result, nearly all fish exhibiting symptoms of abdominal distention have been reported as "disease other" rather than BKD since 2015.

Predation Marks

Bite marks were recorded on fish from the condition subsample, which were indicative of predation attempts by bird, fish, lamprey, and mammalian predators such as mink and otter. A total of 551 smolts were observed with one or more predatory wounds, for an overall rate of 2.7% of the total condition subsample. The majority of marks observed in the subsample were indicative of attempted predation by bird at 43.0% of the 551 total individual bite marks recorded, followed by fish (36.5%) and lamprey bites (20.4%). No mammalian bite marks were observed this year. The highest rate of predatory attempts were observed on clipped coho salmon (4.7%), unclipped steelhead (4.0%), and clipped steelhead (3.9%; See Table 16 above).

The overall rate of bird bite marks was slightly higher than the 5-year average of 0.9% (Table 19). The highest prevalence of bird bite marks was observed on clipped steelhead (104 out of 3,624) and unclipped steelhead (42 out of 1,533).

Table 19. Annual bird bite rates for salmonids examined at Little Goose Dam, 2016-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	All	
2016	0.8%	0.2%	0.5%	1.6%	2.3%	2.7%	1.7%	0.0%	1.0%	1.4%
2017	1.0%	0.3%	0.3%	0.5%	2.7%	2.2%	2.2%	1.9%	0.2%	0.9%
2018	0.8%	0.5%	0.2%	0.3%	1.8%	2.0%	0.6%	0.6%	0.6%	0.8%
2019	0.8%	0.5%	0.2%	0.3%	2.1%	1.6%	0.3%	0.0%	0.7%	0.8%
2020	0.8%	0.5%	<0.1%	0.3%	2.8%	2.8%	3.6%	0.0%	1.0%	0.8%
2021	1.3%	1.4%	0.3%	0.4%	2.9%	2.7%	1.2%	0.4%	0.8	1.1%

Other Miscellaneous Conditions

The other miscellaneous conditions category included popeye (exophthalmos), hemorrhaged fin, pink fin, discolored fin, and hemorrhaged eye. There were 4,434 smolts with one or more miscellaneous conditions, for an overall miscellaneous condition rate of 21.4% of the total condition subsample (See Table 16 above). A total of 5,333 individual observations of miscellaneous conditions were found. Many smolts that were examined had multiple conditions. For example, pink fin and hemorrhaged fins often occurred on the same individual fish, though in different fins. Pink fins constituted most of the observations in this category at 48.2% of the individual miscellaneous conditions total followed by hemorrhaged fin(s) (33.4%), fin discoloration (17.8%), eye hemorrhage (0.3%), and popeye (exophthalmos) (0.2%). Subyearling fall Chinook salmon had the highest rates in this condition category at 37.3% for unclipped and 29.8% for clipped, due to the high incidence of pink and hemorrhaged fin(s).

Mortality

Mortality at the JFF included fish that entered the JFF system dead as well as those that died at the facility. Mortality was recorded by location within the facility and was divided into facility mortality (raceways and separator) and sample mortality. Total facility mortality is the sum of facility mortality (raceway and separator) and sample mortality.

The total facility mortality rate this year was equal to that of the 5-year average at 0.2% from a total collection of 453,587 smolts (Table 20). The average weekly total facility mortality rate ranged from 0.0% to 3.0% (Table 21). The minimum weekly rates of 0.1% and less than 0.1% occurred prior to May 20 when mortalities that occurred represented a small proportion of the total collection. Increased mortality rates later in the collection season occurred when total collection numbers decreased and disease and injury rates increased, presumably due to warmer river temperatures. The average monthly total facility mortality rate was highest in October, at a rate of 2.1% from a collection total of 987 smolts.

The maximum weekly total facility mortality rate of 3.1% occurred during the week ending August 19, 2021, with a total weekly collection of 4,249 fish and 128 mortalities. The relatively high mortality rate was presumed to be the result of the high prevalence and severity of Columnaris disease. The median weekly total facility mortality rate for all smolts was 0.14%. The highest number of total facility mortalities occurred during the week ending August 19, when a total of 128 mortalities were recorded.

Sample mortality for smolts was 0.5% of 41,162 smolts sampled (Table 22). As in previous years, increased sample mortality in late summer was observed when river temperatures and outbreaks of disease, such as Columnaris, were higher than in the spring and fall. On average, monthly sample mortality rates were lowest in June (0.1%) from a sample total number of 13,076 smolts. The highest sample mortality rate was in October (1.2%) from a sample total number of 982 smolts.

The total sample mortality rate for Pacific lamprey *Entosphenus tridentatus* ammocoetes was 3.2%, which was 1 of 31 total ammocoete sampled. The sample mortality rate for Pacific lamprey macropthalmia was 4.3%, which was 38 from a total of 879 sampled (Table 22). Sample mortality rates for both ammocoetes and macropthalmia were comparable to the 5-year average, with ammocoetes being slightly lower and macropthalmia being slightly higher than the average. No notable peak in sample mortality for either life stage of juvenile Pacific lamprey was observed.

Table 20. Annual total facility mortality as a percentage of total collection at LGS JFF 2016-2021.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye				Pacific lamprey	
Year	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Coho	Total[1]	Ammocoete	Macropthalmia
2016	<0.1%	<0.1%	0.2%	0.2%	<0.1%	<0.1%	1.2%	0.2%	<0.1%	<0.1%	0.2%	<0.1%
2017	0.4%	0.3%	0.4%	0.5%	<0.1%	<0.1%	0.8%	4.9%	0.1%	0.3%	0.3%	0.3%
2018	0.3%	0.2%	0.8%	0.7%	<0.1%	<0.1%	0.7%	2.4%	0.2%	0.2%	0.1%	0.1%
2019	0.2%	0.2%	0.2%	0.3%	<0.1%	<0.1%	0.5%	0.6%	0.2%	0.1%	0.5%	0.2%
2020	0.1%	0.1%	0.1%	0.3%	<0.1%	<0.1%	1.2%	0.6%	0.1%	0.1%	0.1%	0.1%
2021	0.2%	0.1%	0.2%	0.3%	0.1%	<0.1%	0.7%	0.8%	0.6%	0.2%	0.5%	0.8%

Note: Mortality rate for collected fish includes sample, raceway, and separator mortalities. Lamprey numbers are not included in "Totals" column.

Table 21. Weekly total facility mortality in percent at Little Goose Dam JFF, 2021.

Week Ending	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	Total
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	All	
1-Apr	--	--	--	--	--	--	--	--	--	--
8-Apr	0.00%	0.00%	--	--	0.00%	0.00%	--	--	--	0.00%
15-Apr	0.00%	0.00%	--	--	0.03%	0.10%	--	--	--	0.04%
22-Apr	0.10%	0.00%	--	--	0.03%	0.00%	--	--	--	0.03%
29-Apr	0.15%	0.05%	--	--	0.05%	0.00%	--	--	--	0.07%
6-May	0.04%	0.05%	--	--	0.08%	0.08%	--	--	0.23%	0.07%
13-May	0.14%	0.06%	--	0.00%	0.02%	0.00%	7.39%	0.00%	0.11%	0.10%
20-May	0.13%	0.18%	0.00%	0.00%	0.03%	0.04%	0.00%	0.62%	0.80%	0.12%
27-May	1.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.49%
3-Jun	0.27%	0.56%	0.00%	0.07%	0.74%	0.00%	0.00%	0.00%	0.76%	0.23%
10-Jun	3.45%	0.00%	0.00%	0.08%	0.71%	1.01%	0.00%	0.00%	0.00%	0.13%
17-Jun	0.00%	0.00%	0.01%	0.04%	0.00%	0.00%	0.00%	--	2.56%	0.03%
24-Jun	0.00%	0.00%	0.03%	0.02%	0.00%	0.00%	0.00%	--	0.00%	0.02%
1-Jul	0.00%	0.00%	0.03%	0.04%	0.00%	0.00%	0.00%	--	0.00%	0.03%
8-Jul	0.00%	0.00%	0.13%	0.12%	0.00%	0.00%	1.40%	--	0.00%	0.14%
15-Jul	--	0.00%	0.36%	0.33%	7.14%	0.00%	0.00%	--	--	0.46%
22-Jul	--	0.00%	0.42%	0.54%	4.94%	0.00%	--	--	--	0.56%
29-Jul	--	0.00%	0.57%	0.30%	0.00%	0.00%	--	--	--	0.33%
5-Aug	--	--	0.09%	0.22%	0.00%	0.00%	--	--	--	0.20%
12-Aug	--	--	0.97%	0.55%	--	--	--	--	--	0.59%
19-Aug	--	--	8.11%	2.64%	0.00%	--	--	--	40.00%	3.01%
26-Aug	--	--	1.12%	0.77%	--	25.00%	--	--	--	0.98%
2-Sep	--	--	0.00%	2.00%	0.00%	0.00%	--	--	--	1.86%
9-Sep	--	--	0.00%	0.00%	--	--	--	--	--	0.00%
16-Sep	--	--	0.00%	0.00%	0.00%	--	--	--	--	0.00%
23-Sep	0.00%	0.00%	0.00%	0.76%	--	0.00%	0.00%	--	--	0.71%
30-Sep	0.00%	0.00%	0.00%	0.29%	0.00%	--	--	0.00%	--	0.28%
7-Oct	0.00%	0.00%	0.00%	0.76%	--	--	--	--	--	0.74%
14-Oct	0.00%	0.00%	16.67%	1.39%	0.00%	--	--	0.00%	--	1.68%
21-Oct	0.00%	0.00%	0.00%	1.06%	--	--	--	--	0.00%	1.03%
28-Oct	0.00%	0.00%	0.00%	0.00%	--	--	--	0.00%	--	0.00%
1-Nov	0.00%	0.00%	0.00%	0.00%	--	--	--	--	0.00%	0.00%
Total Exam.	**80,728**	**18,119**	**61,200**	**160,352**	**97,559**	**23,131**	**1,255**	**3,022**	**8,221**	**453,587**
Percent Mort.	**0.17%**	**0.11%**	**0.17%**	**0.35%**	**0.10%**	**0.05%**	**0.71%**	**0.76%**	**0.56%**	**0.22%**
Median	**0.00%**	**0.00%**	**0.00%**	**0.17%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.14%**

[1]Total facility mortality includes facility, sample and raceway mortality.
Note "-----" indicates that the species group was not present in the sample during the week

Table 22. Annual sample mortality as percent of total sample at Little Goose Dam JFF, 2016-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	Total	Pacific Lamprey	
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip			Ammocoetes	Macropthalmia
2016	0.3%	0.2%	0.4%	0.4%	0.2%	0.1%	4.0%	0.0%	0.1%	0.4%	8.6%	3.8%
2017	0.5%	0.4%	0.4%	0.7%	0.2%	0.1%	0.0%	12.1%	0.2%	0.5%	4.6%	2.3%
2018	0.3%	0.6%	0.7%	0.9%	0.1%	<0.1%	0.8%	3.0%	0.4%	0.6%	2.6%	4.3%
2019	0.5%	0.6%	0.4%	0.8%	0.1%	0.2%	1.9%	1.7%	1.2%	0.6%	3.6%	5.8%
2020	0.4%	0.2%	0.7%	1.0%	0.1%	0.1%	3.5%	<0.1%	1.0%	0.8%	2.3%	2.1%
2021	0.7%	0.3%	0.1%	0.5%	0.5%	0.1%	4.6%	2.2%	1.4%	0.5%	3.2%	4.3%

Note: Mortality rate in sampled fish excludes research, raceway, and separator mortalities. Includes GBT sample fish. Pacific lamprey mortalities are not included in the total mortalities to facilitate across year comparisons.

Incidental Species

The total incidental fish collection was determined by using the sample rate to expand the number of incidental fish in the sample and adding the number of incidental fish removed from the separator to the expanded sample count. Incidental species were counted individually, except when handling large numbers of Siberian prawn *Exopalaemon modestus* and juvenile American shad *Alosa sapidissima.* When the number of Siberian prawn and juvenile shad became too large to practically count, a weekly fish per pound calculation was obtained for these species. The result was then multiplied by the daily weight of the sampled species to obtain an estimated count for the day. All sampled incidental fish were returned to the river except for Siberian prawns. Siberian prawns that occurred in the sample were euthanized per the directive issued by Washington Department of Fish and Wildlife on July 24, 2007. All Siberian prawns from the sample were frozen and disposed of in a landfill.

When the sample rate was less than 100%, incidental species were inadvertently collected and transported along with the smolts. Therefore, when the sample rate was below 100%, incidental fish species were weighed, and the average weight was applied to the expanded sample count to determine their contribution to transport loading densities. When the sample rate was at 100%, all incidental species, except Siberian prawns, were collected and returned to the river.

Incidental collections totaled 207,232 fish. This included an expanded sample count of 32,948 fish and 131,109 Siberian prawn, plus 43,175 fish from the separator, 38,986 of which were juvenile American shad (Table 23).

Collection numbers of Siberian prawns , walleye *Sander vitreus*, and kokanee *Oncorhynchus nerka* were much higher than the 2016 to 2021 average, while numbers of most other species were slightly lower than the 2016 to 2021 average. (Tables 24).

This year saw a high number of juvenile *O. mykiss* too large to fit through the separator bars. Because it could not be determined in some cases if these fish were rainbow trout or residualized steelhead, they were all reported simply as "*O. mykiss*" and are included in the totals for rainbow trout in Tables 23 and 24.

Adult Pacific lamprey collections totaled 54 in 2021: 19 from the separator and raceways and 35 from the sample. The first adult Pacific lamprey of the season was collected on April 30 and the last on August 24. Upriver adult migrants were most frequently observed falling back into the collection system from July to August. All adult Pacific lamprey captured at the facility were transported approximately 1 mile above the dam at Little Goose Landing. In addition, to avoid exposure to sampling anesthesia, any adult Pacific lamprey found in the sample tanks were removed by USACE, ODFW, and EAS personnel prior to SMP sampling.

Table 23. Collection of incidental species at Little Goose Dam, 2021.

Common Name	Scientific Name	Expanded Sample	Separator	Total Collection[1]
American shad	*Alosa sapidissima*	16,806	39,447	56,253
Banded killifish	*Fundus diaphanus*	0	0	0
Bass, smallmouth	*Micropterus dolomieu*	5,883	50	5,933
Bass, largemouth	*M. salmoides*	4	0	4
Bullhead	*Ameiurus* sp.	202	0	202
Bull trout	*Salvelinus confluentus*	0	0	0
Channel catfish	*Ictalurus punctatus*	30	43	73
Chiselmouth	*Acrocheilus alutaceus*	0	10	10
Common carp	*Cyprinus carpio*	3	9	12
Crappie	*Pomoxis* sp.	246	2,769	3,015
Dace	*Rhinichthys* sp.	0	0	0
Goldfish	*Carassius auratus*	0	0	0
Kokanee	*Oncorhynchus nerka*	2,020	7	2,027
Lamprey adult, Pacific[2]	*Entosphenus tridentatus*	35	19	54
Lamprey ammocoete, Pacific	*E. tridentatus*	184	0	184
Lamprey macropthalmia, Pacific	*E. tridentatus*	4,992	0	4,992
Mountain whitefish	*Prosopium williamsoni*	159	13	172
Northern pikeminnow	*Ptychocheilus oregonensis*	22	3	25
Peamouth	*Mylocheilus caurinus*	742	34	776
O. mykiss species	*O. mykiss*	0	272	272
Redside shiner	*Richardsonius balteatus*	0	0	0
Sand roller	*Percopsis transmontana*	73	13	86
Sculpin	*Cottus* sp.	389	0	389
Siberian prawn	*Exopalaemon modestus*	131,109	0	131,109
Sucker	*Catostomus* sp.	616	60	676
Sunfish[4]	*Lepomis* sp.	71	8	79
Tadpole madtom	*Noturus gyrinus*	0	0	0
Walleye	*Stizostedion vitreum*	418	325	743
White sturgeon	*Acipenser transmontanus*	0	48	48
Yellow perch	*Perca flavescens*	53	45	98
Other[5]		0	0	10
Total		**164,057**	**43,175**	**207,232**

[1] Collection totals are estimated by expanding the sample counts, then adding the separator counts. Numbers include live and dead incidental fish.

[2] Number includes adult lamprey removed from the separator and from raceways.

[3] Includes all juvenile *O. mykiss* too large to fit through the separator bars.

[4]"Sunfish collection total includes bluegill/pumpkinseed and warmouth.

[5]"Other" fish include expanded counts of live non-salmonid and unidentifiable/decomposed non-salmonid.

Table 24. Numbers of incidental species collected at Little Goose Dam JFF, 2016-2021.

Common Name	Scientific Name	2016	2017	2018[1]	2019	2020	2021	2016 to 2021 Average
American shad	*Alosa sapidissima*	5,634	157,259	136,814	91,725	81,366	56,253	88,175
Banded killifish	*Fundus diaphanous*	53	0	1	0	0	0	9
Bass, smallmouth	*Micropterus dolomieu*	2,102	2,992	8,977	2,939	4,896	5,933	4,640
Bass, largemouth	*M. salmoides*	1	13	5	28	2	4	9
Bullhead	*Ameiurus* sp.	284	166	1,263	574	403	202	482
Bull trout	*Salvelinus confluentus*	0	10	1	0	1	0	2
Channel catfish	*Ictalurus punctatus*	440	80	91	99	118	73	150
Chiselmouth	*Acrocheilus alutaceus*	7	19	3	57	71	10	28
Common carp	*Cyprinus carpio*	44	49	296	103	61	12	94
Crappie	*Pomoxis* sp.	9,407	3,135	38,778	3,807	1,043	3,015	9,864
Dace	*Rhinichthys* sp.	3	0	6	3	4	0	3
Goldfish	*Carassius auratus*	0	0	0	0	0	0	0
Kokanee	*Oncorhynchus nerka*	1	101	4	0	0	2,027	356
Lamprey adult, Pacific	*Entosphenus tridentatus*	163	117	232	137	66	54	128
Lamprey ammocoete, Pacific	*E. tridentatus*	89	1,592	5,157	4,794	2,674	184	2,415
Lamprey macropthalmia, Pacific	*E. tridentatus*	8,155	33,631	2,431	31,332	22,010	4,992	17,092
Mountain whitefish	*Prosopium williamsoni*	271	81	973	3,189	1,744	172	1,072
Northern pikeminnow	*Ptychocheilus oregonensis*	32	29	106	0	9	25	34
Peamouth	*Mylocheilus caurinus*	1,230	512	4,687	707	624	776	1,423
Rainbow trout[2]	*O. mykiss*	27	2	25	336	1,483	272	358
Redside shiner	*Richardsonius balteatus*	0	0	0	0	0	0	0
Sand roller	*Percopsis transmontana*	1,603	294	559	138	71	86	459
Sculpin	*Cottus* sp.	1,836	633	199	2,908	5,786	389	1,959
Siberian prawn	*Exopalaemon modestus*	464,586	51,518	31,668	11,159	36,217	131,109	121,043
Sucker	*Catostomus* sp.	1,631	504	1,225	797	1,345	676	1,030
Sunfish[3]	*Lepomis* sp.	263	501	1,182	736	123	79	481
Tadpole madtom	*Noturus gyrinus*	4	3	1	1	0	0	2
Walleye	*Stizostedion vitreum*	27	65	110	170	101	743	203
White sturgeon	*Acipenser transmontanus*	11	15	4	20	45	48	24
Yellow perch	*Perca flavescens*	63	78	77	120	92	98	88
Other[4]		52	2	0	11	21	0	14
Total		**498,019**	**253,401**	**234,875**	**155,891**	**160,376**	**207,232**	**251,632**

Notes:Numbers include expanded sample counts and separator releases.
[1] No data on incidentals exist for 19 days between September 16 and October 13 in 2018 due to the system being in primary bypass.
[2] Starting in 2018, includes all juvenile O. mykiss too large to fit through the separator bars.
[3] Sunfish include bluegill/pumpkinseed and warmouth.
[4] "Other" fish include expanded counts of live non-salmonid and unidentifiable/decomposed non-salmonid.

Research

ODFW and USACE personnel provide various types of research assistance during the fish passage season. Typically, ODFW provides research specimens that are collected on site via the sample. The summaries below describe each research or monitoring project that occurred at LGS in 2021.

Kelt Reconditioning and Reproductive Success Evaluation Research

USACE staff collected 15 steelhead kelts from the Little Goose juvenile separator from May 3 to June 17 for University of Idaho, Columbia Intertribal Fish Commission (CRITFC) and the Nez Perce Tribe (NPT). The purpose of the study is to evaluate steelhead kelt physiology and endocrinology for rehabilitating post-spawned steelhead. NPT/CRITFC personnel took genetic samples, PIT-tagged, and returned 3 unclipped steelhead that did not meet their criteria to the tailrace. Of the kelts collected, 12 steelhead were transported to Dworshak National Fish Hatchery for acclimation and feeding studies. No steelhead died before handling or after handling.

Gas Bubble Trauma Monitoring

GBT monitoring was performed by PSMFC biological technicians from Lower Monumental Dam. When juvenile salmonid numbers permitted, a maximum of 102 fish were examined. Sampling occurred weekly from April 5 to July 26; GBT monitoring ended for the season the week of July 26 due to low numbers of fish. Sampling was designed to determine the relative proportion of migrating juvenile salmonids passing the dam that exhibited symptoms of GBT in the unpaired fins and eyes.

A total of 1,285 fish were handled by PSMFC GBT personnel in 2021. Of the 44 fish handled and enumerated but not examined for GBT, 16 were coho salmon and 28 were clipped sockeye salmon. A total number of 1,241 fish were examined for GBT. Of those, 46.3% were subyearling Chinook salmon, 31.3% were steelhead smolts, and 22.3% were yearling Chinook salmon. Of those examined, 35 (2.8%) showed signs of GBT. The total GBT mortality rate was 0 (0.0%) of the 1,285 fish handled.

Sample System/PIT Tag System

The PIT tag detection and diversion systems at the lower Snake and Columbia River dams are maintained and operated by the Pacific States Marine Fisheries Commission. PIT-tagged salmonids have been monitored for movement and behavior in the Columbia and Snake rivers since 1987. At Little Goose Dam, there are 11 PIT tag monitors located throughout the JFF. Further discussion of the PIT Tag System, including the Divert During Sample (DDS) system, can be found in the Facility Operations & Maintenance portion of this report.

Miscellaneous Monitoring

Juvenile Lamprey Monitoring

Beginning in 2011, all SMP sites were directed to report juvenile lamprey collections in more detail. Lamprey numbers are not included in the overall salmonid mortality data in this report but have been added to the mortality tables for future years' comparisons (Tables 20 and 22). The lamprey ammocoete total mortality rate in 2021 was 0.5%, from a total collection count of

184 lamprey ammocoetes. The total mortality rate for Pacific lamprey macropthalmia this year was 0.8%, from a collection total number of 4,992 Pacific lamprey macropthalmia. No notable peak in total facility mortality for either life stage of juvenile lamprey was observed.

Mussel Monitoring

USACE personnel at the Little Goose JFF monitored the facility for both zebra mussel *Dreissena polymorpha* and quagga mussel *Dreissena rostriformis bugensis* infestations. The mussel monitor is a piece of substrate suspended in the adult fish ladder near the ladder exit. There were no zebra or quagga mussels observed during the 2021 season.

Turbine Strainers

USACE continued to monitor turbine unit strainers this year at LGS. Strainers are located in the piping associated with the cooling water intake valve for each of the six turbine units. Strainers were rotated and flushed weekly by USACE staff. Inspections took place at least once per month from January through July and again in December, in accordance with the Fish Passage Plan. USACE staff inspected for any fish entrapment, particularly juvenile lamprey, and results were reported monthly to District biologists.

Avian Predation and Behavior

Avian activity was monitored and reported by USACE and EAS. New bird protocols documenting bird behavior were established and implemented in 2012 and revised in 2014 by the USACE Fisheries Field Unit. One of the main goals of the avian data collection process is to standardize bird survey methodologies amongst the eight Federal Columbia River Power System hydro-projects. Collecting behavioral data will augment existing historical bird data and aid in bird hazing activities during the smolt out-migration.

EAS personnel conducted avian surveys daily from April 1 to November 1, 2021. Surveys were typically conducted between 1100 hours and 1400 hours during the juvenile collection system inspection. Only two specific bird behaviors were recorded this year—foraging and non-foraging—compared to the loafing/resting (on land or water), flyby, scavenging, and predating behaviors previously recorded. Piscivorous birds present in 2021 included seagulls, double crested cormorants, American white pelicans, western grebe, and osprey. The number of piscivorous birds sighted remained relatively low between April and June, ranging from 10 to 75 birds per day. Numbers increased late in the season when the number of juvenile American shad entering the facility increased. The maximum number of birds counted was 450 on October 21: 409 gulls, 40 cormorants, and 1 grebe.

Juvenile Facility Operations & Maintenance

The juvenile fish bypass system was inspected a minimum of three times daily during the fish passage season. The juvenile bypass system and the collection facility were not significantly impacted by debris during the 2021 fish passage season.

Forebay Debris/Trashracks

The surface area covered by debris and its location in the forebay was estimated daily by EAS personnel during juvenile bypass system and adult fishway inspections. In 2014, the trash sheer

boom cable separated rendering the equipment ineffective. It was repaired in 2018 prior to the start of the season. Consequently, this year all forebay debris was recorded as outside trash sheer boom, inside trash sheer boom, or in front of the spillway. All debris passed through the project via spill, turbine intakes, or the juvenile collection system. Minimal to moderate accumulations of woody debris averaging 7,464 square feet and ranging from 0 to 65,000 square feet were present in the forebay from April 01 through June 15. Orifice blockages did not occur during the 2021 season. A few small logs were removed from the orifices in the spring, but none resulted in juvenile mortality. Forebay debris decreased to minimal amounts from June 15 through August 3, averaging 21 square feet. Debris in the forebay moderately increased September 01 through November 01 averaging 655 square feet during this period.

Spillway Weir

The ASW was placed into operation on April 03 in the high crest (622 ft. msl) position. The ASW was operated in high crest all season during peak adult Chinook salmon passage to facilitate upstream passage due to lower than normal spring outflow. The spillway weir was removed from service for the 2021 season on July 9 due to concerns of the TMT focused on higher than average river temperatures.

The ASW was operated in high crest, four hours in the morning, three days a week in spring and fall to provide passage for adult steelhead overshoots. This operation occurred March 1 through March 30 and October 1 through November 15.

Turbine Operation

Efforts were made to operate all turbine units within 1% limitation of best efficiency from April 1 to October 31. There were numerous scheduled and unscheduled turbine unit outages during the fish passage season. Unit out of service (OOS) and return to service (RTS) dates, times and descriptions are listed in Table 25.

Table 25. Little Goose turbine unit outages, 2021.

Turbine Unit	Date OOS	Date RTS	Description
Unit 1	30-Nov 2020	15-Apr 17:15	6-year Overhaul
	08-Jun 12:45	08-Jun 16:15	Trash rake, ESBS/VBS inspection
	13-Jul 05:02	13-Jul 17:07	Line outage to isolate T2
	27-Jul 10:21	27-Jul 10:36	Blade response trip
	28-Jul 11:00	28-Jul 14:05	Controls check
	31-Jul 08:31	31-Jul 10:18	T2 transformer replacement
	02-Aug 14:36	02-Aug 16:00	Exciter trip
	02-Aug 16:07	03-Aug 16:15	Exciter trip
	08-Sep 09:08	08-Sep 19:07	T2 line outage for bus connection
	09-Sep 09:05	09-Sep 19:40	T2 line outage for bus connection
	10-Sep 09:02	10-Sep 17:40	T2 line outage for bus connection
	28-Sep 09:57	28-Sep 16:53	T2-C phase work
	29-Nov 05:50	17-Dec 17:20	Annual maintenance
Unit 2	06-Mar 18:30	06-Mar 19:00	Exciter Hi-temp alarm
	18-Mar 14:17	18-Mar 16:27	T2 ground
	22-Mar 11:18	22-Mar 16:20	ESBS installation
	06-Apr 11:54	06-Apr 17:25	Line outage for T2
	29-Apr 03:53	29-Apr 14:15	Brakes did not disengage on start

	09-Jun 09:00	09-Jun 11:30	ESBS/VBS inspection
	13-Jul 05:02	13-Jul 17:07	Line outage to isolate T2
	31-Jul 08:31	31-Jul 10:18	T2 Replacement
	03-Aug 10:05	03-Aug 12:16	T2 Replacement
	08-Sep 09:08	08-Sep 19:07	T2 line outage for bus connection
	09-Sep 09:05	09-Sep 19:40	T2 line outage for bus connection
	10-Sep 09:02	10-Sep 17:40	T2 line outage for bus connection
	28-Sep 09:57	28-Sep 16:53	T2-C phase work
	18-Oct 07:00	10-Nov 13:20	Annual maintenance
	06-Dec 07:15	06-Dec 16:48	Line outage for T2 commissioning
	07-Dec 06:38	07-Dec 17:16	Line outage for T2 commissioning
	08-Dec 09:20	08-Dec 10:27	Line outage for T2 commissioning
Unit 3	18-Mar 14:17	18-Mar 16:27	T2 ground
	23-Mar 07:00	23-Mar 10:00	ESBS install
	06-Apr 11:54	06-Apr 17:25	Line outage for T2
	09-Jun 12:25	09-Jun 15:50	ESBS/VBS inspections
	10-Jun 13:30	10-Jun 15:50	ESBS/VBS inspections
	13-Jul 05:02	13-Jul 17:07	Line outage to isolate T2
	26-Jul 07:20	15-Sep 16:00	Annual maintenance and controls upgrade
	28-Sep 09:57	28-Sep 16:53	T2-C phase work
	25-Oct 10:50	27-Oct 16:20	Inspection for unit overheating
	30-Oct 07:33	30-Oct 08:19	ESBS brush calibration
	06-Dec 07:15	06-Dec 16:48	Line outage for T2 commissioning
	07-Dec 06:38	07-Dec 17:16	Line outage for T2 commissioning
	08-Dec 09:20	08-Dec 10:27	Line outage for T2 commissioning
Unit 4	18-Mar 14:17	18-Mar 16:27	T2 ground
	22-Mar 07:20	22-Mar 11:00	ESBS install
	06-Apr 11:54	06-Apr 17:25	Line outage for T2
	10-Jun 13:30	10-Jun 15:50	ESBS/VBS inspections
	13-Jul 05:02	13-Jul 17:07	Line outage to isolate T2
	31-Jul 08:31	31-Jul 10:18	T2 replacement
	03-Aug 10:05	03-Aug 12:16	T2 replacement
	31-Aug 14:18	02-Sep 10:00	Ground on brushes
	08-Sep 09:08	08-Sep 19:07	T2 Line outage for bus connection
	09-Sep 09:05	08-Sep 19:40	T2 Line outage for bus connection
	10-Sep 09:02	08-Sep 19:07	T2 Line outage for bus connection
	20-Sep 08:00	14-Oct 16:45	Annual maintenance
	06-Dec 07:15	06-Dec 16:48	Line outage for T2 commissioning
	07-Dec 06:38	06-Dec 17:16	Line outage for T2 commissioning
	08-Dec 09:20	06-Dec 10:27	Line outage for T2 commissioning
Unit 5	14-Apr 2017		Spider arm and upper guide bearing replacement
Unit 6	18-Mar 14:17	10-Dec 08:30	T2 transformer ground

Extended-Length Submersible Bar Screens (ESBS)

All ESBS were installed the week of March 21 and performed satisfactorily for the entire season. All screens were removed for the end of fish passage season on December 16 and 17. Drawdown inspections across trashracks and ESBS/VBS were performed according to the FPP. All inspections measured within criteria throughout the season. Video inspections and manual operation inspections showed all screens in good operating condition.

Vertical Barrier Screens (VBS)

Inspections of all VBS were performed by underwater video camera per FPP requirements. Underwater camera inspections occurred on June 8-10 for all Units except Unit 5. Camera inspections in conjunction with Unit annuals occurred on August 26 for Unit 3, October 7 for Unit 4 and October 22 for Unit 2. Unit 5 ESBS screens are stored in a position that does not allow underwater inspections

In conjunction with ESBS/VBS underwater video camera inspections, orifice liners were also inspected. During camera inspections in 2021, the orifice liner for orifice 2A1 was found to be missing bolts which secure the liner to the inside of the gatewell.

Gatewells

Gatewells were checked for debris and oil contamination daily. As needed, debris was removed using a dip basket or grappling hook. In 2021, the occasional oil films were observed on the water surface in several gatewells similar to previous years. Some oil films appeared to be petroleum based and may have been produced, in part, from rain-washed oil/grease residue associated with mechanical equipment and vehicles. A fish salvage occurred June 22 in gatewell 6B to support a VBS panel replacement. No salmonids were recovered. Approximately 10 Siberian prawns were removed from the gatewell. Another salvage occurred on August 5 in gatewell 3C during the Unit 3 annual maintenance period. No salmonids were recovered.

Orifices and Collection Channel

The collection channel was operated throughout the season with 18 to 22 open orifices depending on forebay elevations. Orifices were inspected and/or back-flushed two to five times per day. All orifice operations were manually performed throughout the year.

The collection channel was dewatered and removed from service on December 20. Fish salvage operations during the dewatering included releasing approximately 65 adult steelhead, 2 adult Chinook salmon, 3 juvenile subyearling Chinook salmon, 2 walleye and 1 white sturgeon to the tailrace via the emergency release pipe. Inspection underneath the Johnson bar screen the following day lead to the recovery of 5 juvenile lamprey, 13 sculpins and 2 juvenile catfish. These fish were alive and released into the tailrace.

Primary Dewaterer/Primary Bypass Pipe

The primary dewatering structure and components functioned adequately throughout the season. Weirs were adjusted manually when needed. Inspection of the primary dewaterer and manual operation of the cleaning brushes was performed twice daily. As in past years, the excess water was diverted to the adult fish channel pump chamber throughout the season to improve adult fish attraction and migration.

Bypass Flume/Pipe

The primary bypass flume functioned satisfactorily in 2021. During winter maintenance 2010, the flume outfall was relocated from near shore to mid channel. The relocation extended the release site approximately 400 feet north into the river mid-channel. This new section of outfall is made of 36 inch corrugated metal pipe. The new point of release returns bypassed fish farther from the shoreline and in an area of higher velocity to reduce exposure to piscivorous predation. The flume was inspected during the winter maintenance period and observed in overall good condition and found free of obstructions and rough edges.

Separator

The separator was operated similar to previous years. The water level was kept about one to two inches above the downstream end of the B-side separator bars. During the winter maintenance period, the interior and exterior surfaces of the separator were cleaned and refurbished as needed.

Sample System/PIT Tag System

The PIT tag detection and diversion systems at the lower Snake and Columbia River dams are maintained and operated by the Pacific States Marine Fisheries Commission. PIT tagged salmonids have been monitored for migration in the Columbia and Snake rivers since 1987. At Little Goose Dam, there are 11 PIT tag monitors located throughout the JFF.

In previous years, the state of the Divert During Sample (DDS) system was manually changed by USACE project biologists and technicians based upon fish passage and sample rates. However, in 2012, the DDS system was upgraded during the winter maintenance period to allow for automatic changes of operational mode per entry of the sample rate. However, the system still retains the ability to override the automation and change the system manually.

At low sample rates ($\leq$20%), when large numbers of fish are passing through the system, the DDS setting is deactivated. When the DDS is deactivated, the PIT tag slide gate will not open when the sampling system is engaged. This setting helps avoid potential sample bias caused by diverting large numbers of untagged fish, along with the targeted PIT tagged fish, away from the sample during a sampling event. At sample rates greater than or equal to 20%, (low numbers of fish passing through system), the potential for sample bias is lower and the DDS system is set to "On" or activated.

DDS settings for the A and B side sample tanks followed recommendations for most of the season. Minute deviations (hundredths of a second) typically occur daily at approximately 0700 as a result of equipment operation as the facility prepares for a new 24 hour sampling period. In addition, deviations from the recommended settings occur when debris removal is conducted at the separator. During a separator clean out, large volumes of fish and debris are flushed from the separator and thus it becomes essential to turn the DDS off. There were no separator cleanouts conducted this year. There were no problems with the DDS system in 2021.

Pit Tag Detections

The PIT tag detection system records data on PIT-tagged salmonids as they pass through the juvenile collection system. The PIT Tag Information System database categorized all PIT tag

detections based on species, race, and clip/rearing type. An additional "orphan" category was used for detections of PIT tags for which the database contained no record of tagging and release. Fish dispositions were categorized as follows based upon exit monitor detections: 1) to the river; 2) to transport holding areas; 3) to the smolt monitoring sample; and 4) unknown. This last category included final detections of PIT-tagged fish at locations that did not constitute an exit from the facility.

From March 1 to November 1, a total of 13,306 PIT-tagged fish were detected within the juvenile collection/bypass system: 7,490 Chinook salmon, 5,654 steelhead, 92 coho salmon and 70 sockeye salmon. Of the total number of detections, 4,657 (35.0%) were routed to the river and 4,847 (36.4%) were routed to transport areas. PIT-tagged fish in the sample were treated as the other fish in the sample and were either released to the river—if the facility was operating in secondary bypass mode—or transported—when the facility was operating in collection mode. Approximately 621 (4.7%) of the PIT-tagged fish detected at LGS were last detected in the sample. Prior to the start of the transportation season, and between June 21 and July 5, all PIT-tagged fish were bypassed to the river. Approximately 3,485 (26.2%) of the total PIT-tagged fish detected were detected prior to the start of collection for transportation, or between June 21 and July 5 when no transport was taking place.

Avian Predation Deterrence

USDA Animal and Plant Health Inspection Service (APHIS) began bird hazing activities in 1999. In 2021, APHIS bird hazing activities at Little Goose took place from March 30 through June 19. The hazing schedule included 8 hours per day, 7 days per week of land-based hazing and 8 hours per day, 3 days a week of boat based hazing from March 30 through June 19. Additionally, a second 8 hour per day shift was conducted from April 11 through May 22. Bird hazing took place in the areas of the juvenile bypass outfall, spillway and powerhouse discharge areas, and areas where birds congregate or feed, ranging from about 2,000 feet upstream of the dam to as much as 1 mile downstream of the dam.

USACE Biologists and personnel from EAS conducted bird counts extending from the immediate tailrace and forebay to approximately one half mile upstream and downstream of Little Goose Dam and were broken into two zones; tailrace (T1) and forebay (FB1).

Counts were conducted using binoculars 2 to 3 times daily from April 01 through October 31, 2021. Bird counts also monitored foraging and non-foraging activities of gulls, cormorants and terns. Maximum daily bird counts were utilized to tabulate weekly and annual reports.

Avian counts did not reach the maximum threshold allowed per the Fish Passage Plan from April 01 to August 31. Gull counts exceeded the 100 bird threshold 11 times throughout the bird counting season, all within the month of October. Cormorant counts exceeded the 50 bird threshold twice throughout the bird counting season, also in October. Lethal take was implemented with 125 gulls sacrificed during the 2021 season. There were no cormorants lethally taken in 2021. Additional hazing by project personnel utilized bird scare products including propane scare cannons, bird bangers and bird screamers deployed intermittently throughout the remainder of the fish passage season. The water cannon located at the bypass outfall was used continuously throughout the season. Little Goose continued to use passive bird deterrent devices to include needle strips, bird wires and visual scare devices.

Gull Counts

The maximum total daily number of 409 gulls counted occurred on October 21. The average daily total count was 27 gulls. The maximum daily count in the forebay was 352 gulls and occurred on October 31 with a daily average of 18 gulls. The maximum daily count in the tailrace was 240 gulls and occurred on October 12 with a daily average of 15 gulls.

Double Crested Cormorant Counts

The maximum total daily number of 77 cormorants occurred on October 19. The average daily total count was 6 cormorants. The maximum daily count in the forebay was 40 cormorants and occurred on October 12 and again on October 19. The maximum daily count in the tailrace was 52 cormorants and occurred on October 31.

Caspian Tern Counts

There were no terns observed during the 2021 season.

Other Piscivorous Bird Counts

The maximum total daily number of 4 grebes occurred on September 23. The average daily total count was <1 grebe. The maximum total daily number of 19 pelicans occurred on April 19. The average daily total count was 1 pelican.

Avian Foraging Behavior

Foraging behavior was monitored and recorded for gulls, cormorants and Caspian terns. Gulls had the highest overall percent of observed foraging behavior (47.4%) followed by cormorants (37.8%). Cormorants had the highest percent of feeding behavior in the tailrace (82.7%) followed by gulls (72.6%). Gulls had the highest percent of feeding behavior in the forebay (26.4%) followed by cormorants (7.9%). Caspian terns were not observed at Little Goose in 2021. The majority of all avian foraging occurs in the tailrace with resting, loafing and perching occurring in the forebay.

Facility Modifications

Several modifications and repairs were made prior to, during and after the 2021 season.

1. Repaired and replaced PIT tag gate components per FPP requirements.
2. All scaling and rough edges removed in sample tanks and holding tanks
3. Repaired separator and resurfaced and painted various sections.
4. Repaired/replaced multiple ESBS screen cleaning motors.
5. Repaired juvenile bypass system orifice cylinders.

Juvenile Facility Recommendations

1. Continue to write revisions and updates to the operations maintenance manual pertaining to new equipment and facility collection and transport procedures
2. Continue to rebuild orifice valve cylinders.
3. Repair or replace corroded outer steel orifice pipe with stainless steel.
4. Review protocols yearly to ensure effective communication between all parties during truck/barge loading, dewatering events, separator cleanouts, etc. This will ensure that fish are properly routed, flush water is available for fish transfer, and that there is sufficient water in holding tanks
5. Continue to remove scale and rough edges in the facility flumes, tanks, and transition areas.

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