2016 Juvenile and Adult Fish Passage Report
Little Goose Dam

Prepared by:

Scott St. John

U.S. Army Corps of Engineers

and

Paul Burke and Paige Stinebaugh

Anchor QEA

February 2019

TABLE OF CONTENTS

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 along with adult and juvenile fish passage facilities.

Adult Fish Passage

This report summarizes the operation and maintenance of the adult fish passage facility from March 1, 2016 to December 31, 2016. The Adult fishway was in service from February 22, 2016 to January 03, 2017. Fish counting activities took place from March 1 to December 31, 2016 and a total of 228,044 salmonids were counted passing upstream through the adult fish ladder. Video counts were conducted from March 1 through March 31 and from November 1 through December 31. The species counts were 109,365 Chinook adults; 19,793 Chinook jacks; 95,404 steelhead; 964 sockeye; 1,903 coho adults and 615 coho jacks. Additionally, 192 adult lamprey were counted migrating upstream at the adult fish counting window. A total of 126 fishway inspections were conducted by U.S. Army Corps of Engineers and Oregon Department of Fish and Wildlife 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. 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 water, gravity-fed, 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 the Normandeau Associates, under contract with the Corps, takes place from April through November.

Juvenile Fish Collection

This report also summarizes activities and results associated with the collection, transportation and bypass of out-migrating juvenile steelhead *Oncorhynchus mykiss*; Chinook salmon *Oncorhynchus tschawytscha*; sockeye salmon *Oncorhynchus nerka*; and coho salmon *Oncorhynchus kisutch* in 2016. The data represented in this report was collected from April 1 through October 31, 2016 by the United States Army Corps of Engineers (USACE), Anchor QEA and Oregon Department of Fish and Wildlife (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

During the 2016 fish passage season, April 1 through October 31, the average daily flow was 45.9 thousand cubic feet per second (kcfs). The maximum average daily flow of 123.9 kcfs occurred on April 24 and the minimum average daily flow of 12.8 kcfs occurred on October 20 (Figure 1). Monthly flows were below the five year average for all months except May (Table 1).

Table 1. Comparisons of average monthly flow and spill in kcfs at Little Goose Dam JFF 2011-2016.

Month	2011	2012	2013	2014	2015	2016	2011 to 2015 Average
				Flows (kcfs)			
Apr	103.34	113.60	56.68	74.33	48.27	87.05	79.24
May	133.19	102.07	79.99	99.66	59.08	87.36	94.80
Jun	163.98	87.38	55.41	84.92	41.34	52.32	86.61
Jul	93.50	46.35	33.44	45.53	27.69	32.11	49.30
Aug	42.07	28.38	23.16	26.87	20.91	23.70	28.28
Sep	33.61	21.09	18.37	19.93	17.96	18.86	22.19
Oct	26.58	18.09	21.75	17.55	15.53	20.76	19.90
				Spill (kcfs)			
Apr	30.08	36.99	16.30	22.37	12.84	24.70	23.72
May	81.37	32.28	24.75	29.34	17.68	25.77	37.08
Jun	73.32	31.86	16.62	24.95	12.74	15.68	31.90
Jul	28.54	17.89	10.57	13.97	9.11	10.42	16.02
Aug	14.00	9.52	7.64	8.73	6.98	8.67	9.37
Sep	0.39	0.18	0.50	0.17	0.13	0.18	0.27
Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00

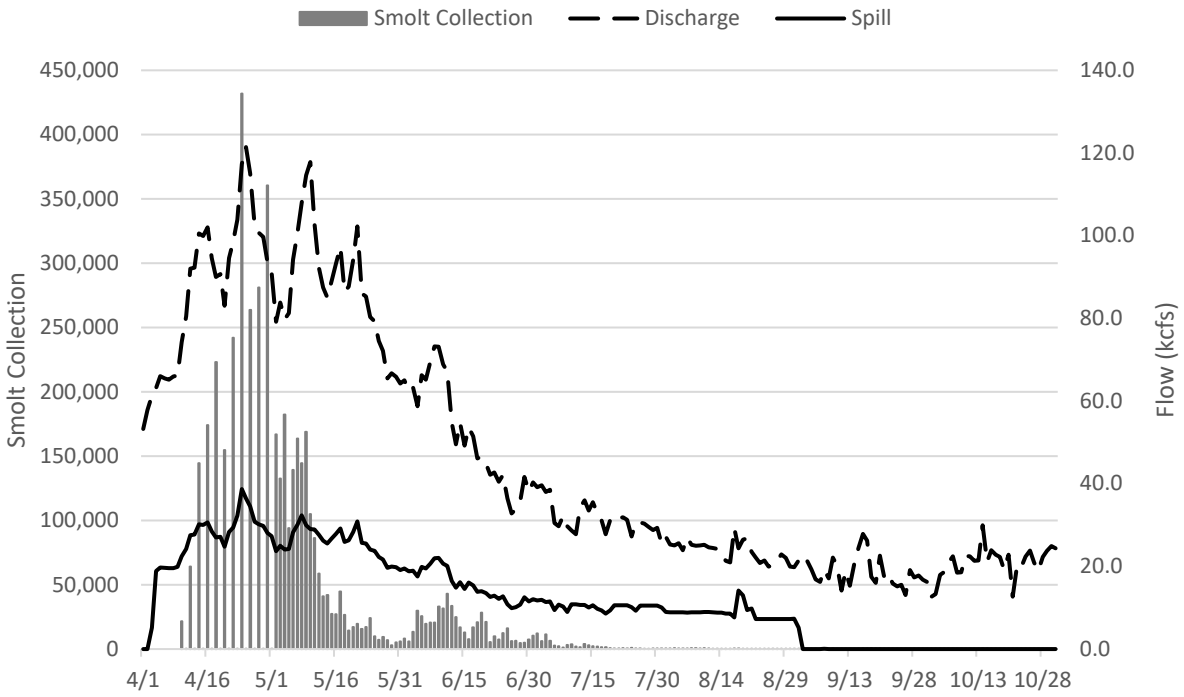

Figure 1. Total river flow, spill, and number of juvenile salmonids collected at Little Goose Dam during the fish collection and transport season, 2016.

Spill to aid juvenile fish passage occurred from April 3 through August 31, 2016, in accordance with the 2016 FPP. The spill target of 30% of total flow was maintained during that interval except for May 9, 10, 11 and August 17. Flow decreased to below 32 kcfs June 6, and, in accordance with the FPP, spill was changed to a constant rate of between 7 and 11 kcfs, whichever more closely provided the target spill rate of 30% of the total flow. The Temporary Spillway Weir (TSW) was installed into spillbay 1 on April 3 and removed on July 11 due to total flow falling below 32.0 kcfs for 3 consecutive days.

In compliance with the 2016 supplemental FCRPS BiOp, Minimum Operating Pool (MOP) elevations, to enhance fish migration, were placed into effect during the spill to aid fish passage season. Forebay elevations were increased from MOP elevations (633-634 feet MSL), to MOP +2 (634-636 feet MSL) after September 1, when spill to aid fish passage ended. All deviations from the FPP were coordinated through the Fish Passage Operations and Maintenance (FPOM) forum or the Technical Management Team (TMT), as necessary, to meet real-time operational requirements.

River Temperature

The average daily river temperature during the fish passage season was 61.1°F. Average monthly water temperatures were 2.8°F warmer than the five year average during the month of April, 4.1° F warmer during June, and within 1.9° F of the 5 year average every other month. The maximum river temperature of 69.5° F was recorded on July 3 and was slightly above the five year average maximum of 69.4° F. The 2016 minimum river temperature of 46.4° F was recorded on April 5, and was above the five year average minimum of 45.0° F. Fish ladder water temperatures were recorded during fishway inspections and averaged 57.5 ^{o}F, with a low of 38.0 ^{o}F on December 27 to a high of 71.5 ^{o}F on August 14.

As per the Water Management Plan, river temperatures were tempered by scheduled cool water releases from Dworshak Reservoir. Supplemental flow from Dworshak averaged 9.5 kcfs at 43.3°F for the month of July and 8.8 kcfs at 45.6° F for the month of August (Columbia River DART). Temperatures recorded daily in the LGS JFF averaged 67.6° F during July and 67.1°F during August.

Total Dissolved Gas

Total Dissolved Gas (TDG) data are automatically collected and transmitted hourly to the Columbia River Operational and Hydromet Management System (CROHMS) to provide information for spill and gas saturation management. TDG was monitored in the forebay from March 14 through September 8 and in the tailwater year around. The USACE Reservoir Control Center (RCC) coordinates efforts to maintain dissolved gas saturation levels in accordance with the Washington State TDG Level Variance Standard of 120% saturation in the project tailwater and 115% in the forebay of the next project downstream, as measured over 12 consecutive hours.

The average daily TDG level in the LGS forebay, from April 3 through August 31, 2016 was 107.7% saturation. Total Dissolved Gas saturation ranged from 101.0% on April 5 to 115.4% on July 2. June 29, July 1 and July 2 were the only day in which total dissolved gas saturation levels exceeded 115.0% in the LGS forebay.

The TDG level in the LGS tailrace ranged between 107.2% on August 27 to 116.0% on April 23, averaging 110.7% during the spill to aid fish passage season, April 3 through August 31. Tailwater TDG levels did not exceed 120% saturation during the 2016 spill for fish passage season. Forebay TDG levels at Lower Monumental Dam (LMN) ranged from 101.5% on April 4 to 116.3% on May 7, averaging 109.8% from April 3 through August 31. The LMN forebay TDG levels exceeded 115% on April 19, 20, 21, 22, 26, 27, 28 and May 7, 8 and 18 (USACE via Columbia River DART).

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 just over 6 feet. The fish ladder water supply is gravity fed from the forebay and is representative of river conditions. Highest turbidity was recorded during periods of high outflow from April 1 through May 31, with secchi measurements ranging between 2.8 and 4.8 feet and averaging 3.8 feet. Turbidity was lowest during periods of low flow, from June 26 through October 31, with secchi measurements ranging from 3.9 feet to over 6.0 feet with an average of 5.3 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 both 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 backed 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 proved 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 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 dewater 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 (flowmeter) 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 flowmeter failed in spring of 2011 and was replaced with a hydrologic current meter. In 2016, 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

Research and Monitoring Activities

In 2016 a total of 228,044 salmonids were visually counted passing upstream through the adult fish ladder. The species counts were: 109,365 Chinook adults; 19,793 Chinook jacks; 95,404 steelhead; 964 sockeye; 1,903 coho adults and 615 coho jacks. Additionally, 192 adult lamprey were counted migrating upstream at the adult fish counting window.

Several monitoring activities involving the use of the adult fishway were in progress in 2016. These included:

- Normandeau Associates Inc. conducted visual fish counting activities from 0400 hours to 2000 hours April 1 – October 31[1].

- Normandeau Associates Inc. conducted video fish counting activities from 0400 hours to 2000 hours March 1 – March 31 and from 0400 hours to 2000 hours November 1 – December 31[1].

- As in previous years water temperature at the ladder exit was recorded on an hourly basis in an ongoing trend study in support of safe fish passage.

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

Operations and Maintenance

The adult fishway facilities were in service from February 22, 2016 through February 3, 2017. Corps project biologists and Oregon Department of Fish and Wildlife biologists inspected the fishways for proper operating criteria on average, three times per week during fish passage season. The in-water maintenance period occurred from January 4 to February 22, 2016.

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.

[1] 0500 to 2100 Hours during daylight savings time.

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 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 again used in 2016 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 ranged between 2.3 and 3.4 feet per second (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 1.0 and 3.1 fps near the NPEs and 0.7 and 3.1 fps near the NSEs.

Auxiliary water supply (AWS) system operated with two fish pumps beginning February 22, as fish pump 1 was awaiting install. Fish pump 2 tripped offline on March 2 and intermittently operated from March 3 through March 7. Fish pump 2 was taken offline from March 8 through March 16. During that time, several fishway modifications were made following recommendations of the Fish Passage Plan (3.3.2.3). First, NSE 2 and NPE 2 were closed, but this did not result in the desire 1'-2' head differential. Next, NSE 1 was adjusted to a depth of 5' below tailwater (normal operating criteria is 6'). These adjustments made it possible to meet the desired 1'-2' head differential at all open fish entrances. Fish pump 2 was returned to service on March 16. Fish pump 1 was placed in service on August 2. The adult fishway operated on all three fish pumps for the remainder of the season.

The adult fishway was removed from service on January 4, 2016 when the ladder was closed off. Fish salvaged from the ladder included 24 adult steelhead, 30 live shad and 8 dead shad. All live fish were released unharmed and in good condition to the tailrace.

Fish ladder maintenance included repairing the uppermost 4 expansion joints, inspecting weirs, reattaching access hatch for diffuser grating, removing debris, cleaning the picketed leads, cleaning lamp lenses and cleaning viewing windows. Collection channel maintenance included inspecting diffuser grating and supporting beams, removing debris and repairing the fallback fence from the powerhouse section of the adult channel. The spillbay section of the adult channel was not dewatered in January or February of 2016. 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 operational working condition to adjust correct gate position to provide the optimum water supply and flow criteria for adult fish passage.

Adult Fishway Inspections

Adult fishway inspections during the 2016 fish passage season were conducted by Corps fishery biologists and/or technicians and by natural resources specialists with the Oregon Department of Fish and Wildlife (ODFW). Inspections by the ODFW were done once a month

from April through October, generally on designated days. Inspections by the Corps 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 fishway which includes, differentials at the ladder exit, ladder weirs and counting station met criteria 100% of the time in 2016 (Table 2). 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 was met 92.1% or better at all locations throughout the season. Weir depth criteria was met at least 45.2% of the time at NSE, 33.3% of the time at NPE and 84.9% of the time at SSE. NSE weirs were out of criteria because project staff were only able to lower the weirs to approximately 532.7 feet elevation due to electrical limits within the new FSC software. NPE weirs were on sill for at least 49.2% of all inspections (Table 3). Low tailwater elevations will cause NPE weirs to bottom-out on sill elevation at 532 feet.

Surface water velocities measured near the NPE and near the NSE met criteria (1.5 – 4.0 fps) 96.8% and 95.7% respectively (Tables 2 and 3). Surface velocities near the South junction pool were not measured in 2016. As mentioned earlier, upwelling from diffuser 2 interferes with laminar flows near the South shore junction pool.

Table 2. Summary of adult fishway inspections at Little Goose Dam, 2016. [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 Rasied	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)	122	96.8	***	***	***	***	***	***	***
	***	***	***	***	***	***	***	***	***
	126								
Channel Velocities (NSE)	112	95.7	***	***	***	***	***	***	***
	***	***	***	***	***	***	***	***	***
	117								
Differentials									
Ladder Exit	126	100.0	***	***	***	***	0	0	0
	***	***	***	***	***	***	0.0	0.0	0.0
	126								
Ladder Weirs	126	100.0	***	0	0	0	0	0	0
	***	***	***	0.0	0.0	0.0	0.0	0.0	0.0
	126								

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 Rasied	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	
Counting Station	126	100.0	***	***	***	***	0	0	0
	***	***	***	***	***	***	0.0	0.0	0.0

	126								
South Shore	**118**	**93.7**	***	**5**	**0**	**2**	**0**	**0**	**1**
	***	***	***	**4.0**	**0.0**	**1.6**	**0.0**	**0.0**	**0.8**
	126								
North Powerhouse	**116**	**92.1**	***	**1**	**0**	**1**	**3**	**3**	**2**
	***	***	***	**0.8**	**0.0**	**0.8**	**2.4**	**2.4**	**1.6**
	126								
North Shore	**118**	**93.7**	***	**2**	**0**	**4**	**0**	**0**	**2**
	***	***	***	**1.6**	**0.0**	**3.2**	**0.0**	**0.0**	**1.6**
	126								
Weir Depths									
SSE-1	**113**	**89.7**	**0**	**1**	**2**	**10**	***	***	***
On Sill2	**0**	**0.0**	**0.0**	**0.8**	**1.6**	**7.9**	***	***	***
	126								
SSE-2	**107**	**84.9**	**2**	**3**	**3**	**10**	***	***	***
On Sill2	**1**	**0.8**	**1.6**	**2.4**	**2.4**	**7.9**	***	***	***
	126								
NPE-1	**48**	**38.1**	**0**	**1**	**0**	**15**	***	***	***
On Sill2	**62**	**49.2**	**0.0**	**0.8**	**0.0**	**11.9**	***	***	***
	126								
NPE-2	**42**	**33.3**	**6**	**0**	**2**	**4**	***	***	***
On Sill	**72**	**57.1**	**4.8**	**0.0**	**1.6**	**3.2**	***	***	***
	126								
NSE-1	**58**	**46.0**	**0**	**2**	**1**	**65**	***	***	***
On Sill2	**0**	**0.0**	**0.0**	**1.6**	**0.8**	**51.6**	***	***	***
	126								
NSE-2	**57**	**45.2**	**0**	**2**	**0**	**67**	***	***	***
On Sill2	**0**	**0.0**	**0.0**	**1.6**	**0.0**	**53.2**	***	***	***
	126								

[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 3. LGS collection channel in-criteria rates 2012-2016.[1]

Location	**Collection Channel Success Rates - Annual Comparison**				
	2012	2013	2014	2015	2016
Channel Surface Water Velocities					
South Shore Entrance (SSE)	80.6%	67.3%	84.1%	N/A	N/A
North Powerhouse Entrance (NPE)				99.1%	96.8%
North Shore Entrance (NSE)	99.0%	100.0%	98.3%	99.1%	95.7%
Channel Head Differentials					
SSE	98.4%	96.1%	100.0%	96.6%	93.7%
NPE	96.9%	89.8%	99.2%	94.8%	92.1%
NSE	95.3%	86.7%	96.6%	84.5%	93.7%
Channel Weir Depths					
SSE1	99.2%	100.0%	98.4%	90.5%	89.7%
SSE2	96.1%	98.4%	93.6%	87.9%	84.9%
NPE1 without on-sill criteria	33.3%	27.8%	37.1%	9.5%	38.1%
NPE1 with on-sill criteria	100.0%	100%	96.0%	19.0%	87.3%
Location	**Collection Channel Success Rates - Annual Comparison**				
	2012	2013	2014	2015	2016
NPE2 without on-sill criteria	17.8%	25.4%	38.7%	9.5%	33.3%
NPE2 with on-sill criteria	70.5%	34.1%	96.0%	19.8%	90.5%
NSE1	79.7%	47.3%	65.0%	88.8%	46.0%
NSE2	80.5%	47.3%	65.0%	88.8%	45.2%

[1] Data compiled from Appendix 1, previous monitoring report appendixes and inspection forms for the years 2012-2016.

Average tailrace elevations in 2016 were slightly lower than average at SSE and NPE and higher at NSE (Table 4). 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 4. LGS average tailrace water elevations, 2011-2016.[1]

Location	**Average Tailrace Water Elevations**						
	2011	2012	2013	2014	2015	2016	2011 – 2015 Average
SSE	538.91	538.67	538.27	538.46	538.34	538.43	538.53
NPE	538.66	538.52	538.22	538.42	538.26	538.34	538.42
NSE	538.45	538.38	538.05	538.48	538.36	538.44	538.34

[1] Data compiled from Appendix 1 and previous monitoring report appendixes for years 2011-2016.

Overall, average channel to tailwater head differentials in 2016 were slightly lower than average at SSE and near average at NPE and NSE, but values averaged near the middle of the 1.0-2.0 foot differential criteria (Table 5). NPE3 and NSE3 were permanently sealed with concrete in February 2011.

Weir depths were similar in all years for the SSE. In 2015, NPE weir depths were lower than average due to issues with the FSC software. 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. Both NSE 1 and 2 were not operational during 2011, 2012 and placed at fixed positions at 531.5 feet in elevation. In 2013, NSE1 and 2 were placed at fixed position of 532.0 feet to compensate for two pump operation. New NSE weir gate hoists were installed and commissioned on February 27, 2014, which allowed the weirs to be adjusted. New FSC software was placed into operation in 2016, but failed to maintain fishway criteria while operating in automatic mode and the system was returned to manual operation.

Table 5. LGS adult fishway average differentials and weir depths 2011-2016.[1]

Location	**Average Differential or Depth in Feet**						
Channel to Tailwater Differential	2011	2012	2013	2014	2015	2016	2011 – 2015 Average
SSE	1.66	1.68	1.69	1.54	1.21	1.41	1.55
NPE	1.64	1.66	1.77	1.49	1.61	1.67	1.63
Location	**Average Differential or Depth in Feet**						
Channel to Tailwater Differential	2011	2012	2013	2014	2015	2016	2011 – 2015 Average
NSE	1.37	1.48	1.67	1.31	1.09	1.32	1.38
Weir Depth							
SSE-1	8.41	8.34	8.31	8.28	8.49	8.44	8.37
SSE-2	8.38	8.31	8.29	8.21	8.45	8.38	8.33

NPE-1	6.50	6.40	6.15	6.32	5.46	6.47	6.17
NPE-2	6.52	6.22	6.83	6.33	5.47	6.45	6.27
NSE-1	6.95	6.87	6.05	6.35	6.48	5.74	6.54
NSE-2	6.95	6.89	6.05	6.35	6.53	5.62	6.55

[1] Data compiled from Appendix 1 and previous monitoring report appendixes for years 2011-2016.

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. Additionally, incorrect sill elevations for entrance weirs were programmed which impacted the ability of USACE staff to properly adjust weir elevations, specifically NSE's. Therefore, NSE weirs were unable to be fully lowered to the correct sill elevation for the duration of 2016. The improper sill elevation at NSE was remedied during the 2016-2017 winter maintenance period by project maintenance staff.

Adult Fish Facility Recommendations

1. 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 dike that protects the NSE entrance from turbulent water forces created by the north shore clockwise eddy.
5. Repair or replace the Fishway Control System
6. Rotate the rebuild of fish pump gear boxes to ensure the ability to run on three fish pumps
7. Replace cleaning brush system for the counting room and viewing room windows

Juvenile Fish Facility

Facility Description

The Little Goose Juvenile Fish Facility was designed to bypass juvenile salmon and steelhead to the tailrace, or transport them by truck and barge below Bonneville Dam. 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 22. Every other day collection and sampling began in April, with the first condition sample occurring on April 10. Collection for transport began on May 1 at 0700 hours and ended on October 31 at 0700 hours. A total of 4,784,745 smolts were collected during the 2016 season (Table 6). Of those, 2,421,054 were transported, 2,361,667 were bypassed, and 2,024 were facility mortalities.

Table 6. Annual collection, bypass, and transport activity at Little Goose Dam JFF, 2011-2016

	Chinook Yearling		Chinook Sub-yearling		Steelhead		Coho		Sockeye		
Year	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Total
Collection											
2011	1,125,551	323,791	232,116	508,188	868,702	263,726	0	41,631	3,487	20,869	3,388,061
2012	1,067,044	431,462	268,235	399,054	658,540	312,732	775	52,541	252	25,583	3,216,218
2013	768,720	257,791	155,896	297,206	864,292	310,421	50	36,839	15,952	6,683	2,713,850
2014	1,487,105	462,499	278,019	463,013	1,013,203	346,944	0	41,542	9,115	51,956	4,153,396
2015	643,606	163,926	169,349	478,654	590,849	158,004	8,276	33,797	11,050	2,818	2,260,329
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
Bypass											
2011	56,672	46,496	1	92	216,725	21,908	0	401	0	5,227	347,522
2012	242,353	145,896	1	125	227,179	60,328	0	1,601	0	691	678,174
2013	24,036	22,662	5	343	56,575	9,627	0	200	0	2	113,450
2014	78,418	102,125	0	294	178,448	32,046	0	600	0	5,911	397,842
2015	192,212	69,754	0	140	191,460	21,760	400	1,320	0	40	477,086
2016	1,032,728	382,708	1	2,876	766,337	163,410	3,600	10,000	6	1	2,361,667
Truck											
2011	1	16	59	10,680	8	22	0	277	2	77	11,142
2012	1	0	133	6,306	17	26	0	7	0	106	6,596
2013	0	0	638	25,106	13	18	0	4	2	16	25,797
2014	0	4	400	7,520	4	6	0	0	0	34	7,968
2015	1	1	44	5,982	35	8	0	9	0	2	6,082
2016	0	0	1,345	10,576	23	3	0	0	0	0	11,947
Barge											
2011	1,067,450	276,919	230,973	494,558	651,617	241,734	0	40,943	3,480	15,416	3,023,090
2012	824,116	285,393	267,834	391,916	431,232	252,302	775	50,931	252	24,775	2,529,526
2013	744,193	235,046	155,117	271,046	807,600	300,745	50	36,635	15,950	6,657	2,573,039
2014	1,408,338	360,039	277,207	453,966	834,621	314,847	0	40,932	9,107	45,757	3,744,814
2015	451,267	94,129	168,929	470,315	399,120	136,176	7,868	32,447	11,046	2,772	1,774,069
2016	840,410	181,791	202,183	400,476	494,818	176,078	26,140	64,542	18,645	4,024	2,409,107
Total Transport											
2011	1,067,451	276,935	231,032	505,238	651,625	241,756	0	41,220	3,482	15,493	3,034,232
2012	824,117	285,393	267,967	398,222	431,249	252,328	775	50,938	252	24,881	2,536,122
2013	744,193	235,046	155,755	296,152	807,613	300,763	50	36,639	15,952	6,673	2,598,836
2014	1,408,338	360,043	277,607	461,486	834,625	314,853	0	40,932	9,107	45,791	3,752,782
2015	451,268	94,130	168,973	476,297	399,155	136,184	7,868	32,456	11,046	2,774	1,780,151
2016	840,410	181,791	203,528	411,052	494,841	176,081	26,140	64,542	18,645	4,024	2,421,054

During the month of April, prior to the start of the fish transport season, the facility was in secondary bypass every day for every-other-day condition sampling and gas bubble trauma monitoring. Fish were routed to the river without being sampled on non-sample days. Collection for sampling did not begin until 0700 on April 9 due to a broken water supply pipe. An estimated total of 2,361,765 smolts entered the facility in April. Of this total, 2,361,583 were bypassed, 102 were facility (raceway/separator) mortalities during non-sample days, 66 facility mortalities during sample days and an additional 14 mortalities were recorded in the sample

resulting in a total 2,361,583 smolts bypassed. There are no passage estimates on dates when the facility was operated in secondary bypass during this time period.

Transportation

A total of 2,422,975 salmonid smolts were collected for transport during this period. Of this total, 2,409,107 smolts were barged, 11,947 were trucked, 84 were bypassed, and 1,837 were facility mortalities.

Daily barging and direct loading operations occurred from May 2 to May 25, alternate day barging occurred from May 25 to August 15. Transportation by truck began on August 17 and ended on November 1. Juvenile salmonids collected for transport were directly loaded into barge holds and truck tanks or were held in raceways and wet lab tanks prior to loading and transport. The maximum holding time prior to transport ranged from 24 to 48 hours. Barge transport time from Little Goose to the mid channel release point below Bonneville Dam was approximately two days. Barging accounted for approximately 99.5% of the smolts transported. The estimated species composition and clip type of the fish transported by barge was; clipped yearling chinook 34.9%, clipped steelhead 20.5%, unclipped subyearling chinook 16.6%, clipped subyearling chinook 8.4%, unclipped yearling chinook 7.5%, unclipped steelhead 7.3%, coho 3.8%, clipped sockeye 0.8% and unclipped sockeye 0.2%.

Transportation by truck to the release sites at the Bonneville Juvenile Fish Facility Flume took approximately six hours. Trucked Fish were transported in a saline solution of 1 to 2 mg/L of sodium chloride to reduce stress and treat presumed Columnaris disease. Of the 2,421,054 juvenile salmonids transported from Little Goose in 2016, 11,947 of them, or 0.5% of the total, were transported by truck. The species composition of salmonids transported by truck was; unclipped subyearling chinook 88.5%, clipped subyearling chinook 11.3%, combined steelhead 0.2%, unclipped sockeye <0.1% and unclipped yearling chinook <0.1%. In 2016, all fish transport operations were performed without incident. Fish bypassed during the transportation season, May 2 through October 31, included 77 chinook and 7 sockeye fry.

The maximum daily estimated collection of 432,007 fish occurred on April 24 and accounted for 9.0% of total collection (Table 7). The composition of the collection for that date was: clipped steelhead 42.4%, clipped yearling Chinook 39.8%, unclipped yearling Chinook 14.1%, unclipped steelhead 3.2%, and clipped coho 0.2%.

Table 7. Peak passage dates and totals by species group at Little Goose Dam JFF, 2011-2016.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	
Year	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Season
2011	May 13 (121,429)	May 13 (28,802)	June 04 (16,859)	June 04 (39,613)	May 18 (58,203)	May 18 (27,400)	May 22 (700)	May 12 (1,406)	May 20 (4,400)	May 13 (225,048)
2012	April 30 (176,464)	April 30 (76,835)	June 16 (25,750)	June 04 (23,025)	April 30 (104,051)	April 30 (29,612)	May 29 (150)	May 23 (3,000)	May 19 (4,200)	April 30 (389,763)
2013	May 10 (156,233)	May 10 (44,008)	June 10 (15,290)	June 08 (14,452)	May 14 (107,846)	May 14 (46,209)	May 17 (4,600)	May 19 (2,400)	May 14 (5,200)	May 10 (280,443)

2014	May 06 (156,006)	April 22 (53,031)	June 02 (19,016)	June 03 (24,044)	April 22 (89,625)	May 08 (25,215)	May 10 (3,600)	May 20 (4,003)	May 10 (6,813)	May 06 (279,206)
2015	April 28 (53,656)	April 24 (16,602)	May 29 (15,400)	July 13 (18,551)	April 28 (66,016)	May 09 (11,601)	May 19 (3,500)	May 12 (400)	May 17 (4,700)	April 28 (136,712)
2016	April 30 (180,800)	April 18 (62,401)	June 11 (15,750)	June 11 (25,750)	April 24 (183,201)	April 30 (28,400)	May 21 (3,750)	May 11 (400)	May 9 (13,200)	April 24 (432,007)

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 3,442 adult salmon and steelhead fallbacks occurred in 2016 (Table 8). There were 2,022 steelhead fallbacks in April, May and June (Table 9). Of these there were 816 clipped and 1149 unclipped which were classified as 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. Table 10 lists the numbers of fish by species and condition categories.

Other fish of particular interest that were bypassed back to the river from the separator included 96 adult pacific lamprey and 15 white sturgeon. The 96 adult pacific lamprey were transported to one mile above the dam and released.

Table 8. Total Annual Adult Salmonid Fallbacks at Little Goose Dam JFF, 2011-2016.

Year	Adult Chinook	Jack/mini Chinook	Clip Steelhead	Unclip Steelhead	Sockeye	Coho	Total
2011	1,683	1,020	1,996	1,549	17	14	6,280*
2012	1,064	1,077	1,215	1,399	9	21	4,785
2013	1,341	1,050	1,469	1,061	15	2	4,938
2014	991	558	1,518	1,425	46	186	4,724
2015	515	240	659	903	15	10	2,342
2016	643	452	1049	1273	16	9	3,442

*2011 total includes 1 Pink Salmonid.

Table 9. Monthly totals of fallbacks bypassed from separator at Little Goose Dam, 2016.

Month	Adult Chinook	Jack Chinook	Clip Steelhead	Unclip Steelhead	Sockeye	Coho	Total
April	0	1	517	624	0	0	1142
May	70	4	302	492	0	2	870
June	49	28	18	69	0	0	164
July	37	5	6	8	13	0	69
August	12	4	12	7	1	0	36
September	95	56	69	19	0	2	241
October	380	354	125	54	2	5	920
Total	643	452	1049	1273	16	9	3,442

Table 10. Condition of adult salmonids released at Little Goose Dam, 2016.

Fish	Chinook		Chinook Jack		Steelhead		Sockeye		Coho	
Condition[1]	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Total
Good	283	314	248	190	864	973	11	5	8	2,896
Fair	18	17	4	7	141	196	0	0	1	384
Poor	8	2	2	1	34	86	0	0	0	133
Dead	1	0	0	0	10	18	0	0	0	29
Total	310	333	254	198	1049	1273	11	5	9	3,442

[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 6 does not separate post spawned "kelt" steelhead from pre-spawned healthier steelhead.

Separator Efficiency

Separator efficiency is a measure of how efficiently fish entering the facility are separated by size. Smaller fish, primarily salmon smolts, are expected to enter through the narrowly spaced "A" side sorter bars on the upstream end of the separator, and the larger fish, primarily steelhead, should enter through the more widely spaced "B" side sorter bars on the downstream end. Table 4 gives efficiency expressed as the percentage of each group, passing through the desired side of the separator, for 2011-2016. Efficiency rates are based on expanded sample counts.

Separator efficiency was highest for clipped and unclipped steelhead, with 88.6% of clipped steelhead and 68.7% of unclipped steelhead entering on "B" side. Separator efficiency was lowest for clipped and unclipped sockeye salmon with 23.9% of clipped sockeye salmon and 27.3% of unclipped sockeye salmon entering on "A" side (Table 11).

Table 11. Annual juvenile salmonid separator efficiency (%) at Little Goose Dam JFF, 2011-2016.

	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
2011	73.6	69.9	58.0	57.7	76.9	67.3	-----	32.9	22.6	38.2
2012	75.1	72.3	59.1	59.9	83.7	64.8	45.2	42.1	0.0	37.7
2013	71.5	71.2	53.8	48.8	82.1	62.1	100.0	23.7	64.5	52.4
2014	81.8	78.6	58.5	56.5	75.9	54.7	-----	41.3	49.5	37.6
2015	72.9	69.3	65.8	62.8	72.7	57.0	39.0	35.9	45.2	38.2
2016	65.4	64.0	57.3	56.1	88.6	68.7	36.0	32.2	23.9	27.3

Note: Counts do not include sample mortalities. There were no clipped coho sampled in 2014.

Sampling

The fish sampling system was operated without incident throughout the 2016 season. Sampling procedures followed the smolt monitoring guidelines developed by the Fish Passage Center and the USACE. The resulting data were used for management of facility and fish transport operations. Collection and fish condition data were also transmitted daily to the FPC electronic database in support of the Smolt Monitoring Program (SMP) by ODFW personnel.

Sample rates were set by USACE project biologists. To obtain the target sample of 300 to 500 smolts, sample rates were varied between 0.25% and 100% 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 12).

Table 12. Annual percentages of juvenile salmonids collected per species and clip type that were sampled at Little Goose Dam JFF, 2011-2016[1].

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	
Year	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Total
2011	0.6	0.8	2.8	6.9	0.7	0.8	2.3	1.8	1.7	1.8
2012	0.5	0.7	3.0	8.0	0.8	0.9	2.4	1.5	0.9	1.8
2013	0.6	0.8	5.1	15.4	0.8	1.0	0.7	1.5	0.8	2.6
2014	0.4	0.7	3.0	6.1	0.6	0.6	0.6	0.9	0.6	1.4
2015	0.8	1.0	2.8	4.7	1.0	1.1	0.9	0.9	1.0	1.8
2016	0.3	0.5	4.7	7.8	0.5	0.6	2.9	1.0	0.7	1.3

[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 fry were defined by length, under 60 mm, and were bypassed for continued growth. None of the 2016 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.

Pound counts (number of fish per pound) were taken daily during condition sampling and provided to the USACE from April 2 through October 31. During transport, when the sample rate was set below 100%, weights were also recorded on all non-salmonid species in the sample to determine their contribution to barge loading densities. A total of 60,592 fish were sampled during the 2016 season. Of these, 58.894 were examined for descaling, 1,397 were removed from the separator for GBT monitoring, 77 were fry and not examined and the remaining 224 were sample mortalities (Table 13).

Table 13. Weekly sample as percent of collection total and sample totals at LGS JFF, 2015.

Week Ending	Weekly % Sampled (%)	Yearling Chinook Clip	Yearling Chinook Unclip	Subyearling Chinook Clip	Subyearling Chinook Unclip	Steelhead Clip	Steelhead Unclip	Sockeye Clip	Sockeye Unclip	Coho	Totals[1]
7-Apr	----	0	0	0	0	0	0	0	0	0	0
14-Apr	0.7	512	325	0	1	509	185	0	0	1	1,533
21-Apr	0.4	775	533	0	1	594	135	0	0	0	2,038
28-Apr	0.3	1,475	418	0	2	1,074	165	0	0	13	3,147
5-May	0.3	1,391	234	0	18	610	149	0	2	36	2,440
12-May	0.3	1,107	182	0	23	720	227	0	4	148	2,411
19-May	0.9	549	236	0	38	627	329	4	4	129	1,916
26-May	2.3	270	291	16	139	813	490	311	24	175	2,529
2-Jun	5.9	205	320	409	513	482	279	230	5	184	2,627
9-Jun	3	37	101	2,016	2,378	213	134	3	1	40	4,923
16-Jun	2	5	14	1,221	2,018	70	33	0	0	10	3,371

23-Jun	3.7	8	8	1,216	2,855	15	6	0	0	4	4,112
30-Jun	5	3	4	905	2,007	25	4	0	0	2	2,950
7-Jul	6.3	0	2	725	2,524	2	2	0	0	0	3,255
14-Jul	19.7	0	0	560	3,005	6	1	0	0	0	3,572
21-Jul	16.6	0	0	194	1,203	19	2	0	0	0	1,418
28-Jul	50	1	1	242	1,371	45	1	0	0	0	1,661
4-Aug	71.8	0	0	439	2,135	93	3	0	2	0	2,672
11-Aug	50	0	0	343	1,381	16	1	0	0	0	1,741
18-Aug	80.8	0	0	138	1,074	5	2	0	0	0	1,219
25-Aug	100	0	0	112	906	11	0	0	0	0	1,029
1-Sep	100	0	0	144	873	2	1	0	0	0	1,020
8-Sep	100	0	0	187	932	1	0	0	0	0	1,120
15-Sep	100	0	0	250	1,634	2	0	0	0	0	1,886
22-Sep	100	0	0	296	2,386	0	0	0	0	0	2,682
29-Sep	99.7[2]	0	0	38	347	0	1	0	0	0	386
6-Oct	100	0	0	33	279	1	0	0	0	0	313
13-Oct	99.8[2]	0	0	49	571	1	0	0	0	0	621
20-Oct	100	0	0	84	1,154	1	0	0	0	0	1,239
27-Oct	100	0	0	34	396	0	0	0	0	0	430
31-Oct	100	0	0	23	308	0	0	0	0	0	331
Total Sampled		6,338	2,669	9674	32,472	5,957	2,150	548	42	742	60,592
Total Collection		1,873,536	564,588	203,981	414,605	1,261,259	339,520	18,868	4,032	104,356	4,784,745
% of Sample		10.5	4.4	16	53.6	9.8	3.5	0.9	0.1	1.2	100
% of Coll.		0.3	0.5	4.7	7.8	0.5	0.6	2.9	1	0.7	1.3

[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.
Note: Little Goose JFF was in secondary bypass mode at 0700, switching to 24-hour condition sampling on April 10, 12, 14, 16, 18, 20, 22, 24, 26, 28 and 30. Collection for transport with daily 24-hour sampling began at 0700 on May 1 and ended at 0700 on October 31.

Fish Condition

Fish condition was monitored daily by Anchor QEA and ODFW biologists and biological aids. "The primary role of condition monitoring is to identify the proportion of each species of migrant juvenile salmonid that are descaled or have significant injuries indicative of problems in fish passage at dams, such as debris in fish bypass apparatus" (Condition Sampling Protocol 2014 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 (Table 14).

Table 14. Annual injury rates (%) for salmonids examined at Little Goose Dam, 2011-2016.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	
Year	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Total
2011	0.7	1.4	0.6	1.7	1.9	1.8	0.0	3.6	0.9	1.5
2012	2.5	2.7	4.9	6.0	2.0	3.3	0.0	1.8	2.7	4.6
2013	3.4	4.3	8.9	17.0	1.8	1.6	0.0	3.2	2.9	12.1
2014	8.4	8.4	9.0	12.3	4.3	3.4	13.3	12.9	8.6	9.8
2015	12.5	14.1	12.9	16.6	6.2	5.5	7.0	11.5	11.1	13.4
2016	10.2	12.2	19.5	23.5	0.1	6.4	5.6	13.5	14.8	17.9

A total of 23,495 smolts from the condition subsample were examined for injuries. Of the fish examined, 17.9% or 4,199 individual smolts were observed with one, or more than one, injury. A total of 4,267 individual injuries were observed this year. The vast majority of injuries involved damage to fins at 92.1% of the total followed by operculum injury (3.5%), body injury (3.0%), head injury (0.9%), and eye injury (0.4%) (Table 15). The highest rates of injury this year were observed in subyearling fall Chinook salmon.

Table 15. Percent of fish examined that were injured, had predation marks, or had signs of disease by species and clip type at Little Goose Dam, 2016.

	Yearling Chinook		Subyearling Chinook		Steelhead		Coho		Sockeye		
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Total[1]
Injuries											
Eye	0.2	0.1	0.0	0.0	0.0	0.0	0.5	0.2	0.6	0.0	0.1
Operculum	0.8	0.5	0.4	0.2	2.3	1.1	1.1	1.7	1.2	0.0	0.6
Head	0.2	0.0	0.1	0.2	0.3	0.3	0.0	0.4	0.2	0.0	0.2
Body	0.2	0.5	0.7	0.6	0.5	0.8	0.0	0.0	0.4	2.7	0.5
Fin	9.0	11.3	18.5	22.8	3.5	4.5	15.4	12.4	3.1	10.8	16.7
Total Injury	10.2	12.2	19.5	23.5	0.1	6.4	16.5	14.2	5.6	13.5	17.9
Disease											
Fungus	0.2	0.0	0.0	0.1	0.5	0.3	0.0	0.2	9.7	0.0	0.4
Columnaris	0.0	0.0	3.6	6.0	0.1	0.1	0.0	0.0	0.0	0.0	3.6
BKD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parasites	0.5	0.7	0.4	0.4	2.6	5.2	0.0	2.8	0.0	0.0	0.9
Deformity	0.4	0.1	1.4	0.5	0.0	0.4	0.0	4.6	1.4	0.0	0.6
Disease Other	0.4	0.2	2.1	3.0	0.4	0.1	0.5	0.7	65.6	2.7	3.3
Total Disease	1.5	1.0	7.4	9.9	3.8	6.0	0.5	8.1	67.1	2.7	8.5
Predation											
Bird	0.8	0.2	0.5	1.6	2.3	2.7	1.1	0.9	1.7	0.0	1.4
Fish	1.5	0.5	1.1	1.5	0.5	0.6	0.5	0.7	3.3	0.0	1.3
Lamprey	0.0	0.0	0.3	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.3
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Yearling Chinook		Subyearling Chinook		Steelhead		Coho		Sockeye		
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Total[1]
Total Predation	2.4	0.7	1.9	3.6	3.0	3.2	1.6	1.7	5.0	0.0	3.0
Misc. Conditions											
Pop Eye	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Fin Hemorrhage	5.2	6.0	12.2	14.1	2.2	2.6	1.6	2.4	8.1	8.1	10.3
Pink Fin	8.4	9.8	34.6	41.2	9.7	9.2	2.2	1.1	3.1	8.1	28.7
Fin Discoloration	2.6	1.8	11.5	12.1	0.9	0.4	1.1	0.4	0.0	2.7	8.2
Eye Hemorrhage	0.4	0.5	0.0	0.1	0.2	0.2	0.5	0.7	0.2	0.0	0.2
Total Misc. Conditions	15.3	16.8	44.2	49.6	12.2	11.4	5.5	4.4	11.0	10.8	35.9
Total sample size	2,460	1,094	2,935	12,236	2,472	1,055	182	541	483	37	23,495

[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 58,893 smolts were examined for descaling in 2016. The overall rate of descaling was 1.31% (769 descaled), which is similar to rates observed in previous years (Table 16). Of the 58,893 smolts examined for descaling, 39.9% or 23,495 smolts were examined as part of condition subsampling. During condition subsampling, fish with descaling equal to or greater than 20% were differentiated into two categories; descaling associated with dam passage and descaling on fish with bite marks indicative of predation attempts by birds, fish, or mammals. Of the 451 descaled smolts observed in the condition subsample, descaling associated with dam passage was 49.7% of the condition descale total and the rate of descaling on fish with predation marks present was 50.3% of the condition descale total. The rate of descaling observed in the non-condition sample was 0.9% from a sample size of 35,398 salmon. Note that all descaling recorded from the full sample does not differentiate between descaling as a result of passage and descaling on fish with evidence of attempted predation.

Table 16. Annual descaling rates (%) for salmonids examined at Little Goose Dam JFF, 2011-2016.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	
Year	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Totals
2011	0.5	0.5	0.3	0.5	0.2	0.1	0.0	0.6	0.3	0.4
2012	1.0	0.6	0.5	0.9	0.8	1.4	0.0	1.9	0.6	0.9
2013	0.7	1.0	0.8	1.0	0.6	0.8	0.9	1.1	0.7	0.9
2014	1.2	0.5	1.0	0.9	1.0	1.2	0.0	3.4	1.9	1.0
2015	1.3	1.1	0.7	0.7	1.9	1.9	0.0	3.8	1.4	1.0
2016	1.1	0.7	1.0	1.5	1.2	1.2	1.3	2.4	1.8	1.3

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 was also recorded. Partial descaling was considered scale loss above background levels of approximately 5% scale loss but below the 20% threshold for descaling. The rate of partial descaling was 4.49% of the 23,495 smolts examined for condition in 2016.

Overall weekly descaling rates per species and clip types are listed in Table 17. In 2009, descaling associated with predatory attempts was not included in the total descaling rate, while in 2010 through 2016, it was included. The average weekly descaling rate ranged from 0.0% to 8.2%. Weekly descaling rates were variable throughout the season and, as in previous years, appeared to coincide with peak migrations, increased river discharge, increased river debris, and/or small sample sizes.

Table 17. Weekly descaling rates (%) for salmonids examined at Little Goose Dam JFF, 2016.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	
Week Ending	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Total[1]
7-Apr	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
14-Apr	1.29	0.68	-----	-----	0.41	0	-----	-----	0	0.70
21-Apr	0.98	0.78	-----	-----	0.88	0	-----	-----	-----	0.83
28-Apr	0.77	0.25	-----	-----	0.49	0.62	-----	-----	0	0.59

5-May	0.82	1.73	-----	0	0.88	2.16	-----	0	0	0.99
12-May	1.42	0.57	-----	0	2.07	0.46	-----	0	0	1.35
19-May	1.17	0.46	-----	0	1.50	0.98	0	0	3.10	1.28
26-May	0.39	0.36	0	0.76	1.31	2.36	1.64	4.17	0.57	1.29
2-Jun	2.70	0.00	0.25	0.21	1.33	1.14	0.93	0	3.80	1.00
9-Jun	0.00	2.00	0.10	0.34	2.01	0.81	0	0	2.50	0.37
16-Jun	0.00	7.14	0.51	0.77	0.00	3.03	-----	-----	0.00	0.71
23-Jun	0.00	0.00	0.42	1.04	0.00	16.67	-----	-----	0.00	0.88
30-Jun	33.33	25.00	1.62	0.98	0.00	0.00	-----	-----	0.00	1.23
7-Jul	-----	-----	0.71	0.82	0.00	0.00	-----	-----	-----	0.80
14-Jul	-----	-----	0.92	1.24	16.67	0.00	-----	-----	-----	1.21
21-Jul	-----	-----	0.53	1.10	0.00	0.00	-----	-----	-----	1.01
28-Jul	0.00	0.00	0.83	1.04	4.44	0.00	-----	-----	-----	1.10
4-Aug	-----	-----	1.83	0.99	2.15	0.00	-----	0	-----	1.17
11-Aug	-----	-----	1.75	0.88	0.00	0.00	-----	-----	-----	1.04
18-Aug	-----	-----	2.92	1.40	20.00	0.00	-----	-----	-----	1.65
25-Aug	-----	-----	0.00	0.77	0.00	-----	-----	-----	-----	0.68
1-Sep	-----	-----	0.00	0.57	0.00	0.00	-----	-----	-----	0.49
8-Sep	-----	-----	2.14	0.86	-----	-----	-----	-----	-----	1.07
15-Sep	-----	-----	0.00	1.35	0.00	-----	-----	-----	-----	1.17
22-Sep	-----	-----	1.36	1.47	-----	-----	-----	-----	-----	1.46
29-Sep	-----	-----	2.63	2.90	-----	0.00	-----	-----	-----	2.86
6-Oct	-----	-----	3.03	6.86	0.00	-----	-----	-----	-----	6.43
13-Oct	-----	-----	12.24	7.05	0.00	-----	-----	-----	-----	7.46
20-Oct	-----	-----	14.29	6.86	0.00	-----	-----	-----	-----	7.36
27-Oct	-----	-----	8.82	7.58	-----	-----	-----	-----	-----	7.67
31-Oct	-----	-----	4.35	8.44	-----	-----	-----	-----	-----	8.16
Total Exam	6,020	2,557	9,459	31,853	5,651	2,045	526	41	741	58,893
% Desc	1.05	0.70	0.96	1.52	1.17	1.22	1.33	2.44	1.31	1.31
Median	0.82	0.57	1.14	0.99	0.2	0.00	0.46	0.00	0.00	1.13

[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 also dwarfism or truncated body were also documented.

A total of 2,007 smolts or 8.5% of the total condition subsample were observed with one or more symptoms of disease (See Table 15 above). Of the 2,089 individual signs of disease observed this year, Columnaris was the most prevalent at 40.7% of the total, followed by other disease (37.3%), parasite (10.5%), deformity (7.2%), fungus (4.0%), , and presumed BKD (0.2%). Note that the majority of "other" diseases this season consisted of observations of sick subyearling fall Chinook smolts exuding clear fluid from an inflamed vent, coupled with abdominal distention. Several subyearling fall Chinook smolt mortalities were observed with

these symptoms which prompted us to collect a specimen for the Oregon Department of Fish Wildlife Fish Health Lab in LaGrande, Oregon. Preliminary results were positive for the intestinal protozoan parasite *Ceratomyxa Shasta. C. Shasta* is a parasite of the Pacific Northwest known to cause losses in hatchery reared and wild salmonids and also contributes significantly to pre-spawning mortality of adult salmonids.

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 711 smolts were observed with one or more predatory wounds for an overall rate of 3.0% of the total condition subsample. The majority of marks observed in the subsample were indicative of attempted predation by bird at approximately 46.1% of the 713 total individual bite marks recorded, followed by fish bites (42.5%), and lamprey bites (11.4%). No mammalian bite marks were observed this year. Subyearling Chinook salmon sustained the highest rate of predatory attempts, which were predominately a result of predation attempts by birds (See Table 15 above).

The overall rate of bird bite marks decreased slightly from last year and was similar to the previous 5 years (Table 18). The highest prevalence of bird bite marks was observed on clipped steelhead.

Table 18. Annual bird bite rates (%) for salmonids examined at Little Goose Dam, 2011-2016.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	
Year	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip		Total
2011	0.8	0.3	0.1	0.5	2.4	2.3	0.0	1.8	0.0	0.7
2012	0.7	0.5	0.1	0.5	3.9	3.8	0.0	0.0	0.0	1.0
2013	1.0	1.0	0.1	0.5	1.8	2.6	2.2	1.6	1.4	0.8
2014	0.5	0.5	0.3	0.3	2.7	2.5	0.0	0.7	0.9	0.7
2015	0.8	0.9	0.2	0.3	4.4	3.3	0.0	3.9	<0.1	1.1
2016	0.8	0.2	0.5	1.6	2.3	2.7	1.7	0.0	1.0	1.4

Other Miscellaneous Conditions

The Other Miscellaneous Conditions category included popeye (exopthalmos), hemorrhaged fin, pink fin, discolored fin, and hemorrhaged eye. There were a total 8,443 smolts with one or more miscellaneous conditions for an overall miscellaneous condition rate of 35.9% of the total condition subsample (See Table 15 above). A total of 11,128 individual observations of miscellaneous conditions were found. Many smolts that were examined had multiple conditions. For example, pink and hemorrhaged fins often occurred on the same individual fish, though in different fins. Pink fins constituted the majority of the observations in this category at 60.5% of the individual miscellaneous conditions total followed by hemorrhaged fin(s) (21.8%), fin discoloration (17.3%), eye hemorrhage (0.3%), and popeye (exopthalmos) (0.1%). Subyearling fall Chinook salmon had the highest rates in this condition category, 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

total facility mortality (raceways, separator, and sample) and sample mortality. Raceways included barge holds, wet lab tanks and routing flumes.

The rate of total facility mortality was low this year at <0.01% from a total collection of 4,784,745 smolts (Table 19). The average weekly total facility mortality rate ranged from 0.0% to 1.7% (Table 20). The minimum weekly rates of 0.0% occurred frequently during the months of April and May 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 descaling, disease, predation, and injury rates increased. The maximum weekly total facility mortality rate of 1.7% occurred during the week ending July 28, with a total weekly collection of 3,322 fish. The median season total facility mortality rate for all smolts was 0.25%. The average monthly facility mortality rate was highest in July at a rate of 0.46% from a collection total of 83,099 smolts.

Sample mortality for smolts was 0.4% of 60,592 smolts sampled (Table 21). As in 2015, increased sample mortality in late summer was observed, when river temperatures and outbreaks of disease such as Columnaris were on the rise. On average, monthly sample mortality rates were lowest in September at 0.16% from a sample total of 6,238 smolts. The highest sample mortality rate was in July at 0.75% from a sample total of 11,530 smolts.

The total sample mortality rate for Pacific lamprey ammocoetes was 7.14%, which was 3 of the 42 total ammocoetes sampled. The sample mortality rate for Pacific lamprey macropthalmia was 3.77%, which was 31 from a total of 822 sampled (Table 21). No notable peak in sample mortality for either life stage of juvenile Pacific lamprey was observed.

Table 19. Annual total facility mortality as a percentage of total collection at LGS JFF 2011-2016.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho		Pacific lamprey	
Year	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Total	Ammocoete	Macropthalmia
2011	0.1	0.1	0.5	0.6	<0.1	<0.1	0.1	0.7	<0.1	0.2	0.7	0.2
2012	<0.1	<0.1	0.1	0.2	<0.1	<0.1	0.0	<0.1	0.0	<0.1	0.5	0.3
2013	<0.1	<0.1	0.1	0.2	<0.1	<0.1	0.0	0.1	0.0	0.1	0.2	<0.1
2014	<0.1	0.1	0.2	0.3	<0.1	<0.1	0.1	0.5	<0.1	0.1	0.4	0.2
2015	<0.1	0.1	0.2	0.4	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1
2016	<0.1	<0.1	0.2	0.2	<0.1	<0.1	1.2	0.2	<0.01	<0.1	0.2	<0.1

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

Table 20. Weekly total facility mortality in percent at Little Goose Dam JFF, 2016.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho	
Week Ending	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Total[1]
7-Apr	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
14-Apr	0.0	0.0	-----	0.0	0.0	0.0	-----	-----	0	0.0
21-Apr	0.0	0.0	-----	0.0	0.0	0.0	-----	-----	-----	0.0
28-Apr	0.0	0.0	-----	0.0	0.0	0.0	-----	-----	0	0.0
5-May	0.0	0.0	-----	0.0	0.0	0.0	-----	0.0	0	0.0

12-May	0.0	0.0	-----	0.1	0.0	0.0	-----	0.0	0	0.0
19-May	0.0	0.0	-----	0.0	0.0	0.0	0.0	0.0	0	0.0
26-May	0.2	0.1	0.0	0.0	0.0	0.0	0.2	0.4	0.3	0.1
2-Jun	1.7	0.3	0.1	0.1	0.1	0.1	3.5	3.0	0.1	0.6
9-Jun	0.3	0.0	0.1	0.0	0.0	0.0	9.8	0.0	3.1	0.1
16-Jun	0.4	0.0	0.2	0.1	0.1	0.2	-----	-----	1.8	0.1
23-Jun	0.0	0.5	0.2	0.1	0.0	0.0	-----	-----	9.4	0.1
30-Jun	0.0	0.0	0.1	0.1	0.8	0.0	-----	-----	6.7	0.1
7-Jul	-----	33.3	0.4	0.3	0.0	0.0	-----	-----	-----	0.3
14-Jul	-----	-----	1.1	0.8	4.0	50.0	-----	-----	-----	0.8
21-Jul	-----	-----	0.8	1.0	0.0	0.0	-----	-----	-----	0.9
28-Jul	50.0	0.0	1.2	1.9	0.0	0.0	-----	-----	-----	1.7
4-Aug	-----	-----	0.7	0.8	0.0	0.0	-----	0.0	-----	0.8
11-Aug	-----	-----	0.1	0.6	0.0	0.0	-----	-----	-----	0.5
18-Aug	-----	-----	1.1	0.6	20.0	0.0	-----	-----	-----	0.7
25-Aug	-----	-----	0.0	0.4	0.0	-----	-----	-----	-----	0.4
1-Sep	-----	-----	0.0	0.3	0.0	0.0	-----	-----		0.3
8-Sep	-----	-----	0.0	0.1	0.0	-----	-----	-----	-----	0.1
15-Sep	-----	-----	0.4	0.3	0.0	-----	-----	-----	-----	0.3
22-Sep	-----	-----	0.7	0.0	-----	-----	-----	-----	-----	0.1
29-Sep	-----	-----	0.0	0.6	100.0	0.0	-----	-----	-----	0.8
6-Oct	-----	-----	0.0	0.7	0.0	-----	-----	-----	-----	0.6
13-Oct	-----	-----	0.0	1.0	0.0	-----	-----	-----	-----	1.0
20-Oct	-----	-----	0.0	0.4	0.0	-----	-----	-----	-----	0.4
27-Oct	-----	-----	0.0	0.3	-----	-----	-----	-----	-----	0.2
31-Oct	-----	-----	0.0	0.0	-----	-----	-----	-----	-----	0.0
Median Weekly Rate	0.00	0.00	0.10	0.20	0.00	0.00	1.85	0.00	0.10	0.25

[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 21. Annual sample mortality as percent of total sample at Little Goose Dam JFF, 2011-2016.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye		Coho		Pacific Lamprey	
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip		Total	Ammocoetes	Macropthalmia
2011	0.6	0.5	0.9	1.4	0.1	0.1	0.0	0.6	0.8	1.1	11.1	7.8
2012	0.4	0.3	0.3	0.5	0.2	0.2	0.0	0.8	0.0	0.4	10.8	4.5
2013	0.2	0.1	0.3	0.8	0.1	0.1	0.0	4.1	0.0	0.6	3.8	1.9
2014	0.3	0.3	0.3	0.8	0.2	0.1	1.7	4.7	0.4	0.6	20.4	5.6
2015	0.2	0.5	0.3	0.9	0.2	0.2	2.0	0.0	0.0	<0.1	20.0	4.1
2016	0.3	0.2	0.4	0.4	0.2	0.1	4.0	0.0	<0.1	0.4	<0.1	<0.1

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. In 2014, the sample mortality rate for Pacific lamprey ammocoete includes 2 unknown ammocoetes.

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. When the sample numbers were too large to practically count each individual, 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 prawn. For the

ninth consecutive season, all Siberian prawn that occurred in the sample were euthanized per the directive issued by Washington Department of Fish and Wildlife on July 24, 2007. All Siberian prawn from the sample were frozen, bagged and sent to a landfill for disposal.

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.

Incidental collections totaled 253,401 fish. This included an expanded sample count of 190,953 fish and 51,518 crustaceans plus 10,930 fish from the separator (Table 22). Incidental collection counts were lower than in 2015, and above the five year average of 171,125 fish (Table 23). The majority of the incidental catch this year consisted of American shad at 157,259 or 62% of the total number of incidentals collected. Siberian prawn collection numbers were highest during the month of August totaling 19,011 or 45.8% of all Siberian prawn collected for the season. Numbers of Pacific lamprey macropthalmia were higher than in 2015, while crappie collection numbers were lower. Collection totals for most other groups that contribute substantial numbers to the incidental collection were similar to those in 2015.

Adult Pacific lamprey collections totaled 117 lamprey in 2016: 96 from the separator and 21 from the sample. The first adult Pacific lamprey of the season was collected May 29, the last on October 10, 2016. Upriver adult migrants were most frequently observed falling back into the collection system from July through August. USACE transported all Pacific adult lamprey captured at the facility to above the dam, releasing them at Little Goose Landing. In addition, to avoid exposure to sampling anesthesia, any adult lamprey found in the sample tanks were removed by the USACE prior to SMP sampling.

Table 22. Collection of incidental species at Little Goose Dam, 2016

Common Name	Scientific Name	Expanded Sample	Separator	Total Collection [1]
American Shad	*Alosa sapidissima*	149,269	7,990	157,259
Banded Killifish	*Fundus diaphanus*	0	0	0
Bass-Smallmouth	*Micropterus dolomieui*	2,846	146	2,992
Bass-Largemouth	*M. salmoides*	10	3	13
Bullhead	*Amierus sp.*	166	0	166
Bull trout	*Salvelinus confluentus*	10	0	10
Channel Catfish	*Ictalurus punctatus*	34	46	80
Chiselmouth	*Acrocheilus alutaceus*	2	17	19
Common carp	*Cyprinus carpio*	11	38	49
Crappie	*Pomoxis sp.*	1,233	1,902	3,135
Dace	*Rhinichthys sp.*	0	0	0
Kokanee	*Oncorhynchus nerka*	101	0	101
Lamprey Adult-Pacific	*Entosphenus tridentatus*	21	96	117
Lamprey Ammocoete-Pacific[2]	*E. tridentatus*	1,592	0	1,592
Lamprey Macropthalmia-Pacific	*E. tridentatus*	33,631	0	33,631
Mountain Whitefish	*Prosopium williamsoni*	75	6	81
Northerrn Pikeminnow	*Ptychocheilus oregonensis*	22	7	29
Peamouth	*Mylocheilus caurinus*	453	59	512
Rainbow Trout	*O. mykiss*	2	0	2
Redside Shiner	*Richardsonius balteatus*	0	0	0
Sandroller	*Percopsis transmontana*	222	72	294
Sculpin	*Cottus sp.*	633	0	633
Siberian Prawn	*Exopalaemon modestus*	51,518	0	51,518
Sucker	*Catostomus sp.*	123	381	504

Sunfish[2]	*Lepomis sp.*	486	15	501
Tadpole Madtom	*Noturus gyrinus*	3	0	3
Walleye	*Stizostedion vitreum*	5	60	65
White Sturgeon	*Acipenser transmontanus*	0	15	15
Yellow Perch	*Perca flavescens*	2	76	78
Other[3]	-----	1	1	2
Total		242,471	10,930	253,401

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

[2] Sunfish collection total includes 487 bluegill/pumpkinseed and 14 warmouth.

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

Table 23. Numbers of incidental species collected at Little Goose Dam JFF, 2011-2016.

Common Name	Scientific Name	2011	2012	2013	2014	2015	2016
American shad	*Alosa sapidissima*	2,122	14,614	6,678	1,799	5,634	157,259
Banded Killifish	*Fundus diaphanous*	14	61	117	111	53	0
Bass-Smallmouth	*Micropterus dolomieu*	3,691	2,442	1,279	3,528	2,102	2,992
Bass-Largemouth	*M. salmoides*	7	6	2	3	1	13
Bullhead	*Amierus sp.*	390	511	291	235	284	166
Bull trout	*Salvelinus confluentus*	7	2	6	4	0	10
Channel Catfish	*Ictalurus punctatus*	235	353	381	204	440	80
Chiselmouth	*Acrocheilus alutaceus*	72	2	6	10	7	19
Common carp	*Cyprinus carpio*	294	139	96	102	44	49
Crappie	*Pomoxis sp.*	86	687	1,139	887	9,407	3,135
Dace	*Rhinichthys sp.*	24	12	3	19	3	0
Goldfish	*Carassius auratus*	0	0	0	0	0	0
Kokanee	*Oncorhynchus nerka*	55	0	0	14	1	101

Common Name	Scientific Name	2011	2012	2013	2014	2015	2016
Lamprey Adult-Pacific	*Entosphenus tridentatus*	63	32	28	77	163	117
Lamprey Ammocoete-Pacific	*E. tridentatus*	6,584[1]	1,903	525	2,495	89	1,592
Lamprey Macropthalmia-Pacific	*E. tridentatus*	11,108	4,749	55,077	18,673	8,155	33,631
Mountain Whitefish	*Prosopium williamsoni*	3,850	697	324	163	271	81
Northerrn Pikeminnow	*Ptychocheilus oregonensis*	72	52	41	43	32	29
Peamouth	*Mylocheilus caurinus*	7,631	1,077	1,292	864	1,230	512
Rainbow Trout	*O. mykiss*	12	2	0	8	27	2
Redside Shiner	*Richardsonius balteatus*	0	0	0	0	0	0
Sandroller	*Percopsis transmontana*	7,591	2,452	6,241	3,681	1,603	294
Sculpin	*Cottus sp.*	996	1,732	1,239	391	1,836	633
Siberian Prawn	*Exopalaemon modestus*	15,743	23,183	45,015	81,310	464,586	51,518
Sucker	*Catostomus sp.*	1,760	882	1,353	1,062	1,631	504
Sunfish[1]	*Lepomis sp.*	218	602	865	791	263	501
Tadpole Madtom	*Noturus gyrinus*	0	8	8	3	4	3
Walleye	*Stizostedion vitreum*	8	7	9	14	27	65
White Sturgeon	*Acipenser transmontanus*	12	15	16	27	11	15
Yellow Perch	*Perca flavescens*	55	43	17	14	63	78
Other		2	0	7	52	52	2
Total		62,702	56,265	122,055	116,584	498,019	253,401

Note- Numbers include expanded sample counts and separator releases

[1] Sunfish include bluegill/pumpkinseed and warmouth.

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 2016.

Gas Bubble Trauma Monitoring

Biological technicians from the Washington Department of Fish and Wildlife (WDFW) examined juvenile salmonids for the presence of Gas Bubble Trauma (GBT). When juvenile salmonids numbers permitted, a maximum of 100 fish were sampled. Sampling occurred weekly from April 6 through July 20 when GBT monitoring was discontinued due to small sample sizes. 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 eye.

A total of 1,436 smolts were handled by WDFW GBT personnel in 2016. Thirty fish had been previously PIT-tagged and were enumerated and released without examination. A total of 1,397 smolts were examined for GBT, and of those, 42.4% were subyearling Chinook salmon, 29.1% were yearling Chinook salmon, and 28.5% were steelhead smolts. Of those examined, none showed signs of GBT.

Evaluation of Adult Pacific Lamprey Migration Behavior and Passage Success in the Lower Snake River.

This study used half-duplex (HD) PIT-tag systems to evaluate passage success of adult Pacific lamprey at McNary Dam, the four Lower Snake River projects and associated river segments. Adult Lamprey were captured and tagged at John Day Dam in 2014 and 2015, and tags remain active for 2016. This study required electrical power for electronics and access to maintain and download data from the PIT-tag detection equipment. Maintenance of equipment occurred during the winter maintenance period when adult fishways were dewatered.

FGE Emergency Gate Closure

This study estimated and compared fish guidance efficiency (FGE) at two adjacent units with head gates in the raised (control) and stored (treatment) operating positions to estimate impacts (if any) to FGE for juvenile fish when units are operated with head gates stored. Results will aid in determining the appropriate path forward for restoring the 10-minute emergency head gate closure criterion.

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 on page 26.

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 15 and 17). The lamprey ammocoete total mortality rate in 2016 was 0.2%, from a total collection count of 1,599 lamprey ammocoetes. The total mortality rate for Pacific lamprey macropthalmia this year was 0.09%, from a collection total number of 33,631 Pacific 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 quaggu 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 quaggu mussels observed during the 2016 season.

Turbine Strainers

USACE monitored turbine unit strainers for the fifth consecutive 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 and inspected for any fish entrapment, particularly juvenile lamprey. Results were reported throughout the season.

Avian Predation and Behavior

Avian activity has been monitored and recorded at LGS by USACE and ODFW for many years. 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 FCRPS hydro-projects. Collecting behavioral data will augment existing historical bird data and aid in bird hazing activities during the smolt outmigration.

Anchor QEA personnel conducted avian surveys daily from April 1 through October 31. State agency surveys were typically conducted mid-afternoon during the juvenile fishway 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. The survey list of piscivorous birds includes Caspian tern, double crested cormorant, and seagulls. American white pelican was removed from the survey list of piscivorous birds in 2015.

As in previous years, copies of the juvenile inspection form were forwarded to project USACE biologists. Survey results, along with the USACE survey results, were entered into a USACE database by USACE fishery personnel.

Juvenile Facility Operations & Maintenance

The juvenile fish bypass system was inspected at a minimum twice daily during the fish passage season. The juvenile bypass system and the collection facility were not heavily

impacted by debris, and equipment and components, for the most part, met operational reliability and overall excellence in operations helping make 2016 a good year for safe fish passage.

Forebay Debris/Trashracks

We estimated the surface area covered by debris and the location of that debris in the forebay daily during JFF inspections. Mild accumulations of woody debris were present in the Little Goose forebay from May through June, with a maximum estimated debris load of 6,000 square feet. On March 1, 2014 the trash shear boom failed. Consequently, any upriver debris, if not entirely entrained in the current during spill operations, passed through the project via turbine intakes or the juvenile collection system.

Spillway Weir

The spillway weir (SW) was placed into operation on April 3 in the high crest (622 ft. msl) position. The spillway was placed into low crest position (618 ft. msl) on April 11. On May 26, the weir was placed back into the high crest position (622 ft. msl). The spillway weir was removed from service for the 2016 season on July 11.

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 24.

Table 24. Little Goose turbine unit outages, 2016.

Turbine Unit	Date OOS	Date RTS	Description
Unit 1	04-Mar 14:16	04-Mar 16:45	Trash raking
	07-Mar 10:00	07-Mar 15:05	Divers
	08-Mar 07:05	08-Mar 10:00	Divers
	24-Mar 06:54	24-Mar 12:58	ESBS Install
	16-May 07:00	16-May 16:24	Trash raking
	13-Jun 07:00	13-Jun 11:15	Trash raking
	15-Aug 05:50	15-Aug 13:35	Doble testing
	18-Aug 05:34	18-Aug 17:45	Doble testing
	26-Oct 16:41	27-Oct 10:00	Possible oil discharge to tailwater
	21-Nov 07:34	08-Dec 17:31	Unit annual
	12-Dec 16:54	17-Dec 11:30	Excessive shaft packing leakage
	17-Dec 11:30	19-Dec 08:15	ESBS removal
Unit 2	01-Feb 07:13	04-Feb 15:43	MIDT Changes
	07-Mar 10:30	07-Mar 15:05	Divers
	08-Mar 07:05	08-Mar 14:20	Divers
	09-Mar 07:40	09-Mar 11:15	Divers
	22-Mar 13:06	22-Mar 15:55	ESBS install
	23-Mar 06:52	23-Mar 14:23	ESBS install
	16-May 07:00	16-May 15:12	Trash raking
	17-May 07:00	17-May 09:10	Trash raking
	20-May 10:10	20-May 13:14	FGE study
	27-May 06:50	27-May 11:46	FGE study
	10-Jun 07:00	10-Jun 14:10	FGE study
	24-Jun 07:03	24-Jun 12:20	FGE study

	08-Jul 07:11	08-Jul 12:25	FGE study
	15-Jul 07:32	15-Jul 13:20	FGE study
	22-Jul 07:45	22-Jul 15:00	FGE study
	15-Aug 05:50	15-Aug 13:35	Doble testing
	18-Aug 05:28	18-Aug 17:45	Doble testing
	30-Aug 07:02	30-Aug 14:49	Remove FGE test equipment
	07-Nov 07:58	23-Nov 13:37	Unit annual
	23-Nov 15:53	28-Nov 07:58	Extend Unit annual
	19-Dec 08:40	19-Dec 16:46	ESBS removal
Unit 3	07-Mar 10:30	07-Mar 15:05	Divers
	08-Mar 07:05	08-Mar 14:20	Divers
	09-Mar 07:40	09-Mar 11:15	Divers
	22-Mar 07:46	22-Mar 13:00	ESBS install
	07-Apr 08:20	07-Apr 14:56	ESBS problems
	19-Apr 15:39	20-Apr 15:15	ESBS problems
	17-May 07:00	17-May 10:51	Trash raking
	20-May 07:11	20-May 09:51	FGE study
	27-May 06:50	27-May 11:46	FGE study
	10-Jun 07:00	10-Jun 14:10	FGE study
	24-Jun 07:03	24-Jun 12:20	FGE study
	08-Jul 07:11	08-Jul 12:25	FGE study
	15-Jul 07:32	15-Jul 13:20	FGE study
	15-Aug 05:50	15-Aug 13:35	Doble testing
Turbine Unit	**Date OOS**	**Date RTS**	**Description**
	18-Aug 05:28	18-Aug 17:45	Doble testing
	26-Sep 07:15	08-Nov 17:20	Unit annual
	19-Dec 09:34	19-Dec 15:05	ESBS removal
Unit 4	14-Dec 12:50	26-Jan 15:00	Digital governor install (Began in Dec 2015)
	26-Jan 16:41	27-Jan 15:00	Complete testing
	01-Mar 08:10	01-Mar 13:44	Inconsistent exciter readings
	08-Mar 10:15	08-Mar 14:20	Divers
	09-Mar 07:40	09-Mar 11:15	Divers
	24-Mar 13:22	24-Mar 16:32	ESBS install
	17-May 09:18	17-May 13:15	Trash raking
	15-Aug 05:50	18-Aug 08:02	6 year inspection
	18-Aug 08:02	23-Sep 10:20	Unit annual
	21-Nov 07:34	21-Nov 16:07	Unit maintenance
	20-Dec 07:30	20-Dec 10:55	ESBS removal
Unit 5	16-Feb 08:15	25-Mar 06:02	Digital governor install/Rotor inspection
	28-Mar 07:23	28-Mar 15:40	ESBS install
	29-Mar 10:00	29-Mar 13:30	ESBS install
	04-Apr 07:00	21-Apr 17:32	Rotor crack inspection
	23-Apr 06:43	23-Apr 08:19	ESBS problems
	17-May 11:05	17-May 14:04	Trash raking
	05-Jul 07:11	21-Jul 08:25	Unit annual
	15-Aug 05:50	18-Aug 17:45	Doble testing
	16-Dec 07:25	16-Dec 15:00	ESBS removal
Unit 6	12-Jan 07:23	13-Jan 13:49	Repair governor oil leak
	22-Mar 07:58	22-Mar 09:00	Unit shutdown reason unknown
	25-Mar 12:16	25-Mar 16:47	ESBS install
	06-Apr 14:10	06-Apr 16:40	ESBS/VBS inspection
	25-Jul 07:25	10-Aug 15:22	Unit annual
	15-Aug 05:50	18-Aug 17:45	Doble testing

	16-Dec 07:25	16-Dec 11:50	ESBS removal

Extended-Length Submersible Bar Screens (ESBS)

All ESBS performed satisfactorily for the majority of the season. Fish screen 3C started having problems on April 3. Limit switches were adjusted and screen was returned to service. Fish screen 3C had similar issues on April 14. On April 19 fish screen 3C lost electrical feed and unit three was removed from service to repair screen 3C. On June 15 2B was off and limit switches were adjusted. On September 13 the limit switches were readjusted for screens in unit 5 and 6. All screens were removed for the end of fish passage season on December 19. Drawdown inspections across trashracks and ESBS/VBS were performed according to the FPP. All drawdown inspections were 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. All inspections showed VBS in good operating condition.

Gatewells

Gatewells were checked for debris and oil contamination daily. As needed, debris was removed using a dip basket or grappling hook. In 2016, 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.

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 21. Fish salvage operations during the dewatering included releasing approximately 30 adult steelhead, 1 sturgeon and 1 juvenile lamprey back to the river.

Primary Dewaterer/Primary Bypass Pipe

The primary dewatering structure and components functioned adequately throughout the season. 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 2016. 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.

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 (≤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.

Pit Tag Detections

The Passive Integrated Transponder (PIT) tag detection system records data on PIT tagged salmonids as they pass through the juvenile collection system. The PTAGIS database categorized all PIT tag detections based upon 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 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 April 1 through October 31, a total of 156,935 PIT tagged fish were detected within the juvenile collection/bypass system: 97,235 Chinook salmon, 56,279 steelhead, 2,065 sockeye

salmon, 989 coho salmon, and 365 orphans of unknown species/rearing type. Of the total number of detections, 58.9% or 92,436 fish were routed to the river, and 41.1% or 64,499 fish were routed to transport areas. PIT tagged fish in the subsample were treated as the other fish in the sample and were either routed back to the river, if the facility was operating in secondary bypass mode, or routed to a transport holding area when the facility operated in collection mode. There were 812 PIT tagged smolts routed to the sample this year, of which 81.7% were transported and 18.3% returned to the river during pre-transport operations (April 1- April 30). This group comprised approximately 0.5% of all PIT tagged fish detected at LGS. Pre-transport operations additionally routed all PIT tagged fish back to the river, constituting approximately 58.6% or 91,935 of total PIT tagged fish detected.

Barge and Truck Loading Operations

Barge loading and transport operations occurred from May 2 through August 16. All fish loading and barge operations at LGS were performed satisfactorily. Truck loading and transport operations occurred on alternate days from August 17 to October 31. In previous years, due to high numbers of fish collected, Lower Granite Fish Facility trucked Little Goose Fish using the 3500 gallon tanker. This "piggyback" operation delayed transport time for those fish transported from Lower Granite by approximately one hour. In 2016 the only occurrence of this piggyback operation occurred when Lower Granite transported 210 pounds of fish from Little Goose on September 20. Fish transported by truck from Little Goose were transported in a mild saline solution of 1 to 2 mg/L to reduce stress and treat columnaris disease.

Avian Predation Deterrence

USDA Animal and Plant Health Inspection Service (APHIS) began bird hazing activities in 1999. In 2016, APHIS bird hazing activities at Little Goose took place from April 3 through June 25. The hazing schedule included 8 hours per day, 5 days per week of land based hazing and 8 hours per day, 3 days a week of boat based hazing. 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 Anchor QEA 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 1 through October 31, 2016. 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 reporting.

Avian counts reached and exceeded the maximum thresholds allowed per the Fish Passage Plan multiple times throughout the season. Gull counts exceeded the 100 bird threshold 26 times throughout the bird counting season, April through October. Of these occurrences, gulls exceeded the threshold 16 times while APHIS personnel were actively hazing, 6 times while APHIS personnel were offsite and 4 times outside the timeframe of the APHIS hazing contract. Cormorant counts exceeded the 50 bird threshold 5 times throughout the bird counting season, all of which occurred in October. Lethal take was implemented with 28 gulls and 3 cormorants sacrificed during the 2016 season. 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 343 gulls counted occurred on May 8. The average daily total count was 44.8 gulls. The maximum daily count in the forebay was 210 gulls and occurred on May 06 with a daily average of 32.6 gulls. The maximum daily count in the tailrace was 189 gulls and occurred on May 08 with a daily average of 12.1 gulls.

Double Crested Cormorant Counts

The maximum total daily number of 114 cormorants occurred on October 20. The average daily total count was 9.0 cormorants. The maximum daily count in the forebay was 83 cormorants and occurred on October 20 with a daily average of 8.1 cormorants. The maximum daily count in the tailrace was 43 cormorants and occurred on October 02 with a daily average of 0.9 cormorants.

Caspian Tern Counts

The maximum total daily number of 57 terns occurred on May 25. The average daily total count was 0.3 terns. The maximum daily count in the forebay was 36 terns and occurred on May 25 with a daily average of 0.2 terns. The maximum daily count in the tailrace was 21 terns and occurred on May 25 with a daily average of 0.1 terns.

Other Piscivorous Bird Counts

The maximum total daily number of 9 grebes occurred on October 30. The average daily total count was 0.1 grebes. The maximum total daily number of 12 pelicans occurred on August 12. The average daily total count was 0.3 pelicans.

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 (20.4%) followed by cormorants (10.0%). Gulls also had the highest percent of feeding behavior in the tailrace (61.1%) followed by cormorants (38.9%). Cormorants had the highest percent of feeding behavior in the forebay (6.2%) followed by gulls (5.3%). Caspian terns were only observed twice at Little Goose and were not observed feeding. 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 2016 season.

1. Replaced 18” dresser fitting below primary dewatering structure (16 LGS 07).
2. Replaced electronic motor for weir operation on primary dewatering structure.
3. Replaced bird sprinkler/water cannon.
4. Repaired/replaced multiple ESBS screen cleaning motors.
5. Repaired overflow barrier in the juvenile channel.

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. Repair the trash/shear boom.
3. Continue to rebuild orifice valve cylinders.
4. Repair or replace corroded outer steel orifice pipe with stainless steel.
5. 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
6. Continue to remove scale and rough edges in the facility flumes, tanks, and transition areas.

Acknowledgements

The Little Goose Dam JFF was managed, operated, and maintained during 2016 by the following people:

Scott St. John, Project Lead Fishery Biologists, COE
Richard Weis, Assistant Fisheries Biologist, COE

Ron Ashley, Maintenance Work Leader, COE
Kreg Buryta, Maintenance Worker, COE
Matthew Hutchens, Maintenance Worker, COE

Deborah Snyder, Lead Biological Technician, COE
Lynn Mings, Biological Technician, COE
Sara Dimick, Biological Technician, COE

Paul Burke, Anchor QEA
Paige Stinebaugh, Anchor QEA

Pat Keniry, Fishery Biologist, Smolt Monitoring Project Leader, ODFW
Anne Dowdy, Natural Resource Specialist, ODFW
Ruth Shearer, Natural Resource Specialist, ODFW

Pacific States Marine Fisheries Commission Personnel: Don Warf, Darren Chase, Alan Brower, Roger Clark, Scott Livingston and Mark Clark.