CENWW-OD-DL HOLDREN (1130) February 2020

MEMORANDUM THRU:
Robert Lustig, Operations Manager Lower Granite Dam

FOR Chief, Operations Division
ATTN: Eric Hockersmith / Chris Peery

SUBJECT: Submission of 2019 Adult and Juvenile Fish Facility Monitoring Report, Lower Granite Dam.

1. Enclosed find the 2019 Adult and Juvenile Fish Facility Monitoring Report Lower Granite Dam, as requested.

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

ELIZABETH HOLDREN
Lead Supervisory Fisheries Biologist, Lower Granite Dam

Enclosure

ADULT AND JUVENILE FISH FACILITY MONITORING REPORT

LOWER GRANITE DAM

2019

Elizabeth A. Holdren

Project Supervisory Fisheries Biologist

And

David Miller

Project Assistant Supervisory Fisheries Biologist

Lower Granite Dam

U.S. Army Corps of Engineers

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INTRODUCTION

The following report on fishway activities at Lower Granite Dam is required under the Endangered Species Act consultation on the operation of the Federal Columbia River Power System and its associated fish passage facilities. This report summarizes the operation and maintenance of adult fish passage facilities at Lower Granite Dam, including the results of visual inspections of the fishway conducted by fisheries biological staff during the adult fish passage period of March 1 to December 31, 2019. Inspection readings are provided in Appendix 1. Recommendations are provided for correcting problems found. This report also contains a synopsis of juvenile fish facility operations. Additional information on juvenile fish collection and transportation activities at Lower Granite Dam can be found in the, "2019 Juvenile Fish Collection and Bypass Report, Lower Granite Juvenile Fish Facility".

River Conditions

The average daily river flow exceeded 100 kcfs on 63 days during the 2019 season. Total river flows averaged 64.4 kcfs this season. Highest daily average flow for the March 26-November 1 collection season was 183.7 kcfs April 11. Lowest daily average flow for the season was 16.7 kcfs October 23. An emergency debris spill through the RSW occurred March 19. Spill fish passage occurred for 152 days from April 3 through midnight on August 31. LWG spilled up to the 120% gas cap for 16 hours a day and performance standard spill (20 kcfs) for hours 8 per day during the spring spill season (April 3-June 20). The majority of spring performance standard spill exceeded 20 kcfs due to high river flows. Summer spill of 18 kcfs began at 0001 hours on June 21 and ended at 2400 hours on August 31. Spill is distributed according to FPP Table LWG-7 and LWG-8. The seasonal average flow through spillways was 32.2 kcfs with a maximum daily average spill of 75.2 kcfs April 11 and a minimum daily average of 11.7 kcfs April 3. The RSW was closed at 1306 hours August 6 due to total project outflow being less than 30 kcfs and flows forecasted to remain less than 30 kcfs for more than 3 consecutive days. River temperatures collected as part of the daily condition sample averaged 58.6° F for the season and ranged from 44.1° F March 28 to 68.0° F September 11.

ADULT FISH FACILITY

Facility Description

Adult fish passage facilities at Lower Granite Dam consist of one south shore adult fish ladder. The upper fish ladder extends from the forebay to tailwater. The fish ladder includes forebay temperature control system with pumps to supply cooling water, one fish ladder exit, slotted weirs control section, upper diffuser, overflow weirs with orifices, and a fish counting station with picketed leads. Auxiliary water is supplied from the forebay through diffuser 14 to maintain flow over the upper ladder weirs. Lower Granite fish trap is located at the turnpool area just upstream from the fish count station. The lower ladder contains a powerhouse collection channel, three electric auxiliary water supply pumps (AWS), collection channel diffusers, a transport channel under the spillway, and ladder entrances. There are six main fish ladder entrances: two north shore entrances (NSE-1 and NSE-2), two north powerhouse entrances (NPE-1 and NPE-2), and two south shore entrances (SSE-1 and SSE-2). The powerhouse collection channel has two out of ten floating orifice gates (FOGs) operating, #1 and #10. The

three electric AWS pumps supply additional water from tailrace intakes through the lower ladder and collection channel diffusers.

Facility Modifications

1. Permanently closed adult entrances NPE-3 and NSE-3.
2. Rehabbed AWS fish pump # 1 guide bearing.
3. Repaired/cleared spillway collection channel lights and repositioned observation mirror.
4. Installed a temporary anesthetic disposal system for the adult trap.

Operations and Maintenance

Fish Ladder and Collection Channel

The adult fish ladder was in service throughout 2019 with the exception of the winter maintenance season from January 2-February 14 and a 4:15 hour dewatering for repairs to the fish count station backboard May 2. During the winter annual outage the upper fish ladder is dewatered for maintenance activities including: debris removal, diffuser grate and structural support inspections, picketed lead, staff gauge, and fish counting window cleaning, maintenance of count station window cleaning mechanisms, and packing of leaks in expansion joints. A minimum of 24 hours prior to dewatering, the auxiliary water is shut off to discourage newly arriving fish from starting up the ladder. A bulkhead is then placed in the fish ladder exit, any exit pool fish are removed and released to the forebay, and the upper ladder is partially dewatered. Diffuser 14 is gradually closed to allow fish to move through the orifices to the tailrace. The drain for diffuser 14 is closed to maintain a minimal amount of water in the ladder while remaining fish are flushed down the ladder. Biologists and maintenance personnel descend the ladder through orifices to remove debris, inspect the ladder, and move remaining fish to the tailrace. There were no fish recovered in the upper section of the ladder during the dewatering process on January 2. All diffuser grating passed inspection.

The lower ladder is typically dewatered to a depth of one foot providing a holding pool for fish. Once the target depth is obtained, maintenance personnel and biologists inspect entrance weirs, diffuser grates, fallback fence, and exposed diffuser gate operating equipment. Staff gauges are then cleaned and debris is removed. Water is lowered $4/10^{th}$ of a foot for visual inspection of grating and fish recovery. When dewatering for repair is necessary; fish are crowded to the entrance pools, netted, and placed in fish only transport containers. Fish in the containers are raised from the collection channel with the crane and transported to the tailrace or forebay for release. Fish recovered from the powerhouse and spillway sections of the collection channel January 4 included 8 adult clipped steelhead, 6 juvenile unclipped chinook, 2 juvenile coho, 7 juvenile sockeye, 14 juvenile unclipped steelhead, 8 juvenile clipped steelhead, 1 bull trout, 2 juvenile lamprey, 8 juvenile shad, 25 sandrollers, 7 peamouth, 4 adult channel catfish, 17 suckers, 3 carp, 1 smallmouth bass, 2 chiselmouth, and 1 sculpin. No problems were observed during the inspection of the north powerhouse and spillway channel.

Auxiliary Water Supply

AWS fish pumps were out of service (OOS) from January 1 to February 14 for annual maintenance. Annual maintenance consists of general mechanical and electrical inspection and repairs. AWS pump 2 was removed from service and AWS pump 1 was returned to service May 7 after completion of lower guide bearing repairs. Fish pumps 1 and 3 remained in service for the remainder of the season with pump 2 in standby mode. All AWS fish pumps were taken out of service from December 17 to December 19 to support concrete pour in spillway 1 as part of the PIT tag array installation. Significant pump outages are summarized in Table 1.

Table 1. Fish pump outages at Lower Granite Dam, 2019 *

Affected Pump(s)	Dates	Reason for Outage/Comments
1	Jan 1 – May 7	Annual maintenance/Repairs
2, 3	Jan 1 – Feb 14	Annual maintenance
1,2,3	Dec 17 – Dec 19	Support spillway 1 PIT antenna installation

*Only outages involving two or more calendar days are included.

Adult Fish Trap Operations

Lower Granite adult fish trap was operated March 25 through November 12 by NOAA Fisheries. Water up was delayed due to NOAA having challenges with developing a method for anesthetic waste disposal in compliance with EPA Clean Water Act. LWG staff assisted NOAA in this effort to enable trap operation. Multiple adult trap tank supply lines ruptured March 21 when NOAA was watering up the trap for operational testing. The damage was likely due to sending supply water through the facility with valves in the incorrect position. LWG mechanical crew completed repairs Monday March 25. Sample rates were adjusted with adult passage to meet collection and research needs. The adult ladder temperature control system sustained adult trap temperatures below 70°F for trapping operations with the exception for September 6-12. This pause in trapping was due to NOAA personnel concerns with temperature readings they were seeing on their hand held thermometer. This thermometer did not match the standard temperatures probes permanently mounted in the adult fish ladder and trap. The maximum adult trap water temperature during 2019 was 70.9°F September 7. The adult trap total collection for the season was 22,955 fish, including 29 sockeye, 1,853 Coho, 7,907 steelhead, 6,390 spring/summer Chinook, and 6,776 fall Chinook.

Idaho Department of Fish and Game (IDFG) assisted NOAA in sampling throughout the trapping season. Sampling included scale collection, genetic sample, sex determination, fork length, adipose fin clipped/unclipped, and evaluating non-adipose clipped hatchery fish run proportion. Natural origin adult steelhead and spring/summer Chinook salmon were PIT tagged to estimate headwater tributary escapement.

Steelhead collection totaled 7,907 (5,092 clipped, 2,815 unclipped) with 2,807 having genetic and scale samples taken, and 2,240 having genetic samples only taken. Of the 5,047 fish sampled, 2,690 were PIT tagged and 1,231 were Floy tagged. There were 325 recaptured PIT tagged fish.

Spring/Summer Chinook collection totaled 6,390 (4,776 clipped, 1,614 unclipped) with 2,392 having genetic samples only taken, 113 with genetics and scale samples taken, and 1,501 PIT tagged with both genetic and scale samples taken, There were 265 recaptured PIT tagged fish.

Genetic samples were taken from 24 of the 29 adult sockeye collected in the trap. There were 2 recaptured PIT tagged fish.

Special operation for steelhead broodstock collection and transport began October 4 and ended November 13. Of the 7,907 steelhead handled at the adult trap, 329 were transported to Dworshak National Fish Hatchery by Nez Perce Tribe and 7,578 were released.

Fall Chinook collection for broodstock transport began August 6. Of the 6,776 fall Chinook handled at the adult trap, 3,257 were transported (genetic samples taken) and 3,519 were released (genetic and scale samples taken). Washington Department of Fish and Wildlife (WDFW) transport to Lyons Ferry Hatchery began August 21 and ended October 25 when collection goals were met. WDFW transported 2,354 (1,872 adults and 482 jacks) fall Chinook. Nez Perce Tribe collection for transport to Cherry Lane/Dworshak hatcheries occurred August 7 through October 15 when broodstock goals were met. Nez Perce Tribe transported 903 (814 adults and 89 jacks) fall Chinook. The turnpool gate remained in trapping position during the fall Chinook collection season.

Broodstock collection of Coho for the Nez Perce Tribe occurred from October 3 to October 24. Coho $\geq$ 45 cm in length were collected. Of the 1,853 Coho collected at the adult trap, 1,176 were transported and 681 were returned to the fish ladder. There were 72 recaptured PIT tagged fish.

All Sockeye collected were returned to the fish ladder.

There were 4 adult lamprey incidentally trapped this year.

For additional information on Lower Granite adult trap operations contact Darren Ogden (NOAA; darren.ogden@noaa.gov) or Tiffani Marsh (NOAA; tiffani.marsh@noaa.gov).

Special Operations for Adult Ladder Water Temperature

Electronic temperature probes were used to monitor fish ladder water temperatures at the ladder exit, diffuser 14, turn pool, and the junction pool throughout the fish passage season. Real-time fish ladder temperature data along with that for four additional Project temperature monitoring stations can be found online at: http://www.nwd-wc.usace.army.mil/dd/nww/fl_temps/www/index.html. The permanent fish ladder temperature control system has been operational since 2016. Forebay fish ladder auxiliary water supply pumps 1 and 2 were modified to intake cooler water from an elevation of 667.0 feet (66.0 feet below MOP) and supply the spray bar in front of the fish ladder exit. Gravity flow then distributes the cooler water from the forebay down the ladder. The system also includes a chimney structure that drafts cold water from an elevation of 667.0 feet into diffuser 14 intake. Water from diffuser 14 cools the ladder as it flows down the overflow sections of the ladder and is the main supply for the adult fish trap. Forebay ladder temperature control system pumps operated June 14 through September 25.

Adult Fishway Inspections

Methods

The automated fishway control system consists of a computer in the control room that interfaces with process level controllers that receive information from remote terminal units. The terminal units are fed by sensors detecting entrance weir gate positions, collection channel and tailwater elevations, and upper diffuser pool levels. Lower Granite automated fishway control system programing continues to be adjusted as needed to maintain fish ladder operational compliance. The system's digital touch screen displays are located in the control room and the third floor of the powerhouse with gates remotely operated from the control room. The control system "biologist snapshot" of fish ladder operation is printed concurrent with ladder inspections to compare physical readings and identify calibration issues. Collection channel temperatures and velocities are measured with sensors in the south powerhouse and the north shore channels as part of the automatic system. Powerhouse electricians manually calibrate fish ladder gates to ensure the control system program operates in criteria parameters following winter maintenance. During the 2019 fish passage season, the fish ladder control system was unable to consistently maintain both depth over the weir and channel/tailwater head differential at the north shore during spill operations at MOP elevation. NSE depth over the weir criteria was sacrificed to achieve channel/tailwater head differentials.

Operating criteria involve normal and special operating conditions. Under normal operating condition: NSE-1 and NSE-2 are operated to meet criteria of at least 7 feet (depth criteria) or be on sill if less than 7 feet (sill criteria), NPE-1, NPE-2, SSE-1 and SSE2 weir gates are operated to meet criteria of at least 8 feet or be on sill if less than 8 feet (sill criteria), and two floating orifice gates (1 and 10) are operated in the powerhouse collection channel. Normal operating criteria for the rest of the ladder include maximums of 0.5-foot head at the exit, maximum 0.3 feet head at the picketed leads, 1.0-1.3 feet of water over the ladder weirs, 1.5-4.0 feet per second collection channel velocity, and 1.0-2.0 foot head differentials at all fishway entrances. Special operating conditions are used if normal operating criteria cannot be met.

Adult fishway inspections consist of observing facility operating conditions and recording visual readings from staff gauges, weir gate selsyns, and electronic meters. Inspections by fisheries staff are normally conducted three or more times per reporting week with day and times randomized. An average of 3.7 inspections per week were performed (164 inspections /44 weeks) in 2019. Depths and head differentials that were out of criteria, as well as other problems, were reported to maintenance staff and/or powerhouse shift operators for correction. Anchor (SMP contractor) biologists performed a minimum of two ladder inspections each week while on Project. Lower Granite biologist staff typically performed 2 to 3 inspections per week. Inspections were also conducted by Oregon Department of Fish and Wildlife personnel once a month.

Inspection Results

Visual readings of staff gauges and weir gate depths were recorded and compared with automated control system readings to check for calibration problems. High variability between wave crests and troughs created by spill reduced the accuracy of biologists' staff gauge readings in the tailrace. The automatic fish ladder control system was upgraded to the Automation Direct PLC and HMI Configuration Software (C-More Programming Software) in 2016. The control

system program is unable to consistently maintain both depth over the weir and channel/tailwater head differential at the north shore during spill operations. Automatic control system adjustments were made throughout the passage season. Entrance gates found out of criteria during ladder inspections due to fish ladder control system problems were manually adjusted to depth or sill criteria and left in manual mode until electricians completed diagnostics and made adjustments. Electricians continue to troubleshoot control system internal functioning errors in the program. Data from fishway inspections were entered into an Excel spreadsheet (Appendix 1). The average compliance of all criteria points in 2019 was 88.7% compared to 92.5% in 2018. The majority of out-of-criteria readings were due to fish ladder control system issues and operating SSEs in manual. A summary of fish ladder performance and variability is provided in Table 2.

Ladder exits

Ladder exit head differentials were in criteria on 100% of the inspections.

Ladder weirs

The depths over the fish ladder weirs were within criteria on 95.7% of the inspections. Out of criteria readings included 2 at 0.11-0.2 feet below criteria, 1 at 0.01-0.1 feet below criteria, 3 at 0.01-0.1 feet above criteria, and 1 at >0.2 feet above criteria.

Counting stations

The head differential across the counting station picketed leads was in criteria on 100% of inspections.

Entrance head differentials

SSE-1 & 2 head differential was in criteria on 98.8% of inspections.
Out of criteria readings included 1 at 0.11-0.2 feet below criteria and 1 at 0.11-0.2 feet above criteria that were likely related to control system calibrations issues.

NPE-1 & 2 head was in criteria on 99.4% of inspections. Out of criteria readings included 1 at 0.11-0.2 feet below criteria.

NSE-1 head differential was in criteria on 79.9% of inspections compared to 90.1% in 2018. Operation with NSE2 closed during 2017 likely contributed to improved north shore channel/tailrace head differential compliance. Historically AWS pump operation was unable to maintain both head differentials and weir depths when tailrace was at minimum operating pool (MOP). Weir depths were sacrificed to maintain a minimum of 1.0 foot of head differential during MOP operation. NSE2 has been suspended with a chain fall hoist since the gate operator failed in 2011. Head differential readings were out of criteria (criteria 1.0-2.0 feet) on 33 inspections in 2019. Out of criteria readings included 7 at 0.1 feet below criteria, 5 at 0.2 feet below criteria, and 2 greater than 0.2 feet below criteria. Out of criteria readings also included 17 readings greater than 0.2 feet above criteria and 2 at 0.2 feet above criteria. NSE channel/tailwater head differentials were likely out of criteria due to the fish ladder control system being unable to consistently maintain both depth over the weir and channel/tailwater head differential at the north shore during spill operations and at MOP.

Entrance Gate Depths

SSE-1 weir gate was in depth or sill criteria on 76.2% of inspections (76.2% depth, 0.0 % sill) compared to 81.9% in 2018. Out of criteria readings included 6 at 7.9 feet, 2 at 7.8 feet, and 33

at 7.7 feet or less. SSE-1 and SSE-2 reading at the gate have consistently been reading higher than the electronic reading on the fish ladder control system.

SSE-2 weir gate was in criteria on 73.8% of inspections (73.8% depth, 0.0 % sill) compared to 78.9% in 2018. Out of criteria readings included 10 at 7.9 feet, 3 at 7.8 feet, and 30 at 7.7 feet or less. SSE-1 and SSE-2 reading at the gate were consistently reading higher than the electronic reading on the fish ladder control system.

NPE-1 weir gate was in depth or sill criteria on 93.9% of inspections (29.9% depth, 64% sill) compared to 97.1% in 2018. Out of criteria readings included 1 at 7.9 feet, 1 at 7.8 feet and 8 at 7.7 feet or less.

NPE-2 weir gate was in depth criteria or sill on 90.9% of inspections (29.3% depth, 61.6% sill) compared to 96.5% in 2018. Out of criteria readings included 1 at 7.9, 2 at 7.8, and 12 at 7.7 feet or less.

NSE-1 weir gate was in depth or sill criteria on 92.1% of inspections (92.1% depth, 0.0 % sill) compared to 85.8% in 2018. Out of criteria readings included 6 at 6.9 feet, 1 at 6.8 feet, and 7 at 6.7 feet or less. The fish ladder control system was unable to consistently maintain both depth over the weir and channel/tailwater head differential at the north shore during spill operations. NSE depth over the weir criteria is being sacrificed to achieve channel/tailwater head differentials.

NSE-2 weir gate was in the closed position for the 2019 season. NSE-2 has been out of service and suspended with a chain fall hoist since the 2011 season. The fish ladder control system was unable to consistently maintain both depth over the weir and channel/tailwater head differential at the north shore during spill operations at MOP elevation. NSE depth over the weir criteria is being sacrificed to achieve channel/tailwater head differentials.

Collection channel velocity

Velocities were in criteria on 63.4% of inspections (criteria: 1.5-4.0 ft/s) compared to 87.1% in 2018. The collection channel velocity meter was upgraded to a Teladyne Signature Flowmeter as part of the fish ladder control system. The sensor also provides water temperature and is located in the powerhouse collection channel between the transition pool and unit 1. A Signature Laser Sensor was also installed above the north shore collection channel that measures channel elevation and also surface velocity.

Recommendations

1. Replace NSE-1 and NSE-2 gates and operating system.
2. Replace all entrance weir gates and operating systems.
3. Continue to operate the north shore with NSE-2 closed to improve channel/tailwater head differential.
4. Resolve adult fish ladder automatic control system programing issues.
5. Replace/relocate staff gauges that are difficult to read.
6. Label adult fish trap valves (identifying their function) and develop updated O&M manual.
7. Update and modify as needed adult fish trap dewatering procedure.

8. Identify/repair the problem with north powerhouse velocity meter.
9. Relocate SSE fish ladder control system tailwater elevation sensor to a location that represent the actual tailrace elevation not the anomaly at that location.

Table 2. Summary of adult fishway inspections at Lower Granite Dam, 2018 [1]

LOWER GRANITE			Not Enough Depth			Too Much Depth		
Criteria & Locations	No. In Criteria / No. On Sill / No. of Inspections	% In Criteria / % On Sill	No. / % Within 0.01-0.1 Foot	No. / % Within 0.11-0.2 Foot	No. / % >0.2 Foot	No. / % Within 0.01-0.1 Foot	No. / % Within 0.11-0.2 Foot	No. / % >0.2 Foot
Channel Velocities	104 *** 164	63.4 ***	*** ***	*** ***	*** ***	*** ***	*** ***	*** ***
Differentials								
Ladder Exit	164 *** 164	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
Ladder Weirs	157 *** 164	95.7 ***	1 0.6	2 1.2	0 0.0	3 1.8	0 0.0	1 0.6
Counting Station	164 *** 164	100 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
South Shore	162 *** 164	98.8 ***	0 0.0	1 0.6	0 0.0	0 0.0	1 0.6	0 0.0
North Powerhouse	163 *** 164	99.4 ***	0 0.0	1 0.6	0 0.0	0 0.0	0 0.0	0 0.0
North Shore	131 *** 164	79.9 ***	7 4.3	5 3.0	2 1.2	0 0.0	1 0.6	2 1.2
Weir Depths								
SSE-1	125 0 164	76.2 0.0	6 3.7	2 1.2	31 18.9	*** ***	*** ***	*** ***
SSE-2	121 0 164	73.8 0.0	10 6.1	3 1.8	30 18.3	*** ***	*** ***	*** ***
NPE-1	49 105 164	29.9 64.0	1 0.6	1 0.6	8 4.9	*** ***	*** ***	*** ***
NPE-2	48 101 164	29.3 61.6	1 0.6	2 1.2	12 7.3	*** ***	*** ***	*** ***
NSE-1	151 0 164	92.1 0.0	6 3.7	1 0.6	7 4.3	*** ***	*** ***	*** ***

[1] Data from Appendix 1.
[2] "On sill" means the weir gate is resting on its sill and meets "on sill" criteria at this location.

SYNOPSIS OF JUVENILE FISH FACILITY OPERATION

Facility Description

Juvenile fish facilities at Lower Granite Dam consist of: extended-length submersible bar screens (ESBSs), vertical barrier screens, ten and fourteen inch orifices, a collection channel, a primary dewaterer, emergency and primary bypass, fish separator, fish distribution system that includes PIT tag bypass and sort by code, sampling system with lab, holding facilities distribution, and barge and truck loading.

ESBS's guide fish in the forebay away from the turbine units into one of the 18 gatewell slots that contain two orifices for diverting fish into the collection channel. South orifices are 14 inches and north orifices are 10 inches in diameter. The collection channel typically operates with the 14 inch orifices open in each gatewell slot of operating units. Lights are directed at each open orifice to enhance fish passage into the collection channel. Fish in the collection channel are transported into an above ground flume and are either bypassed to the river via the outfall pipe or directed to the collection facility juvenile separator. Once in the separator, adult and larger non-target fish are released to the river and juvenile fish pass below separator bars and enter the distribution system. Collected fish are then routed directly to a barge, bypassed back to the river, held in a raceway for later transport, utilized for research, or become part of the sample.

Facility Modifications

The following modifications were made to the JFF prior to or during the 2019 fish collection season:

1. Juvenile collection channel expansion joints from the orifice gallery to the PDW installed as part of phase 1a were replaced.
2. PDW system screen cleaner shafts and brushes installed as part of 1a were upgraded to resolve wear issues and brush failures.
3. Tied the PDW pneumatic system into the JFF for additional/supplemental facility air supply.
4. Baffles were installed in primary bypass switch gate flush water valves to reduce flow.
5. Designed, installed, and modified porosity unit plates, controls, and customized directional water flow fins balance flow following phase 1a.
6. Replaced porosity control system round perforated plate with narrower oval perforation plate.
7. Refurbished the sample diversion slide gates per PSMFC guidelines.
8. Replaced one fish hold water supply pump in 4000 and two in 8000.
9. Front void structural support repairs in barges 8105, 8107, and 8108.
10. Continued replacing aerators biological balls on fish transport barges.
11. Replaced facility air compressors and some system components.
12. Replaced fuel tanks on both 2000 series barges to maintain EPA compliance.
13. Continued replacing old mesh on raceway supply headbox screens to prevent fry and juvenile lamprey passage.
14. Installed ports in 2 or each series of barges used to install TDG monitors in both barge holds and sea chest to evaluate gas levels in barges compared to river.

15. Installed anodes to prevent corrosion on barge fish hold supply pump to prevent electrolysis.
16. Designed and installed sample dewatering system resulting in a reduction of MS222 usages and disposal needs for EPA permit.
17. Installed flatbed on transport pickup for personnel safety and lowered truck loading pit.
18. PH crew installed temperature gauges on turbine each unit for consistent scroll case temperatures.
19. Designed and built a GBT monitoring station located next to the separator to eliminate safety hazards associated with carrying bucks and fish up/down stairs.
20. Designed and built and anesthetic disposal tanks and system for SMP waste.
21. Installed a drain pipe for NOAA tagging trailer anesthetic waste.
22. Continued rebuilding ESBSs and installing anodes.

Operation and Maintenance

Turbine Operations

Efforts were made to operate all turbine units within one percent of the peak efficiency from April 1 to October 31. Deviations were infrequent and brief or required by BPA (table 18).

Table 3. Lower Granite turbine unit outages, 2019.

Unit	Date OOS	Reason out of service
Units 1 – 6	Monthly	ESBS/VBS inspection
Units 1 – 6	Feb 25-27	Trash rack raking
Units 1 – 6	Mar 18-21	ESBS installation
Units 1 - 6	Aug 12-16	Doble Testing
Units 2 - 6	Dec 06-17	ESBS Removal
Units 1 - 6	Aug 26	500 kV line outage to repair transformer nitrogen leak
Unit 1	Dec 27 - Feb15	Annual Maintenance/Digital Governor Upgrade/OPTO 22
	Mar 14	Correct wiring due to incorrect wiring diagram
	Apr 17 - Apr 25	Head cover issues
	Nov 23 - Dec 19	Field ground service (rotor)
Unit 2	Jan 29	Main unit breaker failed to open on trip
	Feb 11 - Apr 04	Annual Maintenance / Digital Governor Upgrade/OPTO 22
	Aug 26 - Aug 29	Forced OOS due to torn VBS screen.
	Nov 04	Overhaul – remains out of service
Unit 3	Jan 22 - 30	OPTO 22 installation
	Sep 30 - Oct 17	Annual Maintenance
Unit 4	Jan 7 – 17	GDACS PLC Replacement
	Jan 29	Main unit breaker failed to open on trip
	Aug 5 - 22	Annual Maint.
	30 Sep - Oct 2	Forced outage – Failed motor operated cooling water valve.
Unit 5	Jan 29 - Feb 06	86 GT & 86 GX lock out, main unit breaker also failed to trip causing Units 2 and 4 to trip.
	Apr 09	XJ2 breaker inspection and maintenance

	Jul 08 - Aug 01	Annual Maintenance/OPTO 22
	Aug 15 - 16	500 kV line outage
	Aug 20 - 22	XJO2 breaker upgrade
Unit 6	Jan 22 - 31	VBS Replacement/Repair
	Apr 15 - 16	Governor relay valve repair
	Aug 12, 13, 15, 16	Doble
	Sep 09 - 26 Sep	Annual Maintenance
	Oct 9 - 10	Forced outage – Fish screen motor gearbox seal failed.
	Dec 04	Tighten wicket gate packing
	Dec 05	Suspected source of oil in tailrace

Debris/Trash Racks

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

Extended-length Submersible Bar Screens (ESBSs)

ESBSs were inspected and tested prior to installation. ESBSs (Extended Length Submersible Bar Screens) were installed March 18 through March 21. Brush cleaning cycle was set to operate every two hours this season.

Vertical Barrier Screens (VBSs)

VBSs were video inspected in conjunction with ESBSs during the 2019 fish passage season. Detailed inspections were performed during the June ESBS inspection. VBS screen panel mesh has the potential to deteriorate and become brittle over time. VBS panels for screens that pass underwater camera inspection but showed potential for deterioration continue to be replaced/repaired during unit annual outages or during winter maintenance as time permits.

Gatewells

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

Orifices/Collection Channel

Orifices operation was determined by collection channel flow and forebay elevation during the 2019 season. When the forebay is raised above MOP 10" orifices in gatewells of non-priority units (typically units 4 & 5) are used to maintain acceptable flow to the PDW. Orifices were inspected every three hours and back-flushed with air as needed to remove debris March 18-May 25. Orifices were inspected and/or back flushed twice a shift May 25-November 1 when river debris loads were minimal. Orifice operation programming issues continue to be a problem resulting in solenoid failures. The facility was operated by two biological technician to monitor

the orifice gallery and the operation of the relatively new system. Orifice lights were checked daily.

Primary Dewaterer

Lower Granite primary dewaterer (PDW) was in operation March 11-December 18. The collection channel orifice gallery was watered up in emergency bypass mode March 11 as part of JBS upgrade commissioning to evaluation juvenile passage through the emergency bypass. Operations were changed to primary bypass mode at 1524 hours March 12. Water and fish were routed to the separator and out the adult release flume to test porosity plate control modifications from 0920 to 1005 hours on March 14. Primary dewaterer floor screen brushes, side screen brushes, and the pneumatic screen cleaners were operated in auto and manual mode powerhouse operators and JFF staff due to mechanical and programing issues with the system. Operational changes in response to programming, mechanical, and structural issues with the PDW continue as needed.

Wet Separator/Distribution and Sampling Systems

Water levels in the separator varied with the forebay elevation and PDW operations requiring adjustment in porosity control valves and separator exit gates. Adjustments in flume flow were made to reduce fish holding in the transport flume and under the separator. Porosity control valves modifications made during the winter outage distributed flow evenly across the porosity. These modifications to the porosity control unit balanced water across the plate and enabled adequate dewatering prior to entering the separator. Biological technicians adjusted porosity dewatering valves and exit gate positions in response to separator water elevation changes related to PDW weir operation. Separator exit gates were adjusted to improve PIT tag detection efficiencies as coordinated with PSMFC technicians

Barge Loading Operations

Barge loading operations occurred from April 24 through July 30. Loading from the raceways went smoothly this season. Direct loading did not occur.

Truck Loading Operations

Truck transport occurred from August 1 through October 31.

Avian Predation

Injuries associated with predators include wounds inflicted by other fish, birds, and lamprey. Predator wounds were observed on 0.6% of the smolts examined. Predator marks caused by birds, characterized by a distinct V-shaped descaling pattern on both sides of a fish were the most common predator mark at 52.1% compared to 41.6% caused by fish and 6.3% caused by lamprey. Predator marks were highest on clipped sockeye at 1.6% (4 of 254 examined), followed by unclipped steelhead at 1.1% (20 of 1,775 examined), and clipped yearling Chinook at 0.9% (40 of 4,404 examined).

Control Measures

Areas of avian monitoring included: the forebay, turbine and spillway discharge, and the JFF bypass outfall. Deterrent measures included: bird wires across the tailrace of the powerhouse and hazing (April 2 through June 30) under the animal control contract (APHIS). Two shift hazing coverage (daylight to dusk) occurred from April 21 through June 1. This appeared to be effective at reducing the number of gulls returning to feed. Hazing efforts included the use of 15 mm pyrotechnics, long-range rockets, and fused rope salutes. Due to safety concerns propane canons were not utilized at Lower Granite. Lethal take was implemented this season with 1 cormorant and 27 gulls removed. Lower Granite biologist binocular monitoring of piscivorous bird presence and foraging behavior occurred from April 1 through October 31.

Gull Counts

Lower Granite biologists made binocular gull counts in the tailrace extending from immediately below the dam to about ½ mile downstream and in the forebay to about ½ mile upstream of the dam. Daily biologist count observations were made after sunrise and just before sunset from April 1 through October 31. During the counting period 1079 gulls were counted with an average daily count of 5.0 and a maximum of 149 counted April 10.

Double Crested Cormorants

Daily count observations were made after sunrise and just before sunset from April 1 through October 31. During the April 1 to October 31 counting period 1878 cormorants were counted with an average daily count of 8.8 and a maximum of 46 counted September 19.

American White Pelicans

White Pelicans were observed foraging in Lower Granite tailrace from April 24 through August 6 with a maximum of 42 counted in the tailrace June 3. Additional pelicans were commonly observed resting on the island adjacent to Boyer Park Marina during this time period. Hazing of pelicans did not occur at Lower Granite.

Avian Foraging Behavior

Foraging behavior was recorded for gulls, cormorants, and Caspian terns. Gulls had the highest percent of foraging behavior observed (50%) followed by cormorants (12.3%) and Caspian terns (0.0%).

Cooling Water Strainer Counts

Turbine unit cooling water strainers were examined for biologic content once per month from January through August and the end of December during operating year 2019. Timing of the lamprey entry into the strainers represents migration timing coupled with susceptibly of being drawn into the cooling water system. Unit run time totaled 16,391.8 hours and 551 lamprey were recovered from cooling water strainers during the 9 months that the strainers were examined. Juvenile lamprey were most abundant in March (251) and April (123).

Invasive Species:

No zebra/Quagga muscles were observed in the trap substrate this season.

Recommendations

1. Complete Phase 1a modifications and resolve programming issues.
2. Operate the PDW flume outflow between 35-40 cfs to reduce delays in system.
3. Eliminate void at the downstream and install an additional fish at the end of the porosity control unit to improve flow at the downstream end into the separator.
4. Replace mesh tailscreens with porosity plates to allow lamprey passage.
5. Improve sample recovery truck loading pipe slope to eliminate fish stranding in pipe.
6. Continue rebuilding motors on the 2000 series barges.
7. Replace barge bumper cable and tire system with bumpers.
8. Paint hulls on 8000 series barges.
9. Install ballast material in barges 4394 and 4382 voids to eliminate use of river water.
10. Receive and prepare trucks and transport tanks and service truck for the 2021 season.
11. Install electronic operators for raceway supply knife gate valves.
12. Improve juvenile collection facility pneumatic system air compressors and air lines.
13. Replace sample holding tank fish exit release manual valves with pneumatic valves.
14. Improve/modify anesthetic chamber door operation.
15. Permanently close the collection channel 5A research weir that is becoming a safety concern.
16. Modify the JFF sample anesthetic system and procedure to minimize volume of MS-222 waste and develop filter and disposal systems for LWG JFF MS-222.
17. Ensure all researcher working at LGW are accountable for anesthetic waste disposal in compliance with the EPA Clean Water Act.
18. Floor screen cleaner modification to allow backward movement that would eliminate continuous operational issues.
19. Modify side screen cleaners for reliability and ability to operate system in auto mode.
20. Replace temporary chain hoist on emergency bypass hatch with a permanent system that will enable the hatch to be operated as designed and reduce personnel safety concerns during fish rescues/dewatering.

APPENDIX