CENWW-OD-DL HOLDREN (1130) January 2021

MEMORANDUM THRU:
Robert Lustig, Operations Manager Lower Granite Dam

FOR Chief, Operations Division
ATTN: Chris Peery

SUBJECT: Submission of 2020 Adult and Juvenile Fish Facility Monitoring Report, Lower Granite Dam.

1. Enclosed find the 2020 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

2020

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And

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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, 2020. 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, "2020 Juvenile Fish Collection and Bypass Report, Lower Granite Juvenile Fish Facility".

River Conditions

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

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. Commissioned alternative water supply for adult trap.
2. Relocated and updated temporary anesthetic disposal system for the adult trap.
3. Replaced supply valves for anesthetic sample tanks.
4. Updated adult fish trap dewatering standard operation procedure.
5. Developed a protocol for emergency flushing procedures for clearing shad mortalities from the adult trap return channel.
6. Repaired fall out fence.
7. Filled/repaired fish ladder expansion joints.

Operations and Maintenance

Fish Ladder and Collection Channel

The adult fish ladder was in service throughout 2020 apart from the winter maintenance season from January 6-February 10. 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 2 unclipped and 1 clipped juvenile steelhead, 1 juvenile lamprey and 1 unidentified salmonid recovered in the upper section of the ladder during the dewatering process on January 6. 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 to $4/10^{th}$ 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 section of the collection channel January 8 included 1sandroller. The spillway section was dewatered on January 9 with 1 clipped adult steelhead, 2 clipped and 2 unclipped juvenile steelhead, 7 sandrollers, 2 peamouth, 2 sucker spp., 2 chiselmouth, and 3 mountain whitefish recovered and released. 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 11 for annual maintenance. Annual maintenance consists of general mechanical and electrical inspection, and repairs. AWS pump 1 and 2 were returned to service February 11 and AWS pump 3 was kept offline for lower guide bearing replacement. Due to Covid-19, guide bearing work on pump 3 was postponed until the 2020-2021 outage. AWS pump 3 was put in standby mode for the remainder of the season. Fish pumps 1 and 2 remained in service for the entirety of the season. Significant pump outages are summarized in Table 1.

Table 1. Fish pump outages at Lower Granite Dam, 2020*

Affected Pump(s)	Dates	Reason for Outage/Comments
1, 2	Jan 1 – Feb 14	Annual maintenance
3	Jan 1 – Mar 31	Annual maintenance/lower guide bearing

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

Adult Fish Trap Operations

Lower Granite adult fish trap was operated March 2-March 24 and July 2-November 12 by LWG biologists, Idaho Department of Fish and Game (IDFG), and NOAA Fisheries. The adult trap was closed and dewatered from March 24 to July 1 due to COVID-19 restrictions. LWG biologists and IDFG resumed operation of the adult trap from July 2 to September 1 with a maximum of four staff members at the trap due to COVID -19 safety protocols. Operations were a success. 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. The maximum adult trap water temperature during 2020 was 70.2°F on August 25. The adult trap total collection for the season was 25,424 fish, including 210 sockeye, 2,308 Coho, 11,641 steelhead, 1,337 spring/summer Chinook, and 9,928 fall Chinook.

Idaho Department of Fish and Game (IDFG) assisted LWG biologists and 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 were PIT tagged to estimate headwater tributary escapement.

Steelhead collection totaled 11,641 (7,775 clipped, 3,866 unclipped) with 3,796 having genetic and scale samples taken, and 2,580 having genetic samples only taken. Of the 11,641 fish sampled, 4,660 were PIT tagged and 2,065 were Floy tagged. There were 434 recaptured PIT tagged fish.

Spring/Summer Chinook collection totaled 1,337 (705 clipped, 632 unclipped). No genetic or scale samples were taken. There were 38 recaptured PIT tagged fish.

Fall Chinook collection for broodstock transport began August 17. Of the 9,928 fall Chinook handled at the adult trap, 3,386 were transported (genetic samples taken) and 6,542 were released. Washington Department of Fish and Wildlife (WDFW) transport to Lyons Ferry Hatchery began

August 18 and ended September 23 when collection goals were met. WDFW transported 2,478 (1,978 adults and 500 jacks) fall Chinook. Nez Perce Tribe collection for transport to Cherry Lane/Dworshak hatcheries occurred August 18 and ended September 23 when broodstock goals were met. Nez Perce Tribe transported 908 (889 adults and 19 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 September 28 to October 20. Coho ≥ 55 cm in length were collected. Of the 2,308 Coho collected at the adult trap, 634 were transported and 1,674 were returned to the fish ladder. There were 29 recaptured PIT tagged fish.

Genetic samples were taken from all 210 adult sockeye collected in the trap. There were 2 recaptured PIT tagged fish. All Sockeye collected were returned to the fish ladder.

There was 1 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 19 through September 18.

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 2020 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. The fish ladder control system continued to have issues maintaining depth over the weirs and operating gates within the same depth range based on tailwater elevation at induvial entrances.

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 3.9 inspections per week were performed (173 inspections /44 weeks) in 2020. 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. Calibrations to the automatic control system 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 calibrations. 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 2020 was 77.4% compared to 88.7% in 2019. The fish ladder control system programming issues were the most common reason for out of criteria readings. LWG electrical team is working with the Project Biologist to find a

permanent solution to this ongoing problem. 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 99.4% of the inspections. Out of criteria readings included 1 at 0.01-0.1 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 differentials were in criteria on 100% of inspections.

NPE-1 & 2 head was in criteria on 98.3% of inspections. Out of criteria readings included 1 at 0.01-0.1 feet below criteria, 1 at 0.11-0.2 feet below criteria, and 1 at >0.2 feet below criteria.

NSE-1 head differential was in criteria on 85.5% of inspections compared to 79.9% in 2019. 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 25 inspections in 2020. Out of criteria readings included 4 at 0.1 feet below criteria, 2 at 0.2 feet below criteria, and 1 greater than 0.2 feet below criteria. Out of criteria readings also included 17 readings greater than 0.2 feet above criteria and 1 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 70.5% of inspections (70.5% depth, 0.0 % sill) compared to 76.2% in 2019. Out of criteria readings included 16 at 7.9 feet, 11 at 7.8 feet, and 24 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 74.0% of inspections (74.0% depth, 0.0 % sill) compared to 73.8% in 2019. Out of criteria readings included 12 at 7.9 feet, 8 at 7.8 feet, and 25 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 86.8% of inspections (43.4% depth, 43.4% sill) compared to 93.9% in 2019. Out of criteria readings included 6 at 7.9 feet, 2 at 7.8 feet and 15 at 7.7 feet or less.

NPE-2 weir gate was in depth criteria or sill on 88.5% of inspections (42.8% depth, 45.7% sill) compared to 90.9% in 2019. Out of criteria readings included 4 at 7.9 feet, 2 at 7.8 feet, and 14 at 7.7 feet or less.

NSE-1 weir gate was in depth or sill criteria on 65.3% of inspections (65.3% depth, 0.0 % sill) compared to 92.1% in 2019. Out of criteria readings included 14 at 6.9 feet, 14 at 6.8 feet, and 42 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 49.7% of inspections (criteria: 1.5-4.0 ft/s) compared to 63.4% in 2019. 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. Sensor reading had remained at the same velocity for several weeks and were not consistent with velocity calculated suggesting the meter is inaccurate. A portable meter was purchased to be used during the 2021 season. LWG electrical team is working with the Project Biologist to find a permanent solution. A Signature Laser Sensor was also installed above the north shore collection channel that measures channel elevation and surface velocity.

Recommendations

1. Replace NSE-1 and NSE-2 gates and operating system.
2. Replace fish ladder/adult trap turnpool diversion gate with hoist operated picketed lead system.
3. Replace all entrance weir gates and operating systems.
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. Replace and relocate the north powerhouse velocity meter.
8. 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, 2020 [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	86 *** 173	49.7 ***	*** ***	*** ***	*** ***	*** ***	*** ***	*** ***
Differentials								
Ladder Exit	173 *** 173	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
Ladder Weirs	172 *** 173	99.4 ***	0 0.0	0 0.0	0 0.0	1 0.6	0 0.0	0 0.0
Counting Station	173 *** 173	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
South Shore	173 *** 173	100.0 ***	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
North Powerhouse	170 *** 173	98.3 ***	1 0.6	1 0.6	1 0.6	0 0.0	0 0.0	0 0.0
North Shore	148 *** 173	85.5 ***	4 2.3	2 1.2	1 0.6	0 0.0	1 0.6	17 9.8
Weir Depths								
SSE-1	122 0 173	70.5 0.0	16 9.2	11 6.4	24 13.9	*** ***	*** ***	*** ***
SSE-2	128 0 173	74.0 0.0	12 6.9	8 4.6	25 14.5	*** ***	*** ***	*** ***
NPE-1	75 75 173	43.4 43.4	1 0.6	1 0.6	8 4.9	*** ***	*** ***	*** ***
NPE-2	74 79 173	42.8 45.7	4 2.3	2 1.2	14 8.1	*** ***	*** ***	*** ***
NSE-1	113 0 173	65.3 0.0	14 8.1	14 8.1	42 24.3	*** ***	*** ***	*** ***

[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 2020 fish collection season:

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

14. Continued replacing aerators biological balls on fish transport barges.
15. Continued upgrading facility pneumatic system including adding condensation drains, new air lines, valves, and valve operators.
16. Continued replacing old mesh on raceway supply headbox screens to prevent fry and juvenile lamprey passage.
17. Continued to install anodes to prevent corrosion on barge fish hold supply pump to prevent electrolysis.
18. Continued rebuilding ESBSs and replacing VBS mesh as time permits.

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 3 contains unit outages during 2020.

Debris/Trash Racks

Trash racks were raked February 25-27. Trash rack raking was not required during the fish passage season.

Extended-length Submersible Bar Screens (ESBSs)

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

Vertical Barrier Screens (VBSs)

VBSs were video inspected in conjunction with ESBSs during the 2020 fish passage season. Detailed inspections were performed during the June ESBS inspection. VBS screen panel mesh has the potential to deteriorate and become brittle over time. VBS panels for screens that pass underwater camera inspection but showed potential for deterioration continue to be replaced/repaired during unit annual outages or during winter maintenance as time permits.

Gatewells

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

Table 3. Lower Granite turbine unit outages, 2020.

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, 3 – 6		RAS Testing
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-Dec 31	Overhaul – remains out of service
Unit 3	January 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 Maintenance
	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.
	April 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	Jan22 - 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

Orifices/Collection Channel

The orifice gallery was watered up at 1130 hours February 20 to support early juvenile collection facility operation. Orifices operation was determined by collection channel flow and forebay elevation during the 2020 season. When the forebay is raised above MOP, 10" orifices in gatewells of non-priority units (typically units 4 & 5) are used to maintain acceptable flow to the PDW. Orifices were inspected every three hours and back-flushed with air as needed to remove debris March 1-May 25. Orifices were inspected and back flushed twice a shift May 25-

November 1 when river debris loads were minimal. Orifice operation programming issues continue to be a problem. The facility was operated by two biological technicians to monitor the orifice gallery and the operation of the relatively new system during the spring freshet. Orifice lights were checked during daily inspections.

Primary Dewaterer

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

Wet Separator/Distribution and Sampling Systems

Water levels in the separator varied with the forebay elevation and PDW operations requiring adjustment in porosity control valves and separator exit gates. Adjustments in flume flow were made to reduce fish holding in the transport flume and under the separator. Porosity control valve modifications made during the 2018-2019 winter outage distributed flow evenly across the porosity. These modifications to the porosity control unit balanced water across the plate and enabled adequate dewatering prior to entering the separator however they did not address all the issues. An additional modification was added to the porosity control unit during the 2019-2020 outage to smooth the downstream flow. Biological technicians adjusted porosity dewatering valves and exit gate positions in response to separator water elevation changes related to PDW weir operation. Separator exit gates were adjusted to improve PIT tag detection efficiencies as coordinated with PSMFC technicians. Debris obstructions became an issue as debris load increased late in the season and seemed to be more prevalent during steelhead overshoot spill operational hours.

Barge Loading Operations

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

Truck Loading Operations

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

Avian Predation

Injuries associated with predators include wounds inflicted by other fish, birds, and lamprey. Predator wounds were observed on 0.7% of the smolts examined. Predator marks caused by birds, characterized by a distinct V-shaped descaling pattern on both sides of a fish were the most common predator mark at 52.6% compared to 44.6% caused by fish and 2.8% caused by

lamprey. Predator marks were highest on unclipped steelhead at 1.4% (25 of 1,804 examined), followed by clipped sockeye salmon at 1.2% (2 of 169 examined), and clipped steelhead 1.2% (62 of 5,260 examined).

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 1 through June 30) under the animal control contract (APHIS). Two shift hazing coverage (daylight to dusk) occurred from April 19 through June 2. 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 4 cormorant and 32 gulls removed. Lower Granite biologist binocular monitoring of piscivorous bird presence and foraging behavior occurred from March 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 March 1 through October 31. During the counting period 1,443 gulls were counted with an average daily count of 5.8 and a maximum of 117 counted April 6.

Double Crested Cormorants

Daily count observations were made after sunrise and just before sunset from March 1 through October 31. During the March 1 to October 31 counting period 2,493 cormorants were counted with an average daily count of 10.2 and a maximum of 56 counted October 6.

American White Pelicans

White Pelicans were observed foraging in Lower Granite tailrace from April 20 through August 6 with a maximum of 65 counted in the tailrace June 7. 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 (52.9%) followed by cormorants (9.5%) 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 July and the end of December during operating year 2020. 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 12,537 hours and 1,022 lamprey were recovered from cooling water strainers during the 8 months that the strainers were examined. Juvenile lamprey were most abundant in February (722) and May (150).

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

APPENDIX