CENWW-OD-DL HOLDREN (1130) February 2018

MEMORANDUM THRU:
Marty Mendiola, Operations Manager Lower Granite Dam

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

SUBJECT: Submission of 2018 Adult and Juvenile Fish Facility Monitoring Report, Lower Granite Dam.

1. Enclosed find the 2018 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
Supervisory Fisheries Biologist, Lower Granite Dam

Enclosure

ADULT AND JUVENILE FISH FACILITY MONITORING REPORT

LOWER GRANITE DAM

2017

Elizabeth A. Holdren

Project Supervisory Fisheries Biologist

And

Stephen D. Hampton

Project Assistant Fisheries Biologist

Lower Granite Dam

U.S. Army Corps of Engineers

TABLE OF CONTENTS

LIST OF TABLES

APPENDIX

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 fishway inspections conducted by fisheries staff during the adult fish passage period of March 1 to December 31, 2017. 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, "2017 Juvenile Fish Collection and Bypass Report, Lower Granite Juvenile Fish Facility".

River Conditions

The average daily river flow exceeded 100 kcfs on 93 days during the 2017 season. Highest daily average flow for the March 26-August 2 collection season was 181.0 kcfs May 14. Lowest daily average flow for the season was 38.1 kcfs July 28. The seasonal average flow was 116.4 kcfs. Lower Granite began spilling due to high river flows March 8. The maximum spill during the March 8-April 3 period was 107.8 kcfs. Spill for the fish passage season occurred for 152 days from April 3 through midnight on August 31 with a maximum daily average spill of 89.8 kcfs May 14, a minimum daily spill of 14.7 kcfs August 19, and a seasonal average of 39.2 kcfs. Several emergency debris spills with the RSW closed and spill shifted primarily through spillway 3 were required due to heavy debris loads this season. Spill volume remained the same during emergency spill operations May 15, 24, and June 3, 4, 8, 19, and 22. Lower Granite operated with the RSW closed in accordance with Fish Passage Plan Table LWG-9 13 July 12 through August 31 due to increased forebay surface water temperatures. Spill operations were extended from 0600-1800 hours September 1 through December 15 to provide fish passage during juvenile bypass system construction. River temperatures averaged 57.2 ^{o}F for the season and ranged from 46.4° F March 26 to 70.0° F August 2.

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 and includes a forebay temperature control system ladder exits, slotted weirs, upper diffusers, forebay pumps to supply cooling water during summer, overflow weirs with orifices, and fish counting stations with picketed leads. There is also an adult fish trap upstream from the adult fish count station. The lower ladder contains a powerhouse collection channel, an auxiliary water supply, channel diffusers, a transportation channel under the spillway, and ladder entrances. There are six main fish ladder entrances: 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 four out of ten floating orifices operating. Three electric pumps (fish pumps) supply auxiliary water from the tailrace through the conduit that extends under the ladder distributing water to the lower ladder diffusers. Additional auxiliary water is supplied from the forebay through diffuser 14.

Facility Modifications

1. Installed PVC trolley pipes for HOBO temperature probe deployment.
2. Fabricated and replaced failed adult trap false weir jump barrier grating.
3. Installed temporary jump barrier over adult trap attraction pool.
4. Upgraded powerhouse collection channel tunnel lights observation mirror.

Operations and Maintenance

Fish Ladder and Collection Channel

The adult fish ladder was in service throughout 2017 with the exception of the winter maintenance season from January 3-February 13 and for debris removal from turn-pool gate March 13. 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 twenty four 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 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 enough water in the ladder to flush remaining fish down the ladder as biologists and maintenance personnel go down the ladder through the orifices to remove debris, inspect the ladder, and move remaining fish to the tailrace. Fish recovered in the upper section of the ladder and released to the tailrace or forebay January 3 included 1 live unclipped juvenile steelhead. There was 1 decomposed adult clipped steelhead recovered and returned to the river. 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. The water was 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 a 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 collection channel January 5 included 2 juvenile clipped steelhead, 2 juvenile shad, 3 juvenile peamouth, and 1 juvenile northern pikeminnow. Mortalities included 2 decomposed adult shad, 1 juvenile shad, and 1 decomposed bluegill. No problems were observed during the inspection of the north powerhouse channel. Diffuser 13 transverse bulkhead was installed at the end of the powerhouse collection channel due to personnel safety concerns related to NPE3 temporary bulkhead. No other problems were observed during ROV inspection of the north collection channel.

Auxiliary Water Supply

AWS fish pumps were out of service (OOS) from January 1 to February 16 for annual maintenance. Annual maintenance consists of general mechanical and electrical inspection and repairs. AWS pumps were removed from service from 1634 hours March 13 to 1215 hours March 14 to discourage newly arriving fish from entering the ladder prior to dewatering to remove a turnpool gate obstruction. AWS pumps 2 and 3 were removed from service from 1220-1457 hours April 27 for bulkhead swapping and pump 1 testing. AWS pumps were removed from service from 1226-1431 hours August 14 for ROV inspection of NPEs. Pumps were removed from service from 1051-1121 hours and 1548-1608 hours August 28 to facilitate repair of NPEs operating cables. Pumps 1 and 3 were removed from service from 1400-1430 October 30 and from 1404-1530 hours October 31 for 5Kv line work. AWS pump 1 tripped off line from 0736-0840 hours November 13 due to the pumps inability to operate in fast at the tailrace elevation. Pumps 1 and 3 were removed from service from 0826-1532 hours November 20 for 5Kv line reconnect. Fish pumps 1 and 3 remained in service for the remainder of the season with pump 2 in standby mode. Significant pump outages are summarized in Table 1.

Table 1. Fish pump outages at Lower Granite Dam, 2017 *

Affected Pump(s)	Dates	Reason for Outage/Comments
2	Jan 1 – Feb 15	Annual maintenance
1, 3	Jan 1 – Feb 16	Annual maintenance

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

Adult Fish Trap Operations

Lower Granite adult fish trap was operated March 07 through November 19. Sample rates were adjusted with adult passage to meet collection and research needs. The turn-pool diversion gate was changed to ladder passage position from about 1400 hours Fridays to 1300 hours Sundays to facilitate volitional fish passage. Trapping operations were not postponed due to water temperatures exceeding 70°F this season. The adult ladder temperature control system installed during the 2015-2016 winter maintenance season sustained adult trap temperatures below 70°F. The maximum adult trap water temperature during 2017 was 68.8°F September 6. The total adult trap fish collection for the season was 36,522 fish including 57 sockeye, 1,914 Coho, 16,546 steelhead, 7,634 spring Chinook, 2,309 summer Chinook, and 8,062 fall Chinook. There was 1 bull trout incidentally trapped and released June 16.

Idaho Department of Fish and Game sampled approximately 20-33% of the adult steelhead, spring/summer Chinook salmon, and sockeye salmon run from March 7 through the end of the adult trapping season November 19. Sampling includes collecting fish scales, genetics tissue, sex and length, clipped/unclipped composition, and evaluating non-adipose clipped hatchery fish run proportion. Natural origin adult steelhead and spring/summer Chinook salmon trapped were also PIT tagged to estimate headwater tributary escapement.

Steelhead collection totaled 16,546 (13,234 clipped, 3,312 unclipped) with 4,000 having genetic samples only taken, 3,100 PIT tagged with both genetic and scale samples taken, 358 being recaptured PIT tagged fish with genetic and scale samples taken, and 123 radio tagged.

Spring Chinook collection totaled 7,634 (6,432 clipped, 1,202 unclipped) with 2,986 having genetic samples only taken, 1,120 PIT tagged with both genetic and scale samples taken, 130 being recaptured PIT tagged fish with genetic and scale samples taken, and 0 radio tagged.

Summer Chinook collection totaled 2,309 (1,449 clipped, 860 unclipped) with 700 having genetic samples only taken, 823 PIT tagged with both genetic and scale samples taken, 60 being recaptured PIT tagged fish with genetic and scale samples taken, and 0 radio tagged. Genetic samples were also taken from 57 adult sockeye.

Fall Chinook collection for WDFW broodstock transport to Lyons Ferry Hatchery began August 18 and ended October 17 when hatchery needs were met. Of the 8,062 fall Chinook collected at the adult trap, WDFW transported 2,223 (1,568 adults and 655 jacks) to Lyons Ferry Hatchery. Nez Perce Tribe collection for transport to Cherry Lane occurred August 18 through October 17 when broodstock needs were met. Of the 8,062 fall Chinook collected at the adult trap, Nez Perce Tribe transported 973 (958 adults and 15 jacks) to Cherry Lane Hatchery. The turnpool gate remained in trapping position during the fall Chinook collection season.

Emergency collection of Coho for the Nez Perce Tribe occurred from September 20 to October 17 with the last fish being transported October 17. Of the 1,914 Coho collected at the adult trap 1,402 were transported and the remaining 512 were returned to the fish ladder. There was no emergency trapping operation of sockeye for IDFG transport. 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

Ladder water temperatures were monitored hourly at the ladder exit, diffuser 14, ladder turn pool, and the bottom junction pool April 1 through October31. An additional eight electronic temperature probes were installed during winter maintenance to provide real-time data at web site http://www.nwd wc.usace.army.mil/dd/nww/fl_temps/www/index.html. A permanent fish ladder temperature control system was installed during the 2015-2016 winter maintenance season. Forebay fish ladder auxiliary pumps 1 and 2 were modified to intake cooler water from an elevation of 667.0 feet (66.0 feet below MOP) and supply a spray bar in front of the fish ladder exit. Gravity flow then distributes the cooler water from the forebay side of the exit down the ladder. Emergency cooling pumps were replaced with a chimney structure that drafts cold water from an elevation of 667.0 feet into diffuser 14 intake. Cooler water from diffuser 14 is then distributed though the overflow sections of the ladder. Water from diffuser 14 also supplies the adult fish trap. Ladder temperature control system operation occurred July 6 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 and receives information from remote terminal units. The terminal units are fed by sensors detecting entrance weir gate positions, collection channel water and tailwater elevations, and upper diffuser pool levels. Lower Granite automated fishway control system was upgraded during winter maintenance. The new system has two digital displays, one in the control room and the other on the third floor of the powerhouse. Gates can be remotely

operated from a touch screen in the control room and a biologist snapshot of fish ladder operation is printed concurrent with ladder inspections. Temperature and velocity sensors were installed as part of the upgrade. Trend graphs of both channel velocity and temperature can be generated on display screens. Powerhouse electricians manually calibrate fish ladder gates to ensure the control system program operates in criteria parameters following winter maintenance. During the 2017 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). Four floating orifice gates (1, 4, 7, and 10) are operated in the powerhouse collection channel. Normal operating criteria for the rest of the ladder include maximums of 0.5-foot heads at the exit, maximums 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 3.8 inspections per week were performed (167 inspections /44 weeks) in 2017. 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 inspection each week while on Project. Once per month, inspections were also conducted with Oregon Department of Fish and Wildlife personnel stationed at Little Goose Dam.

Inspection Results

Visual readings were recorded and compared with automated control system readings to check for calibration problems. High variability between wave crests and troughs created by spill reduces the accuracy of biologists' staff gauge readings in the tailrace. Digital displays of the fishway control system are used to check the accuracy of staff gauge readings recorded during fishway inspections. The automatic fish ladder control system was upgraded during the 2015-2016 winter maintenance outage to an Automation Direct PLC and HMI Configuration Software (C-More Programming Software). 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 was sacrificed to achieve channel/tailwater head differentials. Automatic control system adjustments were made to trouble shoot internal functioning errors in the program. 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 hand mode until electricians completed diagnostics and made adjustments. Electricians continue to troubleshoot control system programming issues. Data from fishway inspections was entered into an Excel spreadsheet (Appendix 1). The average compliance of all criteria points in 2017 was 95% compared to 97% in 2016. The majority of

out of criteria readings were due to fish ladder control system issues. 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 98.8% of the inspections. Out of criteria readings included 1 at 0.1 feet above criteria and 1 at 0.3 feet below criteria.

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

Entrance heads: South shore entrance head differential was in criteria on 96.4% of inspections. Out of criteria readings included 1 at 0.1 feet below criteria, 2 at 0.2 feet below criteria, and 3 greater than 0.2 feet below criteria.

North powerhouse entrance head was in criteria on 93.4% of inspections. Head differential readings were out of criteria (criteria 1.0-2.0 feet) on 11 inspections. Out of criteria readings included 2 at 0.1 feet below criteria, 3 at 0.2 feet below criteria, and 6 greater than 0.2 feet below criteria. Five of these out of criteria readings were taken prior to identifying NPE operating cable failures.

North shore entrance head differential was in criteria on 89.8% of inspections compared to 47.7% in 2015 and 35.4% in 2014. 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 is at minimum operating pool (MOP). Weir depths were sacrificed to maintain a minimum of 1.0 feet of head differential during MOP operation. NSE2 has been suspended with a chainfall hoist since the gate operator failed in 2011. Head differential readings were out of criteria (criteria 1.0-2.0 feet) on 12 inspections in 2017 compared to being out of criteria on 6 inspections in 2017. Out of criteria readings included 1 at 0.1 feet below criteria, 4 at 0.2 feet below criteria, and 7 greater than 0.2 feet below criteria. NSE channel/tailwater head differentials were likely out of criteria due to NPEs being out of service and the inability of NSE1 to adjust to tailwater conditions.

South shore entrances (SSE-1 & 2): SSE-1 weir gate was in depth or sill criteria on 95.8% of inspections (95.8% depth, 0.0 % sill). Out of criteria readings included 3 at 7.9 feet, 2 at 7.8 feet, and 2 at 7.7 feet. Two of these out of criteria readings can be attributed to the tailwater elevation being outside the range of the control system parameters.

SSE-2 weir gate was in criteria on 93.4% of inspections (93.4% depth, 0.0 % sill). Out of criteria readings included 4 at 7.9 feet, 2 at 7.8 feet, and 5 at 7.7 feet. Two of these out of criteria readings can be attributed to the tailwater elevation being outside the range of the control system parameters.

North powerhouse entrance (NPE-1 & 2) depths: NPE-1 weir gate was in depth or sill criteria on 91.6% of inspections (31.7% depth, 59.9% sill). Out of criteria readings included 2 at 7.9, 2 at

7.8 feet and 8 at 7.7 feet. Five of these out of criteria readings can be attributed to the tailwater elevation being outside the range of the control system parameters. Four of these out of criteria readings occurred due to weir gate mechanical failure. Three of these out of criteria readings occurred due to gate synchronization issues between NPE gates.

NPE-2 weir gate was in depth criteria or sill on 95.8% of inspections (34.7% depth, 61.1% sill). Out of criteria readings included 3 at 7.9 and 4 at 7.7 feet. Three of these out of criteria readings can be attributed to the tailwater elevation being outside the range of the control system parameters.

North shore entrance (NSE-1 & 2) depths: NSE-1 weir gate was in depth or sill criteria on 86.2% of inspections (86.2% depth, 0.0 % sill). Out of criteria readings included 1 at 7.9 feet, 3 at 7.8 feet, and 19 at 7.7 feet. 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 2017 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. 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.

Collection channel velocity: Velocities were in criteria on 94% of inspections (criteria: 1.5-4.0 ft/s). 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-2 failed gate and operating system.
2. Replace all entrance weir gates and operating systems.
3. Permanently fill the NSE-3 and NPE-3 bulkhead slot with concrete.
4. Continue to operate the north shore with one NSE closed to improve channel/tailwater head differential.
5. Try different ladder operations including closing FOG's to determine if North Powerhouse and North Shore entrance depth and head differentials can be improved.
6. Resolve adult fish ladder automatic control system programing issues.
7. Replace/relocate staff gauges that are difficult to read.
8. Label adult fish trap valves (identifying their function) and develop updated O&M manual.

Table 2. Summary of adult fishway inspections at Lower Granite Dam, 2017 [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	157 *** 167	94.0 ***	*** ***	*** ***	*** ***	*** ***	*** ***	*** ***
Differentials								
Ladder Exit	167 *** 167	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
Ladder Weirs	165 *** 167	98.8 ***	0 0.0	0 0.0	1 0.6	1 0.6	0 0.0	0 0.0
Counting Station	167 *** 167	100 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
South Shore	161 *** 167	96.4 ***	1 0.6	2 1.2	3 1.8	0 0.0	0 0.0	0 0.0
North Powerhouse	156 *** 167	93.4 ***	2 1.2	3 1.8	6 3.6	0 0.0	0 0.0	0 0.0
North Shore	150 *** 167	89.8 ***	1 0.6	4 2.4	7 4.2	2 1.2	0 0.0	3 1.8
Weir Depths								
SSE-1	160 0 167	95.8 0.0	3 1.8	2 1.2	2 1.2	*** ***	*** ***	*** ***
SSE-2	156 0 167	93.4 0.0	4 2.4	2 1.2	5 3.0	*** ***	*** ***	*** ***
NPE-1	53 101 167	31.7 60.5	2 1.2	2 1.2	7 4.2	*** ***	*** ***	*** ***
NPE-2	58 103 167	34.7 61.7	3 1.8	0 0.0	3 1.8	*** ***	*** ***	*** ***
NSE-1	144 0 167	86.2 0.0	1 0.6	3 1.8	19 11.4	*** ***	*** ***	*** ***

[1] Data from Appendix 1.

[2] "On sill" means the weirgate 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 inch orifices, a collection channel that terminates in an underground transport pipe, a dewatering incline screen, fish separator, and a fish distribution system that includes PIT tag bypass, sampling, holding facilities distribution, and barge and truck loading.

ESBS's guide fish in the forebay away from the turbine units into one of 18 gatewell slots that contain two orifices for diverting fish into the collection channel. Eighteen to 21 orifices are typically open with a minimum of one orifice open in each bulkhead slot of operating units. Lights are directed at each open orifice to enhance fish movement into the collection channel. Fish in the collection channel are transported through an underground pipe to the wet separator. Upon reaching the separator, adult and non-target fish are released to the river and juvenile fish pass below the separator bars and enter the distribution system. Collected fish are then routed directly to a barge, bypassed back to the river, placed in a raceway for later transport, utilized for research, or become part of the sample.

Facility Modifications

The following JFF modifications were made prior or during the 2017 fish collection season:

1. Juvenile bypass upgrade Phase 1a is ongoing.
2. Refurbished the sample diversion slide gates per PSMFC guidelines.
3. Replaced large PVC separator bars with fabricated aluminum bars at the same spacing to reduce adult passage through the sample and transport system.
4. Sea chest and flapper seals replaced/installed on 8108.
5. Replaced balls in six aerators on barge 8108.
6. Refurbished separator box and supply lines.
7. Improved separator exit gate design.
8. Installed a direct loading line dewatering box flush valve to eliminate fish stranding on screens
9. Replaced old mesh on raceway 4 head box screen to prevent fry and juvenile lamprey passage into supply box.
10. Installed sample holding tank jump barrier.
11. Overhauled raceway 1-5 canal gates.
12. Replaced raceway 6-10 evacuation valve cylinders.
13. Installed new barge loading dock chain hoists.
14. Installed battery disconnects on barges 4382, 4394, 8105, and 8106
15. Sea chest and flapper seals replaced/installed on 8107.
16. Replaced all aerator balls on barge 8107.
17. Painted aerators, above deck fish holds, and engine room exteriors of barges 8108, 8107, and 8105.
18. Replaced winch cable on right rear of barge 8105.

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 18. Lower Granite turbine unit outages, 2017.

Unit	Date OOS	Reason out of service
All Units	As Listed Under ESBS	ESBS/VBS inspection.
All Units	March 21-23	ESBS installation
All Units	August 8-11	Doble testing
All Units	August 14-15	VBS inspections
All Units	October 30-31	VBS inspections
All Units	Nov 15-17	ESBS removal
Unit 1		
	February 16	Testing
	April 12-December 31	Kaplan blade linkage repair
Unit 2		
	January 14	NERC Testing
	Jan 27-Feb 1	VBS repair/replacement
	March 1	Rake trash
	March 28, 29, 31	Gatewell dipping for John Day ESBS condition testing ~one hour in the morning
	August 29	Governor oil pump failure
	September 8	Setting governor oil pump
	November 22	Shaft alignment testing prior to unit annual maintenance
	Nov 28-Dec 15	Annual maintenance
	Dec 21-31	Blade packing failure
Unit 3		
	January 14	NERC Testing
	March 4	Rake trash
	March 28, 29, 31	Gatewell dipping for John Day ESBS condition testing ~one hour in the morning
	May 11	Contractor hit PMG tripping unit off line
	June 26-29	Repair VBS in slot 3B
	July 11-14	Repair VBS in slot 3A
	Oct 17-Nov 7	Annual Maintenance
Unit 4		
	January 11	NERC testing
	March 4	Rake trash
	April 11	Exciter issues
	May 5-6	ESBS brush failure in slot 4A
	May 23	Brush gear cleaning due to field ground
	July 5-20	Annual Maintenance
	August 28	ESBS screen cleaner issues
Unit 5		
	January 8	NERC testing
	January 20-26	VBS replacement
	March 4	Rake trash
	March 28	Field ground test
	June 15	Heat exchanger cleaner
	Aug 29- Oct 13	Annual maintenance 6 year overhaul
	October 24	ESBS ground alarm on brush in slot 5A
Unit 6		
	January 11	NERC testing
	March 2	Rake Trash
	April 17	Exciter failure
	June 20	Faulty ESBS ground in gatewell 6B
	June 23-30	EAL install and testing
	August 1-26	Annual maintenance
	December 8	Phase 1a collection channel caisson install
	December 14	Phase 1a collection channel caisson install

Debris/Trash Racks

Unit 2 trashracks were raked March 1 with about 33 cubic yards of debris removed from the forebay and trashracks. Trashracks were raked again March 29-30 with about 23.4 cubic yards of debris removed. Between May 26 and June 8 the powerhouse mechanical crew removed about 438 cubic yards (15 truckloads) of debris from the powerhouse forebay.

Extended-length Submersible Bar Screens (ESBSs)

ESBSs were inspected and tested on the week of March 12. Screens were installed from March 20 through March 23. Video inspection took place May 21-23, and June 25-26. No problems with the ESBSs were detected during video inspections. ESBSs were removed August 1-3 due to bypass upgrade construction. 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 2017 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 will continue to be replaced 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

During the 2017 season the number of open orifices usually varied from 18 to 21 according to forebay level. With the Lower Granite reservoir at minimum operating pool, water discharge through an orifice is reduced. Orifices were cycled and back-flushed with air remove debris every three hours from March 20 through August 3 when the collection channel was dewatered. Heavy debris load resulted in orifice obstructions through June. Beginning May 15 an extra biological tech necessary to manage orifice debris that included monitoring and back flushing orifices hourly to prevent obstruction and clear debris. My 25 the debris load increased with river flows and high winds. The powerhouse mechanical crew removed about 438 cubic yards (15 truckloads) of debris from the powerhouse forebay May 26 and June 8. Orifice lights were checked daily. Orifices with burnt out lights were switched to the other orifice in the slot until the bulb was replaced.

Primary Dewaterer

Lower Granite's primary dewatering structure is an inclined screen just upstream from the porosity control perforated plate for the separator. Debris is removed from the screen with a long handled brush every half hour to once a shift depending on debris level. When the inclined screen becomes severely clogged the facility is put in primary bypass mode to take pressure off the top of the inclined screen. Debris then either floats off or is brushed off. This cleaning procedure takes about 20-30 minutes to complete. During 2017, it was necessary to go to primary bypass due to debris accumulating on the incline screen from 1100-1130 hours March 21.

Wet Separator/Distribution and Sampling Systems

Water levels in the separator also varied with the forebay elevation requiring adjustment in the number of orifices operating and adjustments of the 42-inch valve to maintain proper water level. The separator water levels also fluctuated due the south shore makeup water valve being unable to adjust automatically. Separator personnel manually operated orifice valves to maintain collection channel and separator water levels.

Historical PVC separator bar spacing at Lower Granite allowed kelts, Chinook jacks, shad, and other adults to be collected into the sample, raceways, and barges for transport. Jack bars positioned on the standard PVC bars to keep larger fish out resulted in debris accumulating between the bars. Aluminum separator bars were designed, fabricated, and installed during the 2016-2017 winter outage. The distance between the aluminum bars remains the same as the distance between the PVC bars.

Barge Loading Operations

Barge loading operations occurred from May 2 through August 2. Both direct loading and loading from the raceways went smoothly this season.

Truck Loading Operations

Truck transport did not occur due to early dewatering for bypass upgrade construction.

Avian Predation

Injuries associated with wounds inflicted by birds, other fish, and lamprey were observed on 0.9% of smolts examined. Predator injuries caused by picivorous birds comprised 53.7% of smolts examined with injuries followed by 40.6% caused by fish and 5.7% caused by lamprey. Predator marks were highest on clipped steelhead at 1.4% (65 of 4,724 fish examined), followed by unclipped steelhead at 1.3% (25 of 1,936 fish examined), and clipped yearling Chinook at 1.2% (43 of 3,545 fish 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 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 one gull removed. Lower Granite biologist binocular monitoring of piscivorous bird presence and foraging behavior occurred from April 1 through October 31. American White Pelicans were observed foraging in Lower Granite tailrace from April 14 through August 1 with a maximum of 62 counted in the tailrace June 9. 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.

Gull Counts

Lower Granite biologists made binocular gull counts in the tailrace extending from immediately below the dam to about one half mile downstream. Daily biologist count observations were made after sunrise and just before sunset from March 26 through August 3. During the March 26 to August 3 counting period 786 gulls were counted with an average daily count of 3.7 and a maximum of 25 counted September 26.

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 1,782 cormorants were counted with an average daily count of 8.3 and a maximum of 46 counted September 29.

American White Pelican+

White Pelicans were observed foraging in Lower Granite tailrace from April 14 through October 18 with a maximum of 62 counted in the tailrace June 9. 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 (51.3%) followed by cormorants (14.8%) and Caspian terns (0.0%).

Cooling Water Strainer Counts

Turbine unit cooling water strainers were examined for biologic content once per month throughout operating year 2017. Timing of the lamprey entry into the strainers represents

migration timing coupled with susceptibly of being drawn into the cooling water system. Annual unit run time totaled 21,964.4 hours and 1,083 lamprey were recovered from cooling water strainers this year. Juvenile lamprey were most abundant in February (744) and April (160).

Invasive Species

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

Recommendations

1. Replace mesh tailscreens with porosity plates to allow lamprey passage.
2. Cover upstream raceways to provide shade.
3. Improve flow/elevation in the sample recovery truck loading pipe to eliminate fish being stranded in the pipe.
4. Operate the facility secondary bypass at all times when the collection channel is watered up to prevent fish from becoming stranded on the incline screen until Phase 1a completion.
5. Rebuild motors for pneumatic fish evacuation system on the 2000 barges.
6. Rebuild motors on 2000 series barges.
7. Install bumper system to replace cable and tire system on barges.
8. Paint hulls on 8000 barges.
9. Install ballast material in voids of barges 4394 and 4382 to eliminate the need to use river water.
10. Replace plungers in 2000 series barges.
11. Replace aerator butterfly valves on 8000 series barges.
12. Repair sample recovery fish exit release valves.
13. Replace facility main supply manifold.
14. Replace downstream and direct load line flush water supply valve knife gate.
15. Fabricate and install fueling platforms for 8105 and 8106.
16. Raise fueling platform on barges 8107 and 8108.
17. Purchase a 1000 gallon fish tank and truck, a 3500 gallon tank and semi, and a service truck dedicated to trap and transport truck/barge maintenance.

APPENDIX