CENWW-OD-DL HOLDREN (1130) February 2017

MEMORANDUM THRU:
Marty, Operations Manager Lower Granite Dam

FOR Chief, Operations Division
ATTN: John Bailey / Chris Peery

SUBJECT: Submission of 2016 Adult and Juvenile Fish Facility Monitoring Report, Lower Granite Dam.

1. Enclosed find the 2016 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

2016

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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 fishway inspections conducted by fisheries staff during the adult fish passage period of March 1 to December 31, 2016. 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, "2016 Juvenile Fish Collection and Bypass Report, Lower Granite Juvenile Fish Facility".

River Conditions

During the 2016 season, the average daily flow exceeded 100 kcfs on 18 days. The highest daily average flow for the season was 128.0 kcfs April 25. The lowest daily average flow for the season occurred on September 26 with a flow of 13.0 kcfs. The average flow for the season was 48.5 kcfs. Spill occurred for 152 days from April 3 through midnight on August 31, with a maximum daily average spill of 45.3 kcfs April 25, a minimum daily spill of 8.4 kcfs August 23, and a seasonal average of 18.6 kcfs. The RSW was put into operation when Court ordered spill began April 3. The RSW was taken out of service June 29 to improve tailrace conditions for adult passage. River temperature averaged 60.5^{o} F for the season and ranged from 46.6^{o} F April 1 to 68.0^{o} F June 30.

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 ladder exits, slotted weirs, upper diffusers, 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 channels, 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. Replaced air cylinders for sort by code gates at adult fish trap.
2. Installed permanent fish ladder temperature control system and modified auxiliary pumps 1 and 2 to supply cooler water at the fish ladder exit.

3. Installed HOBO temperature probe housing to eliminate in season loss.
4. Replaced AWS pump 1 lower guide bearing.
5. Upgraded automatic fish ladder automatic control system.
6. Installed velocity meters in powerhouse and north shore collection channels.
7. Installed permanent temperature loggers with real time data availability on line.
8. Fabricated and installed adult fish ladder jump barriers at diffuser 14.
9. Added additional PIT tag arrays in the upper and lower sections of the ladder to facilitate monitoring of sound vibration and temperature control system influence on fish passage behavior.
10. Replaced anti-fatigue mats at adult trap.

Operations and Maintenance

Fish Ladder and Collection Channel

The adult fish ladder was in service throughout 2016 with the exception of the winter maintenance season from January 4-February 21. 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. The fish exit is then bulkheaded off, 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 4 included 1 clipped adult steelhead, 3 unclipped juvenile steelhead, 1 clipped juvenile steelhead, 1 smallmouth bass, and 2 adult shad. One decomposed adult shad was 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 7 clipped adult steelhead, 9 unclipped juvenile steelhead, 23 clipped juvenile steelhead, 1 unclipped juvenile chinook, 2 adult suckers, 6 smallmouth bass, 1 bluegill, and 1 peamouth. Eight decomposing adult shad were recovered and returned to the river. 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

Fish pumps 1, 2, and 3 were out of service (OOS) from January 2 to February 23 for annual maintenance. Annual maintenance consists of general mechanical and electrical inspection and repairs. AWS pump 1 remained out of service until February 25 for lower guide bearing replacement. Pumps 2 and 3 were started at 1125 and 1407 hours February 25. Pump 1 remained in standby mode. Auxiliary water supply pumps 1-3 were offline from 1501-1750 hours June 22 to remove discharge bulk heads and return fish pump 1 to service. Fish pumps 1 and 3 remained in service for the remainder of the season. Significant pump outages are summarized in Table 1.

Table 1. Fish pump outages at Lower Granite Dam, 2016 *

Affected Pump(s)	Dates	Reason for Outage/Comments
1	Jan 3 – Feb 25	Annual maintenance/ Lower Guide Bearing Replacement
2 and 3	Jan 3 – Feb 23	Annual maintenance

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

Adult Fish Trap Operations

Lower Granite adult fish trap was operated March 3 through November 20. Sample rates were adjusted with adult passage to meet collection and research needs. The turnpool diversion gate was changed to ladder passage position from about 1400 hours Friday to 1300 hours Sunday to facilitate volitional fish passage and monitoring sound vibration influence on fish behavior. 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 2016 was 68.4°F July 4 and 5. The total adult trap fish collection for the season was 45,265 fish including 205 sockeye, 634 Coho, 846 spring steelhead, 19,479 fall steelhead, 14,470 spring/summer chinook, and 9,631 fall chinook. There were 10 bull trout incidentally trapped and released during the 2016 season between April 20 and June 17.

Idaho Department of Fish and Game sample approximately 5-20% of the adult steelhead, spring/summer Chinook salmon, and sockeye salmon run from March 1 through the end of the adult trapping season. 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 20,325 (15,619 clipped and 4,706 unclipped) with 3.366 having genetic samples only taken, 4,319 PIT tagged with both genetic and scale samples taken, 387 being recaptured PIT tagged fish with genetic and scale samples taken, and 169 radio tagged. Spring Chinook collection totaled 11,788 (8,563 clipped and 3,225 unclipped) with 2,133 having genetic samples only taken, 3,103 PIT tagged with both genetic and scale samples taken, 122 being recaptured PIT tagged fish with genetic and scale samples taken, and 27 radio tagged. Summer Chinook collection totaled 2,682 (1,336 clipped and 1,316 unclipped) with 340 having genetic samples only taken, 1,254 PIT tagged with both

genetic and scale samples taken, 62 being recaptured PIT tagged fish with genetic and scale samples taken, and 5 radio tagged. Genetic samples were also taken from 205 adult sockeye.

Fall Chinook collection for WDFW broodstock transport to Lyons Ferry Hatchery began August 18 and ended October 11 when hatchery needs were met. Fish were transported Tuesday through Saturday. Of the 9,631 fall Chinook collected at the adult trap WDFW transported 2,603 (2140 adults and 463 jacks) to Lyons Ferry Hatchery. Nez Perce Tribe collection for transport to Cherry Lane occurred August 18 through October 11 when broodstock needs were met. Fish were transported Sunday and Monday. Of the 9,631 fall Chinook collected at the adult trap Nez Perce Tribe transported 960 (942 adults and 18 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 22 to November 4 with the last fish being transported November 5. Of the 634 Coho collected at the adult trap 502 were transported and the reaming 132 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 June 1 through September 30. An additional eight electronic temperature probes were installed during winter maintenance to provide realtime data at web site http://www.nwd wc.usace.army.mil/dd/nww/fl_temps/www/index.html. Forebay fish ladder auxiliary pumps and emergency cooling pumps were used to cool the fish ladder during the previous three season. During the winter outage a permanent fish ladder temperature control system was installed. 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 replace 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 was operation occurred June 9 through September 8. The temporary jump barrier net installed in response to adult fish jumping out of the ladder in the vicinity of diffuser 14 during cooling pump operation was replace with permanent jump barrier during 2015-2016 winter maintenance season.

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 can be 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. Issues with the upgraded automatic fishway control system calibration and programming were not resolved until July 14.

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 (169 inspections /44 weeks) in 2016. 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 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 system tailrace elevation sensors and gate depth sensors readings were inconsistent with physical staff gauge readings until June due to an internal programming error. 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 the contractor made adjustments. Data from fishway inspections was entered into an Excel spreadsheet (Appendix 1). The average compliance of all criteria points in 2016 was 97.0% compared to 75.0% in 2015. The majority of out of criteria reading were taken prior to fishway control system issues being resolved. 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 reading included 2 at 0.1 feet above 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 98.8% of inspections. Out of criteria reading included 1 at 0.1 feet below criteria and 1 at 0.2 feet below criteria. The reading of 6.7 feet was taken during fishway control system calibration.

North powerhouse entrance head was in criteria on 100% of inspections.

North shore entrance head differential was in criteria on 96.4% of inspections compared to 47.7% in 2015 and 35.4% in 2014. Operation with NSE2 closed during 2016 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) 6 times in 2016 compared to 92 times in 2015. Out of criteria readings include 4 at 0.1 feet below criteria, 1 at 0.2 feet below criteria, and 1 at greater than 0.2 feet below. Three of these out of criteria reading were taken when the control system issues were being resolved.

South shore entrances (SSE-1 & 2): SSE-1 weir gate was in depth or sill criteria on 96.4% of inspections (96.4% depth, 0.0 % sill). Out of criteria readings included 5 at 7.9 feet, 1 at 7.8 feet, and 2 at 7.7 feet. Six of these out of criteria reading were taken when the control system issues were being resolved.

SSE-2 weir gate was in criteria on 95.5% of inspections (95.3% depth, 0.0 % sill). Out of criteria readings included 5 at 7.9 feet, 1 at 7.8 feet, and 2 at 7.7 feet. Six of these out of criteria reading were taken when the control system issues were being resolved.

North powerhouse entrance (NPE-1 & 2) depths: NPE-1 weir gate was in depth or sill criteria on 96.4% of inspections (26.0% depth, 70.4% sill). Out of criteria readings included 2 at 7.9 and 4 at 7.7 feet. All of these out of criteria reading were taken when the control system issues were being resolved.

NPE-2 weir gate was in depth criteria or sill on 95.8% of inspections (26.0% depth, 69.8% sill). Out of criteria readings included 2 at 7.9 and 5 at 7.7 feet. All of these out of criteria reading were taken when the control system issues were being resolved. Four of these out of criteria reading were taken when the control system issues were being resolved.

North shore entrance (NSE-1 & 2) depths: NSE-1 weir gate was in depth or sill criteria on 91.7% of inspections. Out of criteria readings included 3 at 7.9 feet, 1 at 7.8 feet, and 10 at 7.7 feet. Four of these out of criteria reading were taken when the control system issues were being resolved.

NSE-2 weir gate was in the closed position for the 2016 season. NSE-2 has been out of service and was suspended at a fixed elevation of 630.0 feet with a chain fall hoist since the 2011 season. The fish ladder control system upgrade improved automatic adjustments of NSE-1.

Collection channel velocity: Velocities were in criteria on 96.4% of inspections (criteria: 1.5-4.0 ft/s). The collection channel velocity meter was upgraded to a Teladyne Signature Flowmeter during the winter maintenance period of 2015-2016. The sensor is located in the powerhouse collection channel between the transition pool and unit 1. This sensor also provides water temperature. 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 NPE-3 bulkhead slot with concrete.
4. Replace velocity meter and relocate sensor to another location.
5. Operate the north shore with one NSE closed to improve channel/tailwater head differential.
6. Try different ladder operations including closing FOG's to determine if North Powerhouse and North Shore entrance depth and head differentials can be improved.
7. Upgrade adult fish ladder automatic control system.
8. Install permanent fish ladder jump barrier at diffuser 14.
9. Replace/relocate staff gauges that are difficult to read.
10. Install PVC trollies for HOBO temperature probe deployment.
11. 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, 2016 [1]

LOWER GRANITE			Not Enough Depth			Too Much Depth		
Criteria and Locations	No. in Criteria/ No. on Sill/ No. of	% 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	163 *** 169	96.4 ***	*** ***	*** ***	*** ***	*** ***	*** ***	*** ***
Differentials								
Ladder Exit	169 ***	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
Ladder Weirs	169 167 ***	98.8 ***	0 0.0	0 0.0	0 0.0	2 1.2	0 0.0	0 0.0
Counting Station	169 169 ***	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
South Shore	169 167 ***	98.8 ***	1 0.6	0 0.0	1 0.6	0 0.0	0 0.0	0 0.0
North Powerhouse	169 169 ***	100.0 ***	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
North Shore	163 *** 169	96.4 ***	4 2.4	1 0.6	1 0.6	0 0.0	0 0.0	0 0.0
Weir Depths								
SSE-1	161 0	95.3 0.0	5 3.0	1 0.6	2 1.2	*** ***	*** ***	*** ***
SSE-2	169 160 0	94.7 0.0	4 2.4	2 1.2	3 1.8	*** ***	*** ***	*** ***
NPE-1	169 44 119	26.0 70.4	2 1.2	0 0.0	4 2.4	*** ***	*** ***	*** ***
NPE-2	169 44 118	26.0 69.8	2 1.2	0 0.0	5 3.0	*** ***	*** ***	*** ***
NSE-1	169 155 0	91.7 0.0	3 1.7	1 0.6	10 5.9	*** ***	*** ***	*** ***

[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 the 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 2016 fish collection season:

1. Juvenile bypass upgrade Phase 1a is ongoing.
2. Refurbished the sample diversion slide gates per PSMFC guidelines.
3. Modified Mule ATV to ESBS inspection vehicle including installation of upgraded underwater camera, electronic equipment, monitor, and hoist system with new cable.
4. Replaced downstream raceway tailscreen guides and filled expansion joint voids.
5. Repaired/replaced potable water supply at barge loading dock used by tug companies.
6. Replaced juvenile sample anesthesia tank chiller recirculation pump in wet lab.
7. Replaced deteriorating fish evacuation/loading lines from lab.
8. Modified upstream and downstream gantry crowders to prevent lamprey and smolt stranding.
9. Installed new brushes on upstream raceway crowder and operating controls.
10. Replaced facility primary pneumatic system broken air lines.
11. Replaced sample slide gate pneumatic seals.
12. Installed new chain on barge loading boom.
13. Rehabbed/repaired gatewell dipping basket including new gasket material.
14. Completed plunger and cylinder installation on 8000 series barges (replaced barge hold plungers, shafts, cylinders, and hoses).
15. Completed compressor and generator upgrade on 8000 and 4000 series barges.
16. Replaced all pneumatic hoses for exit release systems on all barges.
17. Repositions barge engine clutches handles from vertical to horizontal.
18. Extended barge hold latch keys.
19. Installed new fish evacuation plungers and compressors in 2000 series barges.
20. Replaced non-compliant winch cables and all weathered mooring lines.

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, 2016.

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, units 3, 4, and 5 were raked March 4, and unit 6 was raked March 2. About 30 cubic yards of debris was removed from the forebay and trashracks.

EXTENDED-LENGTH SUBMERSIBLE BAR SCREENS (ESBS)

ESBSs were inspected and tested on the week of March 14. Screens were installed from March 21 through March 23. Video inspection took place April 25-26, May 22-23, June 27-28, and August 14-15, and October 30-31. No problems with the ESBSs were detected during video inspections. Manufacturer flaws were discovered on ESBS screen cleaner motors installed during the 2014-2015 maintenance season. Faulty components were replaces during 2015-2016 winter maintenance outage. 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 2016 fish passage season. Detailed inspections were performed during the June ESBS inspection. VBSs in slots 3A and 3B were repaired after small tears were identified during inspection. VBS screen panel mesh has the potential to deteriorate and become brittle over time. Panels for screens that passed underwater camera inspection but showed potential for deterioration in 2015 fish passage season were replaced with new panels during the 2015-2016 winter maintenance season. Mesh screens panels were replaces in gatewell slots of unit 2 and unit 5. VBS screen panels will continue to be replaced 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 2016 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 21 through November 17 when the channel was dewatered. The automated backflush system was not operational this season. Orifice obstructions were not a problem this season. Orifice lights were checked daily. Orifices with burnt out lights were switched to the other orifice in the slot until the bulb was replaced. The south makeup water valve shaft was out of service from 0710 hours July 7 to 1300 hours July 21 due a gate operator issue. During this time 18-30 orifices were operated and the makeup water valve was fixed at

30% open to maintain channel elevation.

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 2016 it was not necessary to go to primary bypass due to debris accumulating on the incline screen. Facility operation remained in secondary bypass through November 17 to eliminate the potential for subyearling Chinook mortalities on the incline screen.

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. North and south makeup water valves were repaired/replaced during the 2015-2016 winter maintenance season.

Historical PVC separator bar spacing at Lower Granite allow shad, Chinook jacks, and other adults to be collected into the sample, raceways, and barges for transport. Jack bars designed to keep larger fish out of the collection system were positioned on top of the standard separator bars. Debris accumulation between the two sets of bars has the potential to increase descaling. Separator bars will be modified to address these concerns during the 2016-2017 outage.

Barge Loading Operations

Barge loading operations occurred from May 2 through August 15. Both direct loading and loading from the raceways went smoothly this season.

Truck Loading Operations

Juvenile fish were loaded every other day from August 16 through October 31 either into the midi-truck or the semi-truck with no problems this season.

Avian Predation

Injuries associated with wounds inflicted by birds, other fish, and lamprey were observed on 1.0% of smolts examined. Predator injuries caused by picivorous birds comprised 61.6% of smolts examined with injuries followed by 34.1% caused by fish and 7.1% caused by lamprey. Predator marks were highest on clipped sockeye at 3.5% (9 of 258 fish examined), followed by

clipped steelhead at 2.0% (70 of 3,553 fish examined), and unclipped steelhead at 1.3% (21 of 1,609 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 with 50 gulls and 4 cormorants sacrificed during the 2016 season. American White Pelicans were observed foraging in Lower Granite tailrace from April 28 through June 25 with a maximum of 12 counted in the tailrace May 24. 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 biological technicians made binocular gull counts in the tailrace extending from immediately below the dam to about one half mile downstream. Daily count observations were made after sunrise and just before sunset from March 26 through October 31. During the March 26 to October 31 counting period 970 gulls were counted with an average daily count of 3.7 and a maximum of 34 counted May 24.

Double Crested Cormorants

Daily count observations were made after sunrise and just before sunset from March 26 through October 31. During the March 26 to October 31 counting period 1801 cormorants were counted with an average daily count of 8.3 and a maximum of 58 counted October 6.

Avian Foraging Behavior

Foraging behavior was recorded for gulls, cormorants, and Caspian terns. Gulls had the highest percent of foraging behavior observed (52.3%) followed by cormorants (3.5%) 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 2016. 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 17976.6 hours and 859 lamprey were recovered from cooling water strainers this year. Juvenile lamprey were most abundant in February (319) and April (361).

Invasive Species

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

Recommendations

1. Retain 10 inch knife gates from orifice gallery as spares for raceways after they are removed as part of Phase 1.
2. Replace mesh tailscreens with porosity plates to allow lamprey passage.
3. Replace PVC separator bars with stainless steel.
4. Cover upstream raceways to provide shade.
5. Improve flow/elevation in the sample recovery truck loading pipe to eliminate fish being stranded in the pipe.
6. 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.
7. Rebuild motors for pneumatic fish evacuation system on the 2000 barges.
8. Rebuild motors on 2000 series barges.
9. Install bumper system to replace cable and tire system on barges.
10. Paint hulls on 8000 barges.
11. Install ballast material in voids of 4394 and 4382 to eliminate the need to use river water.
12. Replace plungers in 2000 series barges.
13. 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