CENWW-ODO BARNES (1130) 18 March 2020

MEMORANDUM THRU:
Jeannette Wilson, Operations Project Manager Lower Monumental Dam

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

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

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

2. If you have any questions contact Chuck Barnes at Lower Monumental Dam, (509) 282-7211.

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Supervisory Fish Biologist, Lower Monumental Dam

Enclosure

ADULT AND JUVENILE FISH FACILITY MONITORING REPORT

LOWER MONUMENTAL DAM

2019

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U.S. Army Corps of Engineers

Enclosure

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INTRODUCTION

The following report on fishway activities at Lower Monumental Dam is required under the Endangered Species Act consultation on the operation of the Federal Columbia River Power System (FCRPS) and its associated fish passage facilities. This report summarizes the operation and maintenance of adult fish passage facilities at Lower Monumental Dam, including the results of visual inspections of fishways conducted by fisheries staff during the adult fish passage period of March 1 to December 31, 2019. Inspection readings are provided in Appendix 1 (2019 Ladders LoMo.xlsx). 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 Monumental Dam can be found in the report titled "2019 Juvenile Fish Collection and Bypass Report, Lower Monumental Juvenile Fish Facility".

River Conditions

The highest daily average flow for the 2019 season was 204.5 kcfs on April 10. The lowest daily average flow for the season occurred on December 8 with a flow of 10.5 kcfs. The average flow for the season was 52.1 kcfs. Mandatory Spill occurred for 151 days from 0000 hours April 3, 2019 through midnight on August 31, 2019, with a maximum daily average spill of 96.0 kcfs on April 10, 2019. The Removable Spillway Weir (RSW) was put into operation when Biological Opinion (BiOp) spill began on April 3, 2019, and was taken out of service for the season on August 8, 2019 due to a decision by the Technical Management Team (TMT).

Average river temperature for the 2019 season was 55.8°F and ranged from 36.0 °F (March 1 - 13) to 70.0 °F (July 25-31, August 10,11, 19 and September 7 and 8).

ADULT FISH FACILITY

Facility Description

The adult fishways at Lower Monumental are comprised of north and south shore fish ladders. The upper ladders extend from the forebay to tailwater and include: ladder exits, slotted weirs, upper diffusers, overflow weirs with orifices, and fish counting stations with picketed leads. The lower ladders contain: collection channels, channel diffusers, and ladder entrances. The north shore lower fish ladder has two north shore entrances (NSE-1 and NSE-2) and two south powerhouse entrances (SPE-1 and SPE-2). The south shore lower fish ladder has two entrances (SSE-1 and SSE-2). Auxiliary water is supplied by three turbine-driven pumps (fish pumps) located in the north side of the powerhouse. The water is pumped into a supply conduit that extends under the north and south shore lower ladders, distributing water to the lower ladder diffusers. Excess water from the juvenile fish bypass system (approximately 180-200 cfs) additionally contributes to the auxiliary water supply during the juvenile fish bypass/collection season.

Facility Modifications

No modifications were made to the adult fish passage system in 2019.

Operations and Maintenance

Fish Ladders and Collection Channels

The adult fishways were in service throughout 2019 with the exception of the winter maintenance season. Inspection and maintenance on the north and south shore fishways occurred from January 3 to January 22 and January 23 to February 22, respectively.

The upper fish ladders are dewatered annually for maintenance activities including: debris removal, diffuser grating and structural support inspections, cleaning of picketed leads, staff gauges and fish counting windows, maintenance of count station window cleaning mechanisms, and repairing 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 ladders. The fish exit is then bulkheaded off, any fish in the exit pool are removed and released to the forebay, and the upper ladders are partially dewatered, leaving about 4 inches running through ladder weir orifices. This flow is maintained to move any remaining fish to tailwater. Approximately 24 hours later, the flow is reduced to two inches and maintenance personnel go down the ladder through the orifices to remove debris, move remaining fish to tailwater, and inspect the full length of the channel.

The lower ladders are 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 and exposed diffuser gate operating equipment. Staff gauges are then cleaned and debris is removed. The north shore water is lowered to 0.50 ft for visual inspection of grating. When dewatering for repair is necessary, fish are crowded to the entrance pools, netted, and placed in a 600 gallon container (or 32 gallon containers if fish numbers are very low). The large container is manipulated with the crane to release fish to tailwater and refill the tank if needed. The need for replacement of the diffuser grates and clasps has been an issue for years and will be addressed when engineering design and funding is available. This work is scheduled to begin during the 2020 winter maintenance period. No other problems were observed during the inspection of the lower north shore channel and the lower south shore ladder.

Auxiliary Water Supply

Fish pumps 2 and 3 were out of service (OOS) from January 3 until February 28 for annual maintenance. Annual maintenance consists of changing oil in pedestals, adjusting or replacing packing and shaft seals, inspecting and cleaning heat exchangers, inspecting and replacing broken shear pins on the wicket gates, adjusting brakes, removing trash and debris from the fish pump turbine, and general mechanical and electrical inspection. Fish pump 1 was out of service (OOS) due to wicket gate bushing and guide bearing repairs and returned to service on April 9, 2019. The more significant pump outages are summarized in Table 1.

Table 1. Fish pump outages at Lower Monumental Dam, 2019

Affected Pump(s)	Dates	Reason for Outage/Comments
1	2018 – Apr 9	Wicket Gate Bushings and Guide Bearing
2, 3	Jan 3 – Feb 28	Annual maintenance

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 within the fishways. The automated fishway control system is based on a GE Fanuc Series 90 control program. The computer is used to change the control parameters of the terminal units and provide datum acquisition and storage. The remote terminal units control the fishway entrance weir gates according to set points that either regulate the gate depths below tailwater or channel-to-tailwater entrance head differentials. The computer printout contains the following information: dates; times (hour, minute, and second); channel temperatures; channel and tailwater elevations (feet above mean sea level) for the north shore, south powerhouse, and south shore; gate elevations; gate depths; entrance heads; and set points for the gate depths and entrance heads. The automated control system was operating throughout the 2019 operating season.

Operating criteria involve normal and special operating conditions. Under normal operating conditions, NSE-1, NSE-2, SPE-1, SPE-2, and SSE-1 weir gates are operated to meet criteria of at least 8 foot depths (depth criteria) or be on sill if less than 8 foot depths occur (sill criteria). SSE-2 weir gate is operated with a 6-foot opening. Normal operating criteria for the rest of the ladder includes maximums of 0.5 foot heads at the exits, maximums of 0.4 foot and 0.3 foot heads at the north and south shore picketed leads, respectively, 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.

Adult fishway inspections consist of observing facility operating conditions and recording visual readings from staff gauges, weir gate selsyns, and electronic meters. Wave action and impact from large debris have consistently resulted in loss of the south ladder tailwater staff gauge. Readings of the lower south ladder and tailwater are therefore taken from an electronic panel in the service gallery.

Inspections by fisheries staff and QC personnel are normally conducted three or more times per reporting week with times randomized. An average of 3.6 inspections per week were performed (159 inspections /44 weeks) in 2019. Depths and head differentials that were out of criteria, as well as other problems, were reported to powerhouse shift operators and/or maintenance staff for correction. Powerhouse operators conduct shift inspections in addition to the inspections performed by fisheries staff.

Inspection Results

Visual readings are normally recorded and compared with automated control system readings to check for calibration problems. Data from fishway inspections was entered into an Excel spreadsheet (Appendix 1). The average compliance of all criteria points in 2019 was 98.4%. A summary of fish ladder performance and variability is provided in Table 2.

Ladder exits: North shore ladder exit head differentials were in criteria during 99.4% of inspections. The out of criteria reading was on March 3 with a reading of 0.6 feet. This was due to woody debris accumulation on the exit trash rack. South shore ladder exit head differentials were in criteria during all inspections. North and south shore exits were operated without debris booms again this season. Changing designs of debris booms which will be able to withstand high winds and wave action have delayed debris boom replacement.

Ladder weirs: The depths over the weirs of the north shore ladder were within criteria during 98.7% of inspections. The two readings out of criteria, both readings 1.4 feet, occurred on September 7 and 13. Both were due to woody debris accumulation obstructing weir orifices immediately downstream of Diffuser # 6.

Depths over the weirs of the south shore ladder were within criteria during 100% of inspections.

Counting stations: The head differential across the north shore counting station picketed leads was in criteria on 99.4% of inspections. The out of criteria reading was on October 29 with a reading of 0.8 feet. This was due to debris, adult American shad mortalities and fibrous algae accumulation on the picketed leads. The south shore counting station met criteria on all inspections.

Entrance heads: North shore entrance head differential was in criteria during 99.4% of the inspections. Readings out of criteria were caused by failure of the automated control system due to the high level of the tailwater during elevated river flows.

South powerhouse entrance head was in criteria during 99.4% of the inspections. Criteria breaches were also caused by failure of the automated control system due to the high level of the tailwater during elevated river flows.

South shore entrance head differential was in criteria during 96.2% of the inspections. Criteria breaches were again caused by failure of the automated control system due to the high level of the tailwater during elevated river flows.

North shore entrance (NSE-1 & 2) depths: NSE-1 weir gate was in depth criteria or sill criteria during 98.1% of the inspections (91.8% depth, 6.3% sill). Readings out of criteria were due to calibration issues within the automated control system.

NSE-2 weir gate was in depth or sill criteria during 98.1% of the inspections (93.7% depth, 4.4% sill). Readings out of criteria were due to calibration issues within the automated control system.

South powerhouse entrance (SPE-1 & 2) depths: SPE-1 weir gate was in depth or sill criteria during 98.7% of the inspections (28.9% depth, 69.8% sill). Readings out of criteria were due to calibration issues within the automated control system.

SPE-2 weir gate was in depth or sill criteria during 98.7% of the inspections (28.9% depth, 69.8% sill). Readings out of criteria were due to calibration issues within the automated control system.

South shore entrances (SSE-1 & 2): SSE-1 weir gate was in depth or sill criteria during 92.4% of the inspections (37.7% depth, 54.7% sill). Readings out of criteria were due to calibration issues within the automated control system

SSE-2 weir gate was in criteria during 95.6% of the inspections. Readings out of criteria were due to the weir operation being defaulted to automatic mode which moved the weir gate off of its set opening height.

North shore collection channel velocity: The velocity unit is located in the north shore collection channel in the transition area between main units 1 and 2. The sending unit is positioned in the channel to avoid non-characteristic high or low readings that are not representative of overall velocity conditions. Accurate velocity readings require the inspector to wait for the digital display to warm up and achieve a duplication of its peak reading.

Velocities were in criteria during 99.4% of the inspections (criteria: 1.5-4.0 ft/s). The North shore collection channel velocity meter did not operate during the November 26 inspection.

Recommendations

1. Design and install ladder exit debris booms capable of withstanding turbulent waters.
2. Remove sand and debris from the supply conduits and replace all original ladder diffuser grates, support structures, and mud valves.
3. Repair north and south shore fish ladder joint leakage.

Table 2. Summary of adult fishway inspections at Lower Monumental Dam, 2019 [1]

			------Not Enough Depth------			-------Too Much Depth-------		
Criteria and Locations	**No. in Depth Criteria/ No. in Sill Criteria/ No. of Inspections**	**% In Depth Criteria/ % In Sill Criteria**	**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**
North Channel Water Velocities	158 *** 159	99.4 ***	*** ***	*** ***	*** ***	*** ***	*** ***	*** ***
Differentials								
North Ladder								
Ladder Exit	158 *** 159	99.4 ***	*** ***	*** ***	*** ***	0 0.0	1 0.6	0 0.0
Ladder Weirs	157 *** 159	98.7 ***	0 0.0	0 0.0	0 0.0	2 1.3	0 0.0	0 0.0
Counting Station	158 *** 159	99.4 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	1 0.6
South Ladder								
Ladder Exit	159 *** 159	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
Ladder Weirs	159 *** 159	100.0 ***	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Counting Station	159 *** 159	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
Coll. Channels								
North Shore Entrance	158 *** 159	99.4 ***	0 0.0	0 0.0	1 0.6	0 0.0	0 0.0	0 0.0
South Powerhouse Entrance	158 *** 159	99.4 ***	1 0.6	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
South Shore Entrance	153 *** 159	96.2 ***	0 0.0	0 0.0	2 1.3	1 0.6	0 0.0	3 1.9
Weir Depths								
NSE-1[2]	146 10 159	91.8 6.3	0 0.0	1 0.6	3 1.9	*** ***	*** ***	*** ***
NSE-2[2]	149 7 159	93.7 4.4	0 0.0	0 0.0	4 2.5	*** ***	*** ***	*** ***
SPE-1[2]	46 111 159	28.9 69.8	0 0.0	1 0.6	1 0.6	*** ***	*** ***	*** ***
SPE-2[2]	46 111 159	28.9 69.8	0 0.0	0 0.0	2 1.3	*** ***	*** ***	*** ***
SSE-1[2]	60 87 159	37.7 54.7	0 0.0	2 1.3	10 6.3	*** ***	*** ***	*** ***
SSE-2	152 Not Applic. 159	95.6 ***	0 0.0	0 0.0	0 0.0	*** ***	*** ***	*** ***

[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 Monumental Dam consist of: vertical barrier screens (VBS), standard length submersible traveling screens (STS), twelve inch orifices, collection channel that terminates in a dewatering structure, transport flume, separator, and fish distribution system. The distribution system includes: Passive Integrated Transponder (PIT) tag bypass, sampling facilities, holding facilities, and barge and truck loading capabilities.

Each of the 18 bulkhead slots contains two orifices for diverting fish into the collection channel. Eighteen to 21 orifices are open at any one time with a minimum of one orifice open in all bulkhead slots of operating units. Lights are directed at each open orifice to enhance fish movement into the collection channel. The collection channel terminates at the primary dewatering structure where all but 30 cfs flow is removed. The remaining 30 cfs flow and fish are routed through the transport flume to the 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. The distribution system directs the fish to their target locations.

Facility Modifications

No modifications were made to the Lower Monumental JFF and support equipment in 2019.

Operation and Maintenance

Turbine Operations

Efforts were made to operate all turbine units within one percent of peak efficiency from April 1 to October 31. Deviations were infrequent and brief or required by BPA. Below is a summary of unit outages and causes from March 1 through December 31.

Table 3. Summary of unit outages and cause at Lower Monumental Dam, 2019.

Unit	Dates out of service	Reason out of service
All Units	February 25 - 27	STS installation
All Units	Monthly(2-3 days)	STS/VBS inspection/hub tapping on fixed blade units
All Units	January 29 – 30 May 20 - 22	Trash rack raking (6-8 hrs/day alternating units)
All Units	December 16 - 17	STS removal
All Units	July 23	Power Outage
All Units	July 25 – August 2	Doble Testing (Units 5 & 6 on service during none day shift working hours)
Units 1–4	April 17 - 18	Trash rack raking (6-8 hrs/day alternating units)
Units 2–6	June 17 – 19	Trash rack raking (6-8 hrs/day alternating units)
Units 2-3	February 4 – 8	Fish guidance efficiency study equipment installation dive.
Units 2-3	April 26 – July 12 weekly on Fridays	Fish guidance efficiency study headgate installation.
Units 1-3	April 16	Fish guidance efficiency study equipment repair dive.
Unit 1	2018 – March 1	Rehab/rewind
	March 27	PSS set points and operations check.
	May 28 – July 10	Digital governor installation
	December 18 – 31	Annual maintenance
Unit 2	January 15	Hub tapping
	July 15 – 2020	Annual/Draft tube liner rehab
Unit 3	September 7 – 9	Smoke alarm
	September 12 – 17	Faulty smoke sensor
	September 25	Stator coolers
	December 2 – 12	Annual maintenance
Unit 4	2018 – March 1	Inspection of Oil Governor System/blade seal replacement/annual/cavitation Repair
	March 1 – 29	Dislodged rotor counterweight
	June 10 – 11	Distributing valve modification
	July 8 – 29	Annual maintenance
	October 9 – December 23	Governor control/Blade seal leak check
Unit 5	February 19	Trash rack raking
	June 11 – 13	Distributing valve modification
	October 3 – December 23	Governor control
Unit 6	January 30	Hub tapping
	February 13 – 27	Water intrusion into hub
	May 10 – 14	Top plate pump failure/Hub oil removal
	June 12	Cylinder move
	June 13	Governor work
	August 5 – November 25	6 year annual

Debris/Trash Racks

In 2019, trash rack raking occurred January 29-30, April 17-18, May 20-22 and June 17-19. Several semi-truck loads of debris were removed during each effort.

Submersible Traveling Screens

The STS's were inspected and tested on February 21, 2019. STS's for units 1, 2, and 3 were installed February 25 and 26, 2019 and units 4, 5 and 6 were installed March 27, 2019. The STS in gatewell 4A was found with three tears in the screen during inspection on April 3, 2019. The STS was lifted and the screen was repaired. The STS was redeployed on April 4, 2019. The STS in gatewell 1B was found not rotating during August 7 inspection. The faulty STS was swapped out with a spare screen.

STS's are usually operated in "cycle" mode when the average fork length of subyearling Chinook and/or sockeye salmon is greater than 120 mm, and in continuous "run" mode when either is less than 120 mm. In 2019, the STS's were placed in continuous run mode on May 16 with average lengths of collected fish being greater than 120mm and changed back to cycle mode on July 11 due to average lengths of collected fish being less than 120mm.

Vertical Barrier Screens

The VBS in gatewell 4B was inspected on August 12, 2019 and found to be in good working order. The VBS in gatewell 5A was inspected on November 26, 2019 and found to be in good working order. The VBS in gatewell 6A was inspected on August 20, 2019 and also found to be in good working order. All visual VBS inspections were conducted via biologist using a man basket.

Gatewells

During the 2019 season, gatewells did not exceed 50% debris coverage criteria on any inspections.

Orifices/Collection Channel

During the 2019 season, the number of open orifices varied from 17 to 20 according to forebay level. With the Lower Monumental reservoir at minimum operating pool, water discharge through an orifice is reduced. During this period, extra orifices were opened to supply additional water to the adult fishway. Orifices were cycled and backflushed with air daily to remove debris. Orifice 9 was found with sticks protruding from it on May 7. Orifice 15 was also found with a blockage June 5. Powerhouse maintenance crews were informed and the blockages were cleared. Orifice lights were also checked daily. If a light was not working, flow was directed to the other orifice in the slot until repairs could be made.

Primary Dewatering Structure

The compressed air screen cleaner functioned well throughout the 2019 season. The Primary Dewaterer mechanical screen cleaner brush was removed from service on May 19 due to a snapped drive belt and returned to service when a new belt was installed on May 30. The mechanical screen cleaner intermittently malfunctioned from June 24 until the end of the season. Electricians identified the problem and plan on replacing antiquated PLC's and rotary switches during winter 2019-2020 maintenance outage. This problem had little impact on keeping debris off of the incline screen, as the bubbler was still operating and technicians were able to run the brush manually during their shifts.

Wet Separator/Distribution and Sampling Systems

Sudden water level drops at the separator were not a problem this year. Water level remained fairly consistent at the separator with manual operation of the automated weirs of the primary dewaterer. As has been the case for the last few years, the separator was operated at a higher water level to assure no problem with exposed separator bars would occur.

PIT-tag diversion gate position sensors were installed several years ago. These sensors act to prevent the over-travel problem that previously occurred, and by so doing, they eliminated gate failure problems caused by metal fatigue. A prototype electric cylinder was installed to operate the PIT tag slide gate on the B side of the facility before the 2019 season. The maintenance cost is much lower and reliability is much higher with the electric system compared to the original pneumatic system. The new cylinder performed well and after some slights modifications, was operating more efficiently than the historic system. Future plans are in place to convert the A side to an electric cylinder prior to 2020 season and begin changing out the systems at upriver facilities.

Barge Loading Operations

Fish were transported by barge from April 24 through July 30. Barge loading at Lower Monumental occurred without any issues during the 2019 transport season.

Truck Loading Operations

Juvenile fish were scheduled to be transported by truck from August 1 to October 1. Per 2019 Fish Passage Plan, the Lower Monumental trucking schedule is contingent upon fish numbers. Saturday, August 3, was the third consecutive day with less than 50 smolts collected, therefore trucking ceased after the second trip. Truck transport never resumed in 2019.

AVIAN PREDATOR MONITORING

Areas of avian predation monitoring included: forebay, turbine discharge, spillway discharge and JFF bypass outfall. Deterrent measures included: bird wires across the tailrace of the powerhouse, water cannon sprinklers at the exit of the bypass outfall pipe, bird deterrent spikes at common perching areas, and hazing (April 1 through June 2) under the animal control contract with USDA Wildlife Services (WS). Two shift hazing coverage (daylight to dusk) occurred from May 6 to June 2. Water cannon sprinklers at exit of bypass outfall pipe were taken out of service on August 8 due to water cannon sprinkler pump failure; replacement pump was installed and the water cannon sprinklers went back into service on August 15.

Avian predators tend to rest in the forebay and chase juvenile fish as they jump. They also spend time perched on the lock wall facing the tailrace. At the downstream navlock guidewall, bird wires were added along the top rail of the handrail during winter 08-09 which effectively reduced the perching previously seen there, however, to a great extent the perching only relocated to the deck in front of the handrails.

The following data is based on bird counts taken in two separate procedures (limited to April 1 through October 1). The first procedure takes place during fish ladder inspections with supplemental counts by WS on days with no ladder inspection. The second procedure is from daily observations of the tailrace area taken at approximately 11:00 hours each day as specified in the Avian Action Plan.

1. Fish Ladder Inspection/APHIS supplemented Bird Monitoring

Fish ladder inspections were conducted three to six times per week at Lower Monumental Dam to ensure ladders were operating within criteria and for training purposes. These inspections were conducted at random times and contain counts during active bird hazing as well as in its absence. On Mondays and Thursdays (April 1 through June 2) WS contracted employees collected bird information in the same format as the ladder inspection data and this information was added to the spreadsheet for inclusion in this report. During daylight hours, gulls were present if hazing was not occurring. High juvenile fish numbers passing the dam via spill related to higher gull numbers. In the absence of hazing, gulls appeared to be fairly effective at feeding in the tailrace areas. Each ladder inspection included an avian predator count section for five areas that included: forebay (FB), spillway (SWT1), under the bird wires of the turbine discharge (PHT1), downstream of the birdwires below the turbine discharge (PHT2), and lastly the juvenile bypass outfall (JFOF). Each area included counts of both foraging and resting birds. The following summarizes the data collected from April 1 through October 1 of the 2019 operating year. The averages offered in each category include all data through the time period; it is an average of all the Fish Ladder Inspection/WS supplemented Bird Monitoring Inspections for that condition (feeding/resting) in each zone.

Gulls

Gull numbers were highest from April 11 to May 23. There were also smaller peaks in gull activity spread into late September. In all areas, gull numbers dropped after May 28 as juvenile

salmonid numbers became increasingly sparse. Gull numbers increased again later in the year in response to increasing numbers of out-migrating juvenile American shad.

Gull numbers feeding in the forebay (**FB**) ranged from 0 to 17 (May 22) and averaged 0.86. Gull numbers resting in the FB ranged from 0 to 64 (May 2) and averaged 9.98. FB gulls are typically seen resting on the navigation lock guide wall.

Gull numbers feeding in the spillway (**SWT1**) ranged from 0 to 75 (May 20) and averaged 8.95. Gull numbers resting in SWT1 ranged from 0 to 50 (August 18) and averaged 2.62. SWT1 gulls are typically seen avoiding the pyrotechnics of the hazers firing over the spillway discharge from the navigation lock deck (elevation 536).

Gull numbers feeding in the power house tailrace under the bird wires (**PHT1**) ranged from 0 to 12 (June 19) and averaged 1.02. Gull numbers resting in PHT1 ranged from 0 to 4 (September 25) and averaged 0.06. PHT1 gulls are only typically seen when the hazer is not present.

Gull numbers feeding in the power house tailrace downstream of the bird wires (**PHT2**) ranged from 0 to 26 (May 13) and averaged 2.9. Gull numbers resting in PHT2 ranged from 0 to 36 (July 5) and averaged 1.23. PHT2 gulls are also only typically seen when the hazer is not present.

Gull numbers feeding at the juvenile bypass outfall (**JFOF**) ranged from 0 to 29 (April 11) and averaged 2.27. Gull numbers resting at JFOF ranged from 0 to 8 (April 1) and averaged 0.1. JFOF gulls are typically seen when large numbers of juvenile salmonids are bypassed.

Hazing was effective at moving gulls out of the area. Two shifts were used to provide daylight to dusk coverage throughout the historic peak of salmonid outmigration. The second shift of hazing was equally as effective as the morning shift. On days when hazing was not occurring but fish passage numbers were high, the birds returned and resumed normal feeding behaviors. Gull numbers correlated well with the peak of the juvenile fish outmigration this season, as has been the rule in the past, but this season as a whole had relatively low total gull numbers.

Cormorants

Cormorant numbers were fairly consistent throughout the season. Fall and winter cormorant numbers tend to be higher than those during the juvenile salmonid outmigration.

Cormorant numbers feeding in the forebay (**FB**) ranged from 0 to 20 (April 30), and averaged 0.44. Cormorant numbers resting in the FB ranged from 0 to 26 (April 3), and averaged 1.42. FB cormorants are commonly seen foraging and are impervious to hazing.

Cormorant numbers feeding in the spillway (**SWT1**) ranged from 0 to 19 (September 21) and averaged 0.52. Cormorant numbers resting in SWT1 ranged from 0 to 40 (September 13, 15 and 20), and averaged 2.22. SWT1 cormorants are not effectively prevented from foraging by the pyrotechnics of the hazers.

Cormorant numbers feeding in the power house tailrace under the bird wires (**PHT1**) ranged from 0 to 5 (September 21), and averaged 0.17. Cormorants were not seen resting in the PHT1. PHT1 cormorants come and go and are impervious to hazing.

Cormorant numbers feeding in the power house tailrace downstream of the bird wires (**PHT2**) ranged from 0 to 7 (September 28) and averaged 0.55. Cormorant numbers resting in PHT2 ranged from 0 to 11 (May 28), and averaged 0.16. PHT2 cormorants also come and go and are impervious to hazing.

Cormorant numbers feeding at the juvenile bypass outfall (**JFOF**) ranged from 0 to 1 (April 1 and May 16) and averaged 0.03. Cormorant numbers resting in JFOF ranged from 0 to 14 (April 22) and averaged 0.12.

Terns

Tern numbers were very low throughout the season. Only 2 sightings occurred.

Tern numbers feeding in the forebay (**FB**) ranged from 0 to 2 (May 16), and averaged 0.02. Terns were not seen resting in the FB.

Terns were neither seen feeding nor resting in the spillway (**SWT1**).

Terns were neither seen feeding nor resting in the power house tailrace under the bird wires (**PHT1**).

Terns were neither seen feeding nor resting in the power house tailrace downstream of the bird wires (**PHT2**).

Terns were neither seen feeding nor resting at the juvenile bypass outfall (**JFOF**). JFOF tern observations are also extremely rare.

Grebes

Grebe numbers were highest from May 27 to June 9.

Grebe numbers feeding in the forebay (**FB**) ranged from 0 to 8 (June 9) and averaged 0.22. Grebe numbers resting in the FB ranged from 0 to 5 (July 10) and averaged 0.05. FB grebes are often underwater and are hard to accurately count.

Grebes were neither seen feeding nor resting in the spillway (**SWT1**).

Grebes were neither seen feeding nor resting in the power house tailrace under the bird wires (**PHT1**). PHT1 grebes are often underwater and are hard to accurately count.

Grebes were neither seen feeding nor resting in the power house tailrace downstream of the bird wires (**PHT2**).

Grebes were neither seen feeding nor resting at the juvenile bypass outfall (**JFOF)**. JFOF grebe observations are extremely rare.

Pelicans

Pelicans were first present prior to April 1 and last seen in all areas on September 6.

Pelican numbers feeding in the forebay (**FB**) ranged from 0 to 5 (May 9) and averaged 0.22. Pelican numbers resting in the FB ranged from 0 to 10 (April 16) and averaged 0.34. FB pelicans are typically seen cruising as a group; generally along the north shoreline.

Pelican numbers feeding in the spillway (**SWT1**) ranged from 0 to 6 (May 30) and averaged 0.35. Pelican numbers resting in SWT1 ranged from 0 to 13 (April 9) and averaged 0.25. SWT1 pelicans typically are not impacted by the pyrotechnics of the hazers firing to prevent gulls and cormorants from feeding.

Pelican numbers feeding in the power house tailrace under the bird wires (**PHT1**) ranged from 0 to 14 (July 19) and averaged 0.48. Pelican numbers resting in PHT1 ranged from 0 to 11 (July 24) and averaged 0.2.

Pelican numbers feeding in the power house tailrace downstream of the bird wires (**PHT2**) ranged from 0 to 7 (July 3 and 13) and averaged 0.51. Pelican numbers resting in PHT2 ranged from 0 to 15 (July 17) and averaged 0.44. PHT2 pelicans typically are not bothered by the pyrotechnics of the hazers firing to prevent gulls and cormorants from feeding.

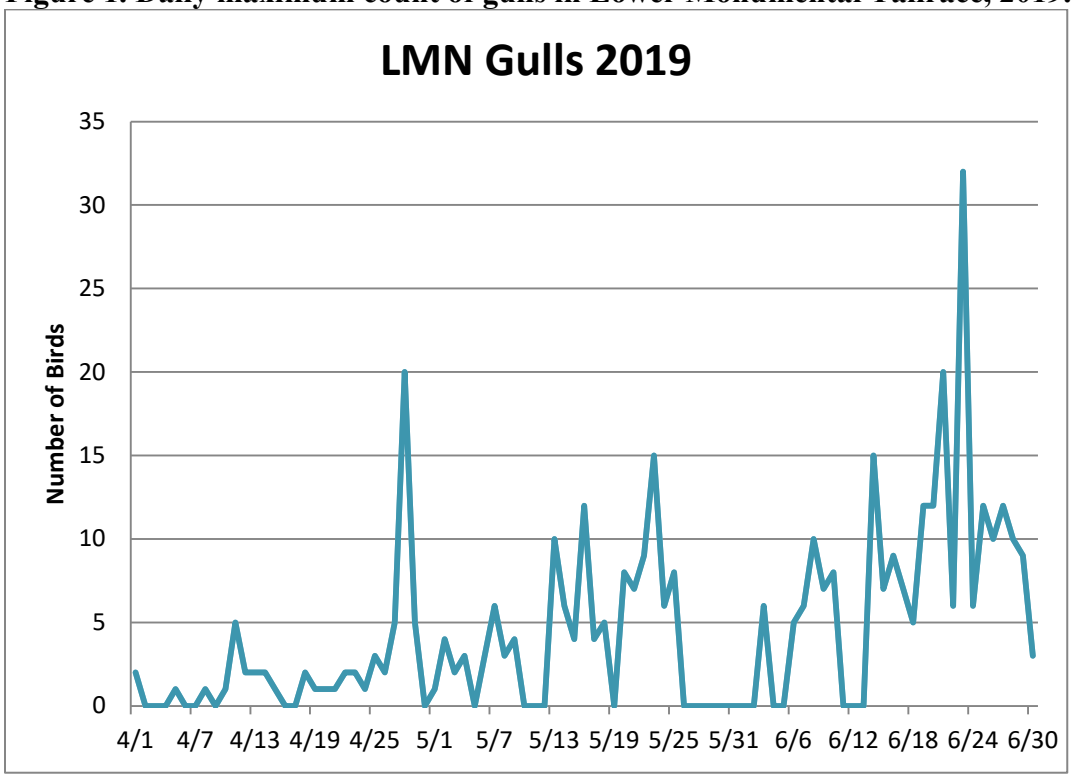
The number of pelicans feeding at the juvenile bypass outfall (**JFOF**) ranged from 0 to 3 (May 21 and 23) and averaged 0.15. Pelican numbers resting at JFOF ranged from 0 to 2 (May 13) and averaged 0.02. JFOF pelicans are typically seen when large numbers of juvenile salmonids are bypassed.

2. Tailrace Bird Monitoring of Lower Monumental Dam (Avian Action Plan)

Single daily counts of gulls, cormorants and terns occurred between the hours of 1100 and 1300 each day from April 1 through June 30 as per the Avian Action Plan. Maximum counts with date of occurrence, average count through the April 1 to June 30 period, and a graph of the daily counts for each species throughout the period are as follows (Figures 1-2).

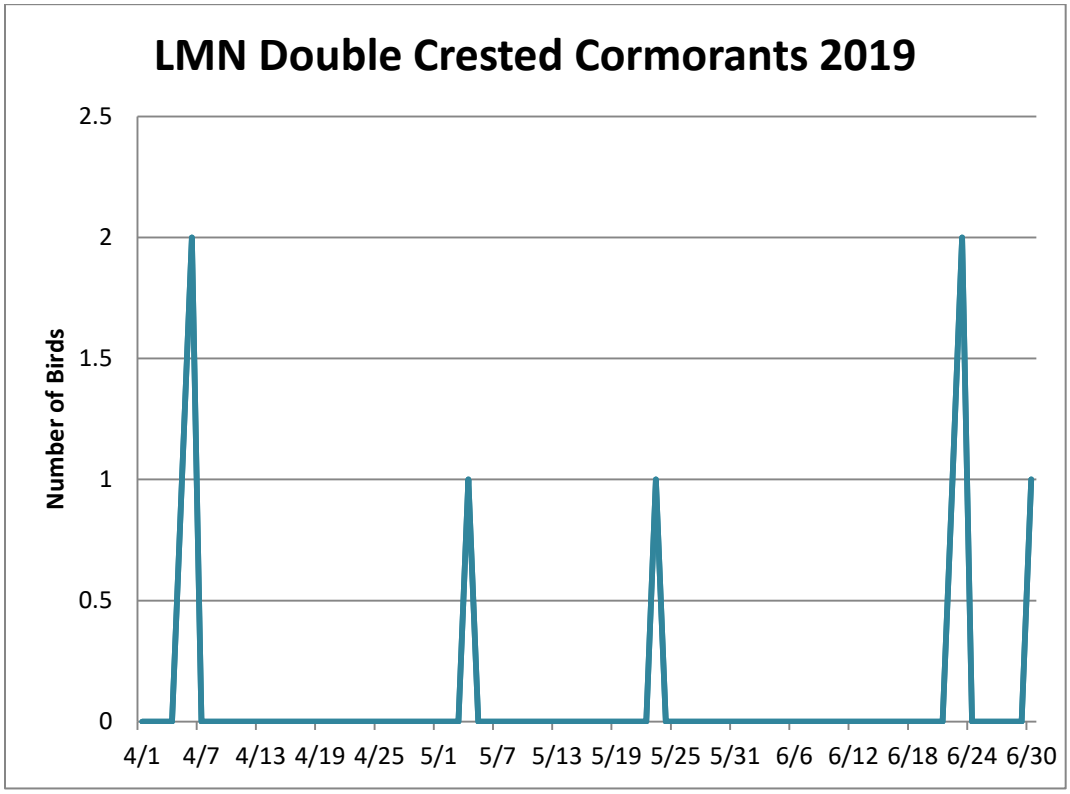
The maximum number of gulls was 32 (June 23) with a daily average of 4.52.

Figure 1. Daily maximum count of gulls in Lower Monumental Tailrace, 2019.



The maximum number of cormorants was 2 (April 6 and June 23) with a daily average of 0.10.

Figure 2. Daily maximum count of cormorants in Lower Monumental Tailrace, 2019.



No terns were seen during the Avian Action Plan bird monitoring in the tailrace.

Cooling Water Strainer Counts

Turbine unit cooling water strainers were examined for biologic content once per month from January until June 2019. Species content included lamprey, salmon species, steelhead, prawns, and a final category titled "other" which included all other species. The vast majority of other species were American shad. The number of each group and percent of the total of individuals of all groups combined was: juvenile lamprey 300 (18.67%), salmon species 46 (2.86%), steelhead 6 (0.37%), prawns 0 (0.0%) and other 1255 (78.1%).

Timing of the entry of each group into the strainers represents migration timing coupled with susceptibly of being drawn into the cooling water system for each group at that growth stage. Juvenile lamprey were generally present from February through May with numbers peaking at 99 in March. Salmon species were generally susceptible only in May and June peaking at 44 in May. Steelhead were rarely seen in the strainers with a total of 9 for the entire year. The vast majority of all groups were no longer living when collected. The percent of each group released alive was: lamprey 5.33%, salmon species 2.17%, steelhead 16.67%, prawns 0%, and other 0%.

Probability of any individual being alive at the time of strainer cleaning was likely more related to time of entry rather than which unit's strainer it was found in.

Recommendations

1. Install a shear boom across the forebay to direct debris to the spillway during the high flow/high debris period to reduce orifice fouling and associated fish injury.
2. Research converting the pipe system between the PIT facility counter tanks and the PIT facility holding tank exits with an open system that eliminates the need to hold fish in the PIT system holding tanks.

APPENDIX

Appendix 1. Lower Monumental Adult Fishway Inspections, 2019. (spreadsheet)