ADULT AND JUVENILE FISH FACILITY MONITORING REPORT

LOWER MONUMENTAL DAM

2015

William F. Spurgeon

Supervisory Fisheries Biologist

Lower Monumental Dam

U.S. Army Corps of Engineers

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX

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 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, 2015. Inspection readings are provided in Appendix 1 (2015 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, "2015 Juvenile Fish Collection and Bypass Report, Lower Monumental Juvenile Fish Facility".

River Conditions

During the 2015 season, the average daily flow did not exceeded 100.0 kcfs. The highest daily average flow for the season was 77.6 kcfs on April 3. The lowest daily average flow for the season occurred on September 5 with a flow of 12.8 kcfs. The average flow for the season was 36.1 kcfs. Spill occurred for 152 days from April 3 through midnight on August 31, with a maximum daily average spill of 31.0 on April 18 and 19. The RSW (Removable Spillway Weir) was put into operation when BiOp spill began on April 3, and was taken out of service for the season on August 11.

River temperature averaged 63.3^{o} F for the season and ranged from 49.4^{o} F in mid-April, to 71.5^{o} F in mid-July.

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 to the adult fish passage system were done this operating year.

Operations and Maintenance

Fish Ladders and Collection Channels

The adult fishways were in service throughout 2015 with the exception of the winter maintenance season. Inspection and maintenance on the north and south shore fishways occurred from January 5 to February 3 and February 4 to February 28, respectively.

The upper fish ladders are dewatered annually 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 ladders. The fish exit is then bulkheaded off, any exit pool fish 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 a day 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 $4/10^{th}$ of a foot 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. Fish salvage was required in the lower ladders this year to accommodate inspection associated with planning for diffuser grate replacement. No problems were observed during the inspection of the lower north shore channel, however, the lower south shore ladder had one displaced grating due to failed fasteners. Replacement of diffuser grates and clasps has been an issue for years and will be addressed when engineering design and funding for replacement is available.

Auxiliary Water Supply

Fish pumps 1, 2, and 3 were out of service (OOS) from January 5 to February 26 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 a general mechanical and electrical inspection. The more significant pump outages are summarized in Table 1.

Table 1. Fish pump outages at Lower Monumental Dam, 2015

Affected Pump(s)	Dates	Reason for Outage/Comments
1, 2, 3	Jan 5 – Feb 26	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, upper diffuser pool levels, and water temperatures 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 provides 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 2015 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 (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. Special operating conditions are used if normal operating criteria cannot be met. When only two fish pumps are operational, SSE-2 and SPE-2 may be closed and SPE-1 raised to provide 1.0-2.0 feet of entrance head differentials. This special operation was not required to maintain depth criteria this season.

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 large debris impacts 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, and day rarely randomized. An average of 3.7 inspections per week were performed (163 inspections /44 weeks) in 2015. 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 2015 was 99.3%. A summary of fish ladder performance and variability is provided in Table 2.

Ladder exits: North shore ladder exit head differentials were in criteria on 99.4% of the inspections. The one out of criteria reading of 0.7 feet occurred on March 5 due to debris on ladder exit trash rack. South shore ladder exit head differentials were in criteria on 100% of the 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 has delayed debris boom replacement.

Ladder weirs: The depths over the weirs of the north shore ladder were within criteria on 100% of the inspections.

Depths over the weirs of the south shore ladder were within criteria on 99.4 % of inspections.

Counting stations: The head differential across the north shore counting station picketed leads was in criteria on 98.2% of inspections. The three out of criteria readings were 0.5 feet each and were due to debris or algae accumulating on the picketed leads. The south shore counting station met criteria on 100% of inspections.

Entrance heads: North shore entrance head differential was in criteria on 100% of inspections.

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

South shore entrance head differential was in criteria on 95.7% of inspections. Failure of the automated control system caused criteria breaches.

North shore entrance (NSE-1 & 2) depths: NSE-1 weir gate was in depth criteria or sill criteria on 100% of inspections (100% depth, 0.0% sill).

NSE-2 weir gate was in depth or sill criteria on 97.5% of inspections (97.5% depth, 0.0% sill). Failure of the automated control system caused criteria breaches.

South powerhouse entrance (SPE-1 & 2) depths: SPE-1 weir gate was in depth or sill criteria on 100% of inspections (3.7% depth, 96.3% sill).

SPE-2 weir gate was in depth criteria or sill on 100% of inspections (3.7% depth, 96.3% sill).

South shore entrances (SSE-1 & 2): SSE-1 weir gate was in depth or sill criteria on 98.8% of inspections (31.3% depth, 67.5 % sill). Failure of the automated control system caused criteria breaches.

SSE-2 weir gate was in criteria on 100% of inspections.

North shore collection channel velocity: The velocity unit is located in north shore collection channel in the transition area between unit 1 and unit 2. The sending unit is positioned in the channel's length and width 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 on 100% of inspections (criteria: 1.5-4.0 ft/s).

Recommendations

1. Leave pumps permanently installed in the auxiliary water supply conduit to reduce the preparation time for dewatering the lower ladders.
2. Remove sand and debris from the supply conduits and replace all original ladder diffuser grates, support structures, and mud valves.
3. Replace plastic picketed leads at the north shore with stainless steel leads to eliminate the expansion and warping that the plastic exhibits with hot temperatures. Construct the downstream leads so that the vanes are oriented at an angle to the water flow to prevent algae and debris from adhering to the vanes.
4. Modify the south shore picketed leads from a single set to a double set, and install an electric hoist system. This will allow for easier cleaning of the leads and prevent fish from becoming trapped between the leads during cleaning.
5. Modify the method of attachment of ladder exit debris booms and install exit booms capable of withstanding turbulent waters.
6. Operate the number of fish pumps needed to keep the fishway in criteria, such as three pumps during periods of higher tailwater levels, and two pumps at higher speeds when tailwater is lower. Manipulate weir gate depths and entrance head differentials as needed to keep all inspection points in criteria.
7. Finish rebuilding the fish pumps to fix the bearing housing attachment problems so that three reliable fish pumps are available to meet criteria.
8. Fully open the north shore Diffuser N1 and N2B gates to obtain higher head differentials at main entrances, greater weir depths, and increase total system discharge.
9. Improve south shore fishway conditions by either reversing the direction Diffuser S1 gates move with increasing tailwater or converting them from automatic operation to a fixed setting.
10. Verify the condition and settings for all diffuser gates and calibrate position indicators to actual gate position when the AWS is unwatered for inspection and maintenance.
11. Rebuild south shore entrance gate operating equipment. All other fish ladder entrance gates have rebuilt.
12. Repair north and south shore fish ladder joint leakage.

Table 2. Summary of adult fishway inspections at Lower Monumental Dam, 2015 [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	163 *** 163	100.0 ***	*** ***	*** ***	*** ***	*** ***	*** ***	*** ***
Differentials								
North Ladder								
Ladder Exit	162 *** 163	99.4 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	1 0.6
Ladder Weirs	163 *** 163	100.0 ***	0 0.0	0 0.0	2 1.2	0 0.0	0 0.0	0 0.0
Counting Station	160 *** 163	98.2 ***	*** ***	*** ***	*** ***	3 1.8	0 0.0	0 0.0
South Ladder								
Ladder Exit	163 *** 163	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
Ladder Weirs	162 *** 163	99.4 ***	0 0.0	1 0.6	2 1.2	0 0.0	0 0.0	0 0.0
Counting Station	163 *** 163	100.0 ***	*** ***	*** ***	*** ***	0 0.0	0 0.0	0 0.0
Coll. Channels								
North Shore Entrance	163 *** 163	100.0 ***	0 0	0 0	2 1.2	0 0.0	0 0.0	0 0.0
South Powerhouse Entrance	163 *** 163	100.0 ***	0 0	0 0	2 1.2	0 0.0	0 0.0	0 0.0
South Shore Entrance	156 *** 163	95.7 ***	1 0.6	1 0.6	5 3.1	1 0.6	0 0.0	1 0.6
Weir Depths								
NSE-1[2]	163 *** 163	100.0 ***	0 0	0 0	2 1.2	*** ***	*** ***	*** ***
NSE-2[2]	159 *** 163	97.5 ***	1 0.6	2 1.2	3 1.8	*** ***	*** ***	*** ***
SPE-1[2]	6 157 163	3.7 96.3	0 0.0	0 0.0	2 1.2	*** ***	*** ***	*** ***
SPE-2[2]	6 157 163	3.7 96.3	0 0.0	0 0.0	2 1.2	*** ***	*** ***	*** ***
SSE-1[2]	51 110 163	31.3 67.5	0 0.0	0 0.0	4 2.5	*** ***	*** ***	*** ***
SSE-2	163 Not Applic. 163	100.0 ***	0 0.0	0 0.0	0 0.0	*** ***	*** ***	*** ***

[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 Monumental Dam consist of: standard length submersible traveling screens, twelve inch orifices, a collection channel that terminates in a dewatering structure, transport flume, separator, and fish distribution system including, PIT tag bypass, sampling, holding facilities distribution, and barge and truck loading.

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 on 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. That 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

The following modifications were made to the JFF prior to or during the 2015 fish collection season:

1. To accommodate the needs of the avian action plan, an area has been prepared with storage and concrete pads for deploying propane cannons at the LoMo tailrace.
2. The drive cable of the mechanical screen cleaner (primary dewatering) was replaced with a lugged drive belt to reduce maintenance requirements and cable related failures in season.
3. A water line was rerouted in the mechanical electrical room to move it away from electrical panels. (Safety)

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.

Below is a summary of unit outages and cause from March 1 through November 10.

Table 3. Summary of unit outages and cause at Lower Monumental Dam, 2015

Unit	Dates out of service	Reason out of service
All Units	Feb 20-21	BPA scheduled line outage
All Units	March 16-19	Trash rack raking
All Units	March 30-31	STS installation
All Units	Monthly(2-3 days)	STS/VBS inspection
All Units	July 25	Line Outage for T-2 Doble Testing
Unit 1	All Year	Awaiting overhaul
Unit 2	Nov 9 – est. Jan 17	Annual Maintenance
Unit 3	June 24 – July 16	Annual Maintenance
	July 20	Headgate cylinder removal
	August 18	Install flow meter on AC turbine bearing pump
Unit 4	March 31 – April 1	High Amp draw STS
	August 10	Obtain headgate for Unit 5 outage
	August 31	Headgate and cylinder transfer
	Sept 28 – Nov 9	Annual Maintenance
Unit 5	April 13	Headgate removal
	July 23	PM on JO 1 Breaker
	August 10 - 27	Annual Maintenance
	August 31	Headgate and cylinder transfer
	Sept 10	Hub oil sampling
Unit 6	Aug 31 – Sept 24	Annual Maintenance
	Sept 28	Headgate cylinder removal

Debris/Trash Racks

Trash rack raking occurred on March 16, 17, 18, and 19. A total of 26 cubic yards of debris was removed in this operation. With low flows throughout the year debris was exceptionally light this season.

Submersible Screens

The submersible traveling screens (STSs) were inspected and tested on March 18 and were installed from March 30 through March 31. After installation, inspection was done monthly by underwater video camera through November. Only 1 STS problem required repair during the 2015 season. The STS in slot 4A had high amp draw on March 31. The unit was removed from service and the STS was replaced on April 1.

STSs were operated in “cycle” mode while the average fork length of subyearling Chinook and/or sockeye/kokanee were greater than 120 mm (March 24 through May 15, and, from July 7 through July 21), and in continuous “run” mode when either was less than 120 mm (May 15 through July 7, and, July 21 through August 6).

Vertical Barrier Screens

The vertical barrier screens (VBSs) were inspected by underwater video camera on August 4 and 5. Additionally, they were spot-checked monthly during STS inspections. No problems were found.

Gatewells

Dipping the bulkhead slots (gatewells) yielded 18.5 cubic yards of debris this season. Gatewells were normally less than 10% covered. Gatewells did not exceed the 50% debris criterion in 2015 with the exception of preparation for initial STS deployment. Occasional oil sheens were dealt with by floating oil absorbent pads in the affected gatewells.

Orifices/Collection Channel

During the 2015 season the number of open orifices varied from 18 to 21 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 fouling was not a problem this season with low flows and a minimal debris load typifying the season. Orifice lights were checked daily. If a light was not working, the operating orifice was switched to the other orifice in the slot until repairs could be made.

Primary Dewaterer

A major problem occurred regarding the primary dewaterer during the 2012 season. Two weir stem drive gear assemblies failed. Weirs that were no longer useable were set to an acceptable elevation and an adjustment nut was used to hold them in place. A new automatic weir drive system is being researched and should be installed during the winter maintenance period of 2016.

The compressed air screen cleaner functioned well. The mechanical screen cleaner cable drive was upgraded to a belt drive during the winter maintenance season. No breakdowns occurred during the transport season but occasional adjustment of the mechanical screen cleaner was required. As usual, the system as a whole functioned very well keeping debris from plugging the inclined screen.

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 the automated weirs of the primary dewaterer in manual. As has been the case for the last few years, the separator was run at a higher water level to assure no problem with exposed separator bars would occur.

PIT-tag diversion gate position sensors were installed eight years ago. These sensors act to prevent the over-travel problem we once had, and by so doing, they eliminated gate failure problems caused by metal fatigue.

Barge Loading Operations

Fish were transported by barge from May 1 through August 14. Barge loading went very smoothly this season with one exception. On May 11 the barge collided with the center cell and then with the horizontal timbers on the upstream half of the barge dock. Damage occurred and the contractor is being required to repair the damage.

The guide for the downstream mooring bit, having been deformed in a collision by a barge years ago, has caused the downstream floating mooring bit to stick low in the guides. Additionally, it has occasionally taken on water. Plans are being made to refurbish all the mooring bits and repair/replace the damaged downstream mooring bit guide.

Truck Loading Operations

Juvenile fish were transported by truck from August 14 to October 1. Throughout the late season the midi-tanker was used because of low fish numbers. A 2.5 mg/l salt solution was used to treat and/or ease outbreaks of *columnaris*.

AVIAN PREDATOR MONITORING

Areas of avian predation monitoring included: the forebay, turbine and spillway discharge, and the 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 Wildlife Services (WS). Two shift hazing coverage (daylight to dusk) occurred from May 6 through June 2 with the exception of the holidays May 25.

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 the winter 08-09 which effectively reduced the perching normally 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 of 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/WS supplemented Bird Monitoring**

Fish ladder inspections are conducted three to six times a week at Lower Monumental Dam to assure ladders are operating within criteria and for training purposes. These inspections are conducted at random times and so contain counts during, as well as absent of active bird hazing. On Mondays and Thursdays (April 1 through June 2) WS contracted employees collect bird information in the same format as the ladder inspection data and this information is 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 includes an avian predator count section for five areas including: the forebay (FB), spillway (SWT1), under birdwires of the turbine discharge (PHT1), downstream of the birdwires below the turbine discharge (PHT2), and lastly at the juvenile bypass outfall (JFOF). Each area includes counts of both foraging and resting birds. The following summarizes this data collected from April 1 through October 1 of the 2015 operating year. The averages offered in each category include all data through the time period, and so 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 20 through May 26. Additionally, there was a second smaller peak in gull activity from July 1 to September 6. In all areas gull numbers dropped after May 26 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 20 (May 4), and averaged 1.13. Gull numbers resting in the FB ranged from 0 to 55 (May 9), and averaged 5.79. FB gulls are typically seen resting on the nav lock guide wall.

Gull numbers feeding in the spillway (**SWT1**) ranged from 0 to 92 (July 11) and averaged 9.66. Gull numbers resting in SWT1 ranged from 0 to 52 (July 17), and averaged 1.96. 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 4 (July 1), and averaged 0.18. Gull numbers resting in PHT1 ranged from 0 to 0 (Date N/A), and averaged 0.00. PHT1 gulls are 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 25 (May 11) and averaged 2.05. Gull numbers resting in PHT2 ranged from 0 to 59 (July 5), and averaged 2.03. PHT2 gulls are typically seen when the hazer is not present.

Gull numbers feeding at juvenile bypass outfall (**JFOF**) ranged from 0 to 7 (May 23), and averaged 0.62. Gull numbers resting at JFOF ranged from 0 to 5 (September 2), and averaged 0.08. JFOF gulls are typically seen when large numbers of juvenile salmonids are bypassed.

Hazing was effective at moving the gulls out of the area. Two shifts were used to provide daylight to dusk coverage through the historic peak of the 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. Annual gull numbers were low this year and last as compared to the past.

Cormorant

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

Cormorant numbers feeding in the forebay (**FB**) ranged from 0 to 4 (May 3), and averaged 0.25. Cormorant numbers resting in the FB ranged from 0 to 25 (April 30), and averaged 1.21. FB cormorants are commonly seen foraging and are impervious to hazing.

Cormorant numbers feeding in the spillway (**SWT1**) ranged from 0 to 11 (September 28) and averaged 0.38. Cormorant numbers resting in SWT1 ranged from 0 to 15 (September 6), and averaged 0.94. 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 (April 17), and averaged 0.15. Cormorant numbers resting in PHT1 ranged from 0 to 2 (June 13), and averaged 0.02. 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 20 (April 21) and averaged 0.71. Cormorant numbers resting in PHT2 ranged from 0 to 5 (June 13), and averaged 0.12. PHT2 cormorants come and go and are impervious to hazing.

Cormorant numbers feeding at the juvenile bypass outfall (**JFOF**) ranged from 0 to 3 (June 2) and averaged 0.09. Cormorant numbers resting in JFOF ranged from 0 to 5 (April 21), and averaged 0.05. JFOF cormorants come and go and are impervious to hazing.

Terns

Tern numbers were very low throughout the season. Only 4 sightings occurred.

Tern numbers feeding in the forebay (**FB**) ranged from 0 to 1 (April 8), and averaged 0.01. Tern numbers resting in the FB ranged from 0 to 0 (Date N/A), and averaged 0.00. FB terns are rarely seen foraging.

Tern numbers feeding in the spillway (**SWT1**) ranged from 0 to 1 (July 25) and averaged 0.02. Tern numbers resting in SWT1 ranged from 0 to 0 (Date N/A), and averaged 0.00. SWT1 terns are effectively prevented from foraging by the pyrotechnics of the hazers.

Tern numbers feeding in the power house tailrace under the bird wires (**PHT1**) ranged from 0 to 3 (July 25), and averaged 0.02. Tern numbers resting in PHT1 ranged from 0 to 0 (Date N/A), and averaged 0.00. PHT1 tern observations are extremely rare.

Tern numbers feeding in the power house tailrace downstream of the bird wires (**PHT2**) ranged from 0 to 0 (Date N/A) and averaged 0.00. Tern numbers resting in PHT2 ranged from 0 to 0 (Date N/A), and averaged 0.00. PHT2 tern observations are extremely rare.

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

Grebe

Grebe numbers were highest from May 5 through June 2. Grebe numbers began to rise again after October 1.

Grebe numbers feeding in the forebay (**FB**) ranged from 0 to 16 (May 15 and 26), and averaged 1.00. Grebe numbers resting in the FB ranged from 0 to 17 (May 13), and averaged 0.48. FB grebes are often underwater and are hard to accurately count.

Grebe numbers feeding in the spillway (**SWT1**) ranged from 0 to 0 (Date N/A) and averaged 0.00. Grebe numbers resting in SWT1 ranged from 0 to 2 (September 12), and averaged 0.02. SWT1 grebes are not effectively prevented from foraging by the pyrotechnics of the hazers.

Grebe numbers feeding in the power house tailrace under the bird wires (**PHT1**) ranged from 0 to 0 (October 1), and averaged 0.00. Grebes were not observed resting in PHT1. PHT1 grebes are often underwater and are hard to accurately count.

No grebes were recorded feeding or resting in the power house tailrace downstream of the bird wires (**PHT2**) from April 1 through October 1. PHT2 grebes are often underwater and are hard to accurately count.

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

Pelicans

Pelicans were present in numbers ranging from 1 to 22 from April 13 through September 2. In all areas pelican numbers ended after September 2.

Pelican numbers feeding in the forebay (**FB**) ranged from 0 to 4 (May 4), and averaged 0.17. Pelican numbers resting in the FB ranged from 0 to 12 (May 28), and averaged 0.24. 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 4 (May 17) and averaged 0.26. Pelican numbers resting in SWT1 ranged from 0 to 4 (June 17 and 19), and averaged 0.17. SWT1 pelicans typically are not bothered by the pyrotechnics of the hazers firing to prevent gulls and terns from feeding.

Pelican numbers feeding in the power house tailrace under the bird wires (**PHT1**) ranged from 0 to 0 (Date N/A), and averaged 0.00. Pelican numbers resting in PHT1 ranged from 0 to 3 (July 15 and August 8), and averaged 0.06. Pelicans come and go and can't be legally hazed as they are state protected.

Pelican numbers feeding in the power house tailrace downstream of the bird wires (**PHT2**) ranged from 0 to 17 (May 11) and averaged 0.41. Pelican numbers resting in PHT2 ranged from 0 to 18 (May 5), and averaged 0.72. Pelicans come and go and can't be legally hazed as they are state protected.

The number of pelicans feeding at the juvenile bypass outfall (**JFOF**) was 0 to 2 (May 19 and June 2), and averaged 0.08. Pelican numbers resting at JFOF ranged from 0 to 6 (May 10), and averaged 0.15. JFOF pelicans are typically seen when large numbers of juvenile salmonids are bypassed.

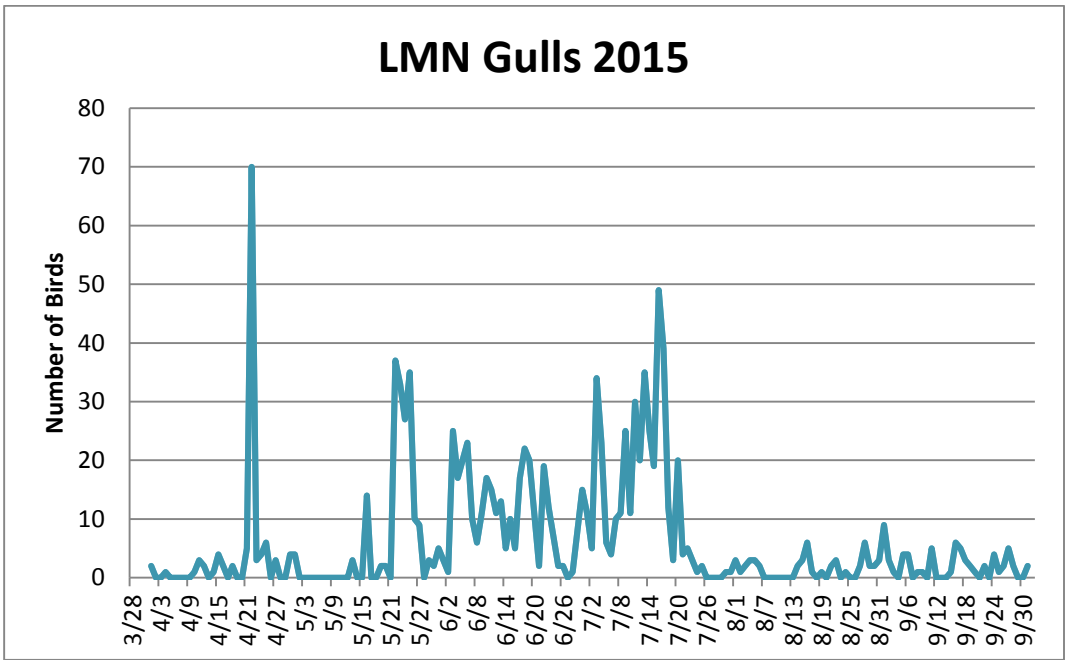
2. Tailrace Bird Monitoring (Hazing Effectiveness) of Lower Monumental Dam (Avian Action Plan)

Single daily counts of gulls, cormorants and terns occurred between the hours of 1100 and 1300 each day from April 1 through October 1 as per the Avian Action Plan.

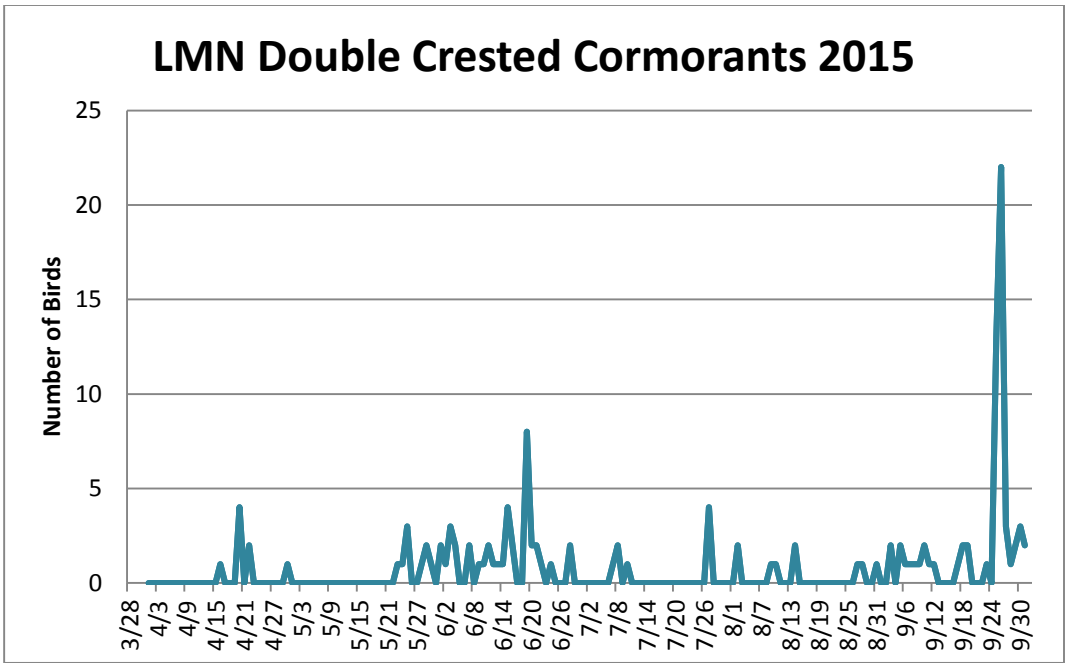
For the period of the hazing effectiveness monitoring (April 1 through June 30) the maximum counts with date of occurrence and average count through the period are shown above the graph for each bird species.

All graphs show the daily counts for each species through October 1 and demonstrate bird response to the high numbers of juvenile shad passage during the late season.

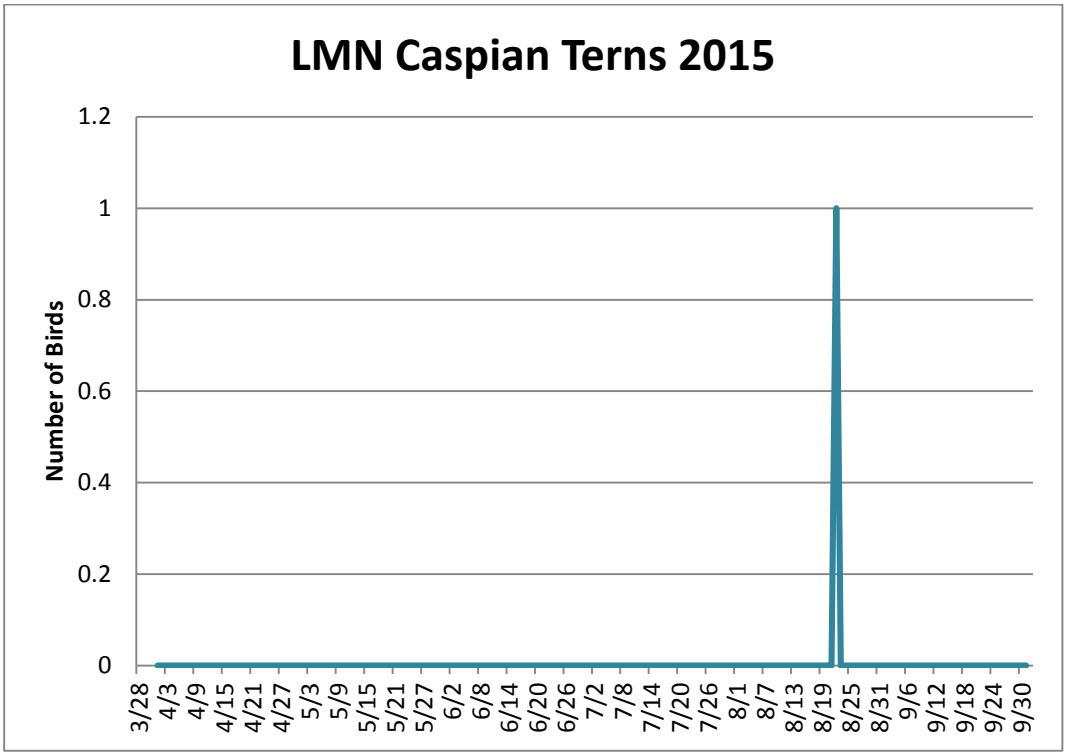
The maximum number of gulls was 70 (April 22) with a daily average of 6.91.



The maximum number of cormorants was 8 (June 19) with a daily average of 0.62.



The maximum number of terns was 0 (Date N/A) with a daily average of 0.00.



Cooling Water Strainer Counts

Turbine unit cooling water strainers were examined for biologic content once per month throughout the calendar year 2015. In all this year, 2,020 individuals were collected during cooling water strainer cleaning. Species content included lamprey, salmon species, steelhead, prawn, and a final category titled "other" which included all other species; the vast majority of which were American shad. The number of each group and percent of the total of individuals of all groups combined was: juvenile lamprey 1620 (80.2%), salmon species 15 (0.74%), steelhead 3 (0.15%), prawn 304 (15.05%), and other 78 (3.86%).

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 January through July with numbers peaking at 1276 in March. Salmon species were generally susceptible only in May through June peaking at 12 in May. Steelhead are rarely seen in the strainers with a total of 3 for the entire year. Prawn were present throughout the year peaking at 97 in September. The group "Others" was generally present in August and November peaking at 75 in November. The vast majority of all groups were no longer living when collected. The percent of each group released alive was: lamprey 17.04%, salmon species 0%, steelhead 0.0%, prawn 24.34%, and other 1.28%. 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 porosity unit upstream of the separator to a third stage of the separator designed for the removal and bypassing of fry and juvenile lamprey. The concept has been discussed with COE's engineer Ryan Laughery and he is optimistic regarding its feasibility and functionality. (in AMRIP)
3. 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. This also has been discussed with Laughery and he believes it can be accomplished.

APPENDIX