CENWW-ODH FONE 6 October, 2020

MEMORANDUM THRU:
Brian Vorheis, Operations Project Manager, Ice Harbor Dam

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

SUBJECT: Submission of 2018 Adult and Juvenile Fish Facility Monitoring Report, Ice Harbor Dam.

1. Enclosed is the 2018 Adult and Juvenile Fish Facility Monitoring Report for Ice Harbor Dam as requested.

2. If you have any questions contact Ken Fone at Ice Harbor Dam, (509) 544-3137.

Kenneth R. Fone
Fisheries Biologist, Ice Harbor Dam

Enclosure

2018 ADULT AND JUVENILE FISH FACILITY MONITORING REPORT

ICE HARBOR DAM

Prepared by:

Kenneth R. Fone

Project Fisheries Biologist

and

Tim DeKoster

Fisheries Technician

U.S. Army Corps of Engineers

October, 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX

INTRODUCTION

This report summarizes the operation and maintenance of the adult and juvenile fish passage facilities at Ice Harbor Dam in 2018. The juvenile fish passage facility at Ice Harbor Dam consists of standard length submersible traveling screens, vertical barrier screens, 12-inch diameter orifices (36 orifices), a collection channel and dewatering structure, fish sampling facilities, and a transportation flume/pipe to the tailrace downstream from the dam. The juvenile fish collection channel is operated with approximately 300 cubic feet per second (cfs) flow (forebay head-dependent), which is the design operating flow produced by 20 of the juvenile fish passage orifices open. All but 30 cfs of the flow is removed at the primary dewatering structure and utilized as adult fish attraction water. The remaining 30 cfs flow and fish are routed through a transport pipe and flume to the fish sampling facility or directly to the tailwater.

The adult fish passage facilities at Ice Harbor are comprised of separate north and south shore systems. The north shore facilities include a fish ladder with a counting station, an adult fish collection channel, and a pumped auxiliary water supply system. The collection system includes two downstream entrances near the navigation lock wall at the base of the dam and one side entrance (which is bulkheaded off) from the spillway basin. The downstream entrance nearest the navigation lock wall is normally open for fish passage. Three electric pumps supply the auxiliary water for fish attraction flow. Two of the three pumps operate continuously during normal operation. The third pump serves as a backup in the case of a pump failure.

The south shore facilities are comprised of a fish ladder with a counting station, two south shore entrances, a powerhouse collection system, and a pumped auxiliary water supply system. The powerhouse collection system includes two downstream entrances and one side entrance (which is bulkheaded off) from the spillway basin at the north end of the powerhouse, twelve floating orifices, and a common fish transportation channel. The fishway entrances used during normal operation include: one south shore entrance nearest the powerhouse, one downstream north powerhouse entrance, and four floating orifices. Eight electric pumps are available to supply the auxiliary water for fish attraction, of which five to eight pumps are used during normal operation. Excess water from the juvenile fish bypass system (approximately 200-270 cfs depending on forebay head) was added to the south shore fish pump discharge chamber from March 22 to December 21, 2018.

RIVER CONDITIONS

Daily Ice Harbor outflows averaged 54.0 thousand cubic feet per second (kcfs) in 2018, with a peak outflow of 178.0 kcfs occurring on May 28. Spill for juvenile fish passage began on April 3 and continued though August 31. The daily spill during that period averaged 56.0 kcfs., with a maximum daily spill of 122.9 kcfs occurring on May 27. River temperatures taken from unit 1 scroll case ranged from 38 °F in January to 71 °F in mid-August. Water temperatures taken from the juvenile fish channel ranged from 45.0 °F to 68.8 °F during the juvenile fish sampling period of April 2 to July 12.

JUVENILE FISH FACILITY OPERATIONS AND MAINTENANCE

Sampling Summary

The Juvenile Fish Bypass was put in operation on March 22, 2018 and continued in operation to December 21, 2018. Normal operation of the facilities is to bypass all collected fish directly to the river, except when routine sampling is conducted for monitoring fish condition. Sampling for fish condition in 2018 began on April 2 and ended on July 12. Fish were sampled twice a week during this time frame. The goal of a sampling event is to collect 100 fish of the predominant species within a four hour period. Fish are visually counted as they come into the fish separator structure. During the beginning and the latter part of the season, migrating fish numbers can be low, so the target number of fish may not be collected during the four hour period.

A total of 3,159 juvenile salmon and steelhead were sampled at the Ice Harbor Juvenile Fish Facility in 2018 (Table 1), which was a 9.4% decrease in comparison to 2017 sampling season (Table 2). Subyearling Chinook fry in the sample are not examined, but are included in the total number of fish sampled. A total of 57 non-target fish (incidental species) were released off of the separator or sampled in 2018 (Table 3). These incidental fish were identified, observed, recorded, and released back into the river via the bypass. Only one or two juvenile lamprey were worked up in the sample in each of the last five years. Occassionally, there were juvenile lamprey observed in the separator and sample holding tank that did not show up in the lab. These lamprey most likely escaped out of the tank through holes of the water-regulating perforated plates.

Juvenile Fish Condition

The juvenile fish bypass and sampling facility are routinely inspected for debris obstructions, and operational and maintenance problems that could cause descaling and injury to fish. Areas that are periodically or annually unwatered are inspected more closely during the fish passage season and/or during the winter maintenance period.

The numbers of salmon and steelhead sampled by day in 2018 that were observed with descaling (at least 20% of surface area of one side of fish with missing scales), and the associated descaling rates (percent of fish sampled with descaling), are shown in Tables 4A and 4B. The combined annual descaling rate for all salmon and steelhead sampled in 2018 was 7.0%, which was an increase of 3.2% from 2017 (Table 5). In 2018, sampling personnel attributed the descaling to predators (mostly birds) 21.2% of the time. The cause of the higher descaling rate in 2018 was uncertain, as there were no observed orifice obstructions and orifices were routinely cycled and backflushed three times a day during the sampling season. Weekly measurements of the gatewell drawdown (head differential across the unit intake trash racks) showed differentials that were well-within criteria. As a precaution, unit 1 and unit 3 trash racks were raked on June 1 (see Debris/Trash Racks section below). The species composition of subsequent samples was predominantly subyearling chinook (Table 1), which are less prone to descaling than steelhead and yearling chinook, because of their smaller size.

Table 1. Number of juvenile salmon and steelhead sampled per day at Ice Harbor Dam, 2018.

Date	Yearling Chinook		Sub-Yr Chinook		Steelhead		Sockeye		All	Daily
	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Total
2-Apr	6	6	0	0	13	2	0	0	0	27
5-Apr	0	0	0	0	1	0	0	0	0	1
9-Apr	41	61	0	0	15	4	0	1	0	122
12-Apr	39	41	0	0	61	6	0	3	0	150
16-Apr	23	17	0	0	84	9	0	0	0	133
19-Apr	38	51	0	0	35	7	0	0	0	131
23-Apr	41	42	0	0	50	1	0	0	0	134
26-Apr	39	19	0	0	78	13	0	0	0	149
30-Apr	18	7	0	0	88	12	0	1	0	126
3-May	58	12	0	0	75	13	0	0	0	158
7-May	65	16	0	1	66	10	0	0	2	160
10-May	60	6	0	0	90	19	0	0	8	183
14-May	55	5	0	1	73	22	0	1	2	159
17-May	50	7	0	4	51	26	1	1	2	142
21-May	42	17	1	3	49	35	11	7	8	173
24-May	33	19	5	6	50	39	15	3	10	180
28-May	7	7	40	14	63	36	3	1	2	173
31-May	0	0	51	43	0	1	0	0	0	95
4-Jun	0	0	43	54	1	3	1	0	0	102
7-Jun	2	0	30	26	0	2	0	0	0	60
11-Jun	0	0	14	12	1	1	0	0	1	29
14-Jun	1	0	28	25	0	2	0	0	1	57
18-Jun	0	0	15	33	0	0	0	0	0	48
21-Jun	0	0	31	76	4	1	0	0	1	113
25-Jun	0	0	6	12	0	0	0	0	0	18
28-Jun	0	0	8	11	0	0	0	0	0	19
2-Jul	1	0	12	16	0	0	0	0	0	29
5-Jul	0	0	35	63	0	0	0	0	0	98
9-Jul	0	0	24	72	0	0	0	0	0	96
12-Jul	0	0	20	73	0	0	0	0	0	94
Totals	619	333	363	545	948	264	31	18	38	3,159
% Totals	19.59	10.54	11.49	17.25	30.00	8.36	0.98	0.56	1.20	***

[1]Includes unclipped hatchery reared fish

Table 2. Number of juvenile salmon and steelhead sampled at Ice Harbor Dam, 2014-2018.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All	
Year	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Total
2014	477	484	465	676	763	43	10	86	38	3,242
2015	925	212	381	549	925	234	5	2	24	2,606
2016	641	278	321	620	966	296	27	6	25	3,180
2017	747	489	386	624	845	335	13	12	34	3,485
2018	619	333	363	545	948	264	31	18	38	3,159

[1]Includes unclipped hatchery reared fish

Table 3. Collection of incidental species during sampling at Ice Harbor Dam, 2018.

Common Name	Scientific Name	Number of Fish
Crappie	*Promxis nigromaculatus*	1
Lamprey	*Lampetra tridentatus*	1
Peamouth	*Mylocheilus caurinus*	1
Mountain Whitefish	*Prosopium* sp.	7
Siberian Prawn	*Exopalaemon modestus*	22
Yellow Perch	*Perca flavescens*	2
Carp	*Cyprinus carpio*	0
Sandroller	*Percopsis transmontana*	1
Smallmouth Bass	*Micropterus dolomieu*	5
American Shad	*Alosa sapidissima*	8
Bluegill	*Lepomis macrochirus*	7
Sucker	*Catostomidae*	2
Total		57

A variety of other injuries were observed in sample fish. In general, the incidence, rate, and location of injuries on fish throughout the sampling season appeared to be random. The fish injuries observed were not indicative of a trend or pattern of injuries.

Total juvenile facility percent mortality for all salmon and steelhead groups combined was 0.3% (eight fish) in 2018, compared to 0.2% (six fish) in 2017 (Table 6). Fish that are dead prior to coming into the lab are not examined for condition, but are included in the number of fish sampled. However, mortalities are checked for obvious signs of physical trauma that could have contributed to their death. One of the mortalities showed external symptoms consistent with bacterial kidney disease and one had a severe head injury (source of injury unknown). The other six fish did not exhibit any major maladies.

Table 4a. Number of sampled salmon and steehead with descaling at Ice Harbor Dam, 2018.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All	
Date	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Total
2-Apr	0	0	---	---	0	0	---	---	---	0
5-Apr	---	---	---	---	0	---	---	---	---	0
9-Apr	2	1	---	---	1	0	---	0	---	4
12-Apr	0	1	---	---	7	1	---	2	---	11
16-Apr	1	0	--	--	11	2	--	--	--	14
19-Apr	1	2	---	---	2	1	---	---	---	6
23-Apr	3	7	---	---	6	0	---	---	---	16
26-Apr	2	2	--	--	10	2	--	--	--	16
30-Apr	0	0	---	---	6	2	---	0	---	8
3-May	1	1	---	---	7	4	---	---	---	13
7-May	3	2	---	0	3	0	---	---	0	8
10-May	5	0	---	---	6	1	---	---	1	13
14-May	4	0	--	0	5	0	--	0	0	9
17-May	1	1	---	0	8	3	0	0	0	13
21-May	3	1	0	0	7	3	2	1	0	17
24-May	0	2	0	0	7	7	1	0	1	18
28-May	1	0	0	4	12	7	2	0	0	26
31-May	---	---	1	0	---	0	---	---	---	1
4-Jun	---	---	2	1	1	0	---	---	---	4
7-Jun	0	---	1	0	---	0	---	---	---	1
11-Jun	---	---	0	0	0	0	---	---	0	0
14-Jun	0	---	1	0	---	0	---	---	0	1
18-Jun	---	---	1	1	---	---	---	---	---	2
21-Jun	---	---	1	2	2	0	---	---	0	5
25-Jun	---	---	0	1	---	---	---	---	---	1
28-Jun	---	---	0	1	---	---	---	---	---	1
2-Jul	0	---	0	1	---	---	---	---	---	1
5-Jul	---	---	1	1	---	---	---	---	---	2
9-Jul	---	---	0	7	---	---	---	---	---	7
12-Jul	---	---	1	3	---	---	---	---	0	4
Totals	27	20	9	22	101	33	5	3	2	222

--- No fish of this species sampled

[1]Includes unclipped hatchery reared fish

Table 4b. Sampling event descaling rates (%) within salmon and steelhead species groups at Ice Harbor Dam, 2018.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All
Date	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho
2-Apr	0.0	0.0	---	---	0.0	0.0	---	---	---
5-Apr	---	---	---	---	0.0	---	---	---	---
9-Apr	4.9	1.7	---	---	6.7	0.0	---	0.0	---
12-Apr	0.0	2.5	---	---	1.5	16.7	---	66.7	--
16-Apr	4.3	0.0	---	---	13.1	22.2	---	---	---
19-Apr	2.7	3.9	---	---	5.7	14.3	---	---	---
23-Apr	7.3	16.7	---	---	12.0	0.0	---	---	---
26-Apr	5.1	10.5	---	---	12.8	15.4	---	---	---
30-Apr	0.0	0.0	---	---	6.8	16.7	---	0.0	---
3-May	1.7	8.3	---	---	9.3	30.8	---	---	---
7-May	4.6	12.5	---	0.0	4.5	0.0	---	---	0.0
10-May	8.3	0.0	---	---	6.7	5.3	---	---	12.5
14-May	7.3	0.0	---	0.0	6.8	0.0	---	0.0	0.0
17-May	2.0	14.3	---	0.0	15.7	11.5	0.0	0.0	0.0
21-May	7.1	5.9	0.0	0.0	14.3	8.6	18.2	14.3	0.0
24-May	0.0	10.5	0.0	0.0	14.0	18.4	6.7	0.0	10.0
28-May	14.3	0.0	0.0	28.6	19.0	19.4	66.7	0.0	0.0
31-May	---	---	2.0	0.0	---	0.0	---	---	---
4-Jun	---	---	4.7	1.9	100.0	0.0	---	---	---
7-Jun	0.0	---	3.4	0.0	---	0.0	---	---	---
11-Jun	---	---	0.0	0.0	0.0	0.0	---	---	0.0
14-Jun	0.0	---	3.6	0.0	---	0.0	---	---	0.0
18-Jun	---	---	6.7	3.0	---	---	---	---	---
21-Jun	---	---	3.2	2.6	50.0	0.0	---	---	0.0
25-Jun	---	---	0.0	8.3	---	---	---	---	---
28-Jun	---	---	0.0	9.1	---	---	---	---	---
2-Jul	0.0	---	0.0	6.3	---	---	---	---	---
5-Jul	---	---	2.9	1.7	---	---	---	---	---
9-Jul	---	---	0.0	9.7	---	---	---	---	---
12-Jul	---	5.0	4.1	4.1	---	---	---	---	0.0
Annual	4.4	6.1	2.5	4.0	10.7	12.5	16.7	16.7	5.3

--- No fish of this species sampled

[1]Includes unclipped hatchery reared fish

Table 5. Annual descaling rates (%) for salmon and steelhead species groups sampled at Ice Harbor Dam, 2014–2018.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All	
Year	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Total
2014	5.9	6.0	5.0	3.4	6.7	4.9	10.0	10.5	7.9	5.5
2015	4.0	4.2	2.6	1.6	6.5	8.1	0.0	0.0	4.2	4.6
2016	0.5	1.1	0.9	0.6	3.8	2.7	0.0	0.0	0.0	1.8
2017	5.9	2.5	0.5	0.5	6.0	5.7	0.0	0.0	5.9	3.8
2018	4.4	6.1	2.5	4.0	10.7	12.5	16.7	16.7	5.3	7.0

[1]Includes unclipped hatchery reared fish

Table 6. Annual mortality numbers and total mortality rate for salmon and steelhead sampled at Ice Harbor Dam, 2014-2018.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All	Total % of
Year	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Sample
2014	2	0	1	1	1	1	0	1	0	0.2
2015	0	0	0	1	0	1	0	0	0	0.1
2016	0	1	3	4	0	0	0	0	0	0.3
2017	3	0	0	2	0	0	0	1	0	0.2
2018	2	3	1	0	0	1	1	0	0	0.3

[1]Includes unclipped hatchery reared fish

Adult Salmonid Fallbacks

Typically, there are not many fallbacks observed and released from the separator at Ice Harbor, because of the limited operation of the separator and juvenile fish sampling. Most of the 2018 fallbacks were in good condition (Table 7).

Table 7. Condition of adult salmonids released from the juvenile fish separator at Ice Harbor Dam, 2018.

Date	Species Group	Condition
2-Apr	Clipped steelhead	Good
21-May	Clipped Chinook	Good
24-May	Clipped Chinook	Fair
7-Jun	Unclipped Chinook	Good
11-Jun	Clipped Chinook	Good

Main Turbine Unit Cooling Water Strainer Inspections

In 2018, the main unit turbine cooling water strainers were inspected monthly for the presence of lamprey, from January to June, and in December. Additionally, strainers were

cleaned when debris or fish created a pressure differential across the strainers . Juvenile shad clogged up the strainers quite frequently in November and December. The total number of each species group removed were approximately: three juvenile steelhead (unknown if clipped due to deterioration), three juvenile clipped steelhead, five juvenile Chinook (unknown if clipped), one adult Pacific lamprey, 270 juvenile Pacific lamprey, 94,074 juvenile American shad, and 44 Siberian prawns. The only fish found alive were a few lamprey and they were released back to the river.

The total number of juvenile Pacific lamprey that were found in the turbine cooling water strainers in each of the last ten years is shown in Figure 1. In general, there has been a trend of decreasing numbers of lamprey found in the strainers since 2010. The reason for this trend is unknown without further investigation of the strainer data, lamprey population trends, and the associated environmental condtions.

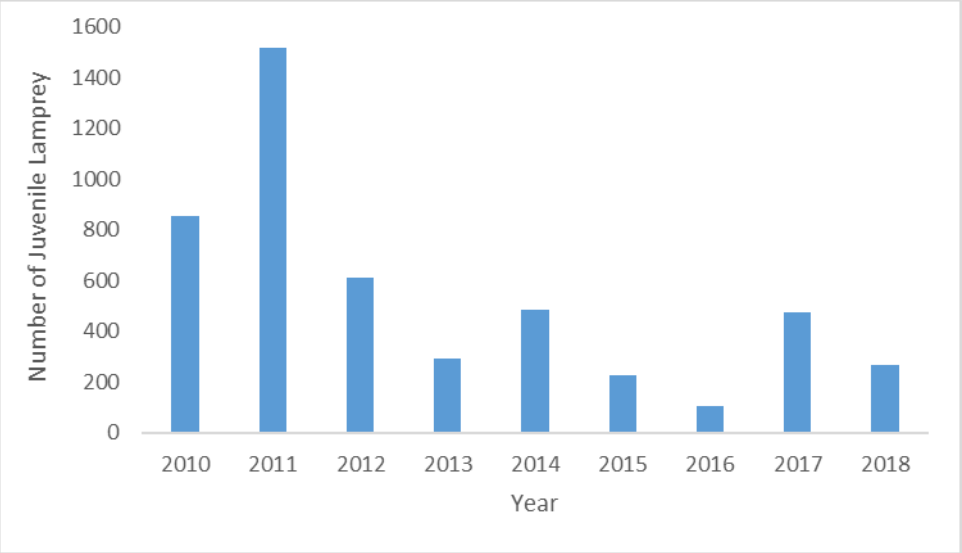

Figure 1. Yearly total number of Pacific Lamprey removed from turbine cooling water strainers at Ice Harbor Dam, 2010-2018.

One important factor that affects whether fish go into the unit cooling water is how the cooling water system is operated. At Ice Harbor, the cooling water is left on when a unit is not running, so fish that are in the scroll case when a unit is turned off may be more likely to get drawn into the cooling water intake (in the wall of the scroll case) than if the cooling water were shut off. Consequently, a unit that is started and stopped frequently may be prone to attracting fish into the cooling water intake. This could explain why juvenile shad frequently clog the strainers at Ice Harbor.

Debris/Trash Racks

In 2018, there was significant forebay debris accumulation in mid-March. Spill that was occurring was directed over the RSW to pass the debris. Forebay debris accumulated again in the middle of May and tapered off in mid-June. A daily maximum of 530 square yards of forebay debris was observed on June 5.

Main unit trash rack raking was completed the week of March 19. A couple cubic yards of debris was removed. Turbine units 1 and 3 trash racks held the most debris. Unit 1 and 3 trash racks were raked again on June 1 as a precautionary measure during a period of higher fish descaling (see Juvenile Fish Condition section above). Approximately two cubic yards of debris was removed. No fish mortalities were found on the trash racks.

Submersible Traveling Screens

Installation of the submersible traveling screens (STSs) was completed on all available units during the week of March 26, 2018. An underwater video camera was used to conduct monthly inspections of STSs that were available to run since the previous inspection occurred. Screens were examined for any condition issues which could injure fish. The STS problems found and fixed during the season are shown in Table 8. There were approximately 75 dead juvenile shad found inside 1A STS when it was raised up to patch the hole in the mesh on November 15. There were no other known fish mortalities associated with the other STS problems.

Table 8. STS problems found during inspections at Ice Harbor Dam in 2018.

Date	Unit & Slot	Screen Location	Problem	Remedy
12-Apr	4B	Gearbox	Oil leak	Replaced with spare STS
17-Apr	3A	Entire screen	Not rotating	Replaced with spare STS
15-May	6B	Seam	4’ long gap	Replaced with spare STS
20-Jun	1B	Two seams	10” long gaps	Replaced clips
17-Oct	1C	Power cable	Damaged from getting stuck in orifice	Replaced cable
17-Oct	1A	Mesh	3’ long tear	Patched mesh
15-Nov	1A	Mesh	8” diameter hole	Patched mesh

Vertical Barrier Screens

Project personnel inspected the vertical barrier screens (VBSs) while conducting STS inspections. A different turbine unit’s VBSs were inspected each month until they were all inspected. No problems were found with the VBSs this season.

Gatewells

Gatewell slot debris was moderate at Ice Harbor Dam in 2018 and never approached the 50% coverage criteria point for mandatory cleaning. Slots were dipped for debris removal prior to installing the STSs.

Orifices/Collection Channel

During the 2018 season, the collection channel was typically operated with 20 orifices open. At least one orifice was open in each gatewell slot, with the following exceptions. Both orifices were closed in individual gatewells for brief periods during the season to accommodate routine maintenance and repair, such as backflushing, STS inspections, and STS repair. On November 9, unit 3 orifices were closed for STS removal and to accommodate unwatering unit 3 to prepare for the runner replacement. Orifices in gatewells 3A and 3B were re-opened on November 21, while 3C orifices remained closed and gatewell 3C stayed unwatered through December 15. Unit 6 was out of service, and the orifices were closed on December 11 for STS removal. Unit 6 orifices stayed closed through December 15.

Orifices were routinely cycled and backflushed by powerhouse operators and fish facility personnel. During periods of higher fish and debris loads (April 1 through July 31), the orifices were backflushed and cycled three times per day. There were no clogged orifices noted by fish facility personnel or powerhouse operators. Orifice lights were checked daily and replaced when required.

Primary Dewatering Structure

During the 2018 winter maintenance period, all of the water regulating weirs were discovered to have deteriorating connection brackets. This condition resulted from electrolysis caused by dissimilar metals being in direct contact with each other. Water regulating weir #10 was found to have its operating stem broken off at the connection bracket. A new weir and bracket were fabricated and installed in its place. On May 1, the operating stem was found to be disconnected from weir #10 again and the weir was sitting low in the guide slots. During the fish season, the other weirs automatically operated approximately 5% higher than normal to compensate for the inoperable weir and properly control the water level. Weir #10 was repaired and five of the deteriorating weirs were replaced during the winter of 2020. The remaining four weirs will be replaced during the winter of 2021.

The primary dewatering mechanical screen cleaner performed fairly well in 2018. The travel cable had to be replaced on June 7, due to observed fraying. The screen cleaner sheaves were replaced periodically during the fish season due to wear.

The juvenile fish channel, including the primary dewatering structure, was unwatered for 2019 winter maintenance on December 21, 2018. The composition of fish recovered was one unclipped adult chinook, ten clipped adult steelhead, four unclipped adult steelhead, one clipped juvenile steelhead, and two channel catfish. Fish were released in good condition at the Levey Park boat ramp.

Sampling System

The sampling system functioned well this season with no maintenance problems associated with sampling equipment.

Removable Spillway Weir

The spill season for fish passage was April 3 to August 31, 2018. In accordance with Fish Passage Plan, the removable spillway weir (RSW) was operated until August 18, when the average daily project outflow declined below 30 kcfs and the inflow was forecasted to stay below 30 kcfs for three consecutive days. The RSW had no operational problems in 2018.

Avian Predation

The U.S. Department of Agriculture (Wildlife Services) utilized pyrotechnics to conduct land-based hazing of piscivorous birds from April 2 to June 30, 2018. In addition, boat-based hazing occurred from April 8 to June 9. Bird deterrent structures at the project include roosting deterrents, a water cannon at the juvenile fish bypass outfall pipe, and a wire array in the tailrace. Propane cannons are available to deploy as additional aids to harass birds in areas where there are continual predation problems. Piscivorous bird counts were conducted daily from April 2 to June 30, and four days per week in July (Figure 2), to track whether the harassment/deterrent program remained effective at reducing bird abundance around the dam. Land-based hazing was effective at pushing birds away from the immediate vicinity of the dam. The boat-based hazing was particularly effective at further removing birds from the downstream spillway tailrace zones. Gulls and cormorants were abundant during the smolt run in April and May, then the bird numbers decreased in June. However, in July their numbers increased again. The gulls and cormorants may have keyed in on the juvenile shad run in the late summer through the end of the year. American white pelicans were often the most numerous piscivorous bird observed around the dam from April to July. The pelicans could not be targeted for hazing because they are a species of concern in Washington State. Tern and grebes were only occasionally spotted in low numbers.

Overall, the average of daily gull and cormorant counts per week in 2018 was similar to that of the previous three years during April and May. However, gull and cromorant numbers were lower in 2017 and 2018 than in 2015 and 2016 during the months of June and July (see Table 9). River flow was higher in 2017 and 2018, with turbid water conditions extending into June and early July, which may have reduced foraging success for these birds. The avian abundance action trigger for increasing hazing efforts (see the Ice Harbor section of Appendix L of the Fish Passage Plan) was reached on eight days during the spring. The incidences of reaching action tigger points to increase hazing efforts were generally isolated events and not on continuous days. Gulls and cormorants were spread out in different observation zones during these events and were not targeting a specific fish passage route. The scheduled hazing effort and methods already in use adequately reduced spikes in bird numbers.

The bird-deterrent hydrocannon at the juvenile fish bypass outfall pipe was turned off on November 25, 2018, and it was left off for the remainder of the juvenile fish passage season. The water line for the hydrocannon had been leaking from one of the couplings. As a result, the amount of water shooting from the hydrocannon was greatly reduced, diminishing its effectivenss at repelling birds. The pump may have burned out if it was left on and went dry with the big leak on the water line. No birds were observed at the vicinity of the outfall pipe for the remainder of the season.

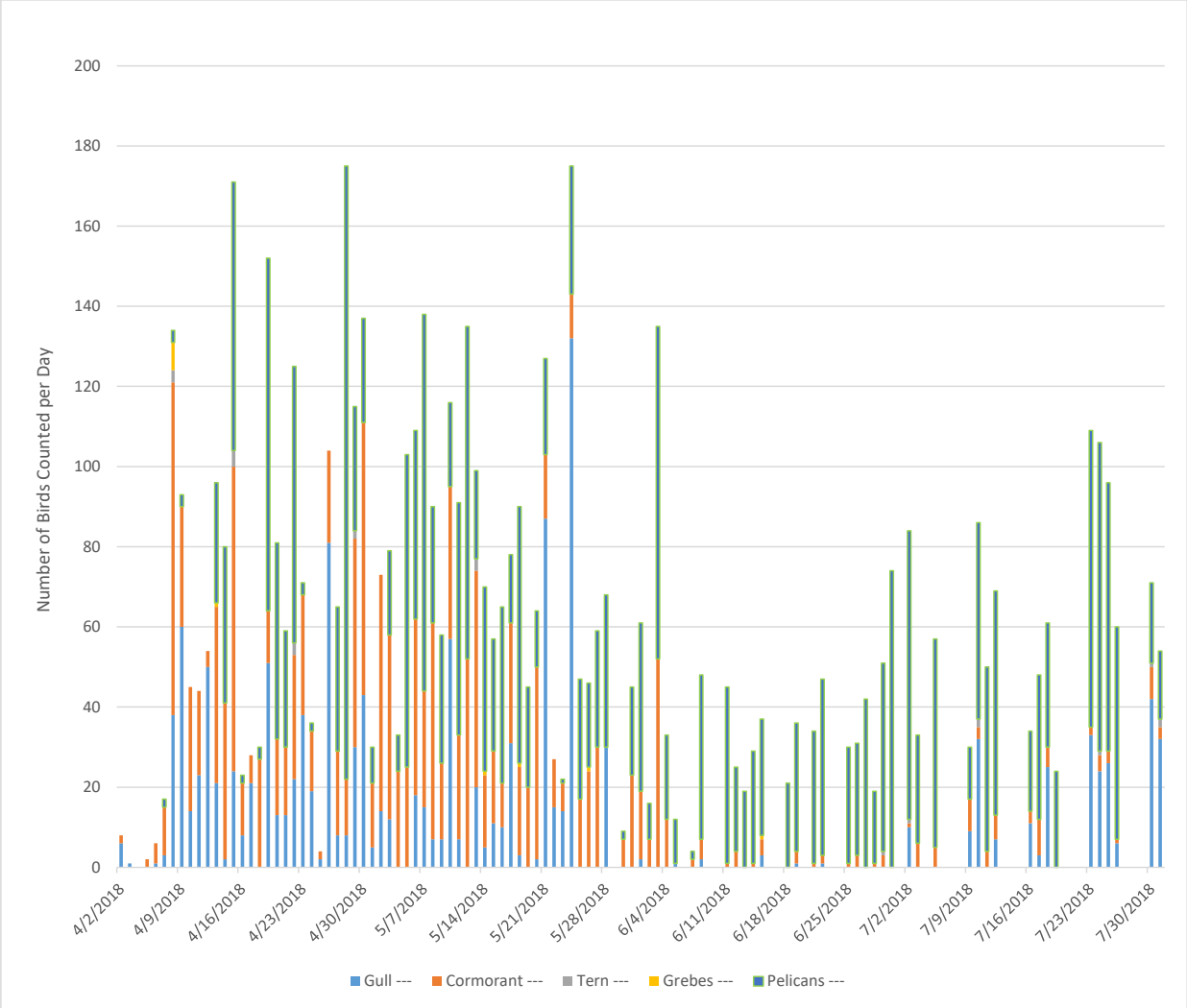

Figure 2. Daily number of piscivorous birds counted at Ice Harbor Dam, 2018.

Table 9. 2015-2018 daily counts of gulls, cormorants, and terns averaged per week at Ice Harbor Dam.

Dates	2015	2016	2017	2018
April 3-9	8	15	16	34
April 10-16	16	52	36	53
April 17-23	51	62	52	44
April 24-30	44	58	30	55
May 1-7	37	66	35	33
May 8-14	61	73	62	52
May 15-21	50	28	36	44
May 22-28	37	27	13	42
May 29- June 4	27	22	10	17
June 5-11	20	19	3	2
June 12-18	16	17	4	2
June 19-25	13	19	5	1
June 26-July 2	57	20	1	3
July 3-9	45	22	2	4
July 10-16	48	41	13	10
July 17-23	47	29	11	11
July 24-30	67	42	24	17

Recommendations for the Juvenile Fish Facility

1. Finish replacing the old deteriorating water regulating weirs and associated connection brackets in the primary dewatering structure.
2. Repaint the interior of the juvenile fish bypass pipe/flume and separator exit flume. The inside surfaces of the pipe and flumes have peeling paint and corroded areas, which created rough spots that could possibly descale or injure fish.
3. Extend the air bubbler screen cleaning system under the entire unwatering floor screen in the primary dewatering structure. This system would serve as a reliable extra cleaning system in the event of failure of aging components of the mechanical screen cleaner.
4. Install a crowding mechanism in the juvenile collection channel that would encourage adult fish to exit.
5. Replace the outfall pipe hydrocannon black iron water line with stainless steel to prevent corrosion. Install a walkway alongside the outfall pipe to provide access to the outfall pipe and hyrocannon water line to conduct inspections and maintenance.

6. Install a fish release chute connecting to the main bypass pipe donstream of the JFF lab. This would permit fish rescued during certain unwatering events to be more easily returned to the tailrace via the bypass pipe.
7. Install stairs on the hillside to provide a direct and safe walking path between the JFF and tailrace deck level.
8. Pave the road and parking area inside the JFF and provide curbing that would direct any water runoff away from the juvenile facility and the hillside. Pavement would provide stable ground for heavy equipment access and setup as needed to perform maintenance and repairs.

Research

Pacific Northwest National Laboratory (PNNL) researchers operated the adult fish trap to capture adult spring chinook ascending the south fish ladder. The fish were tagged with passive integrated transponder tags and acoustic tags, and released in the Snake River at Levey Park. PNNL researchers tracked the fishes' migration upstream for a Little Goose Dam fish passage study.

ADULT FISH FACILITY

Operations and Maintenance

The south shore fish ladder (SFL) and north shore fish ladder (NFL) were operated for fish passage for most of the year. The fish ladders were unwatered one at a time for annual winter maintenance in January and February. In 2018, adult fish counting occurred from March 1 to December 31. The number of adult salmonids and adult lamprey counted passing Ice Harbor Dam, for each fish ladder, is shown in Table 10. For all species groups, except for lamprey, the SFL was used much more than the NFL. The total counts for each species group, except lamprey, were well below the previous ten years' average

Table 10. Number of adult fish passing Ice Harbor Dam in 2018, and average of previous ten years.

	Chinook	Chinook Jack	Steelhead Clipped	Steelhead Unclipped	Sockeye	Coho	Coho Jack	Lamprey
SFL	45,968	6,886	32,579	9,359	244	1,298	262	456
NFL	9,420	570	4,846	1,478	138	12	8	563
Total (SFL + NFL)	55,388	7,456	37,425	10,837	382	1,310	270	1,019
Ten-Year Avg. (SFL + NFL)	128,423	32,990	120,312	42,786	993	4,495	404	531

The upper SFL was unwatered for inspection and maintenance from January 3 to February 2, 2018. One clipped adult steelhead was removed from the flow-control section of the upper fish ladder, and released in good condition into the forebay off of the navigation lock guide wall. Other fish were evacuated down to tailwater level in the ladder. There were 11

juvenile chinook mortalities, most or all being unclipped, observed at that location the next morning. They were presumed to have died from being stressed from inadequate flush water during the fish evacuation procedure. Steps will be taken to ensure that the upper diffuser valve is set to provide enough water during future unwatering events. The lower SFL (channel) was video-inspected from a boat, and the diffuser grating was observed to be intact. The upper diffuser (diffuser #12) grating has deteriorated sections with holes that were patched in previous years. In 2018, additional holes were patched with pieces of perforated plate. All of the diffuser 12 grating was replaced in kind with spare galvanized grating in 2020.

The NFLwas unwatered from February 6 to February 28, 2018. One clipped adult steelhead was removed from the flow-control section of the upper fish ladder, and released in good condition into the forebay off of the navigation lock guide wall. There was a fair amount of debris in the flow-control section partially obstructing some of the salmon orifices and totally plugging most of the lamprey orifices. The lower NFL was partially unwatered for personnel to walk the channel and inspect the diffuser grating, which was observed to be in good shape. There was excessive water leakage into the ladder past bulkheads and valves that delayed unwatering until the leakage could be reduced. Maintenance work performed on both ladders included: debris removal, cleaning picketed leads and staff gages, adult fish counting/viewing window cleaning, and maintenance of auxiliary water supply pumps.

Some of the tailwater staff gauges are in disrepair, and replacement of these gauges may require divers to install. The cleaning of dirty tailwater and channel staff gauges either require personnel access via a crane and man basket, or entry into the channel during the winter maintenance period. The Project Biologist is coordinating with maintenance staff at the dam for assistance with cleaning these staff gauges and replacement of damaged gauges.

Summary of Fish Recovery Operations

Areas that were unwatered in 2018 that required Fish Facility personnel presence for possible fish rescue/evacuation are listed in Table 11. The total number of fish handled during unwatering events in 2018 was 52. The species composition of fish handled is shown in Table 11.

Table 11. Areas at Ice Harbor Dam unwatered in 2018 requiring possible fish removal.

Date	Unwatering Activity	Fish Removed and Released in the River[1]
3-Jan	Upper south fish ladder	1 clipped steelhead
22-Jan	Unit 4 scroll case	None
6-Feb	Upper north fish ladder	1 clipped steelhead, 1 crayfish
22-Feb	Lower north fish ladder	None
17-Oct	Unit 4 tailrace stoplogs	1 juvenile white sturgeon
5-Nov	Unit 4 scroll case	20 juvenile white sturgeon, 2 channel catfish
17-Dec	Unit 3 tailrace stoplogs	1 yellow perch, 1 sucker, 3 crayfish, 3 Siberian prawns
21-Dec	Juvenile fish channel	10 clipped steelhead, 4 unclipped steelhead, 1 unclipped chinook, 1 juvenile clipped steelhead, 2 channel catfish

[1]Fish were adults unless noted as juveniles

Adult Fish Trap Operation

In 2018, PNNL personnel operated the adult fish trap in the SFL to capture spring chinook for the Little Goose Dam adult fish passage study.

Auxiliary Water Supply

The auxiliary water supply (AWS) pumps were operating or available for operation to help maintain fish entrance criteria in 2018, with the exceptions listed below in Table 12. AWS pumps were turned off, taken out of service, or forced out of service during the fish passage season to facilitate maintenance, operations, or emergency repairs (Table 12). Five to eight AWS pumps were operated to maintain criteria in the south fish ladder, depending on tailwater elevation. Two AWS pumps were operated to maintain criteria in the NFL. In-season maintenance and minor repairs can be performed on the pumps that are in standby. Each north shore pump operates at 350 cfs and each south shore pump operates at 300 cfs. In addition, approximately 270 cfs of excess water from the juvenile fish collection channel is added to the south shore AWS pump discharge chamber.

Table 12. AWS pump outages and significant events requiring pumps to be shut off at Ice Harbor Dam in 2018.

Date	Pump Number (#), or How Many Pumps Affected	Pump Outage Description or Reason for Turning Off	Duration that entrance head/depth was out of criteria
Mar. 26	All SFL pumps	Operator turned off to reduce water pressure against SFE-1 to enable lowering entrance weir into criteria	Few minutes
June 12	SFL #1	Changed oil	In criteria
June 13-14	SFL #2	Changed oil	In criteria
June 25	All SFL pumps	Operator turned off to reduce water pressure against SFE-1 to enable lowering entrance weir into criteria	<30 minutes
Nov. 28 – Dec. 31	NFL #1	Breaker tripped off due to a bad relay	16.8 hours
Dec. 5	Five to eight SFL pumps, three NFL pumps	Operator turned off to reduce power demand during loss of station service and subsequent switching of power feeds	SFL – 66 minutes NFL – 81 minutes
Dec. 17	NFL #3	Tripped off due to grease system failure	39 minutes

Adult Fishway Inspections

Visual inspections

Ice Harbor project fisheries personnel conducted visual inspections of the fish ladders during the adult fish passage season of March 1 to December 31, 2018. In addition, the powerhouse operators conducted daily limited inspections of the fishways. Fish facility staff averaged 3.0 fishway inspections per week with 132 inspections completed. The inspections were conducted by visually inspecting various areas of the fishways and recording readings from

staff gages, fishway entrance hoists motor selysns, meters, and tape measures. The data was subsequently transferred to a computer spreadsheet (Appendix 1). Fisheries staff also collected data on flow discharge, AWS pump operation, and juvenile fish orifice operation. In addition, estimates of the amount of debris that accumulated in the forebay, fish ladder exits, and gatewells were made. When the fishway was out of criteria, the powerhouse operator was notified to make adjustments to the fishway control system or arrange for repairs as needed. The combined fish passage data collected was used to compose weekly reports on the status of the fish facility operations and maintenance (See Ice Harbor section 2.5.2 of the 2018 Fish Passage Plan).

Automated Fishway Control System

In the 2018 fish season, water levels were automatically measured with a sonar-based level sensing system manufactured by Milltronics using the Multi Ranger model. A Programmable Logic Control Center (PLC) processed the signals from the Multi Ranger and displayed the readings on a panel in the control room. The PLC interfaces with process level controllers to raise or lower the three entrance weir gates in service as needed. The remote terminal units control the fishway weir gates according to set points that either control the gates at a depth below tailwater or a channel to tailwater head differential. Panels in the control room and Juvenile Fish Facility display the following information: channel and tailwater elevation in feet above mean sea level (MSL) for the north shore, north powerhouse, and south shore entrances; elevation in feet above MSL for the weir gates; water depth at the gates; channel/tailwater differential; and set points for the gate depths and the channel/tailwater differential.

The readings from the automated fishway control system were compared to the visual inspection results to ensure that the readings were comparable and the fishways were operated within criteria. Any significant discrepancies between the readings were reported to the electricians for calibration. The time difference between reading a staff gage and checking the PLC display may have been as much as 120 minutes. The time difference between the automated and visual readings may give different inspection results due to operational changes, such as changing spill volumes, switching units, and water elevation fluctuations.

Inspection Results

Adult fishway inspection results for 2018 are shown in Table 13. Deviations from criteria can be caused by fluctuating water elevations readings at the staff gages during spill. Observable water elevations can vary as much as one foot on either side of the average elevation, which significantly contributes to incorrect visual readings falsely indicating an out of criteria event. Another contributor to out of criteria events are misread staff gauges that are difficult to read because they are dirty or damaged. When a staff gauges become unreadable or is missing, a tape measure is used to measure the distance to the water from the deck to calculate water elevations. The use of a tape measure increases the chances of human error to obtain the measurements. Another consideration is the location of the staff gages in relationship to the water level sensing transducer. Some staff gauges are located at least several feet from the corresponding transducers. This condition makes accurate calibration impossible due to the

relationship between the sensing equipment and the staff gage not being linear. The suitability of the present locations of the staff gauges and transducers for providing representative water surface elevations will be further evaluated.

Channel Velocity: The water velocity in the south shore channel junction pool was below criteria [criteria of 1.5-4.0 feet per second (fps)] on 6.8% of the inspections. When the tailwater and channel elevations are higher during periods of high river flows, more of the stationary weirs in the fish ladder are submerged, slowing the velocity of the water coming down the ladder into the junction pool. The out of criteria readings ranged from 0.5-1.4 fps, and occurred mostly in April.

Ladder Exits: The north and south fish ladder exit head differentials were in criteria (≤0.3 feet) during all inspections. There were no significant debris accumulations on the ladder exit trash racks causing the differentials to get above 0.2', and they were typically 0.1' or less.

Ladder Weirs: The depth over the stationary weirs in both fish ladders were in criteria (1.0-1.3 feet) on all fishway inspections. In July, the upper diffuser valve (diffuser #10) in the north fish ladder was observed to be operating further open than usual in automatic mode to meet the criteria for the depth over the weirs. On July 30, 2018, a video camera inspection of the diffuser valve intake showed a mat of sticks stuck on the trash rack that was probably reducing flow to the diffuser. During the 10 minutes of the video inspection, diffuser #10 was shut off and the depth over the weirs was briefly below criteria. The trash rack is recessed in from the end of the deck, making it difficult to access with a rake. The flow from the diffuser was still adequate to meet criteria for the rest of the season. The debris on the trash rack was blown off with an air hose during the 2020 winter maintenance period.

Counting Stations: The differential across the north shore picketed leads was in criteria (≤0.3 feet) on all inspections. The differential across the south shore picketed leads was out of criteria (criteria of ≤0.3 feet) on one inspection, due to the buildup of filamentous algae on the leads. The leads were cleaned later that day. From mid-summer to early fall, periodic cleaning of the south shore picketed leads up to several times a day was necessary to keep the differential in criteria.

South Shore Entrance (SFE-1): The SFE-1 weir gate depth was in criteria (≥ 8 feet or on sill) on 93.2% of inspections. The weir gate was in sill criteria on 40.9% of inspections, primarily when tailwater was lower from mid-summer to the end of the year. Four out of criteria depths resulted from the weir gate intermittently tripping off on overload, including a depth of 4.3 feet when the gate was being test-operated by electricians to diagnose the problem. Three other out of criteria occurrences can be attributed to setpoints or limits of the automated control system needing to be adjusted. Two slightly low depth readings were attributed to the south shore tailwater transducer needing to be calibrated and operating only five south shore AWS pumps. SFE-2 was opened in place of SFE-1 from March 22 to March 26, 2018, so that a faulty limit switch for SFE-1 could be replaced.

North Powerhouse Entrance (NFE-2): The NFE-2 weir gate depth was in numerical or sill criteria (≥ 8 feet or on sill) for the same percentage of inspections as SFE-1. Almost all of the

out of criteria depths occurred because the gate was in manual control and operations personnel did not notice that the tailwater elevation had gone down. NFE-2 gate was operated in manual control rather than automatic mode during most or all of the spill season to reduce the wear and tear on the gate machinery. When the weir gates are in automatic mode the machinery can become damaged from repeatedly operating to adjust to the fluctuating tailwater level caused by spill.

North Shore Entrance (NEW-1): The NEW-1 weir gate depth was in criteria (≥ 8 feet or on sill) on 91.0% of inspections. The weir gate was in sill criteria on 45.5% of inspections. The majority of the out of criteria depths at this entrance was due to the gate being in manual control and the tailwater level going down, as occurred at NFE-2. At least three of the depths that were reported out of criteria were most likely the result of the north shore tailwater transducer needing calibration.

Fish Collection Channel/Tailwater Head Differential: The south shore entrance channel/tailwater head differential was in criteria (1 - 2 feet) on 97.0% of inspections. Two of the lower out of criteria head differentials were caused by the SFE-1 weir gate tripping off on overload and the subsequent test-operation of the gate. The other two criteria breaches may be attributed to the south shore tailwater transducer needing calibration, and observer error when reading the staff gauges.

The north powerhouse entrance head differential was in criteria (1-2 feet) on 94.7% of inspections. The seven deviations were below criteria, and almost all of them may have resulted from the difficulty of the observer getting an accurate staff gauge reading with the turbulent north powerhouse tailwater conditions during spill, or due to dirty staff gauges. One of the deviations was attributed to only five south shore AWS pumps operating.

The north shore powerhouse entrance head differential was in criteria (1-2 feet) on 89.4% of inspections. Five of the out of criteria differentials were due to the NEW-1 weir gate being in manual control because of the spill and operations personnel not noticing that the tailwater elevation changed. Five criteria breaches were attributed to the difficulty of getting an accurate staff gauge reading with the turbulent north shore tailwater conditions during spill, or observer error when using the tape measure to calculate the north shore tailwater elevation. The other occurrences were probably due to the north shore tailwater transducer being out of calibration, only one north shore AWS pump operating, and the north fish channel diffusers being only half-way open at lower tailwater elevations.

Table 13. Adult Fishway Inspection Results at Ice Harbor Dam, 2018

Criteria and Locations	No. in Numerical Criteria/ No. in Sill Criteria/ No. of Inspections	% In Numerical Criteria/ % in Sill Criteria	Not Enough Depth/Differential			Too Much Depth/Differential		
			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
	123	93.2	***	***	***	***	***	***
Channel Velocities	***	***	***	***	***	***	***	***
	132							
Differentials								
South Fish Ladder								
	132	100.0	***	***	***	0	0	0
Ladder Exit	***	***	***	***	***	0.0	0.0	0.0
	132							
	132	100.0	0	0	0	0	0	0
Ladder Weirs	***	***	0.0	0.0	0.0	0.0	0.0	0.0
	132							
	131	99.2	***	***	***	1	0	0
Counting Station	***	***	***	***	***	0.8	0.0	0.0
	132							
North Fish Ladder								
	132	100.0	***	***	***	0	0	0
Ladder Exit	***	***	***	***	***	0.0	0.0	0.0
	132							
	132	100.0	0	0	0	0	0	0
Ladder Weirs	***	***	0.0	0.0	0.0	0.0	0.0	0.0
	132							
	132	100.0	***	***	***	0	0	0
Counting Station	***	***	***	***	***	0.0	0.0	0.0
	132							
Collection Channels								
	128	97.0	0	0	0	2	1	1
South Shore Entrance	***	***	0.0	0.0	0.0	1.5	0.8	0.8
	132							
North Powerhouse Entrance	125	94.7	2	1	4	0	0	0
	***	***	1.5	0.8	3.0	0.0	0.0	0.0
	132							
	118	89.4	1	1	3	3	1	5
North Shore Entrance	***	***	0.8	0.8	2.3	2.3	0.8	3.8
	132							
Weir Depths								
	69	52.3	2	0	7	***	***	***
SFE-1	54	40.9	1.5	0.0	5.3	***	***	***
	132							
	69	52.3	1	0	8	***	***	***
NFE-2	54	40.9	0.8	0.0	6.1	***	***	***
	132							
	60	45.5	0	1	11	***	***	***
NEW-1	60	45.5	0.0	0.8	8.3	***	***	***
	132							

Recommendations for the Adult Fish Facility

1. Continue to repair south fish ladder mud valves in the auxiliary water supply conduit to facilitate unwatering the lower ladder for inspection and maintenance.
2. Remove the accumulated silt in the south shore AWS conduit that is clogging the mud valves and blocking access to some of the mud valves and sluice gates for inspection and maintenance.
3. Rehabilitate fish ladder entrance weir gates and hoisting equipment.
4. Install a handrail along the outside edge of the north and south shore fish ladders to allow routine in-season inspection of the entire fish ladders and to facilitate safer unwatering and fish evacuation procedures for personnel.
5. Replace the debris booms and attachment systems at the north and south shore fish ladder exits. The log booms are prone to detachment under high winds.
6. Proactively replace fish ladder diffuser grating as needed.
7. Replace broken/dirty staff gauges and guides so that the gauges are easier to clean and read.
8. Relocate staff gages and transducer units as needed so the staff gage and the automated fishway control system readings will be more precise.
9. Install an audible alert on the automated control system PLC when the fish ladder entrance criteria is not being met.
10. Initiate a contract to repair leaks in the fish ladder joints.