CENWW-ODH FONE April, 2024

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

FOR Chief, Operations Division
ATTN: Chris Peery

SUBJECT: Submission of 2022 Adult and Juvenile Fish Facility Monitoring Report, Ice Harbor Dam.

1. Enclosed is the 2022 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

2022 ADULT AND JUVENILE FISH FACILITY MONITORING REPORT

ICE HARBOR DAM

Prepared by:

Kenneth R. Fone

Project Fisheries Biologist

and

Ben McArthur

Fisheries Technician

U.S. Army Corps of Engineers

April, 2024

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INTRODUCTION

This report summarizes the operation and maintenance of the adult and juvenile fish passage facilities at Ice Harbor Dam in 2022. 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 for the ladder. 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 (AWS) 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 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 AWS 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 AWS pump discharge chamber from March 24 through December 14, 2022.

RIVER CONDITIONS

Daily Ice Harbor outflows averaged 42.9 thousand cubic feet per second (kcfs) in 2022, with a peak outflow of 212.4 kcfs occurring on June 12, compared to a peak of 91.6 kcfs occurring in 2021. Spill for juvenile fish passage began on April 3 and continued through August 31. Daily spill during that period averaged 18.1 kcfs, with a maximum daily spill of 144.0 kcfs occurring on June 12. River temperatures taken from unit 1 scroll case ranged from 37 °F in late January to 71 °F in late August. Raw water temperatures taken from the juvenile fish facility laboratory (JFF) ranged from 47.7 °F to 68.0 °F during the juvenile fish sampling period of April 4 to July 18.

JUVENILE FISH FACILITY OPERATIONS AND MAINTENANCE

Sampling Summary

The juvenile fish bypass was operated from March 24 to December 14, 2022. 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 2022 began on April 4 and ended on July 18. 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.

A total of 3,490 juvenile salmon and steelhead were sampled at the Ice Harbor Dam JFF in 2022 (Table 1), which was a 7.42% increase in comparison to 2021 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 142 non-target fish (incidental species) were released from the separator or sampled in 2022 (Table 3). These incidental fish were identified, recorded, and released back into the river via the bypass. Siberian prawns and juvenile lamprey were the most commonly encountered incidental species during sampling events in 2022. 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.

Daily numbers for salmon and steelhead 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 of each species group with descaling) in 2022 are shown in Tables 4A and 4B. The combined annual descaling rate for all salmon and steelhead sampled was 1.5%, which was less than the annual descaling rate of 2.5% in 2021 (Table 5). Sampling personnel attributed descaling to predators (mostly birds) 9.6% of the time in 2022. In 2022, the highest descaling rate was 4.1% on July 11 (Table 4B).

A variety of other injuries were observed on sample fish. In general, the incidence, rate, and location of injuries on fish throughout the sampling season appeared to be random, that is, there did not appear to be a specific cause or source of injuries observed. From June 23 to the end of the sampling season, 4.8% to 9.3% of the sample fish exhibited fin hemorrhaging, mainly in the pelvic fins. Most of these fish did not have fin injuries associated with the hemorrhages.

Table 1. Number of juvenile salmon and steelhead sampled per day at Ice Harbor Dam, 2022.

	Yearling Chinook		Sub-Yr Chinook		Steelhead		Sockeye/Kokane		All	Daily
Date	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Total
4-Apr	88	2	0	0	0	1	0	0	0	90
7-Apr	37	2	0	0	1	2	0	0	0	42
11-Apr	81	5	0	0	21	8	0	0	0	115
14-Apr	43	7	0	0	74	16	0	3	0	143
18-Apr	47	15	0	0	67	14	0	1	0	144
21-Apr	7	1	0	0	39	5	0	2	0	54
25-Apr	30	8	0	0	45	3	0	2	0	88
28-Apr	22	5	0	0	55	8	0	0	0	90
2-May	24	9	0	0	94	9	0	0	0	136
5-May	12	5	0	0	86	6	0	0	0	109
9-May	32	7	1	0	83	8	0	0	1	132
12-May	26	0	0	0	100	12	0	0	1	139
16-May	18	2	0	2	78	15	1	0	0	116
19-May	64	5	0	4	53	17	4	1	0	148
23-May	47	2	0	1	70	23	2	0	1	146
26-May	34	5	0	1	61	37	0	0	1	139
30-May	39	9	7	15	65	30	0	0	4	169
2-Jun	55	13	12	14	36	17	0	0	3	150
6-Jun	3	0	29	48	16	13	0	0	1	110
9-Jun	3	4	44	44	9	2	0	0	0	106
13-Jun	1	1	50	51	14	8	0	0	1	126
16-Jun	2	3	27	31	4	0	0	0	0	67
20-Jun	0	0	0	2	0	0	0	2	0	4
23-Jun	0	4	34	59	43	7	1	0	0	148
27-Jun	2	0	34	69	44	6	0	0	0	155
30-Jun	0	1	33	81	10	1	0	1	0	127
5-Jul	0	6	27	63	12	1	0	0	0	109
7-Jul	0	0	32	59	6	0	0	0	0	97
11-Jul	0	0	32	65	0	0	0	0	0	97
14-Jul	0	0	40	56	1	0	0	0	0	97
18-Jul	0	0	31	65	0	0	0	0	0	96
Totals	717	121	433	730	1,187	269	8	12	13	3,490
% Totals	20.54	3.46	12.40	20.91	34.01	7.70	0.23	0.34	0.37	---

[1]Includes unclipped hatchery reared fish

Table 2. Number of juvenile salmon and steelhead sampled at Ice Harbor Dam, 2018-2022.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All	
Year	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Total
2018	619	333	363	545	948	264	31	18	38	3,159
2019	748	331	552	680	1,082	270	71	5	32	3,771
2020	1,025	279	356	598	1,022	229	7	0	2	3,518
2021	1,050	210	369	524	875	166	7	19	29	3,249
2022	717	121	433	730	1,187	269	8	12	13	3,490

[1]Includes unclipped hatchery reared fish

Table 3. Collection of incidental species during sampling at Ice Harbor Dam, 2022.

Common Name	Scientific Name	Number of Fish
Lamprey	*Lampetra tridentatus*	65
Walleye	*Sander vitreus*	8
Siberian Prawn	*Exopalaemon modestus*	198
Yellow Perch	*Perca flavescens*	25
Smallmouth Bass	*Micropterus dolomieu*	10
American Shad	*Alosa sapidissima*	1
Crappie	*Pomoxis Sp.*	3
Mountain Whitefish	*Prosopium williamsoni*	1
Bridgelip Sucker	*Catostomus columbianus*	1
Bluegill	*Lepomis macrochirus*	1
Total		142

Total sample percent mortality for all salmon and steelhead groups combined was 0.1% in 2022, compared to 0.6% in 2021 (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. Two clipped yearling chinook came into the separator already dead and appeared to have been dead for several days.

Adult Salmonid Fallbacks

Typically, there are few adult fish that fall back and are released from the separator at Ice Harbor, because of the limited operation of the separator and juvenile fish sampling. All of the 2022 fallbacks were in good or fair condition (Table 7).

Main Turbine Unit Cooling Water Strainer Inspections

In 2022, the main unit turbine cooling water strainers were inspected monthly for the presence of lamprey from February to July and in December (the Project Fishery Biologist forgot to request January inspections). Additionally, strainers were cleaned when debris or fish created a pressure differential across the strainers in October, November, and December. Juvenile shad were abundant during November and December inspections. The total number of each species group removed were approximately: 230 juvenile Pacific lamprey, 12,976 juvenile American shad, 122 Siberian prawns, and four fish that could not be identified due to decomposition. The only fish found alive was a single lamprey which was released back to the river.

Table 4a. Number of sampled salmon and steehead with descaling at Ice Harbor Dam, 2022.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All	
Date	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Total
4-Apr	1	0	---	---	---	0	---	---	---	1
7-Apr	0	0	---	---	0	0	---	---	---	0
11-Apr	0	0	---	---	0	1	---	---	---	1
14-Apr	0	0	---	---	1	1	---	---	---	2
18-Apr	0	1	---	---	1	2	---	---	---	4
21-Apr	0	0	---	---	1	0	---	---	---	1
25-Apr	0	0	---	---	0	0	---	---	---	0
28-Apr	0	0	---	---	1	0	---	---	---	1
2-May	0	0	---	---	2	0	---	---	---	2
5-May	0	0	---	---	0	0	---	---	---	0
9-May	0	0	0	---	2	0	---	---	0	2
12-May	1	---	---	---	3	0	---	---	0	4
16-May	0	0	---	---	3	0	0	---	0	3
19-May	0	0	---	0	0	0	0	0	---	0
23-May	0	0	---	0	0	2	0	---	0	2
26-May	1	0	---	0	1	0	---	---	0	2
30-May	0	1	0	0	2	0	---	---	0	3
2-Jun	0	0	0	0	2	1	---	---	0	3
6-Jun	0	---	1	0	0	0	---	---	0	1
9-Jun	0	0	1	1	0	0	---	---	---	2
13-Jun	0	1	1	1	2	0	---	---	0	5
16-Jun	0	0	0	0	0	---	---	---	---	0
20-Jun	---	---	---	0	---	---	---	0	---	0
23-Jun	---	1	0	0	0	0	0	---	---	1
27-Jun	0	---	1	0	0	1	---	---	---	2
30-Jun	---	0	0	0	0	0	---	0	---	0
5-Jul	---	0	0	2	1	0	---	---	---	3
7-Jul	---	---	0	0	1	---	---	---	---	1
11-Jul	---	---	2	2	---	---	---	---	---	4
14-Jul	---	---	0	0	0	---	---	---	---	0
18-Jul	---	---	1	1	---	---	---	---	---	2
Totals	3	4	7	7	23	8	0	0	0	52

--- 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, 2022.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All	
Date	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Total
4-Apr	1.1	0.0	---	---	---	0.0	---	---	---	1.1
7-Apr	0.0	0.0	---	---	0.0	0.0	---	---	---	0.0
11-Apr	0.0	0.0	---	---	0.0	12.5	---	---	---	0.9
14-Apr	0.0	0.0	---	---	1.4	6.3	---	---	---	1.4
18-Apr	0.0	6.7	---	---	1.5	14.3	---	---	---	2.8
21-Apr	0.0	0.0	---	---	2.6	0.0	---	---	---	1.9
25-Apr	0.0	0.0	---	---	0.0	0.0	---	---	---	0.0
28-Apr	0.0	0.0	---	---	1.8	0.0	---	---	---	1.1
2-May	0.0	0.0	---	---	2.1	0.0	---	---	---	1.5
5-May	0.0	0.0	---	---	0.0	0.0	---	---	---	0.0
9-May	0.0	0.0	0.0	---	2.4	0.0	---	---	0.0	1.5
12-May	3.8	---	---	---	3.0	0.0	---	---	0.0	2.9
16-May	0.0	0.0	---	---	3.8	0.0	0.0	---	---	2.6
19-May	0.0	0.0	---	0.0	0.0	0.0	0.0	0.0	---	0.0
23-May	0.0	0.0	---	0.0	0.0	8.7	0.0	---	0.0	1.4
26-May	2.9	0.0	---	0.0	1.6	0.0	---	---	0.0	1.4
30-May	0.0	11.1	0.0	0.0	3.1	0.0	---	---	0.0	1.8
2-Jun	0.0	0.0	0.0	0.0	5.6	5.9	---	---	0.0	2.0
6-Jun	0.0	---	3.4	0.0	0.0	0.0	---	---	0.0	0.9
9-Jun	0.0	0.0	2.3	2.3	0.0	0.0	---	---	---	1.9
13-Jun	0.0	---	2.0	2.0	14.3	0.0	---	---	0.0	4.0
16-Jun	0.0	0.0	0.0	0.0	0.0	---	---	---	---	0.0
20-Jun	---	---	---	0.0	---	---	---	0.0	---	0.0
23-Jun	---	25.0	0.0	0.0	0.0	0.0	0.0	---	---	0.7
27-Jun	0.0	---	2.9	0.0	0.0	16.7	---	---	---	1.3
30-Jun	---	0.0	0.0	0.0	0.0	0.0	---	0.0	---	0.0
5-Jul	---	0.0	0.0	3.2	9.1	0.0	---	---	---	2.8
7-Jul	---	---	0.0	0.0	16.7	---	---	---	---	1.0
11-Jul	---	---	6.3	3.1	---	---	---	---	---	4.1
14-Jul	---	---	0.0	0.0	0.0	---	---	---	---	0.0
18-Jul	---	---	3.2	1.5	---	---	---	---	---	2.1
Annual	0.4	3.3	1.6	1.0	1.9	3.0	0.0	0.0	0.0	1.5

--- 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, 2018–2022.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All	
Year	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Overall
2018	4.4	6.1	2.5	4.0	10.7	12.5	16.7	16.7	5.3	7.0
2019	3.7	2.4	3.6	2.5	5.6	8.9	1.4	0.0	3.1	4.2
2020	1.8	1.8	0.3	1.0	4.8	6.6	28.6	---	0.0	2.7
2021	2.7	1.0	0.8	1.9	3.4	4.8	0.0	0.0	3.4	2.5
2022	0.4	3.3	1.6	1.0	1.9	3.0	0.0	0.0	0.0	1.5

[1]Includes unclipped hatchery reared fish

--- No fish of this species sampled

Table 6. Annual mortality numbers and total mortality rate for salmon and steelhead sampled at Ice Harbor Dam, 2018-2022.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		All	% of
Year	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Clipped	Unclipped[1]	Coho	Sample
2018	2	3	1	0	0	1	1	0	0	0.3
2019	0	0	0	2	1	0	0	0	0	0.1
2020	6	1	0	3	3	0	0	0	0	0.4
2021	14	2	0	3	1	0	0	0	0	0.6
2022	2	0	1	0	0	0	0	0	0	0.1

[1]Includes unclipped hatchery reared fish

Table 7. Condition of adult salmonids released from the juvenile fish separator at Ice Harbor Dam, 2022.

Date	Species Group	Condition
25-Apr	Unclipped steelhead	Fair
2-May	Unclipped Chinook Jack	Good
9-May	Unclipped Chinook Jack	Good
27-Jun	Clipped Steelhead	Good
5-Jul	Clipped Chinook	Good
18-Jul	Unclipped Chinook	Good

The total number of juvenile Pacific lamprey that were found in the turbine cooling water strainers for the last five years is shown in Table 8.

Table 8. Yearly total number of Pacific Lamprey removed from turbine unit cooling water strainers at Ice Harbor Dam, 2018-2022.

Year	Total
2018	213
2019	152
2020	3,310
2021	418
2022	230

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 intake remains open 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 intake were closed. Turbine units that are started and stopped frequently may be prone to attracting fish into the cooling water intake. This is why juvenile shad are frequently found in the strainers at Ice Harbor.

Debris/Trash Racks

A maximum of 355 square yards of foreby debris was observed on Mach 29, 2022, compared to a maximum of 150 square yards observed on March 18, 2021. Main unit trash rack raking was completed the week of March 21. A total of approximately 15 cubic yards of debris was removed. No fish mortalities were found on the trash racks.

Submersible Traveling Screens

Installation of the STSs was completed on all available units (1, 2, 4, 5, and 6) on March 28, 29, and 30. An underwater video camera was used to conduct monthly inspections of STSs that ran since the previous inspection occurred. Screens were examined for any issues that could injure fish. The STS problems found and fixed during the season are shown in Table 9. Gatewell 5B STS was removed for the season on December 5 and gatewell 5A and 5C STSs were removed on December 8, as the unit was out of service for the remainder of the operating season for the juvenile fish bypass. Unit 1, 2, 4, and 6 STSs were pulled out of the water for winter maintenance on December 12 and 13.

Table 9. STS problems found during inspections at Ice Harbor Dam in 2022.

Date	Unit & Slot	Location on Screen	Problem	Remedy
13-June	1B	NA	STS motor failure	Replaced with spare STS

Vertical Barrier Screens

Project personnel inspected the VBSs while conducting STS inspections. Different turbine unit's VBSs were inspected each month until all were inspected. No significant problems were found with the VBSs in 2022.

Gatewells

Gatewell slot debris was moderate at Ice Harbor Dam in 2022 and never approached the 50% coverage criteria point for mandatory cleaning. Slots were dipped for debris removal as needed prior to installing the STSs.

On several occasions throughout the summer and fall, A light oil sheen was observed in gatewell slots particularly 5B, and rarely slots 5C, 6B, and 6C. Whenever this occurred, an oil skimmer was deployed into the head gate slot. The appropriate state and federal agencies were notified of the oil spill. The maintenance bulkhead was installed in gatewell slot 5B and the slot was dewatered on December 5 to facilitate inspecting the head gate cylinder for signs of an oil leak. A slow oil leak was confirmed and contained, and a plan for a permanent fix was developed. Gatewell 5B was watered back up and the bulkhead removed on December 8. Unit 5 was temporarily taken out of service during this time.

Orifices/Collection Channel

The juvenile fish channel was watered up and orifices were opened on March 24. The collection channel is typically operated with 20 orifices open. At least one (the north) orifice is 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/VBS repair.

Orifices were routinely cycled and backflushed by powerhouse operators and fish facility personnel. Orifices were initially backflushed once per day in March until several orifices were found to be partially obstructed by debris. The frequency of backflushing was increased to three times per day during the last week of March, and continued through July 31, to keep orifices clear. Backflushing occurred once per day for the remainder of the year. There were no other clogged orifices noted by fish facility personnel or powerhouse operators. Orifice lights were checked daily, and if a orifice light was found to be burned out, the orifice was closed and the other orifice in that gatewell slot was opened until the light was fixed. Burned out orifice lights were usually promptly replaced.

Primary Dewatering Structure

After the system was watered up on March 24 , the actuator for the water regulating weirs in the collection channel was placed in local control shortly afterwards due to a problem with the automatic control settings. The wiers remained in local control until the system was dewatered on December 14.

In late April, the mechanical screen cleaner in the primary dewatering structure was taken out of service for short periods because of the travel cable getting wrapped over itself on the drive pulley. The sheaves were adjusted to keep the cable separated on the pulley. The air bubbler was operated to clean the downstream section of the inclined screen until repairs could be completed. The system was returned to service on May 5. In May, the mechanical screen cleaner broke down intermittently because of over-travel of the screen cleaner at the limit switches. The drive cable was tightened on May 25 to fix the problem.

The juvenile fish channel, including the primary dewatering structure, was unwatered for winter maintenance on December 14, 2022. The composition of fish recovered was 32 clipped adult steelhead, 13 unclipped adult steelhead, 2 channel catfish, and 59 adult Pacific lamprey. One adult lamprey was also found dead in the bypass flume a couple of weeks later, despite flushing the flume right after the water subsided. Live fish were released in good condition at the Levey Park boat ramp.

Sampling System

In March, areas of open flume with peeling paint and corrosion were cleaned and repainted to maintain smooth surfaces for fish passage.

During Ice Harbor's 2022 fish sampling season, the system functioned well with no maintenance problems associated with sampling equipment.

Removable Spillway Weir

Spill for juvenile fish passage occurred from April 3 to August 31, 2022. In accordance with Fish Passage Plan, the removable spillway weir (RSW) was closed on August 4 when the daily average project outflow decreased below 30 kcfs and the inflow was forecasted to stay below 30 kcfs for three consecutive days. Additionally, the RSW was operated three days per week for four hours in the morning for the downsteam passage of steelhead overshoots from March 1 to 31 and from September 1 to November 15. The RSW had no operational problems in 2022.

Avian Predation

The U.S. Department of Agriculture (Wildlife Services) utilized pyrotechnics to conduct land-based hazing of piscivorous birds from April 1 to June 30, 2022. In addition, boat-based hazing occurred from April 10 to June 11. 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 to track whether the harassment/deterrent program remained effective at reducing bird abundance around the dam from April 1 to June 30 and four days per week in July (Figure 1). 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 and powerhouse tailrace zones. Double-crested cormorants were usually the most abundant piscivorous bird species observed during daily bird counts from April 1 to the middle of May, although there were spikes of much larger numbers of American white pelicans. Gulls and pelicans were then the predominant species for the rest of the bird count season. Total bird numbers generally decreased in June and increased again in July. Birds may have keyed in on the juvenile shad run in the late summer through the end of the year.

Pelicans were the most abundant birds counted in each of the last five years (Table 10). American white pelicans could not be targeted for hazing because they are a species of concern in Washington State. The number of gulls counted has been steady each year, except when there was a drop in 2020. Cormorants numbers are lower than they were five years ago, while tern numbers are higher.

The average of total daily number of cormorants, gulls, and terns per week in 2022 was higher than the averages for the same weeks over the previous four years from mid May to early June (Table 11). Since 2019, there has been a significant bird presence at the project in the month of July, after active bird hazing ended for the season. 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 17 days during the spring, and one time in the summer. However, the bird counts on most of those days occurred when boat-based hazing was not actively occurring. Foraging gulls and cormorants were spread out in different observation zones during these events

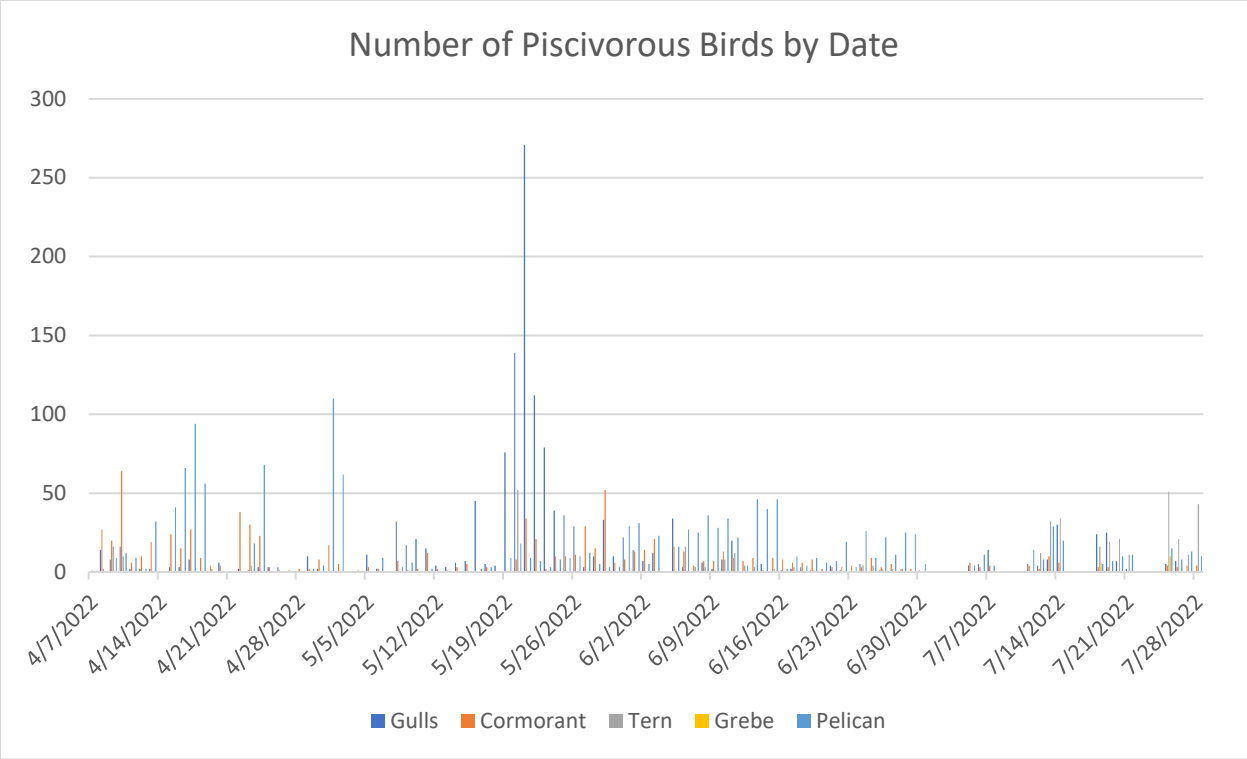

Figure 1. Daily number of piscivorous birds counted at Ice Harbor Dam, 2022.

Table 10. Total numbers of gulls, cormorants, terns, grebes, and pelicans counted at Ice Harbor Dam, 2018-2022.

Year	Gulls	Cormorants	Terns	Grebes	Pelicans
2018	1,372	1,691	23	12	3,027
2019	1,173	1,419	104	12	2,758
2020	348	762	43	0	3,186
2021	1,468	594	242	9	2,139
2022	1,394	923	428	16	1,469

Table 11. Average daily counts of gulls, cormorants, and terns per week at Ice Harbor Dam, 2018-2022.

Week	2018	2019	2020	2021	2022
April 3-9	34	15	2	4	14
April 10-16	53	31	10	4	25
April 17-23	44	26	10	10	19
April 24-30	55	16	9	13	9
May 1-7	33	34	8	12	7
May 8-14	52	41	16	34	18
May 15-21	44	71	6	67	93
May 22-28	42	26	23	25	58
May 29- June 4	17	15	19	22	35

Table 11 continued.

June 5- 11	2	7	9	16	26
June 12-18	2	4	6	12	10
June 19-25	1	5	3	13	7
June 26-July 2	3	5	0	17	4
July 3-9	4	9	0	48	12
July 10-16	10	39	22	44	37
July 17-23	11	16	21	36	33
July 24-30	17	44	32	31	38

and were not targeting a specific fish passage route. Boat-based hazing was effective at reducing the spikes in bird numbers to below the avian abundance trigger.

The bird-deterrent hydrocannon at the juvenile fish bypass outfall pipe was turned off and the hydrocannon pump was removed on December 6 due to ice buildup.

Recommendations for the Juvenile Fish Facility

1. Repaint the interior of the juvenile fish bypass pipe/flume. The inside surfaces of the pipe and flumes have peeling paint and corroded areas, which create rough spots that could possibly descale or injure fish.
2. 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.
3. Replace the black iron water line for the outfall pipe hydrocannon 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.
4. 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

A redd survey of the downstream approach to the navigation lock occurred on November 17. The survey was in preparation for maintenance dredging of the navigation lock approach, which is scheduled to occur in early 2023.

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 2022, adult fish counting occurred from April 1 to October 31. The number of adult salmonids and adult lamprey counted passing Ice Harbor Dam for each fish ladder is shown in Table 12. For all species except lamprey, the SFL was used more than the NFL. The total counts for Chinook, sockeye, coho, and lamprey were higher than the 10 year averages, while the totals for steelhead (both clipped and unclipped) were lower than the 10 year averages.

Table 12. Number of adult fish passing Ice Harbor Dam in 2022, and average of previous ten years.

	Chinook	Chinook Jack	Steelhead Clipped	Steelhead Unclipped	Sockeye	Coho	Coho Jack	Lamprey
SFL	92,303	18,395	43,234	14,254	1,219	15,385	1,056	624
NFL	26,456	4,740	8,558	3,158	631	2,765	276	896
Total (SFL + NFL)	118,759	23,135	51,792	17,412	1,850	18,150	1,332	1,520
Ten-Year Avg. (SFL + NFL)	100,562	20,894	63,546	24,346	1,007	6,219	712	647

The upper SFL was unwatered for inspection and maintenance from January 5 to February 13, 2022. One clipped steelhead was removed from the flow-control section of the upper fish ladder and released in good condition into the forebay off of the roadway deck. The lower SFL (channel) was unwatered over two days and the fish were removed and were released in good condition at Charboneau Park boat ramp on January 12. The species composition of rescued fish is shown in Table 13. On January 13 and 18, four clipped and three unclipped juvenile steelhead mortalities were found in the channel. These fish were missed during the fish rescue on January 12 because of the large area of the channel and availability of places for fish to hide, such as under the wing gates.

Winter maintenance conducted during the 2022 maintenance period included:

- Deteriorated fish jump-netting near the south fish ladder upper diffuser area was replaced with plastic fencing material
- A dislodged lamprey plate was re-installed onto diffuser #6 grating in the south fish ladder. Other lamprey plates had some missing j-bolts that were replaced, but the plates were not loose from the grating.
- The upper diffuser valve #10 in the north fish ladder was unwatered and inspected. The valve and drive shaft assembly looked good, with no deficiencies found.
- Additional general 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. Debris was light in both fish ladders.

It was also noted that 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.

On March 16, The north shore channel and tailwater ultrasonic transducer readings were inconsistent with the staff gauge and tape-measured readings at the same locations. Electricians performed a calibration check and adjustment of the transducers. The tailwater transducer head had to be replaced with a spare head. Further calibration checks were msde throughout the year to monitor transducer performance.

Picketed leads were installed on March 31. The worn window-cleaning brush at the north fish counting station was replaced with a new brush on March 31.

The powerhouse operator noticed that the north fish ladder upper diffuser valve (diffuser #10) had been 90% open in automatic mode to meet the water depth criteria over the stationary weirs. The diffuser is normally at 30-40% open to meet the criteria. Diffuser #10 was shut off from 0001 hours to 0200 hours on June 16 to allow any debris on the trash rack to fall off. On June 29, the diffuser was turned off from 0705 hours to 0805 hours so the trash rack could be lifted out with the crane to do more thorough cleaning. Diffuser #10 was returned to service and opened to 40% after the cleaning.

Summary of Fish Recovery Operations

Areas that were unwatered in 2022 that required fish facility personnel presence for possible fish rescue/evacuation are listed in Table 13. The total number of fish handled during unwatering events in 2022 was approximately 184. The species composition of live fish handled is shown in Table 13.

Table 13. Areas at Ice Harbor Dam unwatered in 2022 requiring possible fish removal.

Date	Unwatering Activity	Fish Removed and Released in the River[1]
5,13-Jan	Upper south fish ladder	1 clipped steelhead
12-Jan	Lower south fish ladder	6 coho, 9 clipped steelhead, 13 unclipped steelhead, 13 clipped juvenile steelhead, 2 unclipped juvenile steelhead, 1 sucker
1-Feb	Upper north fish ladder	1 unclipped steelhead, 1 juvenile white crappie
3-Feb	North fish ladder upper diffuser #10 chamber	7 clipped steelhead, 1 unclipped steelhead, 1 clipped juvenile steelhead, 4 smallmouth bass, 1 crayfish
13-Jul	Unit 2 Scroll Case	2 channel catfish
14-Dec	Juvenile Fish Channel	32 clipped steelhead, 13 unclipped steelhead, 59 Pacific lamprey, 2 channel catfish

[1]Fish were adults unless noted as juveniles

Adult Fish Trap Operation

The adult fish trap was not used in 2022.

Auxiliary Water Supply

The auxiliary water supply (AWS) pumps were operating or available for operation to help maintain fish entrance criteria in 2022, except when 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 14). 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 14. AWS pump outages and significant events requiring pumps to be shut off at Ice Harbor Dam in 2022.

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
March 1 to July 12	SFL #1	Unwatering and investigation of cavitation problem	In criteria
March 16	All SFL pumps	Pump #1 bulkhead guilde slot investigation	73 Minutes
June 13-14	SFL #4,	Replace lower Seal	In criteria
June 14 to July 19	SFL #7	Replace lower Seal	In criteria
July 24	3 SFL, 2 NFL	Loss of station service	26 Minutes
September 20-23	SFL #5	Replace lower Seal	In criteria
September 23	SFL #7	Replace lower Seal	In criteria
November 18 to December 7	NFL #2	Lubrication system failure, causing intermittent outages	In criteria

Adult Fishway Inspections

Ice Harbor project fisheries personnel conducted visual inspections of the fish ladders during the adult fish passage season from March 1 to December 31, 2022. In addition, the powerhouse operators conducted daily limited inspections of the fishways. Fish facility staff averaged three fishway inspections per week with 129 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 compiled was entered into an Excel spreadsheet (Appendix 1). Fisheries staff also collected data on flow discharge, AWS pump and turbine unit 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 fish facility operations and maintenance (See Ice Harbor section 2.5.2 of the 2022 Fish Passage Plan).

Automated Fishway Control System

In the 2022 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, JFF, and north fish ladder entrance deck 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. However, tailwater transducers cannot be accurately calibrated when spill is occurring. 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 2022 are shown in Table 15. Deviations from criteria can be caused by fluctuating water elevation readings at the staff gages during spill. Observable water elevations during spill 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 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 in criteria [1.5-4.0 feet per second (fps)] on 96.1% of the inspections, compared to 96.9% of inspections in 2021. Higher spring flows in 2022 lead to high tailwater conditions, causing more of the stationary weirs in the fish ladder to be submerged and slowing the velocity of the water coming down the ladder into the junction pool. This resulted in channel velocities to be slightly lower than criteria on several non-consecutive days in June.

Ladder Exits: The north and south fish ladder exit head differentials were in criteria ($\leq$0.3 feet) during all inspections. There were no significant debris accumulations on the ladder exit trash

Table 15. Adult Fishway Inspection Results at Ice Harbor Dam, 2022

Inspection Point	In Criteria			Water Depth/Differential Over Criteria			Water Depth/Differential Under Criteria		
South Fish Ladder	No. of Inspections	No. of Inspections in Criteria	% of Inspections in Criteria	Total No. 0.1' Over	Total No. 0.2' Over	Total No. ≥0.3' Over	Total No. 0.1' Under	Total No. 0.2' Under	Total No. ≥0.3' Under
Channel Velocity	128	123	96.09	NA	NA	NA	NA	NA	NA
Ladder Exit Diff.	129	129	100.00	0	0	0	NA	NA	NA
Stationary Weir Depth	129	129	100.00	0	0	0	0	0	0
Counting Station Diff.	129	124	96.12	3	0	2	NA	NA	NA
North Fish Ladder	No. of Inspections	No. of Inspections in Criteria	% of Inspections in Criteria	Total No. 0.1' Over	Total No. 0.2' Over	Total No. ≥0.3' Over	Total No. 0.1' Under	Total No. 0.2' Under	Total No. ≥0.3' Under
Ladder Exit Diff.	129	129	100.0	0	0	0	NA	NA	NA
Stationary Weir Depth	129	129	100.0	0	0	0	0	0	0
Counting Station Diff.	129	129	100.0	0	0	0	NA	NA	NA
Entrance Head	No. of Inspections	No. of Inspections in Criteria	% of Inspections in Criteria	Total No. 0.1' Over	Total No. 0.2' Over	Total No. ≥0.3' Over	Total No. 0.1' Under	Total No. 0.2' Under	Total No. ≥0.3' Under
South Shore	129	105	81.4	10	4	10	0	0	0
North Powerhouse	129	126	97.7	0	0	0	2	1	0
North Shore	129	121	93.8	1	0	3	1	0	3
Entrance Weir Depths	No. of Inspections	No. of Inspections in Criteria	% of Inspections in Criteria	Total No. ≥8'	Total No. <8' and on sill		Total No. 0.1' under and off sill	Total No. 0.2' under and off sill	Total No. ≥0.3' under and off sill
SFE 1	129	122	94.6	69	53		0	0	6
NFE 2	129	123	95.4	67	56		1	3	3
NSE 1	129	128	99.2	55	70		0	1	0

racks causing the differentials to get above 0.3'. Differentials were typically 0.0' the first half of the year and 0.1'-0.2' the rest of the year.

Ladder Weirs: The depths over the stationary weirs in the north and south fish ladders were in criteria (1.0-1.3 feet) on 100% of fishway inspections.

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 five inspections due to the buildup of filamentous algae on the leads. In all cases, the leads were cleaned shortly after the inspections. 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 94.6% of inspections, compared to 93.7% of inspections in 2021. SFE-1 weir gate depth was below criteria on three occasions when the gate was positioned slightly off of sill when the tailwater was low. The operator had the weir gate off of sill to take the slack out of the operating cable to stop the lifting beam from banging in the guides slot. The weir was lowered back to sill and the lifting beam was observed to be relatively still. On four other occasions, the operator did not notice that the weir gate depth was below 8' when the tailwater level decreased. The gate was subsequently lowered or tailwater level increased by the next day to bring the depth back into criteria. The weir gate was in manual control to reduce the wear and tear on the gate and hoist machinery constantly adjusting in automatic control to fluctuating tailwater levels, especially when spill was occurring.

SFE-1 weir gate was in sill criteria on 41.1% of inspections, compared to 56.3% of inspections in 2021. Higher river flows and tailwater levels in 2022 resulted in the weir gate being in depth criteria more than in 2021.

North Powerhouse Entrance (NFE-2): The NFE-2 weir gate depth was in criteria (≥ 8 feet or on sill) on 95.3% of inspections. The out of criteria depths resulted from the gate being in manual control when the tailwater level decreased. The gate was in manual control to reduce wear and tear on the equipment.

NFE-2 weir gate was in sill criteria on 43.4% of inspections, compared to 58.6% in 2021.

North Shore Entrance (NSE-1): The NSE-1weir gate depth was in criteria (≥ 8 feet or on sill) on 99.2% of inspections, compared to 98.4% of inspections in 2021. The one out of criteria depth occurred because the gate was in manual control when the tailwater level decreased, as mentioned above.

NSE-1weir gate was in sill criteria on 54.3% of inspections, compared to 72.7% in 2021..

Fish Collection Channel/Tailwater Head Differential: The south shore entrance channel/tailwater head differential was in criteria (1-2 feet) on 81.4% of inspections, compared to 82.8% of inspections in 2021. The out of criteria readings were high channel/tailwater differentials that occurred in the fall when tailwater was low. Low tailwater caused lower entrance weir gate depths and high channel/tailwater differentials. The entrance weir was on sill and five south shore AWS pumps were running. Operating only four AWS pumps is not an option, because five pumps are needed to help meet the depth criteria over the stationary weirs just above channel water level in the fish ladder.

The north powerhouse entrance head differential was in criteria (1-2 feet) on 97.7% of inspections, compared to 96.1% of inspections in 2021. The few out of criteria readings were low channel/tailwater differentials that occurred due to higher entrance weir gate depths, with the gates in manual control. The low differentials were corrected by raising the gateas needed after the inspection was complete.

The north shore entrance head differential was in criteria (1-2 feet) on 93.8% of inspections, compared to 85.2% of inspections in 2021. The high head differentials were due to low tailwater levels, with two north shore AWS pumps still needing to be operated to meet minimum head criteria. The low channel/tailwater differentials occurred when tailwater and entrance weir depths were very high. However, the PLC showed the differentials to be in criteria. Turbulent tailwater conditions from spill made accurate physical measurements difficult and also prevented calibration of ultrasonic transducers to reduce any inaccuracy in tailwater elevation measurements.

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. Remove the three sets of wing gates in the lower south fish ladder. The wing gates have been inoperable for many years and are not needed for operation of the fish ladder. The gates become obstacles when rescuing fish during unwatering and when inspecting diffuser grating with the ROV.