2019 JUVENILE SAMPLE AND BYPASS REPORT
MCNARY PROJECT JUVENILE FISH FACILITY

May 2020

United States Army Corps of Engineers
McNary Lock and Dam
PO Box 1230
Umatilla, OR 97882

Prepared by
Denise Griffith and Bobby Johnson
Fish Biologists
U.S. Army Corps of Engineers

And

Alexis Bonoff
Anchor QEA, LLC
23 S Wenatchee Ave, Suite 220
Wenatchee, Washington 98801

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ESBS – extended-length submersible bar screen
FPP-Fish Passage Plan
GBT – gas bubble trauma
JCC – Juvenile Collection Channel
JFF – Juvenile Fish Facility
KCFS – kilo cubic feet per second
PIT – Passive Integrated Transponder
PDS – Primary Dewatering Structure
PSMFC – Pacific States Marine Fisheries Commission
TSW-Top-over Spill Weir
USDA-WS-United States Department of Agriculture-Wildlife Services
VBS – vertical barrier screen

SUMMARY

This report summarizes the juvenile bypass and sample collection operations of McNary Project during 2019. Adult passage information is recorded in a separator report. Only adults removed for the sample tanks are recorded in this report.

FACILITY INTRODUCTION AND DESCRIPTION

McNary Dam is located at river mile 292 on the Columbia River and is the first dam downstream of the confluence of the Snake and Columbia Rivers. McNary has 14 turbine units. To bypass the turbines, the juvenile system begins with trash racks, extended length submersible bar screens (ESBSs) and vertical barrier screens (VBSs). When fish enter the turbines' intake, they are diverted into the gatewell slots. Each unit has three gatewell slots. Each gatewell slot has two orifices with one being open. The fish pass through these twelve-inch orifices to the juvenile collection channel.

The channel flow runs from north to south. The dewatering structure and associated equipment are at the southern end of the powerhouse. Here there are the two side-dewatering valves, which regulate the channel elevation. There is also a set of three floor-dewatering valves, which remove excess water. Finally, there is the 48-inch juvenile facility supply line. All flow is gravity fed.

Bar screen in the side and on the floor of the channel retains fish and allows the excess water to be removed. The screen is kept cleaned by the side, rectangular and transition brushes. All systems are controlled by a program logic controller. In the transition area, the channel funnels down to the full flow transport flume/pipe where the fish and debris exit. The transport flume takes the fish to the facility or returns them to the river. Just upstream for the separator is the primary bypass gate. This gate is used during fish passage season to switch between primary (fish go directly back to the river) and secondary bypass (a percentage of fish are sampled fish with the remainder returned to the full flow pipe and river). The separator sorts the fish by size with the small smolts exiting down the A flume and the large smolts going down the B flume. Adult salmonids and other miscellaneous fish are released at the separator's return to river line.

Downstream of the separator in the A and B flumes are the passive integrated transponder (PIT) tag gates, the sample gates and the secondary bypass gates (which tie the A and B lines back into the full flow flume/pipe). The A and B sides each have a set of sample and PIT tag systems. Inside the building is the wet lab where the sample is examined. There are also the sample recovery raceway, from which the sampled fish are returned to the river. The full flow flume/pipe, adult return line and all facility lines have PIT tag detectors with the remainder of the PIT system inside the building.

Finally, in spillbays 19 and 20, there are top spillway weirs (TSWs). In the spring, the TSWs improve fish passage through the spillway.

FACILITY MODIFICATIONS/MAINTENANCE & IMPROVEMENTS

Maintenance and improvements for the winter of 2018-2019 made to enhanced system performance over previous seasons are listed:

Juvenile Collection Channel (JCC) Contract:

1. Sandblasted all areas in the floor drain pit.
2. Repaired any structural issues.
3. Repaired flume and valve leaks in the air, including the south side dewatering valve discharge conduit.
4. Repainted the structure in the drain pit.
5. Installed two new safety ladders.
6. Installed concrete floor in pit to reduce misting from drains.
7. Refurbish support brackets.
8. Removed residue so valves and brushes would function properly.

Collection Channel/Powerhouse:

1. Two orifice covers reconditioned.
2. Water meter shroud cleaned.
3. All maintenance on screen brushes and dewatering valves completed after contractor left.
4. Seams on transition screen sealed after contractor left.
5. Bolts on the east floor valve replaced.
6. Air lines to the facility supply valve were repaired.
7. New pendant on JCC hoist installed.
8. Wiring, motors and gearboxes were replaced on ESBSs as needed.
9. VBS rehabilitation continued.
10. Orifice attraction lighting, orifice operators and area lighting replaced/repaired as needed.
11. A new electrical cord was installed for the transition brush.

Juvenile Fish Facility (JFF) Full Flow Pipe:

1. Sample and PIT tag systems rehabilitated as needed.
2. Flume gaskets replaced as needed.
3. Airline leaks repaired as needed.
4. Sample tank crowding devices rehabilitated as needed.
5. Access step to the A side sample tank added.
6. Separator upwell valves rehabilitation completed.
7. Winterization drain on the A side flume water add in repaired again.
8. Access door to third full flow flume PIT tag detector was repaired.
9. Interference at the full flow flume PIT tag detectors was resolved.
10. Another contractor repaired damaged full flow pipe supports and removed the damaged sections of the access walkway.

Other Maintenance Items during the Year:

1. Full flow flume covers painted and repaired as needed.
2. Two leaks in the full flow flume addressed.
3. Bolt hole in the side of the separator repaired.
4. Flume barriers used during primary bypass were rebuilt.
5. Wet lab floor waxed and sealed as needed.
6. Gas Bubble Trauma (GBT) line from separator to wet lab replaced.
7. Flume gaskets trimmed as needed.
8. Extension on winterization drain on the A side add in line installed.
9. Walkway grating retaining clips installed as needed.
10. Avian spikes at the JFF repaired.
11. All JFF electrical breakers replaced.
12. JFF lighting issues were resolved.
13. Drive cover for the B side sample tank crowding device repaired.
14. Sample tanks net frame covers and crowding device rollers repaired.
15. Examination for separator rehabilitation began in October and will go into the winter season. The paint covering the separator has three heavy metals above standard limits.
16. Orifice attraction lights and operator air leaks were replaced and/or repaired as needed.
17. JCC walkway hand rail jump netting inspected and repaired.
18. Access door to first full flow flume PIT tag detector was repaired.
19. Station service upgrades continued, which will improve electrical reliability to systems.
20. A digital thermometer was installed in scrollcase cooling water line for unit 1 in June, the thermometer failed and was later replaced again in the fall.

Miscellaneous maintenance and winterization occurred as needed. Other maintenance issues may be covered in the remaining text of this report. During all dewatering and maintenance, no invasive mussels were observed.

RIVER CONDITIONS

River Flow

Daily average total river flow, powerhouse flow, and spill were compiled from April 4 to September 30, 2019. The average included hourly values collected from 0700 hours of the previous day to 0700 hours of the current day. Figure 1 below, shows river flow was jumping above and below the 10-year average until the end of May and mostly below the 10-year average through September. The 2019 maximum daily average for total river flow was 354.7 kilo cubic feet per second (kcfs) recorded on May 19. Maximum daily average for powerhouse flow was 168.8 kcfs on April 8 and for spill was 197 kcfs on May 19. Minimum daily average for total river flow was 68.8 kcfs on September 24, and minimum daily average for powerhouse flow during spill was 50.4 kcfs on August 16. Minimum daily average for spill, when spill occurred, was 0.2 kcfs on September 13. Tables 1 and 2 below, summarize river flow for the 2019 season.

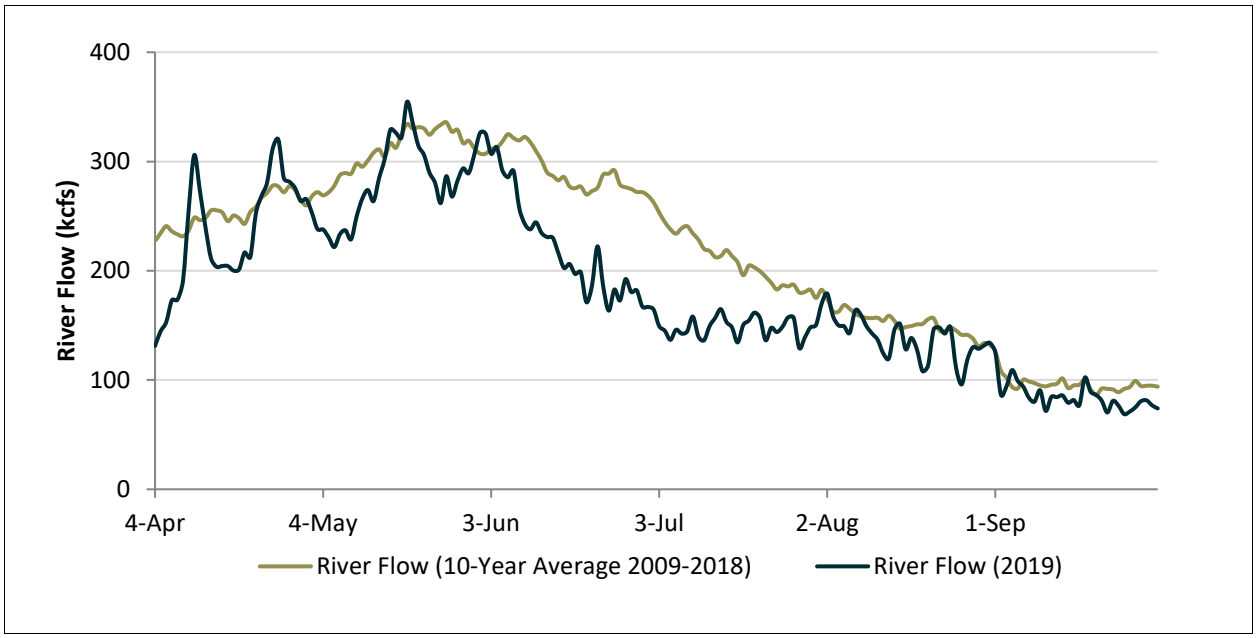

Figure 1. Total River Flow April 4 to September 30, 2019, and 10-Year Average

Table 1. Average Monthly River Flows, 2019

Month	Total Flow (kcfs)	Powerhouse (kcfs)	Spill (kcfs)
April	230.9	105.5	120.8
May	278.5	102.5	171.3
June	228.2	85.3	138.3
July	149.0	59.4	84.9
August	138.6	56.4	77.5
September	84.7	77.4	2.7

Table 2. Season Start, End, Seasonal Average, Maximum, and Minimum River Flows, 2019

Date	Total Flow (kcfs)	Powerhouse (kcfs)	Spill (kcfs)
Season Start (April 4)	131.2	126.5	0.0
Season End (September 30)	74.0	67.6	1.7
Season Average	184.3	80.5	99.1
Maximum (Date)	354.7 (19-May)	168.8 (8-Apr)	197 (19-May)
Minimum (Date)	68.8 (24-Sep)	50.4 (16-Aug)	0.2 (13-Sept)

Note: *The minimum spill only considered dates when spill occurred

River Temperatures

River temperature was recorded at 0700 hours daily in Sample Tank "B" at the JFF from April 4 to September 30. The maximum temperature was 71.7°F on September 4. The minimum temperature was 46.0°F on April 4. Tables 3 and 4 below summarize river temperatures.

Table 3. Average Monthly River Temperatures, 2019

Month	River Temperature (°F)
April	49.0
May	53.8
June	61.5
July	67.8
August	70.7
September	68.7

Table 4. Season Start, End, Average, Maximum, and Minimum River Temperatures, 2019

Date	River Temperature (°F)
Season Start (April 3)	46.0
Season End (September 30)	63.9
Season Average	62.2

JUVENILE BYPASS

Migration, Sampling and Bypass of Juvenile Salmonids

Smolts navigating from the McNary Forebay can pass the dam through either the spillway or the powerhouse to the tailwater. Some of the smolts entering the powerhouse are diverted to a juvenile bypass system, from which a subset of smolts are sampled. Smolts are no longer collected for transport at McNary Dam. Bypass numbers represent the estimated number of smolts navigating the dam calculated from the number of smolts in the sample, mortality rate, and the corresponding sample rate. From 2007 through 2012, smolt enumeration occurred daily during portions of the season when smolts were collected for transport. After 2012 smolt enumeration has been every other day during the fish passage season.

In 2019, smolt enumeration occurred every other day while in secondary bypass from April 4 to September 30. Bypass totals do not include smolts passing during primary bypass operations. However, no sampling was conducted on July 6, 8, or 10, due to a broken valve in the fish channel resulting in an inability to go into secondary bypass at the Juvenile Fish Facility (JFF). Every other day collection resumed on July 11.

The JFF bypassed 763,549 smolts during the 2019 season. The estimated number of smolts passing during the 2019 season was lower than the 5-year average. Table 5 below compares salmonid smolts bypassed, which includes GBT examined fish (Table 21), during the 2019 season and the 5-year average. Figure 2 below compares total salmonid smolts bypassed and river flow.

Bypass operations are in the Operations and Maintenance Section below.

Table 5. Bypassed by Species and Clip Type, 2019-2015 and 5-Year Average

Bypassed											
Year	Yearling Chinook		Subyearling Chinook		Steelhead		Coho		Sockeye		Total
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	
2019	238,849	70,386	92,207	119,481	133,128	26,607	2,948	18,753	10,428	50,762	763,549
2018	441,979	115,619	342,099	631,648	70,293	20,273	37,342	44,674	5,367	540,482	2,249,776
2017	421,423	147,964	301,890	835,622	125,516	39,738	6,975	24,595	700	55,533	1,959,956
2016	946,054	276,893	615,476	1,540,617	323,425	88,826	7,346	81,863	5,249	489,026	4,374,775
2015	622,939	164,455	221,314	552,241	212,435	55,098	8,104	30,780	2,300	73,506	1,943,172
5 YR AVG	534,249	155,063	314,597	735,922	172,959	46,108	12,543	40,133	4,809	241,862	2,258,246

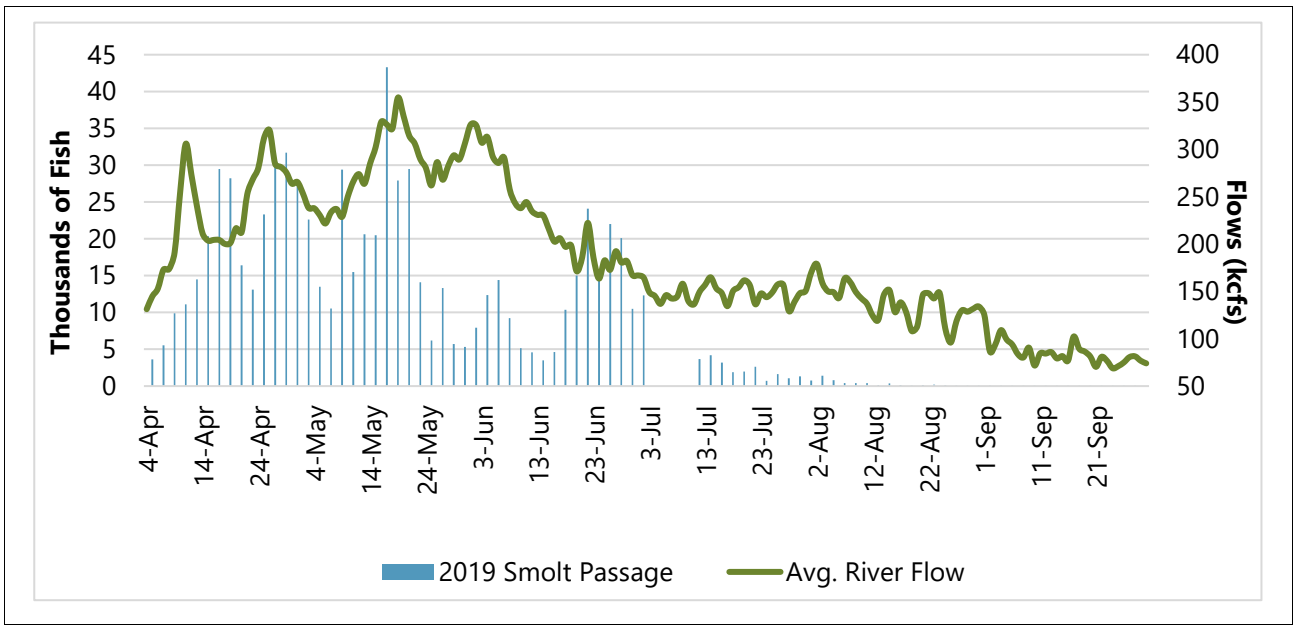

Figure 2. Daily Smolt Passage vs. Average Daily River Flow, 2019

The predominant species bypassed in 2019 was Chinook salmon (40.5% yearling Chinook salmon and 27.7% subyearling Chinook salmon). Table 6 below summarizes the number of juvenile salmonids collected, which is the total fish bypassed (Table 5) and total facility mortalities (Table 18) together, by species and clip type for 2019 and a 5-year comparison.

Juvenile salmonids exhibit a wide range of migration strategies that vary in their seasonal timing and age at migration onset. At McNary Dam, this translates into two semi-distinct peaks in the number of smolts, one in the spring and one in the summer, though annual variation exists. The spring migration is typically dominated by yearling Chinook salmon, steelhead, sockeye salmon, and coho salmon smolts. Subyearling Chinook salmon fry are also present. The summer migration is primarily subyearling Chinook salmon smolts. The spring bypass peak occurred on May 17, and comprised 90.8% yearling Chinook salmon, 6.7 % steelhead, 0.9% coho salmon, 0.9% sockeye salmon, and 0.7% subyearling Chinook salmon. The summer bypass peak occurred on July 22 and comprised 99.6% subyearling Chinook salmon and 0.4% steelhead. Collection peaks for each species are summarized below in Table 7.

Table 6. Collected by Species and Clip Type, 2019-2015 and 5-Year Average

Collected											
Year	Yearling Chinook		Subyearling Chinook		Steelhead		Coho		Sockeye		Total
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	
2019	238,862	70,393	92,219	119,518	133,140	26,609	2,948	18,754	10,430	50,766	763,639
2018	442,017	115,631	342,127	631,747	70,299	20,275	37,344	44,677	5,368	540,514	2,249,999
2017	421,455	147,973	301,905	835,722	125,531	39,744	6,975	24,595	701	55,538	1,960,139
2016	946,286	277,020	615,504	1,540,736	323,457	88,842	7,346	81,881	5,250	489,121	4,375,443
2015	622,962	164,467	221,778	552,880	212,457	55,104	8,105	30,781	2,300	73,513	1,944,347
5 YR AVG	534,316	155,097	314,707	736,121	172,977	46,115	12,544	40,138	4,810	241,890	2,258,713

Table 7. Peak Collection Date by Species and Clip Type, 2019-2015

Peak Collection Dates									
Year	Yearling Chinook	Subyearling Chinook	Clipped Steelhead	Unclipped Steelhead	Coho	Clipped Sockeye	Unclipped Sockeye	Total Smolts	Juvenile Lamprey
2019	17-May	22-Jun	17-Apr	15-Apr	21-May	21-May	1-May	17-May	19-Apr
	39,300	23,092	20,275	2,050	2,100	4,400	7,000	43,300	44,800
2018	5-May	24-Jun	5-May	5-May	5-May	25-May	11-May	11-May	19-May
	75,552	65,967	8,500	2,650	11,750	1,000	123,200	188,101	40,400
2017	3-May	2-Jul	27-Apr	1-May	13-May	19-May	29-May	2-Jul	15-May
	49,480	8,100	19,632	3,200	3,500	275	7,200	81,200	6,800
2016	3-May	28-Jun	1-May	1-May	13-May	25-May	11-May	28-Jun	17-Apr
	163,307	478,503	46,205	9,000	9,002	1,950	72,606	478,503	3,200
2015	5-May	6-Jul	1-Jan	9-May	23-May	23-May	25-May	5-May	8-Jun/24-Jun
	155,901	151,601	29,203	5,000	4,000	800	9,600	195,504	800

Sampling for smolt migration indexing and condition evaluation was conducted every other day when the system was in secondary bypass from April 4 to September 30, 2019. The sample rate was adjusted to allow at least 100 individuals of each of the predominant salmonid species to be sampled. There were 15,466 smolts sampled, comprising 45.8% subyearling Chinook salmon, 29.3% yearling Chinook salmon, 17.0% steelhead, 4.7% sockeye salmon, and 2.3% coho salmon. The number of sampled fish is listed by species and clip type are found below in Table 8.

Table 8. Sampled by Species and Clip Type, 2019-2015, and 5-Year Average

Sampled											
Year	Yearling Chinook		Subyearling Chinook		Steelhead		Coho		Sockeye		Total
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	
2019	3,071	1,468	1,886	5,191	2,336	440	44	306	123	602	15,467
2018	6,789	2,719	2,447	5,783	1,922	578	428	882	124	6,247	27,919
2017	3,675	1,823	2,121	8,724	1,524	490	70	304	22	483	19,236
2016	5,744	2,485	2,204	9,564	2,549	1,120	57	668	94	2,820	27,305
2015	5,065	2,134	1,085	4,423	2,044	513	46	417	12	637	16,376
5 YR AVG	4,869	2,126	1,949	6,737	2,075	628	129	515	75	2,158	21,261

In 2019, the number of salmonids sampled was lower than the 5-year average of 21,260. The largest decrease is found within the number of unclipped sockeye salmon sampled in the 2019 season. Only sample numbers of clipped steelhead and clipped sockeye were greater than the 5-year average.

The average sample rate for the season was 10.3%. Table 9 below summarizes average

monthly and seasonal sample rates. On May 7, the sample rate was changed from 1% for Tank A, to 5.45% for Tank B, due to failure of the B-side sample gate, Table 10 below.

Table 9. Average Monthly and Seasonal Sample Rate, 2019

Month	Rate
April	4.30%
May	1.20%
June	2.70%
July	11.20%
August	25.00%
September	16.30%
Season Average	10.30%

Table 10. Sample Rate by Tank for Days with Split Rates, 2019

Sample Date	Tank A Sample Rate (%)	Tank B Sample Rate (%)
5/7/2019	1.00%	5.45%

Migration, Sampling and Bypass of Juvenile Lamprey

Due to an increased interest in lamprey populations in more recent years, lamprey data is being collected more thoroughly. In previous years, lamprey were found in the incidentals section of the annual report. Lamprey belong to a group of fishes that are eel-like in form; however, they lack jaws and paired fins of true fishes. Lamprey identification largely depends on the number, position, and structure of the teeth found within the mouth of the adult. The primary species found at McNary Dam is the Pacific Lamprey (*Entosphenus tridentatus*), which is characterized by the presence of three large teeth and posterior teeth on the oral disc. Pacific Lampreys spawn in similar habitats to salmon and the spawning occurs between March and July depending upon location within their range.

Metamorphosis from the larvae stage (ammocoetes) to the juvenile stage (macropthalmia) generally occurs over several months as they develop eyes, teeth, and become free swimming. They drift and swim downstream as they migrate to the ocean. It is the macropthalmia stage when most of the lampreys end up in the sample collection at the JFF. Collected, sampled, and mortality data for juvenile Pacific Lamprey are presented below in Table 11. In addition, the 5-year average of collected, sampled, and mortality data are also presented. Mortality includes sample tank mortality only.

Table 11. Pacific Lamprey Collected, Sampled, and Mortality, 2019-2015

Year	2019	2018	2017	2016	2015	5 YR AVG
Collected	226,628	33,257	34,791	9,027	59,953	72,731
Sampled	2,024	408	378	213	985	802
Mortality	35	11	19	7	22	19

Incidental Species Sampled (Including Adults)

Non-target fish and invertebrates incidentally sampled with target species were weighed, measured, and counted at the time of the every-other-day smolt sampling. Juvenile American shad were the most prevalent incidental species encountered in 2019, followed by Pacific Lamprey (*Macropthalmia E. tridentatus*) and Smallmouth Bass (*Micropterus dolomieu*). Juvenile American shad were first sampled on July 14 and their numbers were estimated by sub-sampling and enumerated using a weighing technique instead of counting from July 20 to September 30. Eleven Siberian prawn (*Exopalaemon modestus*) were encountered in the sample and euthanized throughout the sampling period. All other incidental species sampled were bypassed to the tailrace. Table 12 below summarizes incidental species sampled for the 2015 to 2019 seasons.

Table 12. Incidental Species Sampled, 2019-2015

Common Name	Species Name	2019	2018	2017	2016	2015
American Shad (Adult)	*Alosa sapidissima*	15	10	4	1	2
American Shad (Juvenile)	*A. sapidissima*	526,392	336,798	137,630	85,598	40,316
Banded Killifish	*Fundulus diaphanus*	6	56	87	7	0
Bass, Largemouth	*M. Salmoides*	2	0	2	0	1
Bluegill/Pumpkin Seed	*Lepomis spp.*	8	29	158	18	184
Bridgelip Sucker	*Catostomus columbianus*	0	0	2	0	0
Bullhead	*Ameiurus spp.*	9	22	1	6	13
Channel Catfish	*Ictalurus punctatus*	10	21	4	11	9
Chinook salmon (Mini-jack)	*Oncorhynchus tshawytscha*	0	0	0	4	2
Clipped Steelhead Kelt	*O. mykiss*	0	0	1	0	0
Common Carp	*Cyprinus carpio*	17	3	97	3	3
Crappie	*Pomoxis spp.*	1	3	7	7	7
Crayfish	*Pacifastacus spp.*	12	3	1	3	25
Kokanee	*Oncorhynchus nerka*	0	1	1	0	0
Dace, Lomgnose	*Rhinichthys cataractae*	7	2	9	6	13
Mountain Sucker	*C. platyrhynchus*	6	1	1	0	0
Mountain Whitefish	*Prosopium williamsoni*	6	9	23	3	3
Northern Pikeminnow	*Esoxlucius Linneaus*	0	0	2	0	0
Pacific Lamprey (Adult)	*Entosphenus tridentatus*	6	6	14	9	8
Pacific Lamprey (Ammocoete)	*E. tridentatus*	2	3	2	0	0
Pacific Lamprey (Macropthalmia)	*E. tridentatus*	2,675	2,021	406	378	213
Peamouth	*Mylochelius caurinus*	*0*	0	14	8	58
Sculpin	*Cottus spp.*	4	0	0	7	6
Siberian Prawn	*Exopalaemon modestus*	11	7	2	21	120
Smallmouth Bass	*M. dolomieu*	239	78	224	148	60
Speckled Dace	*R. osculus*	0	2	0	0	0
Sturgeon	*Acipenser spp.*	0	0	0	1	0
Sucker	*Catostomus spp.*	0	0	0	2	1
Tench	*Tinca*	0	0	3	0	0
Three-Spine Stickleback	*Gasterosteus aculeatus*	13	22	33	91	275
Umatilla Dace	*R. umatilla*	0	1	0	0	0
Unclipped Steelhead Kelt	*O. mykiss*	0	1	1	0	4
Walleye	*Stizostedion vitreus*	5	20	3	3	11
Yellow Perch	*Perca flavescens*	6	33	12	5	6
Annual Total		529,452	339,152	138,744	86,340	41,340

Separator Efficiency

Historically, when McNary Dam was included in the Juvenile Fish Transportation Program, separator efficiency was monitored to measure the percentage of sampled smolts segregated into the desired sample holding tank. In 2013, McNary Dam was no longer included in the transportation program (switched to 100% bypass) but separator efficiency monitoring continued through 2018. In 2019, separator efficiency was no longer monitored.

FISH CONDITION

Descaling

All sampled salmonid smolts greater than 60 millimeters in total length were examined for descaling. A smolt with descaling greater than or equal to 20% of the area on one side of its body was recorded as descaled. The descaling rate for all species combined was 3.8% for the season. No sample was conducted on July 6, 8, or 10, due to a broken valve in the fish channel resulting in an inability to go into secondary bypass at the Juvenile Fish Facility (JFF). Therefore there were no fish collected to be examined for descaling for week 14. The highest monthly descaling rate (4.9%) was recorded in May. Total descaling rates for all juvenile salmonid by species and clip type are summarized below in Table 13.

Table 13. Percentage Weekly Descaling and Count of Descaled Smolts Sampled, 2019-2015.

2019 Week Ending Date	Current YR	Yearling Chinook		Subyearling Chinook		Clipped Steelhead		Unclipped Steelhead		Coho		Clipped Sockeye		Unclipped Sockeye		Total	
Week Number	4 YR AVG (2015-2018)	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
11-Apr	2019	49	3.4%	---	---	40	4.6%	9	6.7%	0	0.0%	---	---	0	0.0%	98	3.9%
1	AVG	12	4.0%	---	---	8	10.4%	2	3.7%	1	0.8%	0	0.0%	0	6.7%	22	4.6%
18-Apr	2019	12	5.4%	---	---	70	10.4%	4	5.6%	0	0.0%	---	---	---	---	86	8.8%
2	AVG	27	2.4%	---	---	23	7.6%	3	2.7%	3	3.0%	0	0.0%	2	8.8%	56	3.4%
25-Apr	2019	5	1.6%	---	---	34	9.1%	4	7.4%	1	2.9%	---	---	---	---	44	5.6%
3	AVG	30	2.9%	0	0.0%	23	4.2%	4	3.9%	1	3.7%			2	3.5%	59	3.3%
2-May	2019	15	3.0%	---	---	19	10.6%	6	14.0%	1	2.9%	---	---	0	0.0%	41	4.6%
4	AVG	28	4.0%	3	6.7%	10	4.6%	1	3.4%	2	5.4%	0	0.0%	3	2.1%	43	4.1%
9-May	2019	22	3.5%	---	---	9	8.8%	3	9.7%	0	0.0%	---	---	0	0.0%	34	3.9%
5	AVG	51	3.3%	0	0.0%	17	4.9%	3	2.7%	1	0.6%	0	0.0%	10	3.1%	81	3.4%
16-May	2019	8	3.6%	0	0.0%	2	10.0%	1	7.1%	0	0.0%	---	---	0	0.0%	11	3.9%
6	AVG	33	3.3%	0	0.0%	8	6.5%	2	3.9%	3	2.4%	--	--	18	2.1%	63	3.2%
23-May	2019	36	4.6%	1	20.0%	6	12.0%	4	13.3%	1	2.2%	5	6.4%	6	4.1%	59	5.2%
7	AVG	22	2.8%	1	0.9%	8	7.9%	3	5.3%	5	3.9%	0	0.0%	22	3.2%	60	3.2%
30-May	2019	8	4.6%	3	6.7%	12	41.4%	2	8.3%	6	10.7%	5	13.9%	5	7.1%	41	9.4%
8	AVG	23	3.6%	3	0.6%	10	11.5%	5	8.0%	6	3.8%	3	10.5%	16	4.9%	65	4.7%
6-Jun	2019	8	7.2%	17	2.5%	4	23.5%	3	12.5%	2	3.2%	4	50.0%	3	3.0%	41	4.0%
9	AVG	4	2.6%	6	1.4%	3	7.9%	2	5.7%	2	1.8%	3	7.0%	4	3.1%	23	2.7%
13-Jun	2019	0	0.0%	12	2.7%	2	28.6%	0	0.0%	0	0.0%	---	---	0	0.0%	14	2.8%
10	AVG	2	3.0%	5	1.0%	3	11.3%	1	2.6%	1	4.1%	0	0.0%	1	13.8%	12	1.7%
20-Jun	2019	1	2.7%	20	1.8%	2	40.0%	0	0.0%	0	0.0%	---	---	0	0.0%	23	1.9%

2019 Week Ending Date	Current YR	Yearling Chinook		Subyearling Chinook		Clipped Steelhead		Unclipped Steelhead		Coho		Clipped Sockeye		Unclipped Sockeye		Total	
Week Number	4 YR AVG (2015-2018)	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
11	AVG	1	1.7%	9	1.3%	1	22.5%	0	8.3%	0	2.4%	--	--	0	12.5%	11	1.5%
27-Jun	2019	0	0.0%	13	1.6%	---	---	---	---	0	0.0%	---	---	---	---	13	1.5%
12	AVG	0	0.0%	11	1.4%	1	8.6%	1	25.0%	0	0.0%	--	--	0	0.0%	12	1.5%
4-Jul	2019	---	---	7	1.7%	---	---	---	---	0	0.0%	---	---	0	0.0%	7	1.6%
13	AVG	0	0.0%	11	0.8%	1	14.3%	--	--	0	16.7%	--	--	1	25.0%	12	0.9%
11-Jul	2019	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
14	AVG	1	50.0%	7	1.1%	0	0.0%	--	--	--	--	--	--	--	--	7	1.1%
18-Jul	2019	---	---	10	1.9%	---	---	---	---	---	---	---	---	---	---	10	1.9%
15	AVG	--	--	7	1.1%	---	---	0	0.0%	---	---	0	0.0%	1	50.0%	7	1.1%
25-Jul	2019	---	---	12	2.4%	0	0.0%	---	---	---	---	---	---	---	---	12	2.4%
16	AVG	---	---	9	2.4%	1	33.3%	---	---	---	---	---	---	0	0.0%	9	2.5%
1-Aug	2019	---	---	26	2.2%	1	100.0%	0	0.0%	---	---	---	---	0	0.0%	27	2.3%
17	AVG	---	---	8	1.9%	0	0.0%	---	---	1	100.0%	---	---	0	0.0%	8	1.9%
8-Aug	2019	---	---	12	1.9%	0	0.0%	---	---	---	---	---	---	0	0.0%	12	1.8%
18	AVG	---	---	7	3.3%	0	0.0%	---	---	---	---	---	---	0	0.0%	7	3.3%
15-Aug	2019	---	---	8	2.5%	---	---	---	---	---	---	---	---	0	0.0%	8	2.5%
19	AVG	---	---	11	4.2%	0	0.0%	---	---	---	---	---	---	0	0.0%	11	4.1%
22-Aug	2019	---	---	1	1.1%	---	---	---	---	---	---	---	---	---	---	1	1.1%
20	AVG	---	---	7	4.6%	0	0.0%	---	---	---	---	---	---	0	0.0%	7	4.5%
29-Aug	2019	---	---	4	4.2%	---	---	---	---	---	---	---	---	0	0.0%	4	4.1%
21	AVG	---	---	3	8.0%	0	0.0%	---	---	---	---	---	---	---	---	3	7.7%
5-Sep	2019	---	---	1	2.7%	0	0.0%	---	---	---	---	---	---	---	---	1	2.6%

2019 Week Ending Date	Current YR	Yearling Chinook		Subyearling Chinook		Clipped Steelhead		Unclipped Steelhead		Coho		Clipped Sockeye		Unclipped Sockeye		Total	
Week Number	4 YR AVG (2015-2018)	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
22	AVG	---	---	3	4.1%	0	0.0%	---	---	---	---	---	---	0	0.0%	3	3.9%
12-Sep	2019	---	---	1	3.6%	0	0.0%	---	---	---	---	---	---	0	0.0%	1	3.3%
23	AVG	---	---	4	8.6%	---	---	---	---	---	---	---	---	0	0.0%	4	8.5%
19-Sep	2019	---	---	0	0.0%	---	---	---	---	---	---	---	---	---	---	0	0.0%
24	AVG	---	---	1	1.7%	---	---	---	---	---	---	---	---	0	0.0%	1	1.7%
26-Sep	2019	---	---	1	14.3%	---	---	---	---	---	---	---	---	---	---	1	14.3%
25	AVG	---	---	1	5.1%	---	---	0	0.0%	---	---	---	---	1	100.0%	1	5.6%
3-Oct	2019	---	---	0	0.0%	---	---	---	---	---	---	---	---	---	---	0	0.0%
26	AVG	---	---	1	13.4%	0	0.0%	---	---	---	---	---	---	---	---	1	12.1%

Other Injury and Disease

Sub-samples of up to 100 smolts per species from the daily sample were examined for conditions including injuries, diseases, and predator marks. All individuals of a species were examined from the sample if 100 or fewer individuals were present. Injuries included recently acquired damage to the head, eyes, body, and fins possibly attributable to dam operations. Diseases included fungus, columnaris, bacterial kidney disease, parasites, and deformities of the spine, operculum, or other body parts. Predator marks included injury or marks consistent with scratches or bites from birds, fish, or lamprey. Conditions reported here do not include descaling because descaling was calculated separately for all sampled smolts.

Out of 9,209 smolts examined in the sub-sample, 7.7% were observed with at least one condition and less than 1% had multiple conditions. Table 14 below summarizes the prevalence of conditions in examined fish for 2019. Disease was present in 4.4% of fish examined. The trematode parasite responsible for blackspot, the most common disease noted, affected 3.6% of smolts examined. Blackspot was most predominant in subyearling Chinook salmon (329 fish), but it was also observed in steelhead (6 fish) and yearling Chinook salmon (1 fish). Table 15 below summarizes the number and percentage of smolts observed with disease by species. Injuries were observed in 1.9% of smolts. Steelhead experienced the highest injury rate at 2.7%, followed by coho salmon (2.4%), yearling Chinook salmon (2.2%), sockeye salmon (2.2%), and subyearling Chinook salmon (1.3%). Table 16 below summarizes the numbers and percentage of injuries by species. Predator marks were present in 1.7% of smolts, with bird marks being the most prevalent predator mark observed. Steelhead were observed to have the highest rate of predator marks of all species examined at 4.2%, largely attributed to birds. Table 17 below summarizes the number and type of predator mark sustained by species in 2019.

Table 14 Summary of Smolt Conditions Excluding Descaling in Subsample, 2019

	Yearling Chinook				Subyearling Chinook				Steelhead				Coho				Sockeye				Annual Total	
	Clip		Unclip		Clip		Unclip		Clip		Unclip		Clip		Unclip		Clip		Unclip			
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Total Conditions	80	--	32	--	77	--	378	--	103	--	36	--	2	--	13	--	14	--	8	--	743	--
	112				455				139				15				22					
Smolts with Conditions	79	4.1%	28	3.8%	75	8.3%	368	13.1%	97	7.4%	31	9.7%	2	4.3%	12	3.7%	13	8.1%	8	1.2%	713	7.7%
	107		3.99%		443		12.0%		128		7.81%		14		3.78%		21		2.57%			
Total Fish Examined	1,940		743		900		2,802		1,317		321		46		324		160		656		9,209	
	2,683				3,702				1,638				370				816					

Table 15. Number and Percentage of Smolts Observed with Disease in the Subsample, 2019

	Yearling Chinook				Subyearling Chinook				Steelhead				Coho				Sockeye				Total	
	Clip		Unclip		Clip		Unclip		Clip		Unclip		Clip		Unclip		Clip		Unclip			
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Total	20	1.0%	8	1.1%	55	6.1%	291	10.4%	10	0.8%	15	4.7%	1	2.2%	3	0.9%	2	1.3%	0	0.0%	405	4.4%
	#		%		#		%		#		%		#		%		#		%			
	28		1.0%		346		9.3%		25		1.5%		4		1.1%		2		0.2%			

Table 16 .Number and Percentage of Smolts Observed with Injury in the Subsample, 2019

	Yearling Chinook				Subyearling Chinook				Steelhead				Coho				Sockeye				Total	
	Clip		Unclip		Clip		Unclip		Clip		Unclip		Clip		Unclip		Clip		Unclip			
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Total	44	2.3%	14	1.9%	13	1.4%	36	1.3%	36	2.7%	9	2.8%	0	0.0%	9	2.8%	11	6.9%	7	1.1%	179	1.9%
	#		%		#		%		#		%		#		%		#		%			
	58		2.2%		49		1.3%		45		2.7%		9		2.4%		18		2.2%			

Table 17. Number and Percentage of Smolts Observed with Predator Marks in the Subsample, 2019

Predator Mark	Yearling Chinook				Subyearling Chinook				Steelhead				Coho				Sockeye				Total	
	Clip		Unclip		Clip		Unclip		Clip		Unclip		Clip		Unclip		Clip		Unclip			
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Bird	7	0.4%	5	0.7%	1	0.1%	2	0.1%	47	3.6%	9	2.8%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	71	0.8%
Fish	4	0.2%	3	0.4%	5	0.6%	14	0.5%	8	0.6%	1	0.3%	1	2.2%	1	0.3%	0	0.0%	0	0.0%	37	0.4%
Lamprey	5	0.3%	2	0.3%	3	0.3%	34	1.2%	1	0.1%	2	0.6%	0	0.0%	0	0.0%	0	0.0%	1	0.2%	48	0.5%
Total	#		%		#		%		#		%		#		%		#		%			
	16	0.8%	10	1.3%	9	1.0%	50	1.8%	56	4.3%	12	3.7%	1	2.2%	1	0.3%	0	0.0%	1	0.2%	156	1.7%
	26		0.97%		59		1.59%		68		4.2%		2		0.5%		1		0.1%			

Mortality

Total facility mortality comprises mortalities found in the separator, sample tanks, and the sample recovery raceway, and is expressed as the rate of mortality of the bypassed population. Total facility mortality for all species combined was 0.01% in 2019. September had the highest monthly total mortality rate of 0.25%. Table 18 below summarizes monthly and annual total facility mortality for 2019.

Sample mortality is a subset of the facility mortality and comprises mortalities found in the sample tank only and is expressed as the rate of mortality of the sample population. Sample mortality for all species combined was 0.4% in 2019. Sockeye salmon had the highest sample mortality rate of 0.6% for the season. August had the highest monthly sample mortality rates at 0.8%. Table 19 below summarizes monthly and annual sample mortality for 2019. Table 20 below compares the weekly sample tank mortality from 2015 to 2019 and the actual number of mortality in the sample, all listed by species and clip type.

Table 18. Monthly and Total Facility Mortality, 2019

	Yearling Chinook				Subyearling Chinook						Steelhead				Coho				Sockeye					
	Clip		Unclip		Clip		Unclip		Fry		Clip		Unclip		Clip		Unclip		Clip		Unclip		Total	
Month	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
April	6	0.0%	5	0.0%					2	0.1%	7	0.0%	1	0.0%	0	0.0%	0	0.0%			1	0.0%	22	<0.1%
May	6	0.0%	1	0.0%	0	0.0%	0	0.0%	1	0.0%	3	0.0%	0	0.0%	0	0.0%	0	0.0%	2	0.0%	3	0.0%	16	<0.1%
June	1	0.0%	1	0.1%	10	0.0%	8	0.0%	0	0.0%	1	0.1%	1	0.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	22	<0.1%
July	0	0.0%	0	0.0%	2	0.0%	14	0.1%			0	0.0%	0	0.0%	0	0.0%					0	0.0%	16	<0.1%
August					0	0.0%	11	0.2%			1	8.3%					1	25.0%			0	0.0%	13	0.2%
September					0	0.0%	1	0.3%			0	0.0%									0	0.0%	1	0.3%
Total	13	0.0%	7	0.0%	12	0.0%	34	0.0%	3	0.1%	12	0.0%	2	0.0%	0	0.0%	1	0.0%	2	0.0%	4	0.0%	90	<0.1%
	20		<0.1%		49			<0.1%			14		<0.1%		1		<0.1%		6		<0.1%			

Note: Blanks indicate no smolts bypassed.

Table 19. Monthly and Total Sample Mortality for 2019 Season

	Yearling Chinook				Subyearling Chinook						Steelhead				Coho				Sockeye					
	Clip		Unclip		Clip		Unclip		Fry		Clip		Unclip		Clip		Unclip		Clip		Unclip		Total	
Month	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
April	5	0.4%	5	0.5%					2	6.5%	6	0.3%	0	0.0%	0	0.0%	0	0.0%			0	0.0%	18	0.4%
May	4	0.2%	1	0.3%	0	0.0%	0	0.0%	1	5.0%	2	0.8%	0	0.0%	0	0.0%	0	0.0%	1	0.9%	3	0.7%	12	0.4%
June	1	0.6%	1	3.8%	8	0.5%	6	0.3%	0	0.0%	1	3.8%	1	3.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	18	0.5%
July	0	0.0%	0		1	0.3%	8	0.4%			0	0.0%	0	0.0%	0	0.0%					0	0.0%	9	0.4%
August					0	0.0%	9	0.7%			1	33.3%					1	100.0%			0	0.0%	11	0.8%
September					0	0.0%	0	0.0%			0	0.0%									0	0.0%	0	0.0%
Total	10	0.3%	7	0.5%	9	0.5%	23	0.4%	3	4.9%	10	0.4%	1	0.2%	0	0.0%	1	0.3%	1	0.8%	3	0.5%	68	0.4%
	17		0.4%		35			0.5%			11		0.4%		1		0.3%		4		0.6%			

Note: Blanks indicate no smolts sampled.

Table 20. Weekly Mortality in Percentages and Actual Count of Sample Tank Mortality, 2019-2015

Weekly Mortality in Percent and Actual Count of Sample Tank Mortality																	
2019 Week Ending Date	**Current YR**	**Yearling Chinook**		**Subyearling Chinook**		**Clipped Steelhead**		**Unclipped Steelhead**		**Coho**		**Clipped Sockeye**		**Unclipped Sockeye**		**Total**	
Week Number	**4 YR AVG (2015-2018)**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
11-Apr	2019	4	0.3%	---	---	0	0.0%	0	0.0%	0	0.0%	---	---	0	0.0%	4	0.2%
1	AVG	2	0.5%	3	3.6%	0	0.2%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	0.8%
18-Apr	2019	1	0.4%	1	20.0%	5	0.7%	0	0.0%	0	0.0%	---	---	---	---	7	0.7%
2	AVG	2	0.2%	1	0.4%	1	0.2%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4	0.2%
25-Apr	2019	5	1.5%	1	5.9%	1	0.3%	0	0.0%	0	0.0%	---	---	---	---	7	0.9%
3	AVG	4	0.3%	1	0.3%	2	0.4%	0	0.0%	0	0.0%	---	---	0	0.3%	6	0.3%
2-May	2019	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	---	---	0	0.0%	0	0.0%
4	AVG	3	0.4%	1	1.5%	0	0.1%	1	1.2%	0	0.0%	0	0.0%	0	0.3%	4	0.4%
9-May	2019	1	0.2%	0	0.0%	1	1.0%	0	0.0%	0	0.0%	---	---	2	2.0%	4	0.5%
5	AVG	6	0.3%	1	2.3%	2	0.5%	0	0.3%	0	0.4%	0	0.0%	2	0.5%	10	0.4%
16-May	2019	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	---	---	0	0.0%	0	0.0%
6	AVG	2	0.2%	0	0.6%	0	0.2%	0	0.0%	0	0.0%	---	---	2	0.3%	4	0.2%
23-May	2019	3	0.4%	1	9.1%	1	2.0%	0	0.0%	0	0.0%	0	0.0%	1	0.7%	6	0.5%
7	AVG	3	0.3%	5	2.6%	0	0.0%	0	0.5%	1	0.7%	0	0.0%	3	0.3%	12	0.5%
30-May	2019	1	0.6%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	2.7%	0	0.0%	2	0.5%
8	AVG	2	0.3%	5	1.2%	0	0.3%	0	0.3%	0	0.0%	0	0.0%	1	0.3%	8	0.5%
6-Jun	2019	1	0.9%	2	0.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3	0.3%
9	AVG	1	0.7%	5	0.8%	1	2.3%	0	0.0%	0	0.0%	0	1.1%	1	0.8%	8	0.7%
13-Jun	2019	1	2.9%	1	0.2%	1	12.5%	0	0.0%	0	0.0%	---	---	0	0.0%	3	0.6%
10	AVG	1	1.8%	3	0.6%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	4.7%	5	0.7%
20-Jun	2019	0	0.0%	6	0.5%	0	0.0%	1	11.1%	0	0.0%	---	---	0	0.0%	7	0.6%
11	AVG	0	0.0%	3	0.4%	0	0.0%	0	11.1%	0	0.0%	---	---	0	0.0%	4	0.5%
27-Jun	2019	0	0.0%	5	0.6%	---	---	---	---	0	0.0%	---	---	---	---	5	0.6%
12	AVG	0	0.0%	7	0.8%	0	0.0%	0	0.0%	0	0.0%	---	---	0	0.0%	7	0.8%

Weekly Mortality in Percent and Actual Count of Sample Tank Mortality																	
2019 Week Ending Date	Current YR	Yearling Chinook		Subyearling Chinook		Clipped Steelhead		Unclipped Steelhead		Coho		Clipped Sockeye		Unclipped Sockeye		Total	
4-Jul	2019	0	0.0%	2	0.5%	---	---	---	---	0	0.0%	---	---	0	0.0%	2	0.5%
13	AVG	0	0.0%	9	0.5%	0	0.0%	0	--	0	0.0%	---	---	0	0.0%	9	0.5%
11-Jul	2019	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
14	AVG	0	0.0%	16	2.2%	0	0.0%	0	--	---	---	---	---	---	---	16	2.2%
18-Jul	2019	---	---	2	0.4%	---	---	---	---	---	---	---	---	---	---	2	0.4%
15	AVG	---	---	2	0.2%	---	---	0	0.0%	---	---	0	0.0%	0	0.0%	2	0.2%
25-Jul	2019	---	---	1	0.2%	0	0.0%	---	---	---	---	---	---	---	---	1	0.2%
16	AVG	---	---	4	0.8%	0	0.0%	0	--	0	100.0%	0	0.0%	0	0.0%	4	0.8%
1-Aug	2019	---	---	5	0.4%	1	50.0%	0	0.0%	---	---	---		0	0.0%	6	0.5%
17	AVG	---	---	5	1.1%	0	0.0%	0	--	0	0.0%	---	---	0	0.0%	5	1.1%
8-Aug	2019	---	---	2	0.3%	0	0.0%	---	---	---	---	---	---	0	0.0%	2	0.3%
18	AVG	---	---	3	1.2%	0	0.0%	0	--	---	---	---	---	0	0.0%	3	1.2%
15-Aug	2019	---	---	6	1.8%	---	---	---	---	1	100.0%	---	---	0	0.0%	7	2.1%
19	AVG	---	---	3	0.9%	0	0.0%	0	--	---	---	---	---	0	0.0%	3	1.0%
22-Aug	2019	---	---	0	0.0%	---	---	---	---	---	---	---	---	---	---	0	0.0%
20	AVG	---	---	1	0.4%	0	0.0%	0	--	---	---	---	---	0	0.0%	1	0.4%
29-Aug	2019	---	---	0	0.0%	---	---	---	---	---	---	---	---	0	0.0%	0	0.0%
21	AVG	---	---	0	0.0%	0	0.0%	0	--	---	---	---	---	0	0.0%	0	0.0%
5-Sep	2019	---	---	0	0.0%	0	0.0%	---	---	---	---	---	---	---	---	0	0.0%
22	AVG	---	---	0	0.2%	0	0.0%	0	--	---	---	---	---	0	0.0%	0	0.2%
12-Sep	2019	---	---	0	0.0%	0	0.0%	---	---	---	---	---	---	0	0.0%	0	0.0%
23	AVG	---	---	0	0.3%	0	0.0%	0	--	---	---	---	---	---	---	0	0.3%
19-Sep	2019	---	---	0	0.0%	---	---	---	---	---	---	---	---	---	---	0	0.0%
24	AVG	---	---	0	0.0%	0	0.0%	0	--	---	---	---	---	0	0.0%	0	0.0%
26-Sep	2019	---	---	0	0.0%	---	---	---	---	---	---	---	---	---	---	0	0.0%
25	AVG	---	---	0	1.0%	---	---	0	--	---	---	---	---	0	0.0%	0	1.2%
3-Oct	2019	---	---	0	0.0%	0	0.0%	--	--	---	---	---	---	0	0.0%	0	0.0%

Weekly Mortality in Percent and Actual Count of Sample Tank Mortality																	
2019 Week Ending Date	Current YR	Yearling Chinook		Subyearling Chinook		Clipped Steelhead		Unclipped Steelhead		Coho		Clipped Sockeye		Unclipped Sockeye		Total	
26	AVG	---	---	0	4.0%	---	---	0	--	---	---	---	---	0	0.0%	0	3.8%

JUVENILE RESEARCH

Gas Bubble Trauma (GBT) Monitoring

Pacific States Marine Fisheries Commission (PSMFC) conducted GBT monitoring as part of the Smolt Monitoring Program from April 13 to July 30. Twice per week, a combination of up to 100 juvenile Chinook salmon and steelhead were collected from the separator and inspected for GBT.

In 2019, 2,843 smolts were examined for GBT. Signs of GBT were present in 7 smolts: 4 clipped steelhead, 2 clipped subyearling Chinook salmon, and 1 unclipped yearling Chinook salmon. These smolts were examined on May 5 (1 clipped steelhead), May 7 (1 clipped steelhead), May 18 (1 clipped steelhead), June 2 (1 clipped subyearling Chinook salmon and 1 clipped steelhead), July 14 (1 clipped subyearling Chinook salmon), and July 20 (1 unclipped subyearling Chinook salmon). Table 21 below summarizes GBT for the year.

Table 21. Gas Bubble Trauma Monitoring, 2019

	Yearling Chinook		Subyearling Chinook		Steelhead		Clip Type Totals		Annual Total
	Clip	Unclip	Clip	Unclip	Clip	Unclip	Clip	Unclip	
Examined	906	145	507	760	432	93	1,845	998	2,843
GBT Signs	0	0	2	1	4	0	6	1	7

Yakima Nation Research

The Yakama Nation acquired 32 Pacific Lamprey macropthalmia from the samples between April 29 and May 31, 2019. The fish were the subject of an off-site acoustic telemetry project in the lower Yakima and mainstem Columbia rivers.

OPERATIONS AND MAINTENANCE

Bypass Operations

During the winter maintenance season, to prepare to test the system for the juvenile collection channel contractor, the system was operated in a modified emergency bypass mode for four hours to thaw ice from the channel on February 19. The system was operated in a modified primary bypass mode for two hours to check the system for leaks on February 21. The system was again operated in a modified emergency bypass mode for a total of six hours to thaw ice from the channel on March 5 and 6. The system was again operated in a modified primary bypass mode for two hours to check the system for leaks on March 7.

After winter maintenance, primary bypass began on March 28. All systems were watered up, tested and cleaned. The channel systems were fully functional. The facility systems remained out of service until April 4 at 0700 hours, at which time secondary bypass for sample collection began. The season consisted of 24 hour alternating days of primary and

secondary bypass. During secondary bypass, samples were collected. For the season, the sample gates were only on during sample collection.

Listed below are deviations outside the alternating schedule:

1. The system remained in primary bypass while the rectangular screen cleaning brush in the channel was repaired on April 22, from 0700 to 1317 hours. At a one percent sample rate, nineteen samples were missed.
2. The B side sample gate failed on May 6 in the open position. Due to the large number of fish collected and after consulting with PSMFC staff members, the biologist determined it would be best to switch the system to primary bypass at 1500 hours. For the data day, 16 hours of sampling were missed.
3. The system was in primary bypass in order to examine the full flow flume adult flush line which had not opened on June 1, from 0715 to 0725 hours. The sample gates were left on while in primary bypass, one sample was missed.
4. The north side dewatering valve in the juvenile collection channel failed on July 2. No 24 hour sampling occurred on July 3, 5, 7 and 9. The issue with the north side dewatering valve in the juvenile collection channel was not resolved until July 10. Sampling resumed on July 11 with data being reported on July 12.
5. Secondary bypass did not occur while limits were set on the south side dewatering valve in the juvenile collection channel on July 15, from 0700 to 1000 hours. Three hours of index sampling were missed.
6. The facility was in primary bypass due to low water flows caused by a collection channel power outage on July 19, from 1131 to 1231 hours. Two samples were missed.

The system was switched to primary bypass mode for the fall bypass season on September 30, at 0700 hours. During the fall primary season, partial winterization occurred along with light maintenance and preparations for the winter outage.

The juvenile system was switched from primary to emergency bypass mode just after ESBS removal began on December 17. The facility was dewatered and winterized along with the channel systems being removed from service. Channel maintenance also began.

With the last set of ESBSs being raised, the channel orifices were closed for the season and the channel was winterized on December 20.

Turbine Operations

The one percent hard criteria for unit operation ran from April 1 to October 31, inclusive. No records of units running outside the constraint for long periods of time were recorded. Only short test runs of units returning to service along with slight variances occurring were noted during the season. During the soft one percent criterion in January to March and November to December, the project ran units outside the constraint at the BPA's request. Unit priority was in effect from March 1 to November 30.

In order to reduce heat stress, the saw tooth pattern (an alternating pattern of units on/off) was in effect from July 14 to August 31, inclusive. No heat stress mortality was noted this year.

Spill Operations

Before the spill season, spill in excess of powerhouse capacity occurred on April 8 and 9. The spring spill program, which was the regionally agreed upon flex spill, occurred from April 10 to June 15, inclusive. The summer spill program, with 57 percent of flow being spilled, was from June 16 to August 31, inclusive. However, lower spill volumes can occur due to low flows and with the requirement to have 50 kcfs pass through the powerhouse, the spill volume went below 57 percent at times in August. Also, during the spill seasons, spill adjustments for navigation were done as required. During the fall and winter, spill in excess of powerhouse capacity happened only on September 17. In addition, the TSW in bay 20 was operated throughout the fall per the adult steelhead TSW passage efficiency study plan. During the fall, spillway hoist and crane maintenance was performed. However, some maintenance occurred throughout the year. Slight spill may have occurred during hoist or crane testing.

Project engineers performed spillbay hoist inspections on May 14. At bay 1, the engineers found cracks in the hoist pillow block around the bolts. The hoist was removed from service and the bay was closed by 1430 hours. Project staff estimated it would take 13 weeks to buy a replacement block. However, the engineers believed the broken part can be braced. Until then, after discussion with district personnel, the gate in bay 1 was dogged off on the 5th stop. With the flow volume at the time, this setting closely matched Fish Passage Plan (FPP) spill patterns. This operation was completed on May 15 at 1520 hours. Bay 1 was closed for a little over one day with the other bays making up the difference. At spillbay 1, the hoist pillow block was braced and the hoist returned to service on May 22 at 1548 hours. Normal spill patterns were resumed. Spillbay 11 was closed on June 25, from 1005 to 1030 hours, for a seal inspection.

At the BPA substation, bus 1 failed resulting in transmission lines 1 through 5 tripping off and most McNary's turbine units being removed from service on August 5, at 1724 hours. Much of the flow was spilled as outlined in Table 22 below. Initially, unit 9 provide power for the project. By 2032 hours, all systems and units had been returned to service.

Table 22. McNary Dam Discharge on August 5 during BPA Substation Issue

Hour	Total	Power	Spill	% Spill
1600	148.4	59.0	84.7	57
1700	153.4	61.2	87.4	57
1800	134.9	24.6	105.6	78
1900	149.5	0.7	144.2	96
2000	145.9	21.5	119.8	82
2100	152.7	49.0	99.1	65
2200	144.8	57.6	82.5	57
2300	143.6	57.0	81.9	57

Spillgate manipulation for forebay debris removal will be discussed in the Forebay Debris Section below. No smolt mortalities were observed near spillbays 1 and 22 this year.

TSWs

TSWs installation was completed by April 4. The TSWs in bay 19 and 20 are attached to a crane and spillgate hoist, respectively. Limit adjustments were made as required. The TSWs were opened on April 9.

Due to June 8 being a Saturday, the two TSWs were closed and replaced with standard spillway gates from June 10, at 0728 hours, to June 12, at 1630 hours. All Fish Passage Plan spill patterns were followed before, during and after the TSW removal. No problems occurred with the TSWs during the spill season.

The TSW in spillbay 19 remained closed after the spill season. However, the TSW in bay 20 was reinstalled, attached to the hoist on the stand and tested for the adult steelhead top spillway weir passage efficiency study, from September 9 to 12. Testing the TSW resulted in minor spill on September 12. The dive at bay 20 to install study equipment for the TSW passage study occurred on September 13.

The TSW in bay 20 became operational per the TSW study plan on September 15. That day, there was difficulty in fully opening and closing the TSW. The electrical staff resolved the issue and tested the hoist the next day. Also, scheduled maintenance was performed on the hoist on October 1. The fall phase of the study concluded on the night of November 15. The TSW in bay 20 remained closed until the spring phase of the study began in March, 2020.

Forebay Debris

During the winter, the powerhouse debris load was minimal to moderate. Incoming debris volume was minimal to light. Wind direction changes moved the debris from the powerhouse to the Oregon shoreline and back repeatedly.

For the season, wind directional changes continued to move tumbleweeds, woody material and aquatic vegetation across the forebay, from the spillway to the Oregon shoreline and back. Tumbleweeds occurred mostly in the spring. Woody material was throughout the season. Aquatic vegetation began in the summer and ran through late fall.

Besides weather, TSW use, the spill program, trash rack cleaning and powerhouse operations effected the forebay debris volume and location. Most debris was either passed, removed or dissipated over time. When the spill was closed the night of August 31, the spillway debris migrated to the powerhouse.

Along the shorelines, the debris loads varied between minimal and heavy.
Powerhouse and spillway debris loads for the season are recorded in Table 23 below.

Table 23. Forebay Debris Loads

Month	Powerhouse	New Debris	Spillway	New Debris
Mar	Minimal-heavy	Minimal-light	Minimal	Minimal
Apr	Minimal-heavy	Minimal-light	Minimal	Minimal
May	Minimal-moderate	Minimal-light	Minimal-moderate	Minimal-light
Jun	Minimal-moderate	Minimal-light	Minimal-moderate	Minimal-light
Jul	Minimal-light	Minimal	Very light-light	Minimal
Aug	Minimal-light	Minimal	Minimal-very light	Minimal
Sep	Minimal-moderate	Minimal	Minimal-very light	Minimal
Oct	Minimal-moderate	Minimal	Minimal	Minimal
Nov	Minimal-moderate	Minimal	Minimal	Minimal
Dec	Minimal-moderate	Minimal	Minimal	Minimal

Forebay Debris Removal

Along the Washington shoreline, much of the debris was flushed down the navigation lock as needed during the spring and summer months.

When TSWs were in place, trash racks were cleaned, wind direction changed and/or project operations were altered, some forebay debris would pass downstream or be removed. For example, when the spring spill program began on April 10, much of the existing debris at that time was passed. Also, debris that had accumulated at the powerhouse while units 13 and 14 were out of service was passed through the spillway once the units returned to service on May 9.

One emergency debris spill occurred this season. The project staff used spillbays 9, 11, and 16 operated in split leaf mode, which expedited debris removal from these and adjacent bays on June 6, from 1108 to 1525 hours. The bays used were each open for 20 to 30 minutes in a rotating fashion with them either being closed or opened, which drew the debris to the open split leaf bay and passed it to the tailwater. The spillway gates settings were verified after the operation.

Trash Racks

During the winter, trash rack differentials were checked twice a week. No problems were observed. Seven slots were test cleaned with 12 yards of debris removed on January 15. No fish mortalities were noted.

Just before the ESBSs were installed, all trash racks were cleaned on March 25 and 26. Thirty five yards of debris was removed. Again, no fish were observed in the debris.

For the season, trash differentials were monitored daily. Trash racks were cleaned in slots 2A, 10A, 11A and 12A on April 29 and 2.5 yards of debris was removed. Trash racks were cleaned in unit 1, 2A, 3A and 14A slots on May 21 and 10 yards of debris was removed. Finally, the trash racks in 1A, 9A, 13A and 14A slots were cleaned on June 24 and 0.3 yards of debris was removed. Each time, no fish were observed in the debris.

Outside the juvenile passage season, trash racks were cleaned in 1A, 1B, 10A and 10B slots for the adult steelhead top spillway weir (TSW) passage efficiency study on September 3. Less than a cubic yard of debris was removed. In preparation for camera inspection, all trash racks were cleaned from October 29 to 31. A total of 15 yards of debris was removed. No fish were observed in the debris during either cleaning.

An ROV was used to inspect all unit trash racks from November 4 to 5.

Gatewells

During the winter outage, a small amount of oil was removed from 11B slot and unit 12 with absorbent pads. Also, gatewell slots were check twice a week.

During the season, gatewell slots were checked daily. Small amounts of woody material were removed as required and as listed below in Table 24 along with other issues. No large accumulations of woody material were noted.

Table 24. Gatewell Slot Observations

Date(s)	Issue Type	Location	Amount	Source/Solution
Apr 15	Woody	Various Slots	Minimal	River/Removed
May 13	Woody	Various Slots	Minimal	River/Removed
May 21	Woody	Various Slots	Minimal	River/Removed
Jun 4	Woody	4B slot	Large piece	River/Removed
Jul 2	Woody	Various Slots	Minimal	River/Removed
Jul 9	Woody	Various Slots	Minimal	River/Removed
Aug 11-Sep 26	Algae bloom	Units 5 & 13	Surface	River/Dissipated
Sep 10	Fluid	8B slot	Minimal	Transformer/Removed
Nov 3 & 11	Rope	7B slot	One	ESBS/Tied off
Nov 4	Woody	Two slots	Minimal	River/Removed
Nov 11	Rope	12A slot	One	ESBS/Tied off

The emergency bulkhead was installed in slot 14A as part of the process of removing unit 14 from service on August 19. The fisheries staff was not informed so the slot was dewatered without removing fish from the slot with the gatewell trap. Fortunately, fish numbers were very low. The project reviewed the protocols for using the emergency bulkhead. The emergency bulkhead was removed from 14A slot on August 28, rewatering the slot.

Extended Length Submersible Bar Screens

During the winter maintenance season, electrical cables, gearboxes and motors were replaced as required. ESBS control programming was also verified.

ESBSs were installed by unit priority, on April 2 to 4, April 8 to 9 and April 11 to 12. Screens were installed in all units. The brush cycle time for all ESBSs was set at 60 minutes, where it remained. The ESBSs in unit 5 and 14, which were out of service, were

raised on December 11. All other screens were raised for winter maintenance from December 16 to 20.

From May 7 to December 3, the fisheries staff performed underwater camera inspections, which begin about a month after ESBS installation. Issues with the primary and backup cameras were resolved in the off season. A new camera was not ordered. All inspections were completed with the primary camera. Camera inspection results are recorded in Table 25 below.

Table 25. ESBS Camera Inspection Results

Date	Location	Issues
May 7	Units 1, 13 & 14	None
May 14	Units 10, 11 & 12	None
May 21	Units 7, 8 & 9	None
May 28	No inspections	Other work priorities.
Jun 4	Units 4, 5 & 6	None
Jun 11	Units 1, 2 & 3	None
Jun 18	Units 12, 13 & 14	None
Jun 25	Unit 9	None
Jul 2	Units 8, 10 & 11	None/Minor issue with camera cable drum.
Jul 9	Units 4, 6 & 7	None
Jul 16	Units 1, 11 & 14	None
Jul 23	Units 9 & 12	None
Jul 30	Units 5 & 13	None
Aug 6	No inspections	Minor camera issues.
Aug 13	Units 1 & 14	None
Aug 20	Units 9, 10 & 12	None
Aug 27	Units 7 & 8	None
Sep 3	No inspections	Outage used to clean trash racks at units 1 and 10.
Sep 10	No inspections	Due to total number of units out of service.
Sep 17	Units 1, 4 & 6	None
Sep 24	Units 2 & 3	None
Oct 1	Units 10 & 11	None
Oct 8	Unit 8	None
Oct 15	Units 7 & 9	None
Oct 22	Units 1 & 12	None
Oct 29	Units 4 & 6	None
Nov 5	No inspections	Other work priorities.
Nov 12	Units 9, 10 & 11	None
Nov 17	Units 1, 2 & 3	None
Nov 24	Units 7 and 12	None
Dec 3	Units 6 & 8	None

After the ESBSs were raised, an inspection revealed all ESBSs to be clean except for a small section of screen on the ESBS in 3A slot. During the year end inspection, only juvenile shad were noted on top of each brush.

During the season, ESBS problems were mostly due to proximity switch failures, programming and electrical issues. Also, human error may have been involved. Gearbox, motor, brush drive or coupler issues were minimal. Only two ESBSs were replaced this year. No fish mortalities were noted during ESBS issues, which are recorded in Table 26 below.

Table 26. ESBS Issues

Slot(s)	Date(s)	Issue
11B, 12B & 13B	Apr 3 & 4	Brush cycles reset after ESBS installation.
7B & 12B	Apr 10	Repeated alarms/Brushes cycles reset and in/out of timer mode for a week. Screens replaced on April 10.
13A	Apr 17 & 18	After multiple alarms, brush cycle switched to timer mode.
13A	Rest of season	Brush cycle remained in timer mode.
All	Apr 18	ESBS brush control program evaluated.
8C	Apr 21	After multiple alarms, brush cycle switched to timer mode.
8A	Apr 22	After multiple alarms, brush cycle switched to timer mode.
6A	Apr 23	After multiple alarms, brush cycle switched to timer mode.
6A, 8A & 8C	Rest of season	Brush cycles remained in timer mode.
7A	Apr 23	Brush cycle reset after alarms.
Unit 10	Apr 29	Controller not communicating with brushes/Resolved.
1A, 6A & 13A	Apr 30	After multiple alarms, brush cycles reset.
6A & 13A	May 13	After multiple alarms, brush cycles reset.
10A	May 12-15	Brush cycle reset and in/out of timer mode.
10A	Rest of season	Brush cycle remained in timer mode.
10A	May 17	Brush cycle reset after alarms.
8A	May 21	Brush cycle reset after alarms.
8C	May 22	Brush cycle reset after alarms.
10B & 10C	May 20	After multiple alarms, brush cycles switched to timer mode.
10B & 10C	Rest of season	Brush cycles remained in timer mode.
10C	May 22	Brush cycle reset after alarms.
13B & 13C	May 27	After multiple alarms, brush cycles switched to timer mode.
13B & 13C	Rest of season	Brush cycles remained in timer mode.
6A	Jun 4	Brush cycle reset to timer mode after camera inspection.
8B	Jun 16	After multiple alarms, brush cycle switched to timer mode.
8B	Rest of season	Brush cycle remained in timer mode.
Units 8 & 10	Jul 2	Brush cycles reset to timer mode after camera inspections.
6B & 6C	Jul 18	After multiple alarms, brush cycles switched to timer mode.
6B & 6C	Rest of season	Brush cycles remained in timer mode.
All	Aug 5	BPA substation trip/10 minute or less power outage.
Units 8 & 13	Aug 6	Brush cycles returned to timer mode after power outage Aug 5.
Unit 1	Aug 6	Controller not communicating with brushes/Electrical staff resolved/After power outage Aug 5.
Unit 10	Aug 7	Brushes returned to timer mode after power outage Aug 5.
6A & 6B	Aug 14	Brush cycles reset after alarms.
14A	Aug 19-28	ESBS removed for emergency bulkhead installation/Unit out of service.

Unit 10	Aug 20	Brush cycles reset to timer mode after camera inspections.
Unit 1	Aug 22-25	Brush cycles set to one minute/Returned to 60 minutes.
Unit 7	Aug 28	Brush cycles returned to automatic mode after camera inspection on Aug 27/Did not cycle for 24 hours.
2A	Sep 2	After multiple alarms, brush cycles reset.
Unit 11	Sep 2	Controller not communicating with brushes/Operator cycled brushes using manual mode/Electrical staff resolved Sep 3.
10C	Sep 9, 11 & 12	Brush cycle reset to timer mode after each unit outage.
Unit 8	Sep 13	Brush cycles reset to timer mode after unit outage.
Unit 7	Sep 16	Brush cycles found in manual mode and returned automatic mode.
Unit 10	Sep 20	Brush cycles reset to timer mode 24 hours after unit returned to service.
Unit 11	Sep 23	Controller not communicating with brushes/Electrical staff resolved immediately.
Units 2 & 3	Sep 25	Brush cycles returned to automatic mode after camera inspection on Sep 24/Did not cycle for 24 hours.
Unit 8	Sep 25	Brush cycles found in automatic mode and returned timer mode.
2A	Dec 2	Brush cycle not complete/Switch to timer mode.
2A	Rest of season	Brush cycle remained in timer mode.
2A	Dec 6-9	Brush appeared to be missing a cycle occasionally.
Unit 8	Dec 7	Brush cycles found in automatic mode and returned timer mode.
2A	Dec 19-20	Brush appeared to be missing a cycle occasionally.

Vertical Barrier Screens

This season, VBSs were replaced in slots 9A and 9C on May 15 and 13, respectively. VBS rehabilitation occurred on the two screens that were removed. All spare screens were prepared if needed.

Daily VBS head differential monitoring began with ESBS installation and continued until ESBS removal, which is discussed the ESBS section above. The first VBS was cleaned on April 24 and the last screen cleaned on November 30. After removing debris, cleaning the back side of the screens in order to remove the freshwater sponge began in July, as needed. Due to sponge growth becoming substantial, 29 VBSs in operational units were cleaned from July 22 to 25. Sponge removal also occurred for the VBSs in 9B and 9C slots on July 29, completing the first round of sponge removal. After, the sponge continued to be removed during VBS cleaning as required. VBSs cleaned by month and mortalities noted are recorded in Table 27 below. In most cases, VBSs were cleaned as a preventative measure. The nine high differentials recorded in November were when the unit loads were near 80 MW. No repairs were recorded during VBS cleaning.

Table 27. VBS Cleaning by Month

Month	Days	VBSs Cleaned	Measured 1.5 Feet or More	Lamprey Mortality	Live Lamprey	Smolt Mortality
Mar	None	None	None	None	None	None
Apr	2	7	None	None	None	None
May	2	2	None	None	None	None
Jun	6	15	None	1	None	1
Jul	6	36	None	None	None	None
Aug	1	1	None	None	None	None
Sep	5	15	None	None	None	None
Oct	4	19	None	None	None	None
Nov	10	38	9	None	None	None
Dec	None	None	None	None	None	None
Total	36	133	9	1	0	1

VBS inspections, which includes cleaning, are recorded in Table 28 below. With cleaning and inspection, every VBS had been examined by late May.

Table 28. VBS Inspections by Month

Month	Days	VBSs Inspected	Lamprey Mortality	Live Lamprey	Smolt Mortality
Mar	None	None	None	None	None
Apr	1	6	None	None	None
May	5	27	None	None	1
Jun-Dec	None	None	None	None	None
Total	6	33	0	0	1

During the inspections, no serious problems were found but the VBS replacements in unit 9 mentioned above were trigger by the inspections.

JCC Orifices and Collection Channel

For the juvenile channel down well valve pit rehabilitation contractor, the channel was watered as described in Table 29 below. The leak test was completed satisfactorily.

Table 29. Juvenile Collection Channel Water Test

Date	Time	Orifices Open	Reason
3/5	0800 to 1030	One	Remove ice from channel floor/after check for fish.
3/5	1300 to 1500	Up to 42	Remove ice from channel using emergency bypass.
3/6	0900 to 1100	Up to 42	Complete ice removal using emergency bypass.
3/6	1230 to 1430	NA	Check channel system for fish.
3/7	1000 to 1200	Up to 12	Test repaired drains for leaks using modified primary bypass/after check for fish.

The season began with 42 orifices opened on March 28, as primary bypass began. The orifice count remained consistent most of the year. Orifices were cycled once or twice a shift when in primary bypass or on day shift. Orifice issues are described in Table 30 below. Brief orifice exchanges occurred for trash rack cleaning, VBS cleaning, VBS exchanges, ESBS camera inspections or forebay debris removal. Water noted in the orifice operators' air supply line only occurred when the airline system desiccant drier was out of service. Orifice attraction lights and area lighting along with orifice operator air leaks were replaced and repaired as required. The fisheries staff monitored the JCC when the JFF was in primary bypass or on day shift when in secondary bypass, when cleaning or replacing VBSs, during VBS inspections, when cleaning trash racks and during forebay debris removal along with the spillway closure at 0001 hours on September 1. At times, orifice adjustments and cycling resulted in brief high/low water alarms, which were quickly reset. After each incident, orifice cycling protocols were reviewed. No orifice blockages occurred this year. Also, after all issues with the JCC system listed in sections below, the fisheries staff would monitor the system.

Table 30. Orifice Issues

Date	Issue	Result	Comment
Jul 2-10	North side dewatering valve failure.	Reduce orifice count.	39 to 40 used, closed at unit 5, which was out of service.
Jul 4-19	Channel elevation with side dewatering issues.	Reduce cycling to once a day.	Lower debris loads warranted the precaution.
Jul 12-15	South side dewater valve operational range.	41 to 42 orifice used.	Closed at unit 5, which was out of service.
`Aug 19-20	14A slot dewatered, emergency bulkhead.	16.5 hours with 41 orifices.	Unit 14 out of service. Makeup orifice open at 13C slot.
Aug 20-28	14A slot dewatered.	Makeup orifice required.	Second orifice in 13C slot was open.
Sep 12-13	Orifice left closed after cycling.	41 orifice for 7 hours.	No harm to fish noted. Protocols reviewed.
Nov 3 & 11	7B slot ESBS rope in orifice flow.	Rope removed.	No harm to fish noted.
Nov11	12A slot ESBS rope in orifice flow.	Roped removed.	No harm to fish noted.
Nov 11-12	South orifice closed to avoid rope impingement.	North orifice open 28.5 hours.	General maintenance secured ropes.

Orifice were closed during the switched from primary to emergency bypass on December 17. All other systems were removed from services. Orifices were closed for the season and channel maintenance began on December 20.

Before the watering up or dewatering the JCC, with station service unit 1 out of service and dewatered, the deck fire water, which is river water, was used to flush the full flow pipe.

JCC Mortalities

No adult or juvenile salmonid mortalities were found in the JCC this season.

JCC Power Outages

Most of the power outages were related to the station service upgrades (SSU). All outages continue to raise questions about the channel system program. JCC power outages are outlined in Table 31 below.

Table 31. JCC Power Outages

Date	Length	Reason	Result
May 13	10 minutes	Bus switch for SSU.	No adverse effect.
May 15	9 minutes	Bus switch for SSU.	No adverse effect.
Jul 19	Unknown-brief	Bus switch for SSU.	1 hour primary bypass at JFF.
Aug 5	10 minutes or less	BPA substation.	Issue resolved.

JCC Hoist

There were no issues with the hoist this season other than one of the pendants was replaced.

JCC Primary Dewatering Structure (PDS)-Program and Alarms

The channel control program and systems were operational in automatic mode from March 28 to December 17. The control system continued to be monitored closely as concerns over the program functionally remain. Programing along with brush and water alarm issues are reflected in this report in JCC sections above and below. The three screen cleaning brushes will not operate when the alarm is active. The channel's water elevation meter had no problems this year. Also, scheduled maintenance was performed on all JCC systems as described below.

JCC PDS-Rectangular/Transition Screens Air Burst System

The air burst system had no issues this year. The air burst system has five functional zones with the zone 6 still included in the cycle timing. The brushes were programmed to run in sequence (first side screen, next rectangular screen and last transition screen) after a selected number of air burst cycles were completed. Generally, the brushes ran approximately every three hours. Due to low debris loads, the cleaning brushes cycle time was increased from every 3 hours to every 5 hours on November 17 (from every 3 to every 5 air burst cycles).

During rectangular and transition screen cleaning brush failures, the air burst system was instrumental in keeping the screens clean.

JCC PDS-Rectangular Dewatering Screen Cleaning Brush

Before the season, the rectangular screen cleaning brush was adjusted as required. The rectangular and transition screens brushes cycles overlap, thus, both report sections can refer to each brush. The program does not allow them to run at the same time. Issues with the rectangular screen cleaning device are recorded in Table 32 below.

Table 32. Rectangular Screen Cleaning Mechanism Issues

Date(s)	Problem	Resolution
Apr 20	Kinked electrical cord. Not confirmed until Apr 21. Brush removed from service. Out of service 25.6 hours.	Monitor JCC, run air burst. Repaired and adjusted. April 22 returned to service.
Apr 25	Access to east side cable drum.	Access point made.
May 15	Brush raising limit switch repositioned.	Brush out of service 8 hours.
May 16	Brush limit adjustment and testing.	Brush out of service 2 hours.
Dec	Brush required lubrication.	Done in winter outage.

JCC PDS-Side Dewatering Screen Cleaning Brush

The side screen cleaning device received scheduled maintenance on June 3. The side brush tripped an alarm and was reset by the operators on November 26. This was a timing alarm, which was possibly due to debris. The brush ran successfully for approximately 10 hours before another brush timing alarm occurred. This time, due to the sequential brush cycle program, all three brushes (rectangular and transition included) tripped alarms. The operators again reset the alarms. When the next brush cycle was due on November 27, five hours later, the side brush again tripped a timing alarm. On this occasion, only the transition brush alarmed. At this point, the operators waited for the biologist to come in on shift. Four hours later, before the next brush cycle was to occur, the biologist went to the channel to examine the issue. After operating the side brush manually, the biologist determined the brush had jammed on debris on the lower guide, which is on the floor of the channel. The biologist was able to dislodge the debris, clear both alarms and return the side brush to automatic mode. All three brushes were operated to ensure they were fully functional. The nature of these brush alarms continues to raise concerns with the system programming, especially the sequential brush cycle. Also, the side brush did not appear to "bump" the debris as programmed. Thus, the brush did not dislodge the debris, which raises another concern. Finally, it appeared the brush operation timer self-reset, which delayed the next cleaning and raised more concerns with the system programming.

JCC PDS-Transition Dewatering Screen Cleaning Brush

Before the season, residue from the collection channel contract had to be removed from transition screen cleaning brush. Also, the brush was adjusted as required. In season issues with the transition screen cleaning device are recorded in Table 33 below. When the brush was out of service, the air burst system kept the screen relatively clean.

Table 33. Transition Cleaning Mechanism Issues

Date	Problem	Resolution
Apr 22	Brush out of service 6 hours for rectangular screen brush repairs.	Repairs completed, returned to service.
Sep 2-4	Four alarms tripped and reset. Last alarm brush found jammed/stalled on C beam.	By hand mode, brush parked. By manual mode, brush operated.

Sep 4-23	High alarm rate, brush removed from service due to possible limit switch issue.	Air burst zone 5 keep screen clean. Debris loads low.
Sep 23	No issues with brush found. Possibly debris/spider webs caused limit issue.	Brush returned to automatic mode.

JCC PDS-Side Screen Dewatering Valves (2)

During winter maintenance, no new problems were found. These valve are tied into the JCC programming and control the JCC water elevation. For the season, the two side dewatering valves did seem to run frequently and slightly warm at times. However, this did not develop into a problem. Both side dewatering valves were functional, in automatic mode and operated well except as outlined below.

With the percentage open for each valve apparently drifting, concern for the two side dewatering valves began on June 7. The valves normally operate with very similar percentage openings. Initially, there was a thought it might be a programming issue. Both valve were monitored closely.

The biologist tried to manually adjust the valves on June 20. However, when the valves were returned to automatic mode, the large difference in percentages open returned. To lower the north valve percentage open, the biologist had the east floor valve opened two additional inches. The biologist on duty reported the north side dewater valve "popping" on June 29. This is an issue that has been observed over the last couple of years.

The two side dewatering valves issues developed into a serious problem on July 2. Sometime in the early morning, the north side dewater valve slipped from approximately 80 to 50 percent open. The south dewatering valve was able to compensate to a point. When the south valve opened to approximately 60 percent, the control program read the valve at 100 percent open. The south valve was at "maximum" open, the north valve was no longer functional and the forebay elevation increased, which resulted in a high water alarm (0.15 above 327.6 feet) at 0613 hours. After about one hour, the high water alarm cleared as the forebay elevation decreased. There was no severe high water alarm (0.4 above 327.6 feet).

The biologist was able to examine the situation, test the valves and determine a course of action at about 0830 hours. With the north valve at about 50 percent open and the south valve only able to open to 60 percent, it was determined orifices at unit 5, which was out of service, would have to be closed and reopened as needed to allow the south valve to regulate the channel elevation with forebay elevation changes. Also, every other day 24 hours sampling would have to be canceled and the technicians would have to remain in the channel 24/7. Later in the day, the general maintenance staff secured the shaft of the north dewatering valve so it would not slip any lower. The mechanics disassembled the valve actuator and found a brass sheath that connects the operator to the shaft had failed. Thus, the motor would operate but the shaft would not move.

Repairs to the north dewatering valve began on July 8. The creation of a replacement sheath was completed on July 9. The valve was reassembled and the operator installed on July 10 by 1130 hours. The operator and valve limits were set from 1230 to 1400 hours. The north

dewatering valve returned to automatic mode at 1405 hours and had its full functional range. All four water alarms (low, low/low, high and high/high) were tested and functioned properly. After monitoring the juvenile collection channel, the north side dewatering valve appeared to be operating normally and index sampling cautiously resumed on July 11. However, the channel system continued to be monitored closely as the south valve still required examination.

For the south side dewatering valve, what was thought to be a program or sheath issue, was found to be a limit issue. The electrical staff reset the valve upper and lower limits on July 15, from 0745 to 0845 hours. This resolved the problem. Three hours of index sampling were missed. However, the side dewatering valves continued to be monitored very closely for the rest of the season and require a complete examination next winter. Also, spare parts need to be in stock.

JCC PDS-Floor Screen Dewatering Valves (3)

After winter maintenance and initial adjustments, all three floor valves functioned properly. During the season, these valves were partially opened and the actuators turn turned off as the valves only function as drains. The east floor valve was opened two additional inches in order to reduce the percentage opening of the north side dewatering valve on June 20.

Full Flow Bypass Flume and Pipe

Cleanup and repair to the damaged full flow pipe walkway and supports were completed in the winter. At this time, replacing the missing walkway will not be considered in the future. Replacement of the outfall hazing sprinkler system will be a long term discussion. As will be described in the avian sections below, lasers are an alternative, which are being examined.

Two full flow flume leaks upstream of the separator were examined on April 2. The leaks were repaired or diverted and further inspection will required next winter.

Flume Adult Flush Line

The full flow flume adult flush line supply valve, which is trigger to open and close with the primary bypass gate (open during secondary bypass in order to improve the passage of adult fish released from the separator), had minor issues last year.

This season, first, the adult flush line supply valve over heated and tripped off line on April 4. The fisheries and electrical staffs resolved the issue. On June 1, the system was in primary bypass for 10 minutes in order to examine the adult flush line valve which had not automatically opened. The biologist had to manually (by hand) open the valve. One sample was missed. The fisheries staff began to monitor the valve more closely. Later, the full flow flume adult flush line valve failed to open again on June 11, 15, 17 and 19. Also, the valve failed to close on June 16 and 20. The fisheries staff had to manually operate the valve repeatedly. As the season progressed, the adult flush line increasingly continued to have issues when the actuator attempted to open or close the supply valve in automatic

mode and the fisheries staff had to manually operate the valve instead. However, operating the valve in local mode (using the open/close push buttons) increased the valve reliably on July 11. Unfortunately, the full flow adult flush valve continued to hesitate when opening and manual mode was required at times. The valve began to hesitate more when closing during the second week in August. Therefore, operating the valve manually and in local mode continued. The electrical staff began to examine the adult flush valve the first two weeks of August. The issue appeared to be the linkage between the motor and valve. On August 16, the full flow flume adult flush line valve automatic mode failed. The valve was manually operated on August 16 to 18. The valve was opened while still in primary bypass on August 18. The full flow flume was examined and no serious issues were found. It was determined to leave the valve open 24/7. The flush line exit into the flume and the bypass junction were checked periodically to ensure fish were not holding in the hydraulic jumps. The mechanical staff examined the valve on August 21. They agreed there appeared to be a linkage issue. Finally, the full flow flume adult flush line valve was partially closed, where it remained though the season's end, to reduce ice formation on October 28. Whatever the problem is, it will have to be resolved during the winter maintenance season.

Juvenile Fish Facility

JFF Mortalities

For the year, facility mortality records were within normal ranges. Also, there were no unusual fish loses at the facility.

JFF Power Outages

Two power outages at the juvenile facility for bus switching had no adverse effect on May 13 for 10 minutes and on May 15 for nine minutes.

At the BPA substation, bus 1 failed resulting in transmission lines 1 through 5 tripping off and removing most of McNary's turbine units from service on August 5. The power outage at the facility was 10 minutes or less and had no adverse effects with only minor systems needing to be reset.

JFF Issues

Issues that affected the JFF are described throughout the text above and below.

An obstruction was removed from one of two counting tunnels on the A side just upstream of the A side sample holding tank and a piece of woody material was removed from the separator B side down well at the B side exit on April 11.

Two sticks were removed from the "wye" at the junction of the secondary bypass line and the sample return to river line on May 10. No harm to fish was noted.

A piece of rope was removed from the sample return to river line just downstream of the flume drier on May 20. Fish released from the sample cannot be observed downstream of this location. There is no theory on how the rope got there.

A debris blockage was removed from the B side flume near the PIT tag slide gate on June 15. No harm to fish was noted.

This year, juvenile shad become the predominant species on July 24. No smolts were observed in the sample on September 30.

There was possibly a blockage in the B side secondary bypass line on September 18. However, during inspection, no blockage was found. It was determined later the issue was due to excess add in water.

The separator was dewatered for inspection on October 14. The floor screens were removed during the week. The separator will remain dewatered into the winter maintenance season. The test on the paint showed three heavy metals on December 2. Two metals were at fairly high levels. This winter, the project painter will clean separator area and remove the paint appropriately. After which, a project engineer will check the structural integrity of the separator. Then, a path forward for rehabilitation will be determined.

Flow into the separator is depended on collection channel changes and debris blockage on the perforated plate just upstream of the separator. High flows were generally due to debris on the perforated plate, which technicians cleaned. During the spill program, project operations, juvenile channel adjustments and other issues described in this report, the separator can experience fairly severe fluctuations at times. Regularly tapping and back flushing of the separator up well screens improved flow. The end of the spill program had no significant effect on separator debris loads. Flow adjustments were made as required.

Debris issues as describe elsewhere in this report affected the separator and facility when operational. During the year, the facility was cleaned as needed along with algae being removed.

With fall primary bypass season, the system remained watered up to help avoid frozen pipes. In December, with the facility dewatered, winterization was completed and maintenance began.

Other facility issues are outlined in the other sections of this report.

JFF Sample System (A & B)

The sampling season consisted of alternating days of primary and secondary bypass with the switch occurring every morning at 0700 hours. At that time, the sample gates were turned on for the first day of secondary bypass on April 4. The sample gates were activated only during secondary bypass. The sample system was shut down for the year, on September 30 at 0700 hours. Turning the sample gates on and off during other events are also recorded in the Bypass Operations and JCC sections of this report.

During the season, the sampling system operated well. However, there were three interruptions in sampling in early May on the B side. First, the B side sample gate failed with the gate in the closed position on May 4, at 2245 hours. The cylinder shaft and connector had disconnected from the bearing on the gate. The technician turned the gate off at 2300 hours. Sample collection on the A side continued with the system switched to primary bypass at 0700 hours as scheduled. Eight hours of sampling were missed on the B side at 1 percent. The next working day, May 6, the mechanic repaired the B side sample gate system thinking the issue was the shaft in the cylinder. Sample collection on the A side began at 0700 hours with a 1 percent sample rate. The B side gate was activated at 0744, resulting in two samples being missed, which was the second sample interruption. Later that day, the technician on duty informed the biologist that the B side sample gate failed again for the third interruption in B side sampling. This time, the gate was open and fish were being collected. Again, the cylinder shaft and connector had disconnected from the bearing on the gate. The gate was manually closed and turned off at 1345 hours. By examining the count record, it was determined the gate had been open from 1325 to 1345 hours, 20 minutes. The B side count went from 38 to 291, an increase of 253 fish in 20 minutes. There were 36 fish counts on the A side. At this time of year, PSMFC generally sets the sample rate to collect 300 fish. Adding both A and B counts together, there was an estimated 327 fish in the sample tanks. After consulting PSMFC, the biologist determined it would be best switch the system to primary bypass and collect no more fish for the sample. The system was switched to primary bypass at 1500 hours. The A side collected fish for one more hour. After this time, for the data day, 16 hours of sampling were missed. By 1700 hours, the bearing on the B side sample gate where the cylinder shaft attaches was replaced. Testing the gate occurred briefly and it appeared some adjustment was required. These adjustments and a complete inspection of the B sample gate system occurred the early the next day, May 7. The system was ready to collect fish for sampling on schedule on May 8, starting at 0700 hours. The sample was also examined on May 7. The combined number of smolts sampled was 372. With a general increase in smolt numbers, the sample rate has been reduced to 0.5 percent.

There were no issues to report with the sample recovery raceway or sample release line.

JFF PIT Tag System (Primary (A & B) & Secondary (C & D))

The PIT tag system remained out of service as there are no studies requiring its use. During the bypass season, the primary PIT tag gates were not used. All PIT tagged fish were still detected in the full flow flume during primary bypass and at the facility including the return to river lines during secondary bypass so no data was lost and these bypass routes are preferred over the smaller PIT tag release lines system. Also, the PIT tag count tanks delay fish. The primary PIT system received scheduled inspection.

The secondary bypass slide gates, which also can serve as a PIT tag diversion system (C gate is on the A side and D gate is on the B side) have not been used in a PIT tag study for several years. These gates received no preseason or in season adjustments. They are left off and open.

JFF Secondary Bypass Lines (A & B)

There were no problems to report with the secondary bypass lines from the inspections and blind ice block checks done this season.

JFF Operations Related to GBT Examinations/Research

GBT examinations occurred for the most part twice a week (report week/Friday through Thursday) from April 12 to July 29. During the examinations on April 12, injuries were noted on about 20 percent of the fish examined. Two new fittings were installed in the separator to wet lab transport line on April 15. During the next examination, no further injuries were noted. When the north side dewatering valve in the juvenile collection channel failed on July 2, due to primary bypass, no GBT monitoring occurred on July 3, 5, 7 and 9. Monitoring results from July 11 were reported on July 12. During the report week of July 19 to 25, there were three mortalities after the examinations. Monitoring was reduced to once a week but due to low fish numbers, the last day of monitoring was on July 29. During the season, seven smolts were reported with signs of GBT. Finally, GBT examined smolts were allowed to recover in the sample recovery raceway before being released by the project biologists. Monitors/researchers publish their results in separate reports.

From late April to late May, during nine trips, the Yakima Nation removed a total of 124 juvenile lamprey from the smolt monitoring samples for off sight tagging.

Juvenile Fish Salvage

Only juvenile fish salvage at various locations will appear in this report. Adult fish rescue will be covered in the McNary Adult Report. Fish were not examined for clips as their survival was a higher priority. One steelhead and three Chinook smolts were observed during JCC water testing in February and March. One Chinook smolt was noted during JCC dewatering in December. No smolts were observed while dewatering the navigation lock in March. During navigation lock tainter valves #1 and #3 dewatering for replacement in June, there were four live and 11 Chinook smolt mortalities recovered. During dewatering of the Oregon ladder in January, one live steelhead and 11 Chinook smolt mortalities were recovered. During the Washington ladder dewatering in January and again in December for two separate winter maintenance seasons, there were a total of one Chinook and two steelhead mortalities along with five live steelhead and one live Chinook smolt removed. During the dewatering of turbine units 5, 13 and 14 this year, no smolts were observed.

Cooling Water Strainers

Table 34 below reflects the results of this year's main unit cooling water strainer examinations.

Table 34. Cooling Water Strainer Results

Month	Lamprey Mortality	Live Lamprey	Smolt Mortality	Live Smolts
Jan	0	0	0	0

Feb	14	0	0	0
Mar	32	0	0	0
Apr	57	1	0	0
May	150	27	3	0
Jun	41	1	1	0
Jul	19	4	18	0
Aug	4	0	0	0
Dec	0	0	0	0

In January through March and December, juvenile shad were also noted. In May, all of the juvenile lamprey mortalities came from unit 1. Of the live juvenile lamprey, 26 came from units 2 through 8, many of these units were in standby for extended periods. The three juvenile sockeye moralities came from units 5, 6 and 7. In June, the smolt mortality was an unclipped Chinook subyearling. In July, most of the unclipped Chinook subyearling mortalities were from unit 1. For June and July, most of the juvenile lamprey were found in units 1 through 7, which were in standby for extended periods.

Invasive Species

During winter maintenance, other dewatering activities and monthly mussel station examinations, no issues were found.

Eleven Siberian prawns were removed from the sample and euthanized this season. Most of the prawns were collected in August.

Water Temperature Monitoring

The weather station was deployed on May 1. Temperature monitoring by the smolt monitoring contractor occurred from June 15 to August 31, inclusive. All probes, thermometers and the weather station were in place by June 9. The digital thermometer placed for unit 1 scroll case failed during the season and was later replaced. The smolt monitoring staff published separate daily, weekly and annual reports. Any issues with the temperature monitoring system were published in these reports.

AVIAN PREDATION

Avian Predation-General

From January to February, bald eagles, pelicans, great blue herons, gulls, cormorants, mergansers and grebes were occasionally observed around project. In March, before avian observations began, the same species were observed along with osprey. All species were observed in low numbers.

Daily bird counts occurred from April 1 to September 30. There are four zones: bypass outfall, spill, powerhouse and forebay. The first three zones make up the tailwater area. Generally, all zones are counted once a day in the morning. However, there were some deviations, which be discussed below in the Laser section. There are five species of

interest: gulls, pelicans, terns, cormorants (these four are primarily in the tailwater area) and grebes (which are primarily in the forebay zone). Bird numbers fluctuated with smolt, juvenile lamprey and shad outmigration peaks. Pelicans appear to arrive with the adult shad migration. Avian numbers were affected by the birds own migration patterns.

For the tailwater area, the technicians or biologists performed the counts from the separator building using binoculars. (Gulls and terns are difficult to distinguish with binoculars. Cormorants are difficult to observe unless they are roosting.) For the forebay zone, bird counts were performed with the unaided eye while doing gatewell observations. All daily counts were reported in the Endangered Species Act (ESA) weekly reports.

The avian hazing program was based on the ten year smolt passage average. The hazing season this year was from April 21 to July 27. The avian figures provided below are for species during the hazing season(s) in zones where the birds were abundant. The hazing seasons for previous years used in the average were longer than 2019. The longest hazing season was in 2014, April 1 to August 1. This is the time frame used in the tailwater area and forebay zone figures below. These figures do not cover the remainder of the bird counting season, in which bird counts are heavily influenced by the juvenile shad outmigration.

Avian Predation-Tailwater Area

In the tailwater zones, from April 1 to 20, cormorants were observed in all zones but most birds were observed roosting on the outfall pipe where the bird wire has been missing since the spring of 2018. The cormorants appeared to be migrating through the area during this time. Gull numbers gradually increased over time with most birds seen feeding in the spill and roosting on the outfall count. A few pelicans were observed in the spill and in the outfall zones.

Initially, all four bird species were observed from July 28 to September 30. However, the main prey specie was shad, both adult and juvenile by then. Tern and pelican numbers began to decrease to nil by August and September, respectively. The terns and pelicans were mostly feeding in the spill zone with birds occasionally at the outfall. After the spill closure, gulls moved from the spillway to the powerhouse to feed and roost. Cormorants and gulls continued to roost on the navigation lock wing wall, the Washington ladder wall and the outfall pipe. Both species were occasionally observed feeding at the outfall zone. At times, osprey were observed roosting on the outfall pipe. Gulls were also observed feeding at the TSW during the adult steelhead passage study. Gull and cormorant numbers appeared to fluctuate with their and the juvenile shad migrations. These counts included juvenile of both species. Occasionally, great blue herons were observed.

After avian counting concluded, from October 1 to December 31, casual observations of birds were made and reported. Gulls and cormorants remained well into December with roosting and feeding activities similar to late September. However, bird numbers fluctuated more and gradually declined. Also, cormorants appeared to over winter in higher numbers than previous years. In addition, there appeared to be more roosting than feeding at times. Occasionally, a few mergansers and pelicans were noted. When the system was switched to

emergency bypass, a few birds were noted in the area of that outfall. However, birds continued to roost on the primary bypass outfall pipe.

For the hazing season (April 21 to July 27), Figures 3-6 below reflect the primary species (pelicans, gulls, cormorants and terns) in the spillway. Occasionally, loons, mergansers and osprey were observed. The osprey roosted on the outfall and it was assumed they were feeding on adult shad. With the bird wire missing, outfall numbers were high this year compared to past seasons due to roosting on outfall pipe and walkway handrail. However, USDA boat hazing of the outfall reduced bird numbers. There are no figures for the powerhouse zone as this area is lightly used.

Pelicans prefer the shorelines, navigation lock wing wall and outfall. They were mostly feeding in these areas and roosted outside the counting zones. At times, pelicans were also noted feeding just outside the Oregon ladder floating orifice gates. It is assumed pelicans are primarily feeding on adult shad.

Gulls prefer the spillway and outfall. They mostly roosted at the outfall and feed in the spillway. Some roosting on the navigation lock wing wall also occurred. Also, the gulls fed at the outfall and roosted outside the counting zones. Gull numbers appeared to fluctuate throughout the season.

Terns preferred the spillway and outfall for feeding and were rarely observed roosting.

Cormorants were observed roosting on the navigation lock wing wall and on the bypass outfall. They were noted primarily feeding at the outfall.

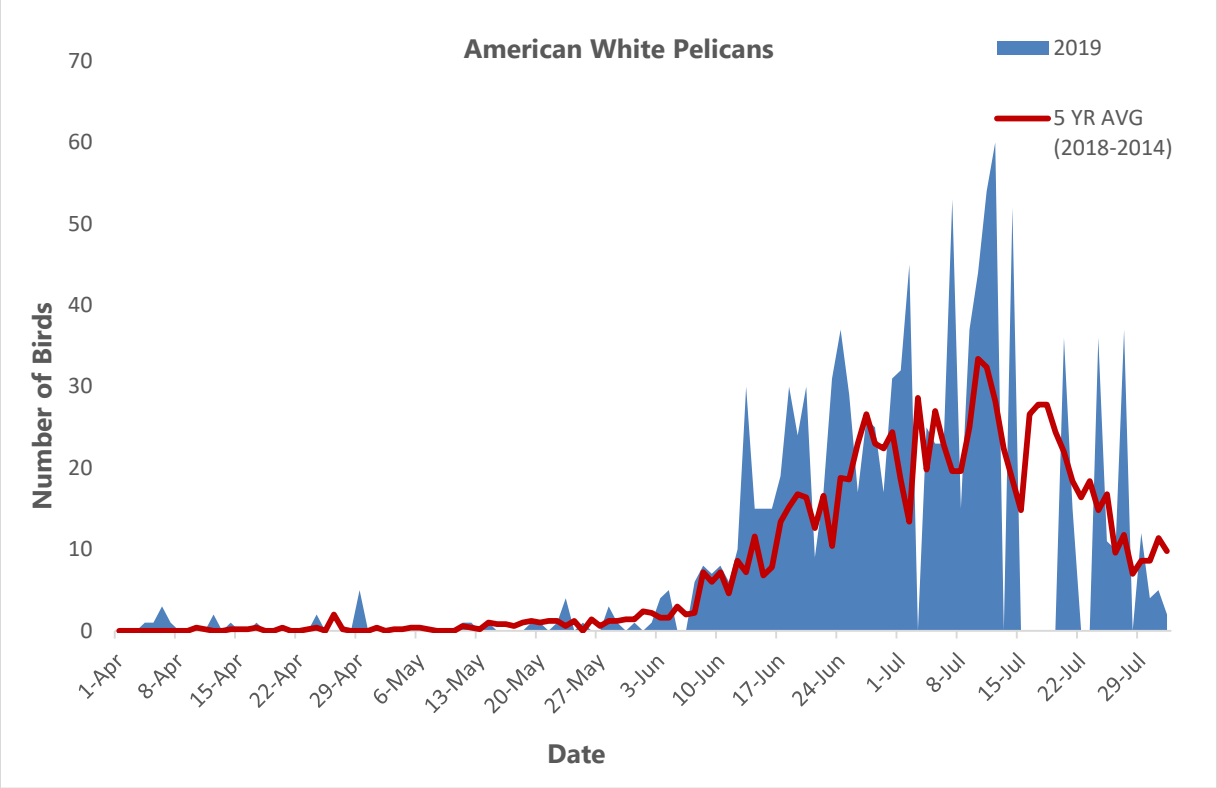

Figure 3. Pelicans in the Spillway, Hazing Season 2019 and 5-Year Average 2018-2014

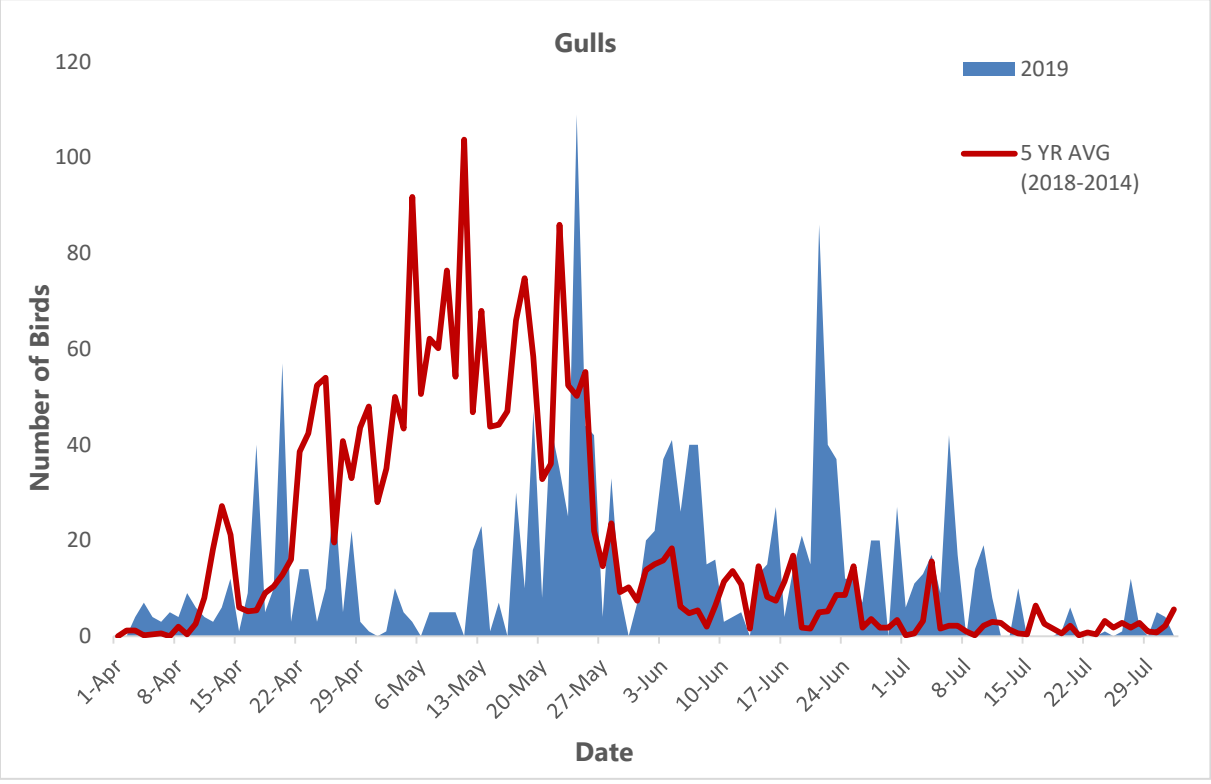

Figure 4. Gulls in the Spillway, Hazing Season 2019 and 5-Year Average 2018-2014

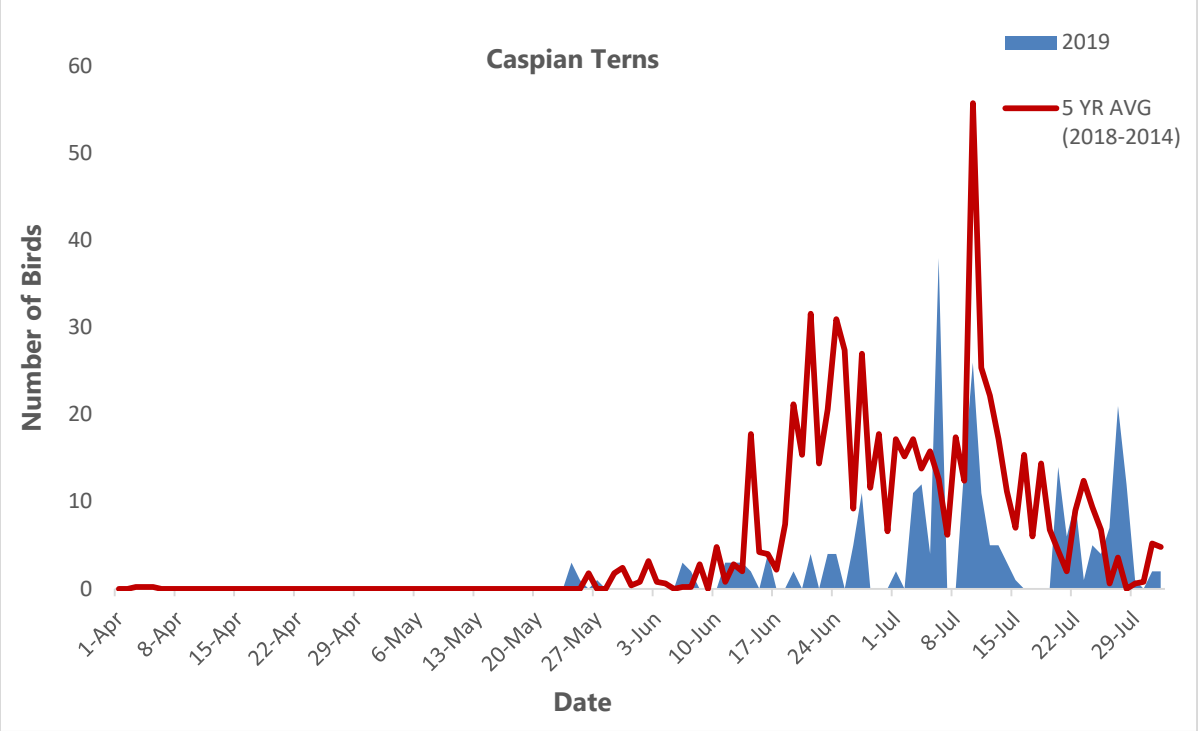

Figure 5. Terns in the Spillway, Hazing Season 2019 and 5-Year Average 2018-2014

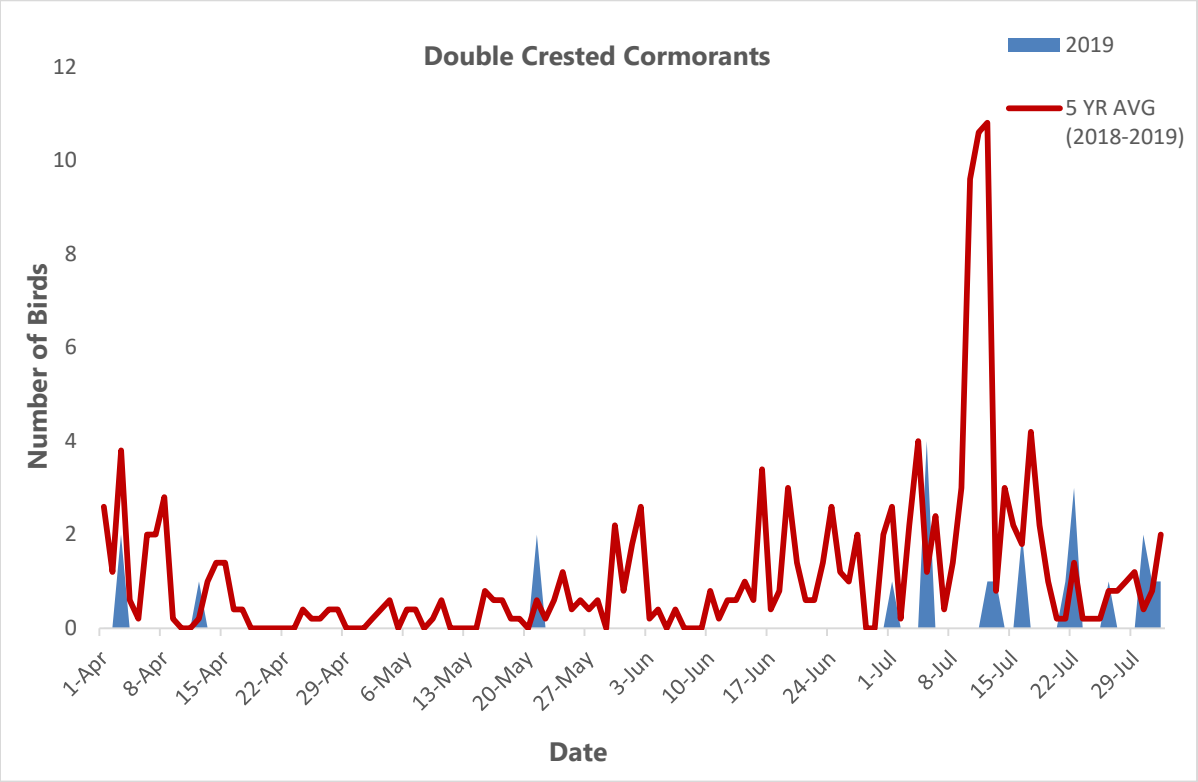

Figure 6. Cormorants in the Spillway, Hazing Season 2019 and 5-Year Average 2018-2014

Avian Hazing-Bypass Outfall

As stated above, cormorants and gulls had a tendency to roost on the outfall pipe. Pelicans were often seen by the outfall pipe, while terns were not seen as often. Figures 7-10 below reflect the primary species (pelicans, gulls, cormorants and terns) in the outfall bypass pipe zone.

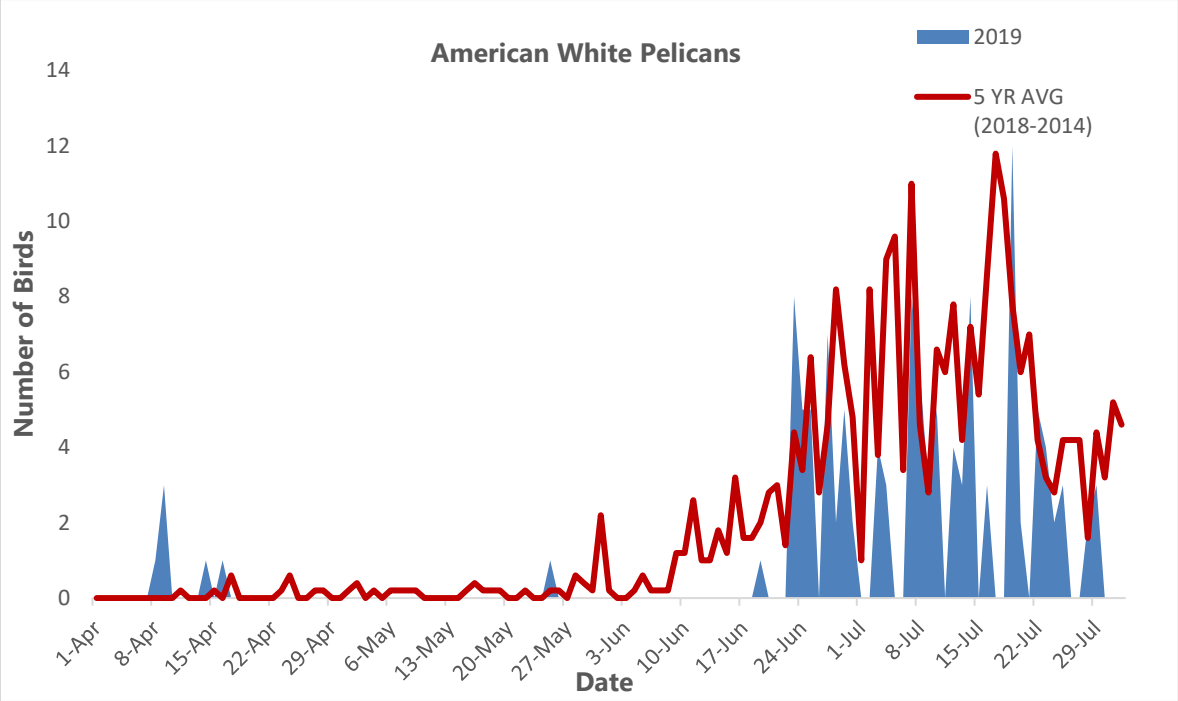

Figure 7. Pelicans at Outfall, Hazing Season 2019 and 5-Year Average 2018-2014

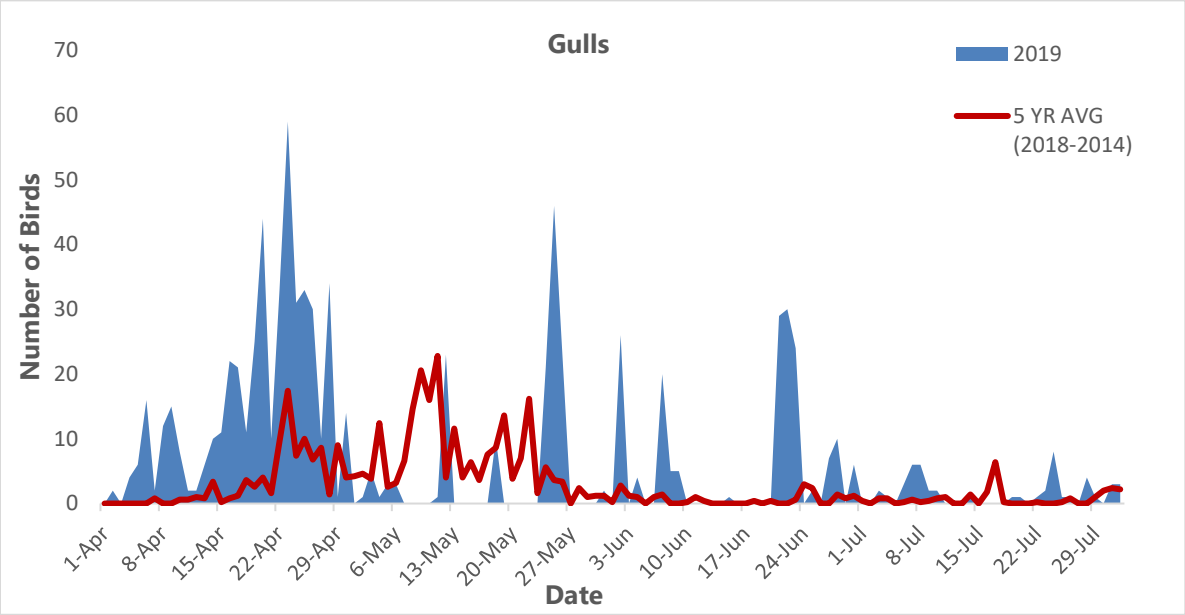

Figure 8. Gulls at Outfall, Hazing Season 2019 and 5-Year Average 2018-2014

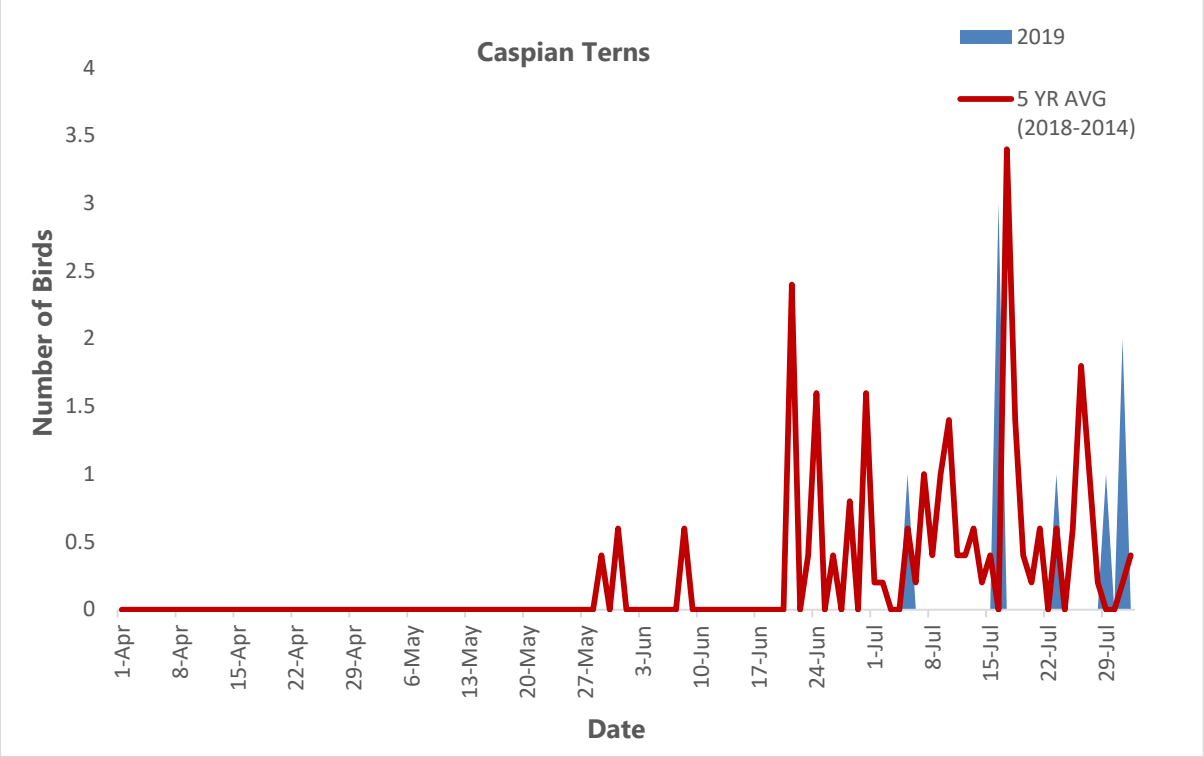

Figure 9. Terns at Outfall, Hazing Season 2019 and 5-Year Average 2018-2014

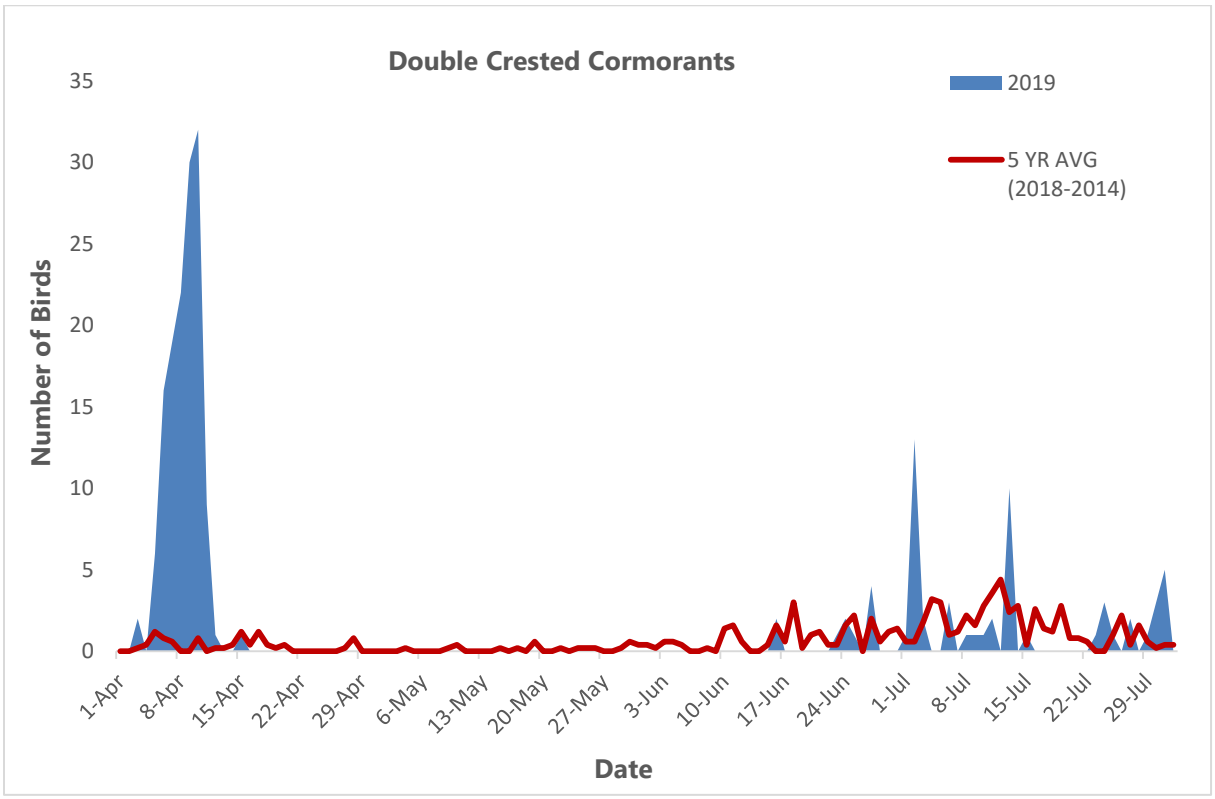

Figure 10. Cormorants at Outfall, Hazing Season 2019 and 5-Year Average 2018-2014

Bypass Outfall Sprinklers

Replacement of the outfall walkway, sprinkler system, bird wire, bird spikes and other items are still under consideration.

Bypass Outfall Laser

A green light laser to haze the juvenile outfall area was purchased in February and arrived on project in early March. The mechanics built stands for the laser and solar panels, which were installed on the navigation lock wing wall directly across the river from the outfall. The laser was installed on April 4. The laser was programmed and became fully functional on April 10 at 0730 hours.

From observations during the season, when functional, the laser appeared to displace the birds that were within its range. Most of the gulls and cormorants noted roosting on the outfall pipe were outside the laser's range and in the section with no bird wire. When comparing the laser effectiveness using past bird counts, feeding birds will have to be considered as the roosting is a new issue.

Initially, the laser was on during all outfall observations except on April 15 and 16. These off days were part of a block study. However, restarting the laser turned out to be problematic so it was decided to leave the laser on as programmed (on at 0500 to 0800, 1030 to 1330 and 1500 to 2000 hours). The block study was cancelled and a replacement laser was asked for.

The replacement laser for bypass outfall hazing was installed on June 12. After sunset, the new laser was programmed on June 13. The first bird counts with the replacement laser occurred on June 14. The new laser was programed to operate its patterns between 0330 and 2200 hours. This laser appeared to have the same effectiveness as the first laser. The block study for evaluating the laser began on June 17. When the laser was off for the block study, pelicans moved to the outfall to feed. The block study for evaluating the laser concluded on July 3. Results of the study were presented to FPOM by a district biologist.

Due to the number of pelicans at the outfall, which attracts other birds, the laser was checked and appeared to be fully functional on June 25. The laser appeared to displace other birds when it was operational but pelicans appeared to be very adaptable. The laser seemed to deter the gulls and terns, birds in flight. However, birds setting on the water, the pelicans and cormorants, were more difficult to haze with the laser. Therefore, a second laser was considered from another angle. The second laser was ordered in August and arrived on project in September. It will be installed next spring. Also, another form of noise deterrent is being looked at.

It was suspected the laser was not covering the outfall zone completely in September, which may have been partly related tailwater elevation changes over the season. The birds continued to be observed late into the season. Due to the avian feeding patterns, the laser functionally came into question in October. It was suspected the laser was not covering the outfall zone. The laser was examined and found to not be functioning on October 22. This

explained the higher bird counts near the outfall. By examining bird counts, it was assumed the laser began to have issues in mid-August and completely failed by the first of October. The laser was examined on October 28 and the length of day to charge the batteries appeared to have been the issue. The program was changed, hazing the navigation lock wing wall was added but the outfall programming could not be verified. Later, the laser appeared to be effective on the wing wall but bird counts remained high near the outfall. At that point, it was determined that further evaluation of laser technology would resume next spring. Gulls slowly dissipated over the fall but cormorant numbers remained high on the outfall pipe. However, the electrical staff informed us the laser was turned off in mid-December for the winter season. This explained the birds roosting on the navigation lock wing wall.

Avian Predation-Forebay Zone

In the forebay zone, from April 1 to 20, occasionally osprey, gulls, terns, cormorants, great blue herons, pelicans and grebes were observed in low numbers. Fairly large numbers of pelicans, cormorants and gulls were noted roosting outside the zone along the Washington shore line. Most birds appeared to be staging. From July 28 to September 30, the same species were observed in the same locations just in gradually decreasing numbers with osprey, terns, pelicans and grebes disappearing. Bird numbers along the Washington shore line fluctuated as they decreased. Also, small groups of juvenile gulls were noted and gull flocks began to staging around project outside the count zones in increasing numbers.

After avian counting concluded, from October 1 to December 31, casual observations of birds were made and reported. Occasionally, a gull or roosting gull flock, grebe, cormorant, great blue heron, kingfisher, loon, pelican or bald eagle was observed. Fluctuating numbers of gulls and cormorants occasionally roosted on the rocks by the Washington shore boat dock. Also, large gull flocks would stage around the project at times.

During the hazing season (April 21 to July 27), the graph below (Figure 11) reflects the primary specie observed in the forebay zone, which was grebes. Osprey, gulls or a roosting gull flock, cormorants, great blue herons, pelicans and terns were observed but the number or frequency of occurrence does not warrant a graph. The roosting/staging rocks by the Washington shore boat dock were visited by pelicans, gulls, cormorants and terns. Starting in July, scavenging juvenile gulls made up a part of the count.

Occasionally, pelicans and cormorants were noted outside the Oregon ladder exit. Two pelicans were inside the Oregon ladder feeding from the count station picketed leads walkway on July 2. When they saw the biologist, the birds drifted downstream.

Avian Predation-Grebes in Gatewell Slots

Grebe observations and counts are difficult due to their behavior, the various locations they appeared and system operations. There is no accurate way to enumerate grebes. From May 10 to June 13, sixteen grebes entered the gatewells slots. Ten were removed from the gatewell slots and six passed to the JCC. One grebe was removed from the JCC and five passed to the separator during secondary bypass and were removed.

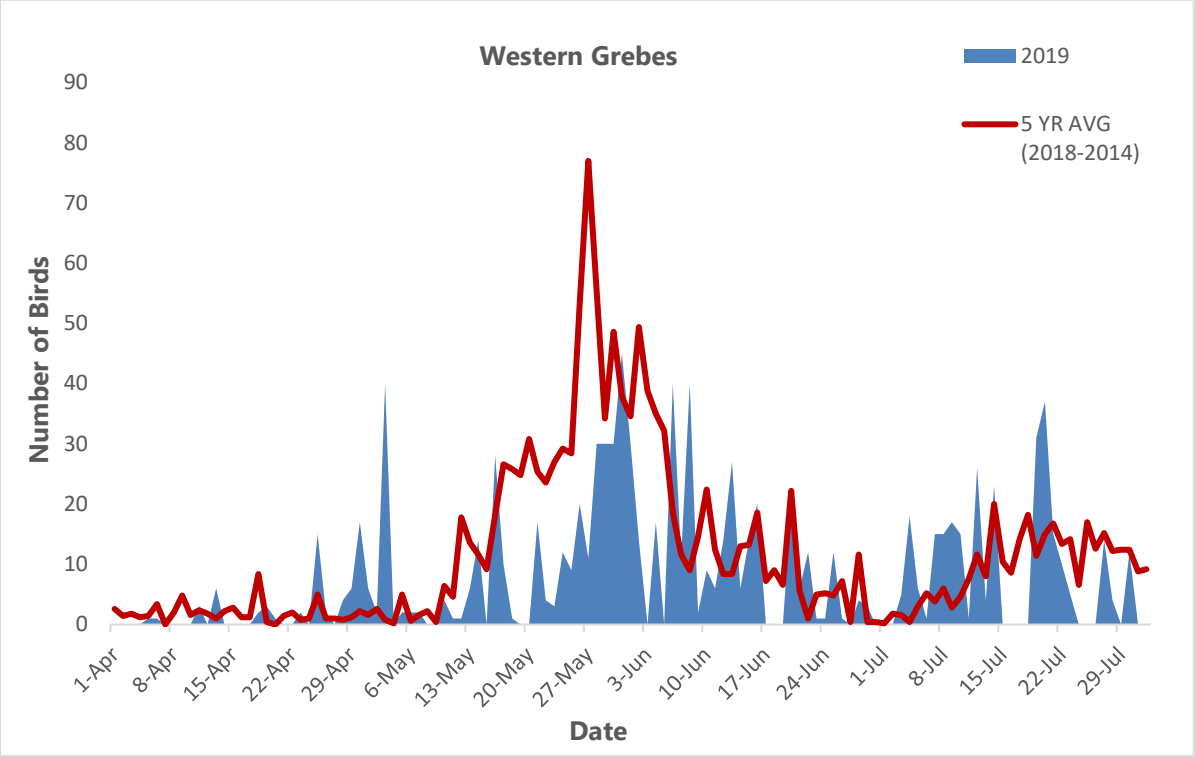

Figure 11. Grebes in the Forebay, Hazing Season 2019 and 5-Year Average 2018-2014

Avian Predation-Pelican Observations

This year, Pacific States Marine Fisheries Commission smolt monitoring personnel did not observe pelican activity at the bypass outfall. Last year, in all likely hood, was the last season for these observations.

Avian Hazing-Distress Calls

The distress call stations include three species of gulls and double crested cormorants. The calls were deployed along the navigation lock wing wall where birds in the past roosted in large numbers on April 9. During smolt passage season, the calls were very effective. After flow volumes decreased, a large distress call system was deployed on the outfall walkway on May 22. Due to the late installation date, the outfall system was less effective. All calls were monitored weekly. In August, when the juvenile shad outmigration began, all distress calls became less effective and gulls began to roost on the navigation lock wing wall. The call systems were removed on October 2 and 3.

A grebe distress call was deployed near unit 12 facing the forebay on July 10. The call appeared to have promise but a system with a higher volume output is needed. The call was removed on October 2. This concept will continue to be explored.

Avian Hazing-Bird Wires/Spikes

Bird wires remain across the powerhouse tailrace, around the barge dock and on the outfall bypass pipe. Wires are also on the handrails of the outfall, navigation lock wing wall, powerhouse and ice/trash sluiceway walkways. Avian spikes are used on the outfall bypass pipe, outfall walkway, barge dock and the light fixtures along the navigation lock wing wall.

Avian Hazing-United States Department of Agriculture-Wildlife Services (UDSA-WS)

The USDA-WS hazing program is outlined in Table 35 below. Deck and boat hazers worked eight hours shifts including travel time. The boat was in the tailwater area for approximately six hours each trip. Early in the season, the boat remained below the bypass outfall due to high flows. Later in the season, the boat was able to move slightly upstream of the outfall pipe. Boat hazing was very effective at the outfall. When weather conditions did not allow the boat crew to go out, they would haze from the shoreline. From the boat, USDA-WS personnel lethally took 13 cormorants and 93 gulls. Direct hazing of pelicans was still prohibited.

Table 35. Avian Hazing Program

Personnel	Days	Dates	Shift
Deck hazer	Mon - Fri	Apr 21 - Jul 27	Day
Weekend hazer	Sat & Sun	Apr 21 - Jul 27	Day
Deck hazer	Mon - Fri	Apr 28 - Jul 13	Swing
Weekend hazer	Sat & Sun	Apr 28 - Jul 13	Swing
Boat captain & hazer	4-days a week except Sun	Apr 28 - Jul 6	Day

Hazing grebes from the forebay deck was very effective as long as USDA-WS personnel were persistent.

The use of a drones by USDA-WS personnel in the tailwater area was not attempted this year.

RECOMMENDATIONS

1. Clear brush along shore line near JFF.
2. Install new plugs in experimental orifices in JCC.
3. Paint inside (joints) and outside (erosion) of new section of full flow bypass pipe.
4. Concrete path for access to JFF valves.
5. Refinish JCC floor and walls.
6. Address inside erosion in old section of full flow flume above separator.
7. Repaint sections of JFF.
8. Install new JFF heating and cooling system.
9. Mothball or remove JFF transport systems.
10. Install larger PIT tag shields around detectors to reduce debris blockages in JFF flumes.
11. Install emergency truck release site at junction box at JFF.
12. Install a new JFF separator or repair and repaint separator.
13. Purchase new boom for forebay debris removal.
14. Install a new outfall hazing system.
15. Reprogram JCC control PLC.
16. Adapt TSWs so installation and removal are improved.
17. Improve fish crowding devices in both JFF sample holding tanks.
18. Install new pulley for transition brush electrical cord.
19. Repair full flow flume adult flush valve.
20. Remove proximity switches and go to program control of ESBS brush cycles.
21. And other issues mentioned throughout this report.

ACKNOWLEDMENTS

Corps of Engineers (COE) personnel included: supervisory biologist Bobby Johnson, assistant biologist Denise Griffith, biological technicians: James Davis, Jeff McLaren, Natasha Geiger and Ned Hastings and maintenance personnel: Ken LePage and Ed Eisele. Representing PSMFC was biologists Thomas VanNice, and Kathleen Carter, and anesthetist Michael Griffith and from Anchor, QEA was Alexis Bonoff and Meghan Wise. Thank you to all crews from the COE and various state, federal, and tribal entities for making this a successful season.