CENWW-ODO GRIFFITH February 2022

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

FOR Chief, Operations Division
ATTN: Christopher Peery and Scott St. John

SUBJECT: Submission of 2021 Juvenile Fish Collection and Bypass Report, Lower Monumental Dam Juvenile Fish Facility.

1. Enclosed find the 2021 Juvenile Fish Collection and Bypass Report for Lower Monumental Dam as requested.

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

DENISE S. GRIFFITH
Supervisory Fisheries Biologist, Lower Monumental Dam

Enclosure

2021 JUVENILE COLLECTION AND BYPASS REPORT
LOWER MONUMENTAL PROJECT JUVENILE FISH FACILITY

February 2022

United States Army Corps of Engineers
Lower Monumental Lock and Dam
5520 Devils Canyon Road
Kahlotus, Washington 99335

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BiOp – Biological Opinion for Operations
BPA – Bonneville Power Administration
CFS – Cubic feet per second
FCRPS – Federal Columbia River Power System
FPC – Fish Passage Center
FPP – Fish Passage Plan
GBT – gas bubble trauma
JCC – Juvenile Collection Channel
JFF – Juvenile Fish Facility
KCFS – kilo cubic feet per second
NOAA – National Oceanographic and Atmospheric Administration
OOS – Out of service
PIT – Passive Integrated Transponder
PDS – Primary dewatering structure
PSMFC – Pacific States Marine Fisheries Commission
STS – Submersible traveling screens
RSW – Removable spill weir
USDA-WS – United States Department of Agriculture-Wildlife Services
VBS – vertical barrier screen

SUMMARY

Juvenile fish transportation and bypass operations occurred for the twenty-ninth year at Lower Monumental Dam Juvenile Fish Facility (JFF) in 2021. Submersible traveling screens (STSs) for all operating units were installed between March 22 and March 24. The JFF was watered up for at 1000 hours on March 29, and fish condition sampling began at 0700 on April 1 and continued through December 17.

Fish were transported by barge from April 24 through June 20. Barge loading at Lower Monumental Dam occurred without any issues during the 2021 transport season. No truck transport occurred at Lower Monumental Dam in 2021.

Total smolt collection in the 2021 season was 306,847. This includes expanded numbers of those sampled during pre-transport. Of the fish collected in the 2021 season, 209,181 were barged, and 97,505 were bypassed. This season's total collection by species group included: 104,155 clipped yearling Chinook salmon, 17,085 unclipped yearling Chinook salmon, 27,414 clipped subyearling Chinook salmon, 56,418 unclipped subyearling Chinook salmon, 68,200 clipped steelhead, 22,481 unclipped steelhead, 2,042 clipped sockeye/kokanee salmon, 1,564 unclipped sockeye/kokanee salmon, and 7,488 coho salmon combined.

Pacific States Marine Fisheries Commission (PSMFC) technicians examined 1,151 fish for gas bubble trauma (GBT) in 2021. Examinations were conducted once a week from April 7 through July 29.

FACILITY INTRODUCTION AND DESCRIPTION

Lower Monumental Dam is located at river mile 41.6 on the Snake River. The dam is located at the head of Lake Sacajawea, the reservoir created by Lower Monumental Dam. Lower Monumental has six 135,000-kilowatt turbine units. To bypass the turbines, the juvenile system begins with trash racks, submersible traveling screens (STS) and vertical barrier screens (VBS). When fish enter the turbines' intake, they are diverted into the gatewell slots by the STSs. Each unit has three gatewell slots. Each gatewell slot has two orifices where lights are directed at each open orifice to enhance fish movement into the collection channel. The fish pass through these twelve-inch orifices to the juvenile collection channel which terminates at the primary dewatering structure (PDS) where all but 30 cfs flow is removed. The remaining 30 cfs flow and fish are routed through the transport flume to the separator. Upon reaching the separator, adult and non-target adult fish are released to the river and juvenile fish pass below the separator bars and enter the distribution system. The full distribution system includes transport flumes, Passive Integrated Transponder (PIT) tag bypass, sampling facilities, holding facilities, and barge and truck loading capabilities.

Downstream of the separator in the A and B flumes are the PIT tag bypass. The A and B sides each have a set of sample and PIT tag systems. Inside the JFF building is the wet lab where the fish condition sample occurs.

Finally, Lower Monumental Dam has 8 spillbays with a removable spillway weir (RSW) in spillbay 8. The RSW was installed to provide a surface passage rout and improve conditions for out-migrating juveniles.

FACIILTY MODIFICATION/MAINTENANCE AND IMPROVEMENTS

Maintenance and improvements for the 2021 year which are made to enhance the system performance over the previous season include a new PIT tag antenna array which was added to the raceways release pipe at flume 3. This new antenna array allows PSMFC to acquire data on PIT tagged fish which have been collected into the facility's raceways and loaded onto the juvenile salmonid transport barges.

The Army Corps of Engineers electrical staff worked on replacing and improving the barge loading lighting in May.

RIVER CONDITIONS

During the 2021 season, the average daily powerhouse flow and spill was less than the 2017-2020 average during all months, Table 1 below. The highest daily average flow for the season was 88.6 kcfs on May 19. The lowest daily average flow for the season occurred on September 13 with a flow of 14.9 kcfs. The average flow for the season was 39.9 kcfs. Spring spill mandated by the National Oceanic and Atmospheric Administration (NOAA) Biological Opinion for Operation (BiOp) of the Federal Columbia River Power System (FCRPS) occurred for from April 3 through midnight on June 20, with a maximum daily average spill of 65.0 kcfs on June 6. The Removable Spillway Weir was put into operation on April 3 following the initiation of BiOp

mandated spill and was taken out of service for the season on July 9, due to high river temperatures with low river flows. Summer spill ended at 23:59 hours on August 31.

Average monthly powerhouse flow and spill was less than the 5-year average (2016-2020) during all months, April through September, Table 1 below.

Table 1. Comparison of average monthly flow (kcfs) and spill (kcfs) at Lower Monumental Dam, 2016-2021 and the 5-year average.

Flow							
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2016-2020 Avg**	**2021**
April	87	136.5	93.7	115.8	53.5	90.1	51
May	85.2	140.6	133.3	62.6	103.7	101.82	68.9
June	51.3	126.9	78.5	87.8	92.9	87.76	52.7
July	31.5	49.7	38.1	37.7	47.3	39.94	26.9
August	22.5	29.2	27.3	26.8	26.8	26.6	22.9
Sept.	19.2	25.7	22.1	24.4	22.8	22.78	18.9
Spill							
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2016-2020 Avg**	**2021**
April	25.2	63.7	36.4	41.3	35.9	42.2	33.7
May	35.3	69.9	54.3	38.3	71.7	56.42	47.9
June	24.5	59.8	28.5	36.4	54.9	42.54	33.1
July	16.2	16.9	17	16.8	17.4	16.3	13.4
August	10.4	14.3	13.1	13.5	11.2	12.3	9.4
Sept.	0.2	1.7	0.4	0.2	0.2	0.54	0.2

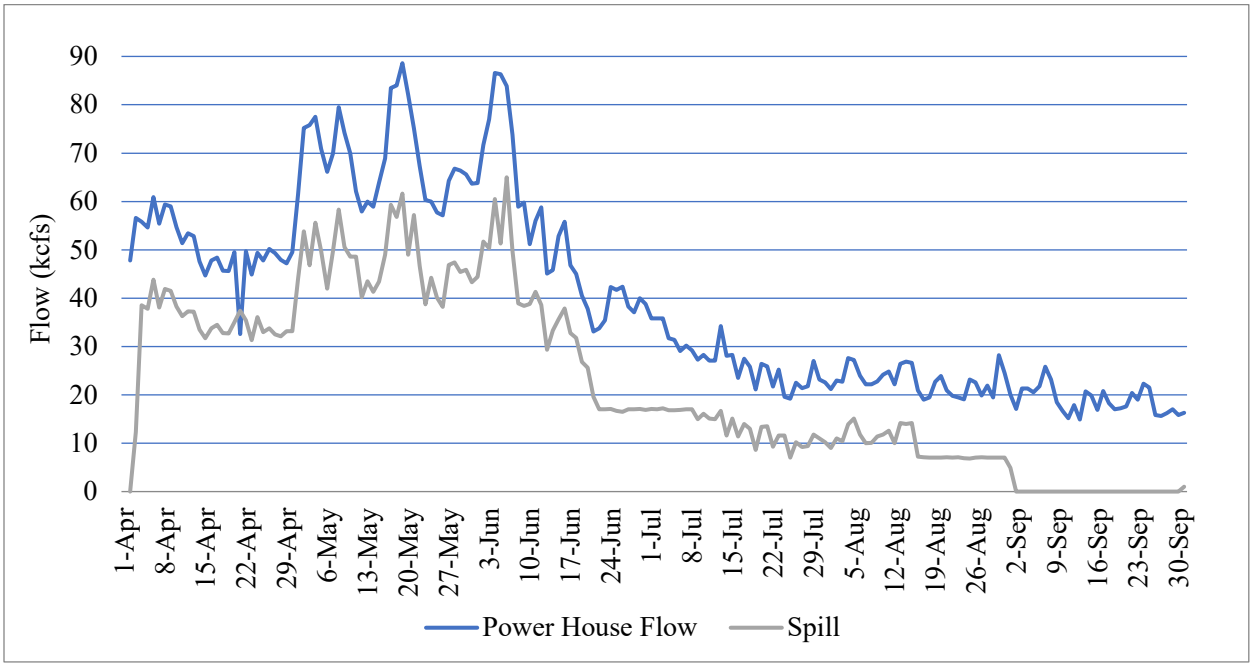

Figure 1. Comparison of daily powerhouse flow and spill at Lower Monumental Dam, 2021.

River Temperature

River temperature is measured daily at approximately 12:00pm in the afternoon in the JFF wetlab freshwater supply. Temperatures observed in the wetlab were greater than the 5-year average in all months except April and September, Table 2 below. The maximum temperature of 71.3°F was recorded on August 19.

Table 2. Average monthly river temperatures (°F), 2016-2021 and 5-year average.

Month	2016	2017	2018	2019	2020	2016-2020 Avg	2021
April	51.2	49.7	50.4	49.3	49.9	50.1	49.4
May	56.2	54.8	55	54.8	53.4	54.8	55
June	63	60.2	61.8	61.6	58.9	61.1	61.5
July	67.9	69.4	68	67.1	65.8	67.6	69.6
August	68.5	70.4	69.3	69.1	68.8	69.2	69.9
September	66.1	67.7	66.3	68	66.4	66.9	66.4

JUVENILE BYPASS

Migration, Collection and Transportation of Juvenile Salmonids

Collection

Pre-transport primary bypass occurred from 0700 hours April 1 through 0700 hours April 23. Fish collection for barge transportation began at 0700 hours on April 23 and continued until 1500 hours on June 20. No truck transport occurred in 2021. An estimated 306,847 juvenile salmonids were collected in 2021, table 3 below. Within each species group, the number collected, and percent of the total collection was: 104,155 clipped yearling Chinook salmon (33.9%), 17,085 unclipped yearling Chinook salmon (5.6%), 27,414 clipped subyearling Chinook salmon (8.9%), 56,418 unclipped subyearling Chinook salmon (18.4%), 68,200 clipped steelhead (22.2%), 22,481 unclipped steelhead (7.3%), 2,042 clipped sockeye salmon (0.7%), 1,564 unclipped sockeye/kokanee salmon (0.5%), and 7,488 coho salmon (2.4%). Post-season bypass occurred from October 1 through December 16.

By the end of May, 74.3% of the total yearly collection for 2021 had arrived. The percent of the total collection arriving by the end of June and the end of July was 94.5% and 99.6% respectively. Juvenile salmonids passing through the Lower Monumental Dam JFF in August and September contributed 0.4% of the 2021 season collection total and consisted primarily of unclipped subyearling Chinook salmon.

In 2021, the peak daily collection total and date for each species group were: 14,050 clipped yearling Chinook salmon (May 9), 2,050 unclipped yearling Chinook salmon (May 9), 4,482 clipped subyearling Chinook salmon (June 30), 10,415 unclipped subyearling Chinook salmon (June 30), 5,257 clipped steelhead (April 22), 1,950 unclipped steelhead (May 9), 320 clipped sockeye/kokanee salmon (May 14), 220 unclipped sockeye/kokanee salmon (May 2), and 725

coho salmon (May 8) with a maximum daily collection of 21,700 fish occurring on May 9, Table 4 below. Daily collection of all species combined versus total flow is shown graphically in Figure 2 below.

Table 3. Annual collection, bypass, and transport at Lower Monumental Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
Collection										
2017	1,085,863	373,783	143,911	201,653	973,825	321,374	8,370	8,290	33,800	3,150,869
2018	880,575	337,530	130,343	174,478	970,517	208,054	26,600	8,605	25,044	2,761,746
2019	886,572	289,846	80,401	142,992	1,330,906	324,527	40,875	3,233	30,700	3,130,052
2020	378,434	97,869	53,739	113,590	195,230	57,550	8,145	214	18,451	923,222
2021	104,155	17,085	27,414	56,418	68,200	22,481	2,042	1,564	7,488	306,847
5-Yr Avg	667,120	223,223	87,162	137,826	707,736	186,797	17,206	4,381	23,097	2,054,547
Bypass										
2017	277,539	212,024	1,336	4,332	472,639	87,447	0	4,597	800	1,060,714
2018	99,180	100,255	67	611	222,896	29,278	120	1,479	100	453,986
2019	222,211	131,218	886	4,139	543,987	86,555	0	128	3,424	992,548
2020	4,030	1,877	26,085	65,890	2,799	739	0	10	287	101,717
2021	20,522	1,096	17,923	41,511	13,984	1,791	8	72	598	97,505
5-Yr Avg	124,696	89,294	9,259	23,297	251,261	41,162	26	1,257	1,042	541,294
Truck										
2017	1	3	32	344	1	2	0	0	0	383
2018	0	0	11	118	0	0	0	0	0	129
2019	0	0	13	59	2	0	0	0	0	74
2020	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0
5-Yr Avg	0	1	11	104	1	0	0	0	0	117
Barge										
2017	807,367	161,580	142,397	196,759	500,873	233,819	8,329	4,239	32,959	2,088,322
2018	781,029	237,187	130,126	173,644	747,509	178,748	26,447	7,113	24,941	2,306,744
2019	663,488	158,459	79,350	138,693	786,712	237,927	40,873	3,104	27,272	2,135,878
2020	374,299	95,939	27,619	47,643	192,349	56,792	8,142	204	18,157	821,144
2021	83,586	15,976	9,482	14,887	54,167	20,679	2,029	1,490	6,885	209,181
5-Yr Avg	541,954	133,828	77,795	114,325	456,322	145,593	17,164	3,230	22,043	1,512,254
Total Transported										
2017	807,368	161,583	142,429	197,103	500,874	233,821	8,329	4,239	32,959	2,088,705
2018	781,029	237,187	130,137	173,762	747,509	178,748	26,447	7,113	24,941	2,306,873
2019	663,488	158,459	79,363	138,752	786,714	237,927	40,873	3,104	27,272	2,135,952
2020	374,299	95,939	27,619	47,643	192,349	56,792	8,142	204	18,157	821,144
2021	83,586	15,976	9,482	14,887	54,167	20,679	2,029	1,490	6,885	209,181
5-Yr Avg	541,954	133,829	77,806	114,429	456,323	145,593	17,164	3,230	22,043	1,512,371

Table 4. Annual peak collection dates at Lower Monumental Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
2017	9-May 78,000	18-Apr 34,200	2-Jun 11,550	2-Jun 12,000	22-Apr 98,200	9-May 24,000	14-May 2,200	20-Apr 1,000	13-May 5,400	9-May 181,600
2018	9-May 61,646	18-Apr 26,000	30-May 19,422	30-May 21,826	2-May 71,040	2-May 12,810	18-May 4,500	18-Apr 800	10-May 2,000	1-May 129,000
2019	24-Apr 51,000	25-Mar 17,800	31-May 7,700	31-May 23,100	24-Apr 114,600	25-Apr 28,818	20-May 14,000	19-May 1,000	18-May 1,800	24-Apr 205,200
2020	17-May 31,200	23-May 5,300	3-Jul 3,100	3-Jul 6,660	26-Apr 25,300	8-May 5,400	17-May 1,600	19-May 100	22-May 1,700	26-Apr 46,600
2021	9-May 14,050	9-May 2,050	30-Jun 4,482	30-Jun 10,415	22-Apr 5,257	9-May 1,950	14-May 320	2-May 220	8-May 725	9-May 21,700

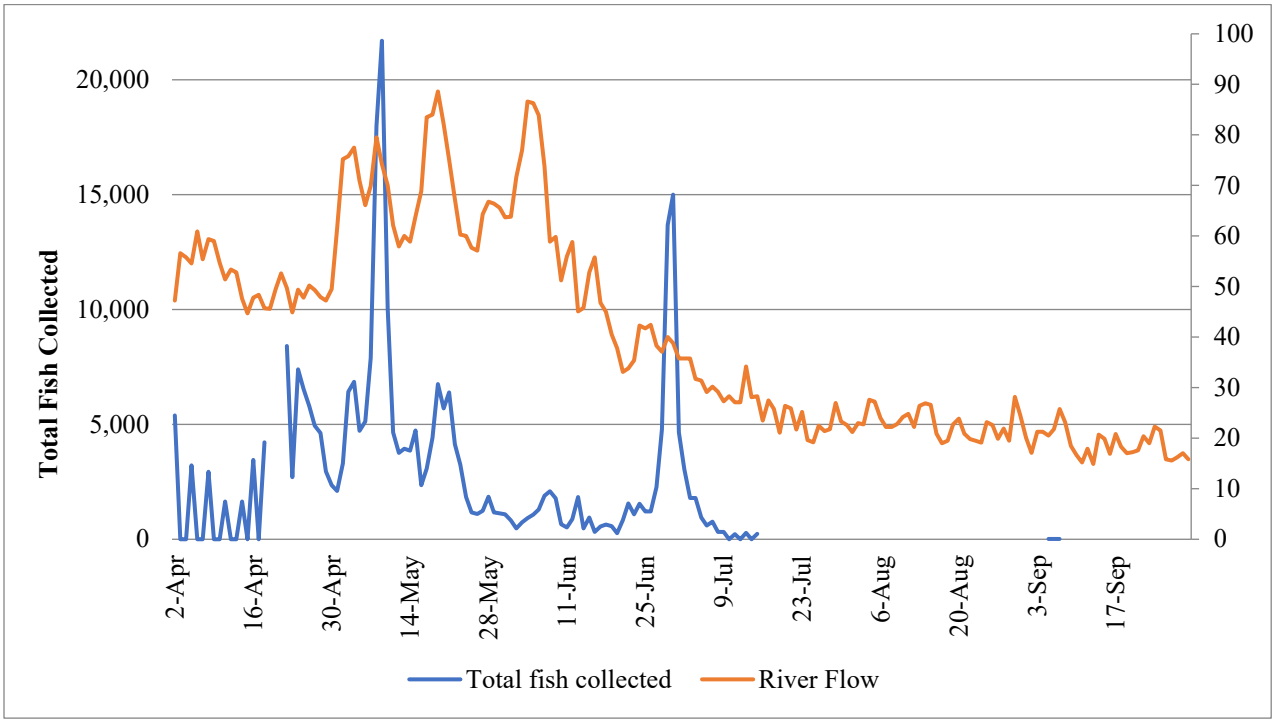

Figure 2. Daily juvenile Salmonid Collection, all species combined, versus daily average river flow at Lower Monumental Dam, 2021.

Sampling

Sampling for condition and outmigration indexing at Lower Monumental Dam began at 0700 hours on April 1. Sampling and collection for transport began at 0700 hours on April 22 and ended at 1500 hours on June 20. Due to elevated river temperature, daily fish sampling was concluded on July 9, and continued on an every-other-day basis thereafter.

Sampling is defined as diverting and segregating groups of fish in a consistent fashion so data collected from those segregated groups will accurately represent all fish collected.

Fish were sampled at Lower Monumental Dam to monitor fish condition, ensure the collection system was operating correctly, and to train personnel on facility operation and sampling protocols. This type of sampling is termed "sampling for condition". Fish sampling for condition occurred every third day from April 2 through April 14, after which time sampling continued on an every-other-day basis through April 23.

Total sampling includes both "sampling for condition" as well as "sampling for transport", which was conducted during the 2021 operating year. A total of 21,320 fish (6.9% of the collection) were sampled in 2021. Within each species group, the number and percent sampled of those collected in that group was: 4,521 clipped yearling Chinook salmon (4.3%), 1,574 unclipped yearling Chinook salmon (9.2%), 3,698 clipped subyearling Chinook salmon (13.5%), 6,635 unclipped subyearling Chinook salmon (11.8%), 2,978 clipped steelhead (4.4%), 1,165 unclipped steelhead (5.2%), 100 clipped sockeye salmon (4.9%), 86 unclipped sockeye/kokanee salmon (5.5%), and 563 coho salmon (7.5%), Table 5 below.

Average weekly sample rates can be found in Table 6 and ranged from 1.67% to 50.00%.

Table 5. Annual percentage sampled of each juvenile salmonid species group at Lower Monumental Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
2017	0.6	0.7	2.7	3.4	0.6	0.8	1.1	0.8	2.2	0.9
2018	0.6	0.7	3	4.6	0.6	0.7	1.1	0.9	1.1	1
2019	0.7	1	5.5	5.5	0.6	0.6	0.6	1.1	1.3	1.3
2020	1.3	2.4	8.9	9.8	1.9	1.7	0.8	1.9	1.9	3.1
2021	4.3	9.2	13.5	11.8	4.4	5.2	4.9	5.5	7.5	6.9

Table 6. Weekly sample rates in percent and sample totals at Lower Monumental Dam, 2021.

Week Ending	Weekly Rate	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Totals*
	(%)	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
9-Apr	2.5	778	27	0	0	33	7	0	0	0	845
15-Apr	1.67	118	2	0	0	38	5	0	0	0	163
22-Apr	4	380	29	0	0	613	72	0	0	2	1096
29-Apr	2.29	182	67	0	0	439	68	0	0	1	757
6-May	4.57	631	177	0	0	423	111	0	40	35	1417
13-May	3.71	1229	171	1	2	462	256	23	12	79	2235
22-May	5	1030	1030	41	60	347	224	69	11	125	2937
27-May	9	80	15	130	182	140	76	3	0	23	649
3-Jun	22.86	45	11	445	636	161	97	2	4	56	1457
10-Jun	23.57	36	21	535	1067	192	152	0	7	108	2118
17-Jun	26.07	3	6	483	717	69	51	0	0	29	1358
24-Jun	37.14	7	5	1006	1174	40	38	2	7	82	2361
1-Jul	9.5	0	10	839	1472	8	4	1	2	14	2350
8-Jul	6.14	1	1	60	223	1	2	0	0	7	295
15-Jul	21.43	0	2	57	293	7	1	0	1	2	363
22-Jul	50	1	0	16	71	0	1	0	1	0	90
29-Jul	50	0	0	28	148	4	0	0	0	0	180
5-Aug	50	0	0	19	78	0	0	0	0	0	97
12-Aug	50	0	0	22	193	0	0	0	0	0	215
19-Aug	50	0	0	10	111	0	0	0	0	0	121
26-Aug	50	0	0	2	93	0	0	0	0	0	95
2-Sep	50	0	0	2	68	0	0	0	0	0	70
9-Sep	50	0	0	1	36	0	0	0	1	0	38
16-Sep	50	0	0	0	3	0	0	0	0	0	3
23-Sep	50	0	0	1	7	0	0	0	0	0	8
30-Sep	50	0	0	0	1	1	0	0	0	0	2
Total Sampled		4,521	1,574	3,698	6,635	2,978	1,165	100	86	563	21,320
% of Sample		21.2	7.4	17.3	31.1	14	5.5	0.5	0.4	2.6	100
% of Collection		4.3	9.2	13.5	11.8	4.4	5.2	4.9	5.5	7.5	6.9

* Daily 24-hour sampling at Lower Monumental Dam began on April 22 this season.

Transportation-Barge Loading Operations

An estimated 209,181 juvenile salmonids (68.2% of the collection) were transported from Lower Monumental Dam in 2021, Table 3. All were transported by barge; no fish were trucked in 2021. Within each species group, the number transported and percent of those collected in each group was: 83,586 clipped yearling Chinook salmon (80.3%), 15,976 unclipped yearling Chinook salmon (93.5%), 9.482 clipped subyearling Chinook salmon (34.6%), 14,887 unclipped subyearling Chinook salmon (26.4%), 54,167 clipped steelhead (79.4%), 20,679 unclipped

steelhead (92.0%), 2,029 clipped sockeye salmon (99.4%), 1,490 unclipped sockeye/kokanee salmon (95.3%), and 6,885 coho salmon (91.9%).

Fish were transported by barge from April 24 through June 20. Barge loading at Lower Monumental Dam occurred without any issues during the 2021 transport season.

Transportation-Truck Loading Operations

Juvenile fish were scheduled to be transported by truck from August 1 to October 1. Per the 2021 Fish Operations Plan, the Lower Monumental trucking schedule is contingent upon the Technical Management Team approval; the Technical Management Team decision was that no truck transport would take place from Lower Monumental Dam during the 2021 transport season.

Bypass

During the 2021 season, a total of 97,505 fish were bypassed (31.8% of the collection), Table 2. Within each species group, the number bypassed and percent of those collected in each group was: 20,522 clipped yearling Chinook salmon (19.7%), 1,096 unclipped yearling Chinook (6.4%) 17,923 clipped subyearling Chinook salmon (65.4%), 41,511 unclipped subyearling Chinook salmon (73.6%), 13,984 clipped steelhead (20.5%), 1,791 unclipped steelhead (8.0%), 8 clipped sockeye/kokanee salmon (0.4%), 72 unclipped sockeye salmon (4.6%) and 598 coho salmon (8.0%). These numbers do not include fish bypassed by the PIT tag diversion system.

Juvenile salmonids were bypassed rather than transported for the following purposes this season:

1. Condition sampling and secondary bypass occurred (see condition sampling frequency in sampling section).

2. Salmonid fry measuring less than 60 millimeters (mm) were bypassed and not sampled due to smolt monitoring protocol.

3. The PTAGIS3 database revealed 2,125 PIT tagged fish of different species groups were bypassed through the PIT tag system. These fish are not included in the facility bypass total. PIT tag diversion gates are set to bypass PIT tagged fish when sample rates are 20% or higher and during sampling intervals when fish are being collected for research to prevent anesthetizing study fish a second time.

The fish rearing designation used by PTAGIS is hatchery/wild, not clipped/unclipped; therefore, the hatchery/wild designation is used to report the PIT tag numbers in the following section rather than the clipped/unclipped designation used throughout the rest of this report. According to the PTAGIS3 database the total number of bypassed PIT-tagged fish was 2,125. The total by unit group was: 1,166 Chinook salmon, 880 steelhead, 39 sockeye salmon, 32 Coho salmon, and 8 fish of unknown species. An unknown number of other fish were bypassed incidentally with the PIT-tagged fish as the PIT tag diversion gates opened and closed to divert the PIT-tagged fish.

Migration, Sampling and Bypass of Juvenile Lamprey

Pacific lamprey, *Entosphenus tridentatus,* the primary species found at Lower Monumental Dam and are characterized by the presence of three large teeth and posterior teeth on the oral disc. Pacific lamprey spawn in similar habitats to salmon. Spawning occurs between March and July, depending upon location within their range.

Metamorphosis from the larvae stage (ammocoetes) to the juvenile stage (macropthalmia) occurs over a period of several months. During this time, 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. Sampled data for Pacific lamprey juvenile life stages are presented in Table 7 below. In addition, the 5-year averages of the total collection, sampled, and fish in the separator are also presented.

Table 7. Pacific lamprey in the sample and separator, and the total collection for both life stages, 2017-2021.

Pacific lamprey (Juvenile)			
Year	**Sample**	**Separator**	**Total Collection**
2017	1,450	0	1,450
2018	54404	0	54,404
2019	65843	0	65,843
2020	37361	2	37,363
2021	2930	0	2,930
Pacific lamprey (Ammocoete)			
Year	**Sample**	**Separator**	**Total Collection**
2017	814	0	814
2018	1,377	0	1,377
2019	388	0	388
2020	1,096	1	1,097
2021	22	0	22

Incidental Species

Non-target fish species that were too large to pass through the separator bars were recorded and bypassed through the adult release pipe at the separator. Those small enough to pass through the separator bars were either sampled and bypassed, or held in the raceways and transported with the juvenile salmonids. Fortunately, most incidental fishes generally arrive late in the season when a high percentage of the collection is sampled. At this time, incidental species are removed while working up the sample, therefore avoiding transport. Sample fish from each incidental species were counted and their total numbers were calculated using the sample rate. These numbers were then added with separator counts of the same group to estimate the total collection for each species. The most common incidental species groups for 2021 included: juvenile American shad, *Alosa sapidissima* (29,181), Siberian prawn, *Exopalaemon modestus* (8,461),

juvenile Pacific lamprey macrophthalmia (2,930), walleye, *Stizostedion vitreum* (859), sculpin, *Cottus spp*. (791), and combined smallmouth bass, *Micropterus dolomieu* and largemouth bass, *M. salmoides* (782), Table 8 below.

The number of juvenile shad (29,181) in 2021 is far less than the 38,430 collected in the 2020 operating year. Other incidental fish species numbers collected at the facility have decreased. In the 2021 season, 2,930 juvenile Pacific lamprey were collected, compared to 37,285 in the 2020 season. However, walleye numbers have increased from the 2020 to the 2021 season. Approximately 859 walleye were collected in the 2021 season, while 309 were collected in the 2020 season. Estimated numbers of some groups may also become exaggerated high or low due to the low sample rates at the time of their collection.

Table 8. Estimated collection of incidental species at Lower Monumental Dam, 2021.

Common Name	Scientific Name	Sample	Separator	Total[1] 2021 Collection
American Shad (Adult)	*Alosa sapidissima*	2	94	96
American Shad (Juvenile)	*A. sapidissima*	26,662	2,519	29,181
Banded Killifish	*Fundulus diaphanus*	0	0	0
Bullhead (misc.)	*Ameiurus* spp.	28	0	28
Bull Trout	*Salvelinus confluentus*	0	0	0
Channel Catfish	*Ictalurus punctatus*	32	12	44
Chiselmouth	*Acrocheilus alutaceus*	0	0	0
Common Carp	*Cyprinus carpio*	4	4	8
Crappie	*Pomoxis* spp.	40	1	41
Kokanee	*Oncorhynchus nerka*	38	0	38
Mosquitofish	*Gambusia affinis*	0	0	0
Northern Pikeminnow	*Ptychocheilus oregonensis*	2	0	2
Pacific Lamprey (Adult)	*Lampetra tridentatus*	8	2	10
Pacific Lamprey (Juvenile)	*L. tridentatus*	2,930	0	2,930
Pacific Lamprey (Ammocoete)	*L. tridentatus*	22	0	22
Peamouth	*Mylocheilus caurinus*	20	1	21
Rainbow Trout	*O. mykiss*	5	17	22
Redside Shiner	*Richardsonius balteatus*	0	0	0
Sandroller	*Percopsis transmontana*	0	0	0
Sculpin	*Cottus* spp.	791	0	791
Siberian Prawn	*Exopalaemon modestus*	8,461	0	8,461
Largemouth & Smallmouth Bass	*Micropterus dolomieu/salmoides*	780	2	782
Sucker	*Catostomus* spp.	145	22	167
Sunfish	*Lepomis* spp.	0	0	0
Tadpole Madtom	*Noturus gyrinus*	0	0	0
Whitefish	*Prosopium* spp.	7	2	9
White Sturgeon	*Acipenser transmontanus*	0	13	13
Walleye	*Stizostedion vitreum*	827	32	859
Warmouth	*Lepomis gulosus*	0	0	0
Yellow Perch	*Perca flavescens*	26	3	29
Total		40,830	2,724	43,554

Incidental species collection estimates are based on sampled number of group expanded by the sample rate plus separator count.

Adult Fallbacks

A total of 148 adult salmonids fell back through the juvenile bypass system and were bypassed from the separator between April and October, table 9 below. The total includes: 46 adult Chinook salmon, 20 jack Chinook salmon, 23 clipped steelhead, 49 unclipped steelhead, 5 sockeye salmon, and 5 coho salmon, Table 9 below.

As has been the case in previous years, most adult fallbacks in 2021 were steelhead and most (56.9%) steelhead fallback occurred April through May, Table 10 below. Total monthly adult fallbacks for all salmonid species peaked in September.

Table 9. Annual totals of adult salmonids released from the separator at Lower Monumental Dam, 2017-2021.

Year	Chinook	Chinook Jack	Steelhead Clipped	Steelhead Unclip	Sockeye	Coho	Total
2017	101	42	263	322	0	0	728
2018	106	20	236	343	1	0	706
2019	71	25	246	363	1	0	706
2020	83	44	79	112	21	8	347
2021	46	20	23	49	5	5	148

Table 10. Monthly totals of adult salmonids released from the separator at Lower Monumental Dam, 2021.

Month	Chinook	Chinook Jack	Steelhead Clipped	Steelhead Unclip	Sockeye	Coho	Total
April	1	0	2	13	0	0	16
May	5	0	11	15	1	0	32
June	1	2	1	4	0	0	8
July	20	7	2	3	4	2	38
August	2	0	0	1	0	0	3
September	16	10	7	13	0	3	49
October	1	1	0	0	0	0	2
Total	46	20	23	49	5	5	148

The condition of adult salmonids was evaluated as the fish were released from the separator. Their condition was predominantly good to fair with 95.9% of the fallbacks rated in these categories, table 11 below. Condition ratings of the adults examined were as follows: 125 good (84.4%), 17 fair (11.5%), 5 poor (3.4%), and 1 was dead (0.67%). The number dead in each species group of adult salmonids was: 1 unclipped steelhead.

Table 11. Condition of adult salmonids released from the separator at Lower Monumental Dam, 2021.

Condition	Chinook	Chinook Jack	Steelhead Clipped	Steelhead Unclip	Sockeye	Coho	Total
Good	39	20	18	38	5	5	125
Fair	5	0	3	9	0	0	17
Poor	2	0	2	1	0	0	5
Dead	0	0	0	1	0	0	1
Total	46	20	23	49	5	5	148

Separator Efficiency

The separator is designed with bar spacing to allow only smaller smolts—subyearling Chinook salmon and sockeye salmon—to divert to the A side of the collection facility. Larger smolts—steelhead and yearling Chinook salmon—divert to the B side through wider spaced bars. Separator efficiency for 2021 by species group was: clipped yearling Chinook salmon (67.6%), unclipped yearling Chinook salmon (55.3%), subyearling Chinook salmon (29.2%), clipped steelhead (69.0%), unclipped steelhead (66.8%), clipped sockeye salmon (60.4%), and unclipped sockeye/kokanee salmon (29.9%), Table 12 below.

Table 12. Annual separator efficiency in percent at Lower Monumental Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook	Steelhead		Sockeye	Sockeye/Kokanee
	Clipped	Unclip	Clipped/Unclip	Clipped	Unclip	Clipped	Unclip
	A-side	A-side	A-side	B-side	B-side	A-side	A-side
2017	60.8	57	64.4	86.8	63	45	28.2
2018	64.5	58.8	52.4	90.9	73.2	39.2	36.7
2019	51	47.1	46.5	88.8	69.1	44.3	5.6
2020	71.9	65.1	42.4	44.8	26.9	34.5	93.5
2021	67.6	55.3	29.2	69	66.8	60.4	29.9

FISH CONDITION

Descaling

Descaling data were collected from all live sample fish (full sample) rather than just a portion (subsample). Full-sample data collection provides a larger sample size and therefore a better representation of fish condition.

The descaling rate for all fish sampled in 2021 was 1.7%, Table 13 below. The annual descaling rate by species group was clipped yearling Chinook salmon (1.0%), unclipped yearling Chinook salmon (1.6%), clipped subyearling Chinook salmon (1.2%), unclipped subyearling Chinook salmon (1.4%), clipped steelhead (3.2%), unclipped steelhead (3.0%), clipped sockeye salmon (4.1%), unclipped sockeye/kokanee salmon (4.7%), and coho salmon (3.6%).

In 2021, the highest weekly descaling rate for all species combined was 3.8% for the week ending September 2 (with fish sampled in a week of condition sampling), while the lowest rate (0.0%) occurred in the weeks ending April 9, April 15 and August 26, Table 14 below.

Table 13. Annual descaling rates in percent for fish sampled at Lower Monumental Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
2017	2.2	2.2	1.7	1.9	3.5	1.6	3.3	3.1	1.1	2.3
2018	2	2	1.7	1.5	2.1	2.9	2.4	1.3	1.9	1.9
2019	1.6	1.6	2.7	2.2	2.5	2.9	2.4	0	2.2	2.2
2020	1.5	1.6	1.6	1.1	2.5	2.9	2.4	0	2.9	1.9
2021	1	1.6	1.2	1.4	3.2	3	4.1	4.7	3.6	1.7

Table 14. Weekly descaling rates in percent for fish sample at Lower Monumental Dam, 2021.

Week Ending	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
9-Apr	0.0%	0.0%	---	---	0.0%	0.0%	---	---	---	0.0%
15-Apr	0.0%	1.5%	---	---	0.0%	0.0%	---	---	---	0.0%
22-Apr	0.4%	0.0%	---	---	1.4%	2.2%	---	---	0.0%	1.0%
29-Apr	0.8%	1.3%	---	---	1.7%	3.8%	---	---	0.0%	1.6%
6-May	0.7%	1.7%	---	---	2.8%	1.0%	---	11.8%	4.2%	1.8%
13-May	1.6%	2.4%	0.0%	0.0%	3.4%	2.3%	0.0%	0.0%	0.0%	2.1%
20-May	1.3%	2.7%	0.0%	0.0%	5.5%	2.5%	3.9%	0.0%	0.0%	2.1%
27-May	1.1%	0.0%	0.8%	0.0%	5.0%	0.5%	25.0%	0.0%	1.3%	1.8%
3-Jun	0.0%	0.0%	0.5%	0.6%	5.9%	6.4%	0.0%	0.0%	3.7%	1.8%
10-Jun	2.3%	0.0%	0.9%	0.9%	4.3%	3.8%	---	0.0%	3.7%	1.5%
17-Jun	0.0%	0.0%	2.6%	2.4%	4.4%	6.8%	---	---	0.0%	2.7%
24-Jun	0.0%	0.0%	1.1%	1.4%	0.0%	10.6%	0.0%	0.0%	2.4%	1.5%
1-Jul	---	0.0%	1.3%	1.2%	8.3%	0.0%	0.0%	0.0%	0.0%	1.3%
8-Jul	100.0%	0.0%	0.0%	2.6%	100.0%	0.0%	---	---	0.0%	2.6%
15-Jul	---	0.0%	0.0%	2.2%	0.0%	0.0%	---	0.0%	0.0%	1.7%
22-Apr	0.0%	---	0.0%	2.1%	0.0%	0.0%	---	0.0%	---	1.7%
29-Jul	---	---	0.0%	0.9%	0.0%	---	---	---	---	0.7%
5-Aug	---	---	0.0%	0.9%	---	---	---	---	---	0.7%
12-Aug	---	---	0.0%	2.0%	---	---	---	---	---	1.8%
19-Aug	---	---	0.0%	2.9%	---	---	---	---	---	2.7%
26-Aug	---	---	0.0%	0.0%	---	---	---	---	---	0.0%
2-Sep	---	---	0.0%	3.8%	---	---	---	---	---	3.8%
9-Sep	---	---	0.0%	2.8%	---	---	---	0.0%	---	2.6%
16-Sep	---	---	---	0.0%	---	---	---	---	---	0.0%
23-Sep	---	---	0.0%	0.0%	---	---	---	---	---	0.0%
30-Sep	---	---	---	0.0%	0.0%	---	---	---	---	0.0%
Total Descaled	43	11	43	95	94	35	4	4	10	339
Total Examined	4,496	693	3,689	6,606	2,966	1160	98	85	560	20,353
% Descaled	1.0%	1.6%	1.2%	1.4%	3.2%	3.0%	4.1%	4.7%	1.8%	1.7%

---No fish sampled during this week.

Other Injury and Disease

Injury and disease data were collected from a subsample of 100 of the dominant species and not more than 100 each of the non-dominant species. A total of 14,215 fish were examined for condition. The most common symptoms observed in 2021 were fin injury (affected fish) and fin hemorrhage (affected fish).

Blood pooling is defined as the vasodilatation of the capillaries in fins (also referred to as pink fin). It seems to be a symptom of anesthetic use during higher water temperatures and is mostly found on subyearling Chinook salmon. Evidence of blood pooling was found on 1.6% of all fish examined. The incidence of blood pooling by species group was yearling Chinook salmon 0.3%, subyearling Chinook salmon 2.7%, steelhead 0.6%, and 0.0% blood pooling was found on sockeye/kokanee salmon and coho salmon.

Fin injuries were found on 10.1% of all fish examined. The incidence of fin injury was yearling Chinook salmon 9.2%, subyearling Chinook salmon 12.3%, steelhead 5.6%, and sockeye/kokanee salmon 36.1%. Fin hemorrhaging often coincided with split fin injuries.

Fin hemorrhaging is the discharge of blood outside the fin tissue. Fin hemorrhaging is a sign of trauma and was found on 4.1% of all fish examined for injuries. The incidence of fin hemorrhaging was yearling Chinook salmon 4.1%, subyearling Chinook salmon 6.4%, steelhead 0.2%, sockeye/kokanee salmon 1.1%, and zero fin hemorrhaging was found on coho salmon. Other common injuries included: bird marks, predatory fish marks, fungus, and Columnaris.

Bird marks were observed on 1.3% of all fish examined. The incidence of bird marks was yearling Chinook salmon 0.7%, subyearling Chinook salmon 0.5%, steelhead 3.2%, sockeye/kokanee salmon 2.2%, and zero bird marks were found on coho salmon.

Predatory fish marks were found on 0.6% of all fish examined. The incidence of fish marks was yearling Chinook salmon 0.4%, subyearling Chinook salmon 0.7%, steelhead 0.5%, sockeye/kokanee salmon 0.5 %, and zero fish marks were found on coho salmon.

Fungus was found on 0.7% of all fish examined. The occurrence of fungus is generally seen early in the season while the water is still relatively cold. Fungus on fish was often found concurrently with body injuries. The incidence of fungus was yearling Chinook salmon 0.4% and steelhead 2.3%, sockeye/kokanee salmon 1.6%. There were zero instances of fungus found on subyearling Chinook salmon and coho salmon.

Columnaris was seen again this year. It occurs most frequently in subyearling Chinook salmon but has been seen on coho salmon and steelhead as well. Typically, it is found on the fish during the warmer water conditions of July, August, and September. Columnaris can be recognized by the presence of yellowish lesions on the belly, as well as some damage to the gills, pelvic fins, snout, and caudal fins. It has also been found in the dorsal region. This year, subyearling Chinook salmon showed the greatest number of Columnaris-affected fish (0.2%).

Mortality

Annual facility mortality for all groups combined was 0.05% in 2021 and totaled 161 fish, table 15 below. Within each species group, the number of facility mortalities and percent of those collected in that group was: 47 clipped yearling Chinook salmon (0.05%), 13 unclipped yearling Chinook salmon (0.08%), 9 clipped subyearling Chinook salmon (0.03%), 20 unclipped subyearling Chinook salmon (0.04 %), 49 clipped steelhead (0.07%), 11 unclipped steelhead (0.05%), 5 clipped sockeye/kokanee salmon (0.24 %), 2 unclipped sockeye/kokanee salmon

(0.13%), and 5 coho salmon (0.07 %). In 2021, weekly mortality rates reached a high of 0.95% for the week ending July 22 and a low of 0.00% for the week ending April 15, July 29 to August 19, and September 2 till the end of the 2021 season, Table 16 below.

Annual sample mortality for all groups combined in 2021 was 0.7% and totaled 75 fish, table 17 below. The number of sample mortalities and mortality rate by species group was: 25 clipped yearling Chinook salmon (0.6%), 4 unclipped yearling Chinook salmon (0.6%), 8 clipped subyearling Chinook salmon (0.2%), 15 unclipped subyearling Chinook salmon (0.2%), 12 clipped steelhead (0.4%), 5 unclipped steelhead (0.4%), 2 clipped sockeye salmon (2.0%), 1 unclipped sockeye/kokanee salmon (1.2%), and 3 coho salmon (0.4%).

Table 15. Annual facility mortality in percent at Lower Monumental Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
2017	0.1	0	0.1	0.1	0	0	0.5	0.9	0.1	0.1
2018	0	0	0.1	0.1	0	0	0.1	0.2	0	0
2019	0.1	0.1	0.2	0.1	0	0	0	0	0	0.1
2020	0.03	0.05	0.07	0.05	0.04	0.03	0.04	0	0.04	0.03
2021	0.05	0.08	0.03	0.04	0.07	0.05	0.24	0.13	0.07	0.05

Table 16. Weekly facility mortality in percent at Lower Monumental Dam, 2021.

Week Ending	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
9-Apr	0.02	0	---	---	0	0	---	---	---	0.02
15-Apr	0	0	---	0	0	0	---	---	---	0
22-Apr	0.03	0	---	---	0.01	0	---	---	0	0.01
29-Apr	0.05	0.06	---	---	0.02	0.03	---	---	0	0.03
6-May	0.07	0.08	---	0	0.16	0.2	---	0.12	0.39	0.12
13-May	0.03	0.07	0	0	0.01	0.01	0	0.28	0	0.03
20-May	0.06	0.09	0.82	0.4	0.22	0.03	0.3	0	0	0.1
27-May	0.13	0.1	0	0	0.23	0.08	0	0	0	0.1
3-Jun	0	0	0.09	0	0.36	0.18	0	0	0.33	0.1
10-Jun	0	0	0	0.04	0.11	0	---	0	0	0.03
17-Jun	6.67	0	0.05	0	0.34	0	---	---	0.89	0.07
24-Jun	0	5.26	0.07	0.06	1.02	0	25	0	0	0.11
1-Jul	---	0	0	0.02	0	0	0	0	0	0.01
8-Jul	0	0	0.05	0.06	0	0	---	---	0	0.05
15-Jul	0	0	0.6	0.35	0	0	---	0	0	0.38
22-Jul	0	---	2.78	0.59	---	0	---	0	---	0.95
29-Jul	---	0	0	0	0	---	---	---	---	0
5-Aug	---	---	0	0	---	---	---	---	---	0
12-Aug	---	---	0	0	---	---	---	---	---	0
19-Aug	---	---	0	0	---	---	---	---	---	0
26-Aug	---	---	0	0.54	---	---	---	---	---	0.53
2-Sep	---	---	0	0	---	---	---	---	---	0
9-Sep	---	---	0	0	---	---	---	0	---	0
16-Sep	---	---	---	0	---	---	---	---	---	0
23-Sep	---	---	0	0	---	---	---	---	---	0
30-Sep	---	---	---	0	0	---	---	---	---	0

---No fish collected during the week.

Table 17. Annual sample mortality in percent at Lower Monumental Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
2017	0.4	0.5	0.6	0.4	0.3	0.5	1.1	5.9	0.5	0.4
2018	0.1	0.1	0.2	0.2	0.1	0	0.7	1.3	0	0.2
2019	0.1	0.2	0.3	0.4	0.1	0.1	0	0	0.7	0.2
2020	0.2	0.3	0.3	0.4	0.2	0.3	1.5	0	0	0.3
2021	0.6	0.6	0.2	0.2	0.4	0.4	2	1.2	0.4	0.7

JUVENILE RESEARCH

Gas Bubble Trauma

Juvenile Chinook salmon and steelhead were sampled once a week for GBT from April 7 to July 29. The GBT inspections were stopped early due to small numbers of available fish. Typically, inspections end when spring spill stops (June 20). This season, 1,151 fish were sampled for GBT. PSMFC personnel examined up to 100 individuals of each of the following groups: yearling Chinook salmon, subyearling Chinook salmon, and juvenile steelhead. The fish were examined for evidence of bubbles in paired and unpaired fins and in the eye, as per Fish Passage Center GBT protocols. Prior to collection for transport, the GBT fish were bypassed to the river after examination. Weekly GBT sampling continued for up to 4 hours or until 100 fish had been sampled per species group. The number of fish sampled for GBT, by species group, was: 213 clipped yearling Chinook salmon, 45 unclipped yearling Chinook salmon, 169 clipped subyearling Chinook salmon, 365 unclipped subyearling Chinook salmon, 283 clipped steelhead, and 76 unclipped steelhead. In the 2021 season, 33 fish showed signs of GBT in the fins (2.87%).

FACILITY OPERATIONS AND MAINTENANCE

Turbine Operations

Efforts were made to operate all turbine units within 1% of peak efficiency from April 1 to October 31, inclusive. Deviations were infrequent and brief. The project ran outside the constraint at the request of the Bonneville Power Administration (BPA). Unit priority was in effect from March 1 to November 30. Units were taken out of service (OOS) for various reasons throughout the year. Table 18 below provides a summary of unit outages and causes.

Table 18. Unit outages and causes at Lower Monumental, 2021.

Dates out of service (OOS)	Unit	Reason out of service (OOS)
January 1- December 31	Unit 2	Annual/Draft tube liner rehab
March 15 - 17	All Units	Trash rack raking (6-8 hrs/day alternating units)
March 22 - 24	All Units	STS installation
March 30	Unit 4	STS motor failure
April 20 – 21	Unit 5	Trash rack raking/Doble testing
June 20 – 22	Unit 1	Exciter issues
July 6 – September 2	Unit 4	Annual maintenance
July 14	Unit 1	PSS setting adjustments
November 29 –	Unit 1	Annual maintenance and exciter upgrade
August 16 – September 3	Unit 3	Annual maintenance
September 13 - 16	Unit 5	Annual maintenance
October 18 - 21	Unit 6	Annual maintenance
December 16	Unit 1	Annual maintenance and exciter upgrade
December 16 - 17	Units 3-6	STS removal
December 21 - 27	Unit 1	Broken head cover pump discharge
2-3 days each month	All Units	STS/VBS inspection/hub tapping on fixed blade units

Spill Operations

Prior to spill season, spill only occurred if it was needed for spill excess of powerhouse capacity. Limited spill through the RSW for adult steelhead passage occurred from March 1 to 31 and again from October 1 through November 15. The spring spill program began at 0001 hours April 3 and ended 0000 hours on June 20. The summer spill program began at 0001 hours on June 21 and ended at 0000 hours on August 31.

During the spill seasons, spill adjustments for navigation were done as required. After spill season ended, spill only occurred if needed for excess of powerhouse capacity.

Removable Spillway Weir

The RSW went into service at 0001 on April 3 with the start of the spring spill program. Due to high river temperatures correlated with low river flows, the RSW was closed on July 9, except for the fall spill to assist with steelhead passage.

Forebay Debris

Forebay debris was moderately light for the year, similar to the 2020 year. The maximum amount of debris observed during ladder inspections was around 120 yards squared, observed in the month of March.

Trash Racks

During the winter, trash rack measurements were not taken. Before the juvenile passage season, trash racks were cleaned at all slots from March 15 to 17. Prior to Doble testing, unit 5 had additional cleaning which occurred from April 20 to 21. No problems were observed during any cleanings.

Gatewells

During the season, gatewell slots were checked during ladder inspections, approximately three times per week. The gatewell drawdown benchmark measurements were taken for units 1, 3 and 6 on March 30. Small amounts of woody material were noted in the gatewell slots, and the debris coverage did not exceed 50% during any inspections. No large accumulations of woody material were noted.

Submersible Traveling Screens

During the winter maintenance season, electrical cables, gearboxes, motors, and screens were examined and repaired or replaced as required. The Submersible Traveling Screens (STS) were inspected and tested on March 18 prior to installation. STSs for units 1 and 3 were installed on March 22, units 5 and 6 were installed on March 23 and unit 4 was installed on March 24. Unit 2 was not installed for the entire season, as this unit continued to be OOS.

STSs deployed in slot 4B had a motor failure on March 30 and was immediately replaced with a spare screen before the unit returned to service.

STSs are usually operated in cycle mode when the average fork length of subyearling Chinook salmon and/or sockeye salmon is greater than 120 mm, and in continuous run mode when either is less than 120 mm. The STSs were placed in cycle-run mode when first deployed on March 24. The STSs were changed to continuous-run mode on June 6 due to average sub-yearling Chinook salmon and sockeye salmon lengths being less than 120 mm. The cycle was changed back to cycle-run mode on July 19 when the average lengths of collected fish were greater than 120mm.

All STSs were raised by December 17. Units 3 and 4 were raised on December 16 and units 5 and 6 were raised on December 17. Unit 1 had been raised prior because the unit was OOS. After the screens were raised, they were visually inspected. The STSs appeared clean and had no apparent damage to them.

Vertical Barrier Screens

VBS differentials are not measured daily at Lower Monumental due to the general structure of the VBSs. Instead, they are spot checked during the monthly STS inspections.

The VBS benchmark differential was measured at unit 1 on April 19. Throughout the season two issues were found with the VBSs at slots 6B and 1C. The VBS at slot 6B was inspected using the underwater ROV on October 18. There were concerns that the top of the upper most screen was not flush with the gatewell wall. Plans to repair the VBS when it is next dewatered were put into place. The VBS in slot 1C was inspection on November 1 using a man basket and found to be missing hardware. Powerhouse personnel repaired that section of the VBS on December 2. No other issues were found throughout the year.

Juvenile Collection Channel (JCC) Orifices

During the 2021 season, the number of open orifices varied from 17 to 20 according to forebay level. The orifices were opened at 1045 hours on March 25, after the winter maintenance period. With the Lower Monumental reservoir at minimum operating pool, water discharge through an orifice is reduced. During this period, extra orifices were opened to supply additional water to the adult fishway. Orifices were cycled and backflushed with air daily to remove debris. Orifice lights were also checked daily. If a light was not working, flow was directed to the other orifice in the slot until repairs could be made. The orifices were closed for the winter maintenance period on December 17 at 1100 hours.

Primary Dewatering Structure

The PDS operated from March 25 to December 17. The compressed air screen cleaner functioned well throughout the 2021 season. The PDS mechanical screen cleaner brush functioned well except for the issue listed below.

The PDS mechanical screen cleaning brush was taken OOS at 1630 hours on April 19 due to a brush arm lift failure. The issue was repaired, and the brush was returned to service on April 27. During the period of time the brush was OOS, the debris load was low, and the air bubbler was able to keep the screen clean enough to keep the system operating.

A leak from the east side of the PDS was reported by powerhouse staff on May 20. After a thorough examination by the fish facility mechanics, it was found that the leak was coming from a rubber gasket which is located on the inside of the PDS between the concrete joints. During the winter maintenance period, a repair to the gasket will be completed.

The PDS and main flume was dewatered for winter maintenance on December 17 and will be OOS till March of 2022.

JUVENILE FISH FACILITY

Separator

Sudden water level drops at the separator were not a problem this year but continued to occur. Water level remained consistent at the separator with manual operation of the automated weirs of the primary dewaterer. As has been the case for the last few years, the separator was operated at a higher water level to assure no problem with exposed separator bars would occur. However, a path forward for the 2022 fish season will occur to understand why the sudden drops continue to happen.

PIT Tag System

The PIT tag system functioned well this season. There were no problems to report with the PIT tag system.

The PIT tag system detected 2,125 PIT tagged fish at the Juvenile Fish Facility (JFF) from April 1 to October 1. None of these PIT tagged fish are included in the bypass numbers. Juvenile hatchery Chinook salmon, hatchery coho salmon, and hatchery steelhead in the Snake River Basin are normally designated by fin clips, usually the adipose fin, but occasionally one of the pectoral or ventral fins.

Sample

The JFF was watered up for testing at 1000 hours on March 29, and every-third-day fish condition sampling began at 0700 on April 1. The first sample was processed on April 2, and continued every third day up until April 14, after which condition sampling took place every other day. Early-season condition monitoring consisted of a 24-hour sample on target days from 0700 hours to 0700 hours. Every-other-day sampling continued until the start of transportation operations on April 22, at which time sampling was conducted every day. During this period, fish were examined and returned to the river. Every-day sampling continued up until July 9, when the fish facility switched to every-other-day sampling in accordance with the newly

updated Fish Passage Center's (FPC) high water temperature guidelines due to Snake River water temperatures exceeding 68.5 °F.

Collection for barge transport began at 0700 hours on April 22 and ended at 1500 hours on June 20. Beginning June 21, all fish collected were sampled for condition and then bypassed. This operation continued until October 1, 2021, when the facility was returned to primary bypass. The JFF was dewatered for winter maintenance on October 2.

FISH SALVAGE

Only juvenile fish salvage at various locations will appear in this report. Fish were not always examined for clips as their survival was a higher priority.

The fish rescue occurred for the North adult fish ladder and powerhouse collection channel on January 11 at 0700 hours. There was a total of 27 live clipped adult steelhead and 5 lived adult unclipped steelhead returned to the river. Most of the steelhead were less than 20 inches in length. In addition, there were 55 adult catfish, 3 smallmouth bass, 1 walleye, 1 carp and 1 perch returned to the river at the tailrace.

Unit 4 scrollcase fish rescue took place on July 22 at 1300 hours. One catfish was released and there were no mortalities found.

The fish rescue for the Juvenile Collection Channel (JCC) occurred December 17. During the rescue, 5 live Steelhead adults, 1 live Chinook salmon adult, and 2 live juvenile Chinook salmon were all released back to the river. In addition, there was 1 live adult catfish, 250 live juvenile shad, 1 live juvenile bass and 20 juvenile shad mortalities released to the river.

COOLING WATER STRAINERS

Turbine unit cooling water strainers were examined for biologic content once per month from January until June and then again in December. The vast majority of other species found within the strainers were American shad. The number of each group and percent of the individual groups consisted of 1200 American Shad (80%), 288 juvenile lamprey (19%), 4 salmonid species (<1%), 1 steelhead (<1%), and 1 Siberian prawn (<1%).

Probability of any individual being alive at the time of strainer cleaning was likely more related to time of entry rather than which unit's strainer it was found in. Table 19 below reflects the results of this year's main unit cooling water strainer examinations.

Table 19. Cooling Water Strainer Results at Lower Monumental Dam, 2021.

Month	Lamprey Mortality	Live Lamprey	Smolt Mortality	Live Smolts
Jan	0	0	0	0
Feb	277	0	0	0
Mar	0	0	0	0
Apr	6	0	2	0
May	1	0	2	0
Jun	4	0	1	0
Dec	0	0	0	0

INVASIVE SPECIES

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

A total of 3,468 Siberian prawns were removed from the sample and disposed of in landfills in accordance with the Washington Department of Fish and Wildlife permit requirements this season. Siberian prawns appeared in many of the samples during the later spring and summer, with the last ones found in the samples during the last few weeks of September.

AVIAN PREDATION

Avian Predation-General

Areas of avian predation monitoring included: forebay, turbine discharge, spillway discharge and JFF bypass outfall. Deterrent measures included: bird wires across the tailrace of the powerhouse, water cannon sprinklers at the exit of the bypass outfall pipe, bird deterrent spikes at common perching areas, and hazing (April 1 through June 2) under the animal control contract with United States Department of Agriculture-Wildlife Services (WS). Two shift hazing coverage (daylight to dusk) occurred from May 3 to June 2.

Avian predators tend to rest in the forebay and chase juvenile fish as they jump. They also spend time perched on the lock wall facing the tailrace. At the downstream navigation lock guidewall, bird wires were added along the top rail of the handrail during winter 2008-2009, which effectively reduced the perching previously seen there, however, to a great extent the perching only relocated to the deck in front of the handrails.

The following data is based on bird counts taken in two separate procedures. The first procedure takes place during fish ladder inspections with supplemental counts by WS on days with no ladder inspection. The second procedure is from daily observations of the tailrace area taken of gulls, cormorants, and terns between the hours of 1100 and 1300 each day from April 1 through June 30. Figure 3 shows the daily count of gulls, cormorants, grebes and pelicans in the tailrace from April 1 to September 30.

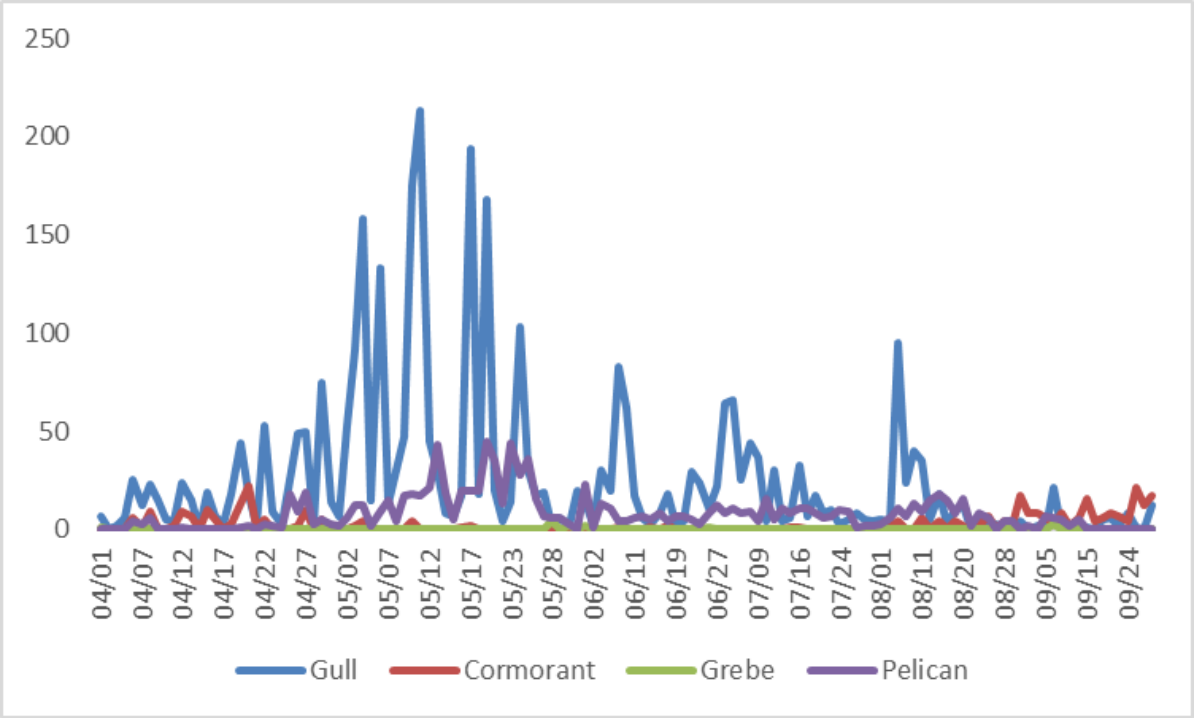

Figure 3. Daily count of gulls, cormorant, grebes and pelicans in the tailrace and forebay, 2021.

Adult Fishway Inspection Bird Counts/Wildlife Services Bird Monitoring

These inspections were conducted at random times and contain counts during active bird hazing as well as in its absence. On Mondays and Thursdays (April 1 through June 2) WS contracted employees collected bird information in the same format as the ladder inspection data and this information was added to the spreadsheet for inclusion in this report. During daylight hours, gulls were present if hazing was not occurring. High juvenile fish numbers passing the dam via spill related to higher gull numbers. In the absence of hazing, gulls appeared to be effective at feeding in the tailrace areas. Each ladder inspection included an avian predator count section for five areas that included: forebay (FB), spillway (SWT1), under the bird wires of the turbine discharge (PHT1), downstream of the bird wires below the turbine discharge (PHT2), and lastly the juvenile bypass outfall (JFOF). Each area included counts of both foraging and resting birds. The following summarizes the data collected from April 1 through October 1 of the 2021 operating year. The averages offered in each category include all data through the period; it is an average of all the Fish Ladder Inspection/WS supplemented Bird Monitoring Inspections for that condition (feeding/resting) in each zone.

Gulls

Gull numbers were highest from April 5 to May 27 with later waves from June 4 to July 23 after the end of hazing efforts and August 6 to 22 after the end of barge transport. In all areas, gull numbers dropped after May 27 as juvenile salmonid numbers became increasingly sparse.

The maximum number of gulls observed in all areas occurred on June 6, with an overall daily average of 6 gulls. The number of gulls feeding in the FB ranged from 0 to 8 (May 3) and averaged <1 while the number of gulls resting in the FB ranged from 0 to 65 (May 11) and averaged 5 gulls. Gulls in the FB are typically seen resting on the navigation lock guide wall. The number of gulls feeding in SWT1 ranged from 0 to 125 (May 17) and averaged 10 while the number of resting gulls in SWT1 ranged from 0 to 20 (April 29) and averaged <1. Gulls in SWT1 are typically seen avoiding the pyrotechnics of the hazers firing over the spillway discharge from the navigation lock deck (elevation 536). The number of gulls feeding in PHT1 ranged from 0 to 60 (July 2) and averaged 2 gulls. Gulls were not observed resting in the PHT1. PHT1 gulls are only typically seen when the hazer is not present. The number of gulls feeding in PHT2 ranged from 0 to 35 (May 11) and averaged 3 gulls while the number of resting gulls in PHT2 ranged from 0 to 36 (June 9) and averaged 1 gull. Gulls in PHT2 are only typically seen when the hazer is not present. The number of feeding gulls at the JFOF ranged from 0 to 23 (May 20) and averaged 1 gull. Gulls were not observed resting at the JFOF. JFOF gulls are typically seen when large numbers of juvenile salmonids are bypassed.

Hazing was effective at moving gulls out of the area. Two shifts were used to provide daylight to dusk coverage throughout the historic peak of salmonid outmigration, Table 20. The second shift of hazing was equally as effective as the morning shift. On days when hazing did not occur, but fish passage numbers were high, the birds returned and resumed normal feeding behaviors. Gull numbers correlated well with the peak of the juvenile fish outmigration this season, as has been the rule in the past. Observers noticed that during higher spring spill volume, large numbers of feeding gulls were seen just below SWT1, so were not included in the tailrace observation numbers. This newly observed feeding location also decreased the effectiveness of hazing efforts.

Cormorants

Overall cormorant abundance was fairly consistent throughout the season. Cormorants tend to be more prevalent in the fall and winter than during juvenile salmonid outmigration. The number of cormorants feeding in the FB ranged from 0 to 8 (April 20) and averaged <1 cormorants while the number of cormorants resting in the FB ranged from 0 to 10 (April 20) and averaged <1 cormorant. Cormorants in the FB are commonly seen foraging and are impervious to hazing. The number of cormorants feeding in SWT1 ranged from 0 to 15 (September 25) and averaged <1 cormorant while the number of resting cormorants in SWT1 ranged from 0 to 4 (April 8) and averaged <1 cormorant. Cormorants in SWT1 are not effectively prevented from foraging by the pyrotechnics of the hazers. The number of cormorants feeding in PHT1 ranged from 0 to 7 (September 15) and averaged <1 cormorant while the number of cormorants resting in PHT1 ranged from 0 to 3 (August 11) and averaged <1 cormorants. Cormorant abundance in PHT1 is erratic and individuals are impervious to hazing. The number of cormorants feeding in PHT2 ranged from 0 to 13 (September 1) and averaged 1 cormorant while the number of resting in PHT2 ranged from 0 to 2 (May 4) and averaged <1 cormorant. Cormorant observations in PHT2 are similar to those in PHT1. The number of cormorants feeding at the JFOF ranged from 0 to 2 (April 27) and averaged <1 cormorant while the number of cormorants resting ranged from 0 to 5 (April 5) and averaged <1 cormorant.

Terns

No tern numbers were observed during piscivorous bird counts conducted during inspections this season.

Grebes

Grebe abundance was highest from May 28 to June 1. The number of grebes feeding in FB ranged from 0 to 4 (May 28) and averaged <1 grebe while no grebes were observed resting in the FB. The number of grebes feeding in SWT1 ranged from 0 to 1 (June 26) and averaged <1 and no grebes were observed resting in SWT1. The number of grebes feeding in PHT1 ranged from 0 to 3 (September 8) and averaged <1 and no grebes were observed resting in PHT1. The number of grebes feeding in PHT2 ranged from 0 to 2 (May 30) and averaged <1 while no grebes were observed resting in PHT2. No grebes were observed at the JFOF and observations in this area are historically rate. Grebes in all zones are frequently underwater and hard to accurately count.

Pelicans

The first pelican was observed on April 5 with the last observation on November 4. The number of pelicans feeding in the FB ranged from 0 to 3 (April 7) and averaged <1 pelican with the number of pelicans resting in the FB ranging from 0 to 10 (April 25) and averaging <1 pelican. Pelicans in the FB are typically seen cruising as a group, generally along the north shoreline. The number of pelicans feeding in SWT1 ranged from 0 to 27 (May 20) and averaged 3 pelicans while the number of pelicans resting in SWT1 ranged from 0 to 8 (May 19 and June 5) and averaged <1 pelican. Pelicans in SWT1 are typically not impacted by WS activities. The number of pelicans feeding in PHT1 ranged from 0 to 19 (May 12) and averaged <1 while the number of pelicans resting in PHT1 ranged from 0 to 13 (August 14) and averaged <1 pelican. The number of pelicans feeding in PHT2 ranged from 0 to 15 (May 26) and averaged 1 pelican while the number of pelicans resting in PHT2 ranged from 0 to 19 (May 23) and averaged 1 pelican. The number of pelicans feeding at the JFOF ranged from 0 to 5 (May 10 and May 20) and averaged <1 pelican while the number of pelicans resting at JFOF ranged from 0 to 2 (May 11, June 19, and July 12) and averaged <1 pelican. Pelicans near the JFOF are typically seen when large numbers of juvenile salmonids are bypassed.

Avian Hazing-United States Department of Agriculture-Wildlife Services

Deck hazers worked eight-hour shifts for seven days a week. Start and end times varied to reduce habituation of birds. Bird hazing efforts by WS personnel began on April 1. The WS hazing program is outlined in Table 20 below.

Table 20. USDA-WS hazing program schedule for Lower Monumental Dam, 2021

Personnel	Days	Dates	Shift
WS Hazer #1	Monday - Friday	4/1/2021 – 6/2/2021	Regular Coverage
WS Hazer #2	Monday - Friday	5/3/2021 – 6/2/2021	Peak Season
WS Hazer #3	Saturday & Sunday	4/1/2021 – 6/2/2021	Regular Coverage
WS Hazer #4	Saturday & Sunday	5/3/2021 – 6/2/2021	Peak Coverage

RECOMMENDATIONS

Install a shear boom across the forebay to direct debris to the spillway during the high flow/high debris period to reduce orifice fouling and associated fish injury.

Research converting the pipe system between the PIT facility counter tanks and the PIT facility holding tank exits with an open system that eliminates the need to hold fish in the PIT system holding tanks.

Remove sand and debris from the supply conduits and replace all original ladder diffuser grates, support structures, and mud valves.

Install ladder exit debris booms capable of withstanding turbulent waters.

Replace staff gauges with fiberglass reinforced plastic staff gauges.

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