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Data Summary of Preliminary Findings: Behavior and Dam Passage of Juvenile Chinook Salmon at Cougar Reservoir and Dam, Oregon, April–September 2014

By John W. Beeman, Hal C. Hansel, Amy C. Hansen, Tyson W. Hatton, Noah S. Adams, Gabriel S. Hansen, Kyle D. Martens, and Collin D. Smith

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Introduction

This document summarizes findings-to-date for studies conducted by USGS at Cougar Dam between April and September of 2014. Although data collection is on-going, these interim results are provided to the COE to assist in the planning process. The studies that generated the data found in this document were conducted to quantify juvenile Chinook salmon behavior near the portable floating fish collector (PFFC) and the water temperature control tower (WTC) to help evaluate the efficacy of the PFFC. Tools used to evaluate the PFFC include acoustic telemetry, acoustic cameras, velocity measurements, and passive (PIT) tags.

Fish Capture, Tagging, and Release

From April 8 to June 19, 2014, we tagged 930 juvenile spring Chinook salmon and released them in Cougar Reservoir near the Slide Creek boat ramp. We tagged 430 hatchery fish with both Juvenile Salmonid Acoustic Telemetry System (JSATS) tags and Passive Integrated Transponder (PIT) tags. These fish were reared at the Fish Performance and Genetics Laboratory in Corvallis, Oregon, and had a mean fork length (FL) of 163.4 mm (range 104.0–180.0 mm). The last group of these hatchery fish was released on May 21, 2014. In addition, we tagged and released four naturally-produced fish (hereafter referred to as "wild") in April that were collected from Cougar Reservoir using a lampera seine (mean FL 114.3 mm, range 104–135 mm) and one naturally-produced fish collected in the PFFC on June 19, 2014 (FL 160 mm). The acoustic tags had an expected life of 150 days. We PIT tagged and released 495 fish on June 4, 2014 (mean FL 77 mm, range 65–93 mm).

Four acoustic/PIT tagged fish were removed from the analysis because the acoustic tag died prior to release (N=1; PFFC fish) or they were thought to be in predators (N=3; hatchery) based on the fish positions in the cul-de-sac. Eight acoustic/PIT tagged fish were not detected in the study area but were included in the analysis as the tags were active at release. These fish may have swum upstream from the release location.

Acoustic Telemetry Detection System

Signals from acoustic transmitters were detected using autonomous and cabled types of JSATS hydrophone systems provided by the US Army Corps of Engineers (USACE). Twelve autonomous nodes were installed in several locations: three downstream of the Slide Creek boat ramp in Cougar Reservoir, four near the log boom at the forebay, two in the tailraces, one in the South Fork McKenzie River near the USGS gaging station (site=14159500), and two at Leaburg Dam forebay. Twenty-eight cabled hydrophones using a common clock and global positioning system were installed near and surrounding the PFFC, and on and inside the water temperature control tower. Data were handled similar to methods in Beeman et al. (2014). The cabled system began collecting data that could be processed for fish position estimates of JSATS tags on May 16, 2014. Prior to this time, no fish position data are available for the spring study season. Data for the dam passage efficiencies were estimated for periods during the PFFC low and high treatment periods (May 27 through September 9, 2014) while data for the reservoir passage efficiencies were estimated from release to the last available PFFC treatment (April 9 through September 9, 2014).

Assigning Dam and PFFC Passage

Passage of acoustic-tagged fish through the PFFC and water temperature control tower (WTC) were determined using presence data from the cabled hydrophones nearest the outlets at Cougar Dam. The date and time of assumed dam passage were assigned if the first detection of the last transmitted message was at any of the hydrophones located on the outlet that were closest to the water outlets. This method was consistent with histories of tagged fish known to have passed the dam based on detections of PIT tags downstream. We estimated four general fish passage metrics (table 1). Ninety-five percent confidence intervals were calculated for these metrics using the Wilson Method.

Table 1. Passage and fish collection efficiency definitions.

["Number" refers to number of tagged fish, PFFC = Portable Floating Fish Collector, WTC = Water Temperature Control Tower. Reservoir passage efficiency was measured from release through September 9, 2014. The DPE, FCE_{PFFC}, and FCE_{WTC} estimates are from data collected from May 27 through September 9, 2014]

Metric	Acronym	Definition
Reservoir passage efficiency	RPE	Number detected at log boom ÷ number released
Dam passage efficiency	DPE	Number passing (WTC + PFFC) ÷ number detected at log boom
Fish collection efficiency PFFC	FCE_{PFFC}	Number passing PFFC ÷ number passing (PFFC + WTC)
Fish collection efficiency WTC	FCE_{WTC}	Number passing WTC ÷ number passing (PFFC + WTC)

PFFC data

The PFFC operating conditions and the PFFC trap catch data were provided by Todd Pierce of the USACE on September 11, 2014. The PFFC operation conditions (percent pump attraction flow, weir height, distance from the water temperature control tower, and reservoir elevation) include treatment blocks #1 to midway through block #8 (May 27–September 9, 2014). We have some unresolved periods in the PFFC operating data where we need additional information from the USACE. These periods were assigned "unknown" in the operation data and omitted from this preliminary analysis. The catch data includes fish that were processed at the PFFC trap from May 28 to September 8, 2014.

Acoustic Doppler Velocimeter

A SonTek Acoustic Doppler Velocimeter (ADV; San Diego, California) was used to measure hydraulic conditions under two operating conditions within and at the opening of the flume at the PFFC. The collected point samples and interpolation between points were used to create three-dimensional representations of velocity magnitude and point vector direction of flow for the volume sampled. Hydraulic profiles of velocity, gradient, and acceleration were also calculated.

PIT interrogator on the Portable Floating Fish Collector

Information from the PIT tag interrogator was manually downloaded on a weekly basis using the USGS Internet connection located on the PFFC. All detection data was uploaded into the PTAGIS database (www.ptagis.org) using the site code CGJ. Tag detection efficiency was calculated using 12 mm SST PIT tags.

Acoustic Cameras

Dual-Frequency Identification Sonar (DIDSON) and Adaptive Resolution Imaging Sonar (ARIS; both Sound Metrics, Bellevue, Washington) acoustic cameras were deployed in front of the PFFC to monitor the behavior of fish near the entrance of the PFFC (fig. 1). Data were collected 24 hours per day, 7 days per week at the PFFC starting on May 30, 2014 to the present. Data collection was interrupted only when equipment malfunctioned or when the cameras were removed for alternative testing at the PFFC.

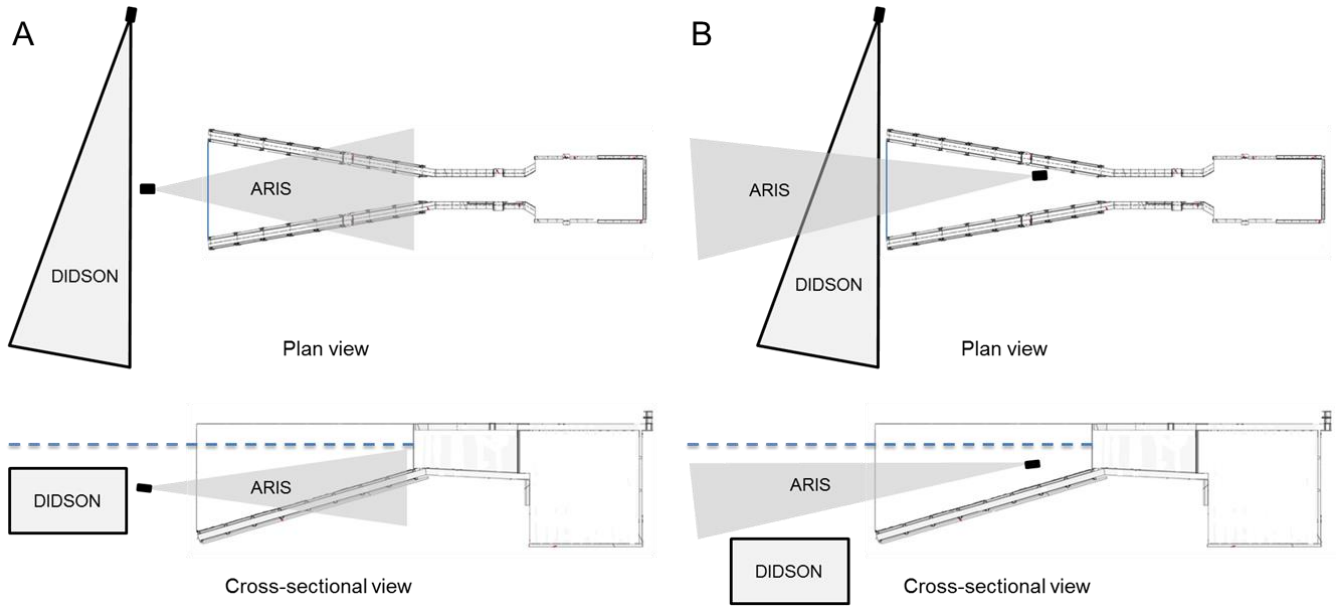

Figure 1. Approximate acoustic camera deployment and sampling locations at the PFFC from May 30 through June 16, 2014 (A) and June 20, 2014 to present (B) at Cougar Reservoir.

Results

Trap operating conditions

The ACOE began operating the PFFC on May 27, 2014. A weir was placed in the throat of the PFFC and the height of the weir was changed based on the operation level of the PFFC to facilitate fish collection at the fish trap. The original "low" operational level used a 60% of pump capacity attraction flow while the "high" level used an attraction flow of 90% of pump capacity. After initial testing and operation, the low operation level was changed to 50% while the high setting was changed to 85% (table 2). The PIT tag interrogator was not operated July 15–24, 2014 due to a battery failure caused by excessive heat in the controller housing. Subsequently, a cooling fan was installed in the controller housing to prevent overheating. The PIT tag interrogator maintained a detection efficiency of over 90%, with a mean of 97.7% (fig. 2).

Table 2. Portable Floating Fish Collector operation data at Cougar Reservoir in 2014.
[Unk= unknown, Na= data were not provided, %=percent]

Start time	End time	Operation level	Block	Reservoir level (feet)	Distance to tower (feet)	Pump attraction flow (%)	Weir height (inches)
5/27/14 11:35	5/28/14 9:41	Low	1	1690	162	60	17.5
5/28/14 9:41	5/28/14 13:30	Low	1	1689	162	60	17.5
5/28/14 13:30	5/30/14 10:30	Unk	1	1689	162	60	17.5
5/30/14 12:01	6/02/14 10:15	Low	1	1689	135	60	17.5
6/2/14 11:01	6/3/14 12:30	Low	1	1690	135	60	17.5
6/3/14 14:01	6/4/14 11:00	High	1	1690	132	90	15.0
6/4/14 14:31	6/5/14 9:20	High	1	1690	Na	90	15.0
6/5/14 10:01	6/6/14 9:53	High	1	1689	Na	90	15.0
6/6/14 11:51	6/9/14 9:50	High	1	1686	144	90	15.0
6/9/14 14:53	6/10/14 10:50	High	1	1685	147	85	15.0
6/10/14 11:57	6/11/14 9:00	High	2	1685	147	85	15.0
6/11/14 9:41	6/13/14 10:00	High	2	1683	150	85	15.0
6/13/14 10:31	6/16/14 10:00	High	2	1681	150	85	15.0
6/16/14 10:46	6/17/14 11:45	High	2	1681	153	85	15.0
6/17/14 12:31	6/18/14 10:15	Low	2	1681	150	50	17.5
6/18/14 10:56	6/19/14 10:05	Low	2	1679	150	50	17.5
6/19/14 10:46	6/19/14 14:15	Low	2	1679	150	50	17.5
6/19/14 14:31	6/20/14 10:45	High	2	1678	156	85	15.0
6/20/14 11:41	6/23/14 14:08	Unk	2	1678	156	50	17.5
6/23/14 15:09	6/24/14 11:37	Low	2	1674	151	50	17.5
6/24/14 12:44	6/25/14 11:20	High	3	1673	156	85	15.0
6/25/14 12:11	6/26/14 9:23	High	3	1672	156	85	15.0
6/26/14 9:36	6/26/14 9:43	High	3	1672	156	85	15.0
6/26/14 10:08	6/30/14 11:47	High	3	1669	162	85	15.0
6/30/14 12:47	7/1/14 10:14	High	3	1668	162	85	15.0
7/1/14 11:09	7/2/14 11:53	Low	3	1668	162	50	17.5
7/2/14 12:31	7/3/14 12:15	Low	3	1668	162	50	17.5
7/3/14 12:48	7/8/14 10:47	Low	3	1667	162	50	17.5
7/8/14 10:48	7/10/14 12:26	High	4	1667	162	85	15.0
7/10/14 12:39	7/14/14 13:00	High	4	1667	162	85	15.0
7/14/14 13:31	7/15/14 10:26	High	4	1665	Na	85	15.0
7/15/14 11:36	7/17/14 10:40	Low	4	Na	162	50	17.5
7/17/14 10:56	7/18/14 12:00	Low	4	1664	162	50	17.5
7/18/14 13:21	7/21/14 11:50	Low	4	1664	162	50	17.5
7/21/14 12:11	7/22/14 12:00	Low	4	1663	153	50	17.5
7/22/14 12:00	7/24/14 14:20	Low	5	1663	153	50	17.5
7/24/14 15:01	7/28/14 13:53	Low	5	1661	156	50	17.5
7/28/14 14:27	7/29/14 10:35	Low	5	1661	156	50	17.5
7/29/14 11:08	7/31/14 14:23	High	5	1661	159	85	15.0
7/31/14 14:59	8/4/14 12:28	High	5	1661	162	85	15.0
8/4/14 12:54	8/5/14 12:00	High	5	1659	153	85	15.0
8/5/14 12:41	8/7/14 12:43	Low	6	1657	159	50	17.5
8/7/14 13:14	8/10/14 20:35	Low	6	1657	159	50	17.5
8/11/14 12:32	8/12/14 12:55	Low	6	1654	153	50	17.5
8/12/14 12:56	8/14/14 10:23	High	6	1653	156	85	15.0
8/14/14 12:11	8/19/14 15:56	High	6	1649	153	85	15.0
8/19/14 16:01	8/21/14 9:20	High	7	1648	153	85	15.0
8/21/14 9:48	8/26/14 10:39	High	7	1646	156	85	15.0
8/26/14 13:01	9/2/14 9:22	Low	7	1646	156	50	17.5
9/2/14 10:31	9/4/14 13:44	High	7	1642	150	85	15.0
9/4/14 13:44	9/8/14 10:30	Unk	7	1642	150	85	15.0
9/8/14 11:21	9/9/14 11:26	High	7	1639	159	85	15.0

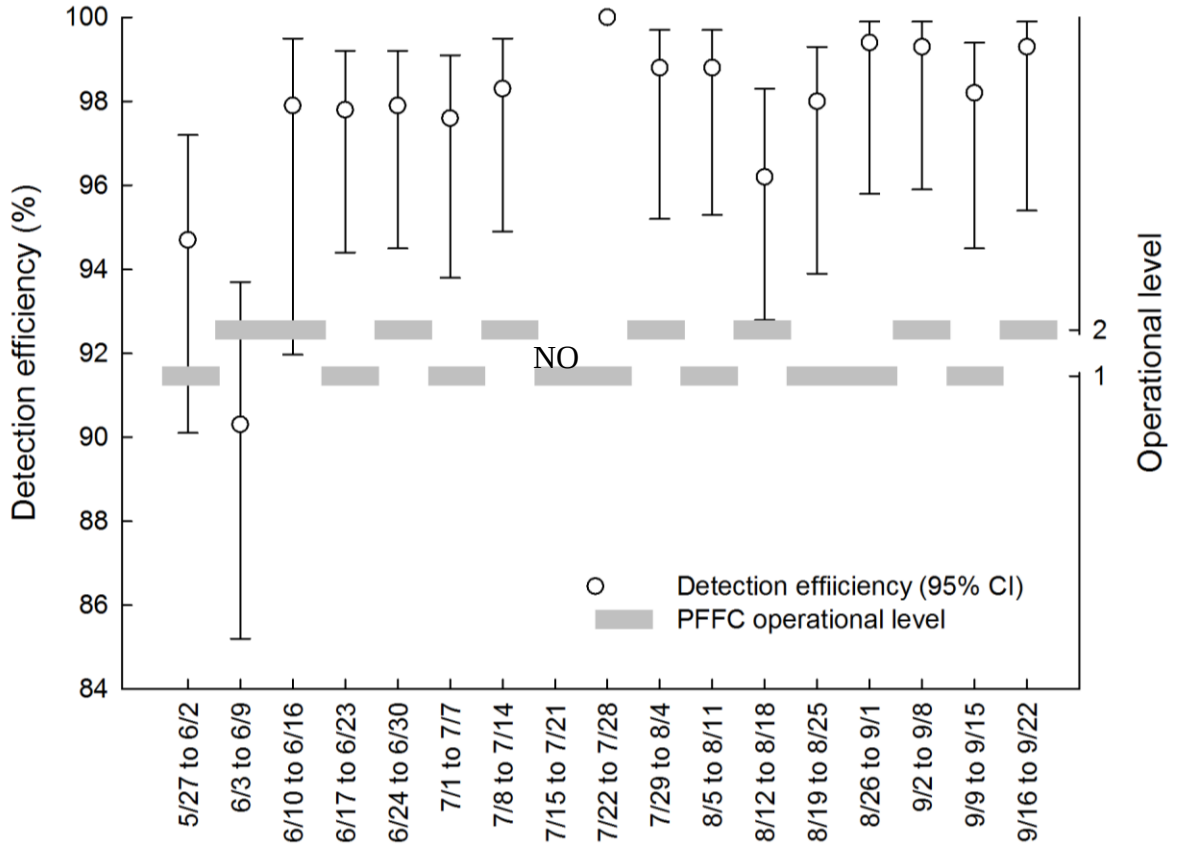

Figure 2. PIT tag detection efficiency for the PIT tag interrogator located on the PFFC at Cougar Reservoir, 2014. NO = PIT tag interrogator was not operating; Operational level 1 = low operation level; Operational level 2 = high operational level. Operational level was based on planned operations.

Acoustic Doppler Velocimeter

The ADV data shows that the inward (downstream) velocities were greater during the high flow treatment than during the low flow treatment, but there were also differences in the gradients and acceleration profiles between the treatments (fig. 3). The velocity increases slightly, but fairly uniformly during the low treatment, but at the high treatment the velocities increase and decrease twice as distance from the entrance increases. There are also subtle differences between the lateral water movement between the port and starboard sides near the opening, which was expected based upon the screen settings.

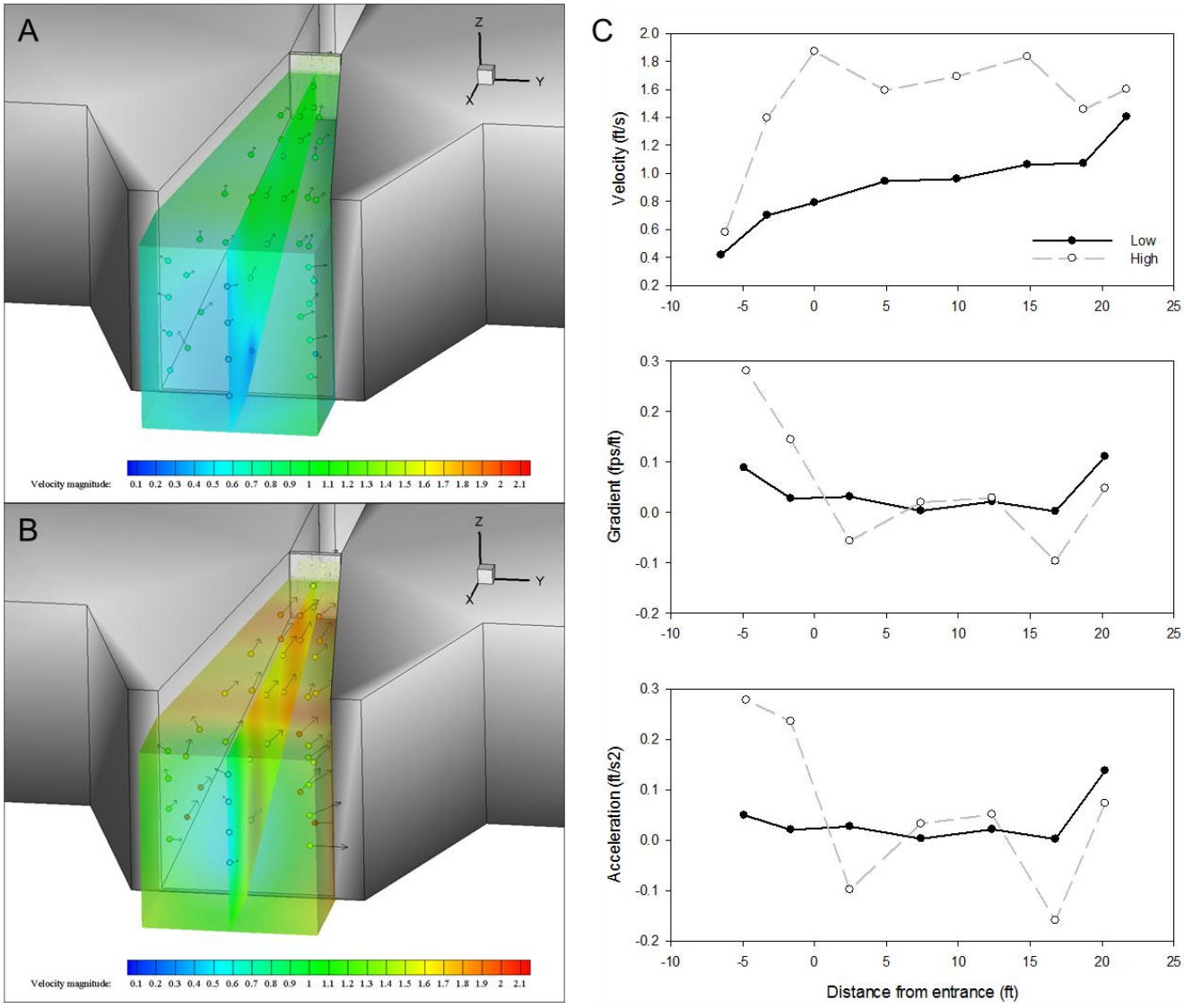

Figure 3. Three dimensional view of interpolated velocity magnitude (ft/s) and velocity vectors for the low flow (attraction pumps at 50%; A) and high flow (attraction pumps at 85%; B) and velocity, gradient, and acceleration profiles (C) for low and high operating conditions of the PFFC at Cougar Reservoir, June 18–20, 2014.

Total trap catch

The PFFC fish trap collected 72 Chinook salmon fry, 19 Chinook parr, and 2 rainbow trout/steelhead parr (fig. 4). The trap collected 260 non-salmonid species mostly comprised of speckled and longnose dace (N = 170) but also included largemouth bass (N = 81), unknown species (N = 6), bluegill (N = 2) and sculpin (N = 1). In addition, five rough skinned newts were collected in the trap. No salmonids were collected in the trap from July 4 through September 2, 2014.

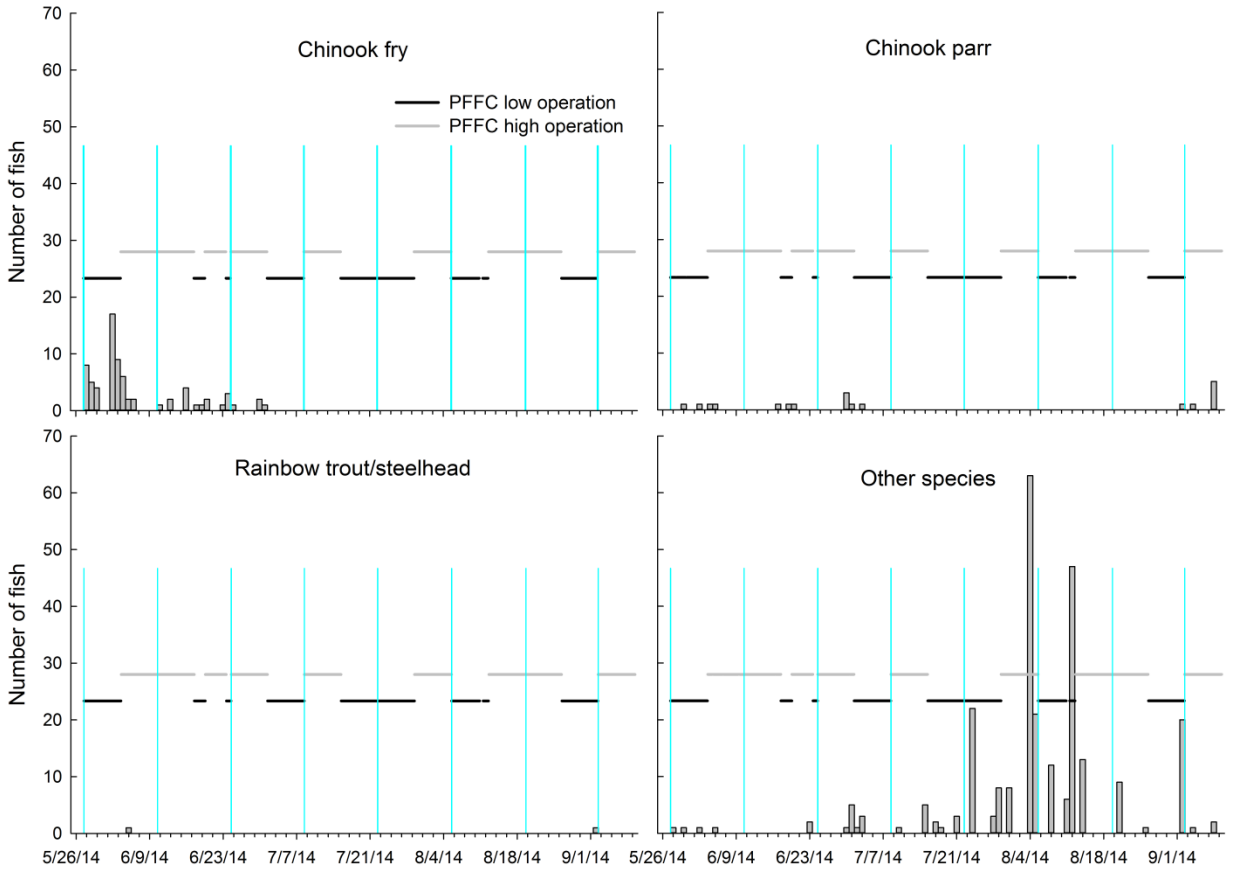

Figure 4. The number of fish collected at the PFFC at Cougar Reservoir during high (black horizontal line) and low operation (gray horizontal line) levels. Other species include: speckled and longnose dace, bluegill, largemouth bass and sculpin. Cyan vertical lines delineate the treatment blocks.

PIT tagged fish

Of the 926 USGS PIT-tagged fish available for analysis, one PIT-tagged (0.2%) and two acoustic/PIT tagged fish (0.5%) were detected at the PFFC PIT tag interrogator. Only one of the acoustic/PIT tagged fish and no PIT-tagged fish was detected at the PFFC PIT tag interrogator and subsequently collected at the fish trap (table 3). In addition to the USGS-tagged fish, three other PIT-tagged fish were detected at the PFFC PIT tag interrogator, and two were collected. Fish detection events were categorized as the total number of unique fish that were detected on the PIT interrogator within each week. Nine fish detection events (five at the low operation and four at the high operation level) were determined from six fish (some fish were detected multiple times) at the PFFC PIT tag interrogator (fig. 5). In all, the six fish made 10 trips (mean=1.6, range 1–4) to the interrogator antenna where trips are defined by a minimum of one hour between detections. Collection efficiency of PIT-tagged fish that were detected at the PFFC interrogator and subsequently collected was 50% (3 of 6).

Table 3. The number and percent of PIT tag detections in the Willamette River Basin from PIT-tagged only and acoustic/PIT-tagged juvenile Chinook salmon. Cougar Dam tailrace sites are screw traps operated by Oregon Department of Fish and Wildlife.

PIT tag detection site	River	Detection type	PIT tag only fish	Acoustic and PIT tag fish
PFFC PIT tag interrogator	SF McKenzie	PIT tag interrogator	1 (0.2%)	2 (0.5%)
PFFC fish collection	SF McKenzie	Recapture	0 (0.0%)	1 (0.2%)
Cougar Dam tailraces	SF McKenzie	Recapture	6 (1.2%)	4 (0.9%)
Leaburg Dam	McKenzie	PIT tag interrogator	21 (4.2%)	3 (0.7%)
Walterville Fish Bypass	McKenzie	PIT tag interrogator	0 (0.0%)	0 (0.0%)
Sullivan Dam	Willamette	PIT tag interrogator	4 (0.8%)	0 (0.0%)

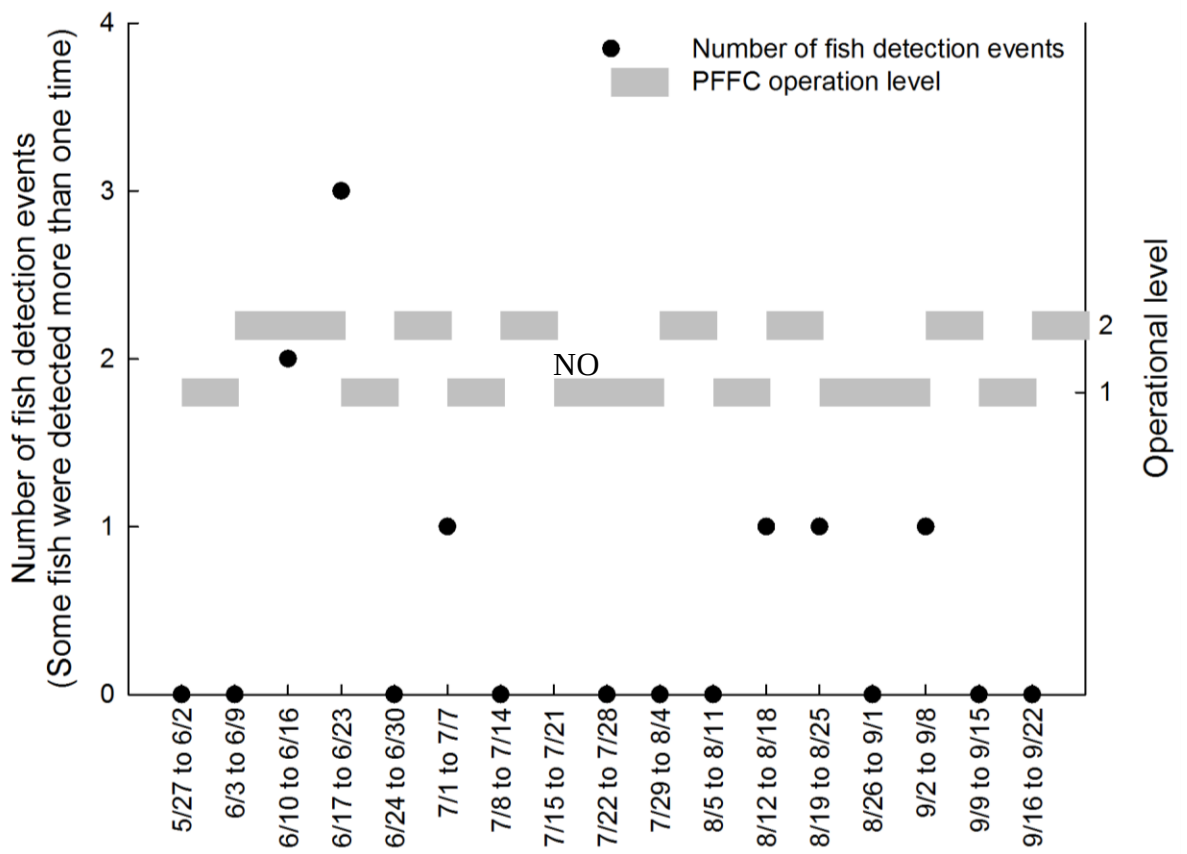

Figure 5. Number of fish detection events at the PIT tag interrogator located on the PFFC at Cougar Reservoir and PFFC operational level in 2014. NO = PIT tag interrogator was not operating; Operational level 1 = Low operation level; Operational level 2 = High operational level. Operational level was based on planned operations.

Data from Acoustic-Tagged Fish

Reservoir and Dam Passage Efficiencies for Acoustic-Tagged Fish

Passage metrics varied by fish origin and PFFC treatment (table 4). Most acoustic-tagged fish were detected at the log boom near the forebay. The RPE was 0.9321 for hatchery fish and 1.000 for wild fish. Passage through the WTC (*N*=40) occurred from April 14 through July 15 and peaked May 10–12, 2014 (*N*=15). Twenty-eight of the hatchery fish and one wild fish passed before the PFFC began operation on May 27, whereas 12 hatchery fish and no wild fish passed during the scheduled PFFC operation up to September 9, 2014. Two hatchery fish that passed the WTC during a period of unknown or off PFFC operating conditions were excluded from this analysis. The one acoustic/PIT-tagged fish collected by the PFFC occurred during the low treatment operation on July 2, 2014. The DPE for fish passing via the combined PFFC and WTC routes were similar during the low and high treatments for both the hatchery and wild fish. The DPE for the hatchery fish during the low and high treatment was 0.0178 and 0.0278, respectively. For the wild fish, the DPE was 0.0000 for both treatments, but only two fish were present in the forebay. For the hatchery fish, the FCE_{PFFC} was greater during the low treatment operation than the high operation, and FCE_{WTC} was greater than the FCE_{PFFC} during both the low and high treatments. However, precision for these estimates were low due to the small sample sizes and confidence intervals for most estimate comparisons overlap greatly.

Table 4. Passage metrics estimates (blocks pooled), standard errors, and lower and upper 95-percent confidence intervals for acoustic-tagged juvenile Chinook salmon at Cougar Dam, Oregon, 2014.
[CI=confidence interval, RPE=reservoir passage efficiency, DPE=dam passage efficiency, FCE=fish collection efficiency, PFFC=Portable Floating Fish Collector, WTC= water temperature control tower. Sample size is the number of tagged fish in the denominator of the estimate]

Fish origin	Treatment	Metric	Sample size	Estimate	Standard Error	95-percent CI Lower	95-percent CI Upper
Hatchery		RPE	427	0.9321	0.0122	0.9082	0.9559
	Low	DPE	225	0.0178	0.0088	0.0069	0.0448
	High	DPE	216	0.0278	0.0112	0.0128	0.0593
	Low	FCE_{PFFC}	4	0.2500	0.2165	0.0456	0.6994
		FCE_{WTC}	4	0.7500	0.2165	0.3006	0.9544
	High	FCE_{PFFC}	6	0.0000	0.0000	0.0000	0.3903
		FCE_{WTC}	6	1.0000	0.0000	0.6097	1.0000
Wild		RPE	4	1.0000	0.0000	0.5101	1.0000
	Low	DPE	2	0.0000	0.0000	0.3332	1.0000
	High	DPE	2	0.0000	0.0000	0.3332	1.0000
	Low	FCE_{PFFC}	Na	Na	Na	Na	Na
		FCE_{WTC}	Na	Na	Na	Na	Na
	High	FCE_{PFFC}	Na	Na	Na	Na	Na
		FCE_{WTC}	Na	Na	Na	Na	Na

Positioned Fish Near the PFFC and WTC

Fish positioned within 100 m of the PFFC entrance and 100 m of the WTC were present in each of the treatments and all blocks (table 5). Overall, 214 fish were positioned within 100 m of the PFFC during treatment blocks 1–7. By treatment block, the number of fish within 20 m of the PFFC entrance ranged from 11 to 176 during the low treatment and from 13 to 199 during the high treatment. The numbers of fish within 3 m of the PFFC entrance ranged from 5 to 65 and from 6 to 87 during the low and high treatments, respectively. During the combined low treatments, 95.2 percent (198 of 208) and 58.6 percent (122 of 208) of the fish positioned within 100 m of the PFFC were also positioned within 20 and 3 m of the PFFC, respectively. Of the fish within 100 m of the PFFC during the combined high treatments, 96.1 percent of fish within 20 m (199 of 207) and 75.8 percent of fish within 3 m (157 of 207) were positioned. Fish positioned within 100 m of the WTC were widely distributed throughout the study area and treatment periods (table 6).

Table 5. Number of acoustic/PIT-tagged fish positioned within 100, 50, 40, 30, 20, 15, 10, 5, and 3 m of the PFFC entrance by block and treatment at Cougar Reservoir in 2014. Number of acoustic/PIT-tagged fish detected on the PFFC PIT interrogator and collected in the trap is also included.

Block	Treat-ment	100 m	50 m	40 m	30 m	20 m	15 m	10 m	5 m	3 m	PIT interrogator	PFFC trap
Overall		214	214	212	210	206	205	202	195	178	2	1
	Low	208	207	206	203	198	193	181	161	122	1	1
	High	207	206	205	203	199	197	191	180	157	1	0
Block 1	Low	196	196	193	188	176	163	148	112	65	0	0
	High	200	197	196	191	178	169	145	125	87	0	0
Block 2	High	178	177	175	167	157	153	137	102	74	0	0
	Low	137	135	133	128	118	107	85	62	41	0	0
Block 3	High	138	133	131	123	117	108	95	75	53	0	0
	Low	97	93	92	90	84	73	62	47	37	1	1
Block 4	High	69	67	67	62	54	48	41	30	17	0	0
	Low	78	78	74	71	59	49	42	23	17	0	0
Block 5	Low	77	75	72	70	66	57	51	40	27	0	0
	High	49	46	45	43	36	31	25	18	16	0	0
Block 6	Low	35	31	30	27	22	20	16	11	8	0	0
	High	35	34	33	31	27	23	18	15	11	1	0
Block 7	High	20	18	17	14	13	12	12	8	6	0	0
	Low	19	17	16	14	11	9	7	5	5	0	0

Table 6. Number of acoustic/PIT-tagged fish positioned within 100, 50, 40, 30, 20, 15, 10, 5, and 3 m of the water temperature control tower (WTC) and fish assigned passage through the WTC by block and treatment at Cougar Reservoir in 2014. Two fish that passed through the WTC during an unknown PFFC operation period and off operation were excluded from this table.

Block	Treat-ment	100 m	50 m	40 m	30 m	20 m	15 m	10 m	5 m	3 m	Passed via WTC
Overall		214	214	214	214	214	214	213	211	211	40
	Low	208	208	208	208	208	208	207	205	204	3
	High	207	207	207	207	207	207	205	203	202	6
Block 1	Low	196	196	196	196	196	196	196	193	189	0
	High	200	200	200	200	200	200	200	195	192	0
Block 2	High	178	178	178	178	178	178	177	169	164	0
	Low	136	136	136	136	136	136	136	136	132	2
Block 3	High	138	138	138	138	138	138	135	131	128	5
	Low	97	97	97	97	97	97	96	90	84	1
Block 4	High	69	69	69	69	69	69	66	61	60	1
	Low	78	78	78	78	78	78	76	71	64	0
Block 5	Low	77	77	77	77	77	77	74	69	62	0
	High	48	48	48	48	48	48	47	40	34	0
Block 6	Low	35	35	35	35	35	35	33	25	19	0
	High	35	35	35	35	35	35	32	28	22	0
Block 7	High	19	19	19	19	19	19	19	15	11	0
	Low	18	18	18	18	18	18	18	15	11	0

Fish generally appear to be widely distributed around the PFFC (fig. 6, 7, and 8). A trend in all of the flood plot figures is a higher residence time for fish between the PFFC and the water temperature control tower. The maximum residence times are found either near the starboard aft of the PFFC or near the left side of the tower (when facing the tower opening). Usually, this seems to coincide with higher fish counts within the 10 m x 10 m cells, represented by the warmer colors of the flood plots.

It is worth noting that the PFFC had only one high treatment during the full pool period in figure 7 - panel A. Additionally, there were only three low treatments during the period when the pool was full, figure 8 - panel A. At the time of data preparation, there are several days during this full pool period that have an unknown treatment and have yet to be reconciled.

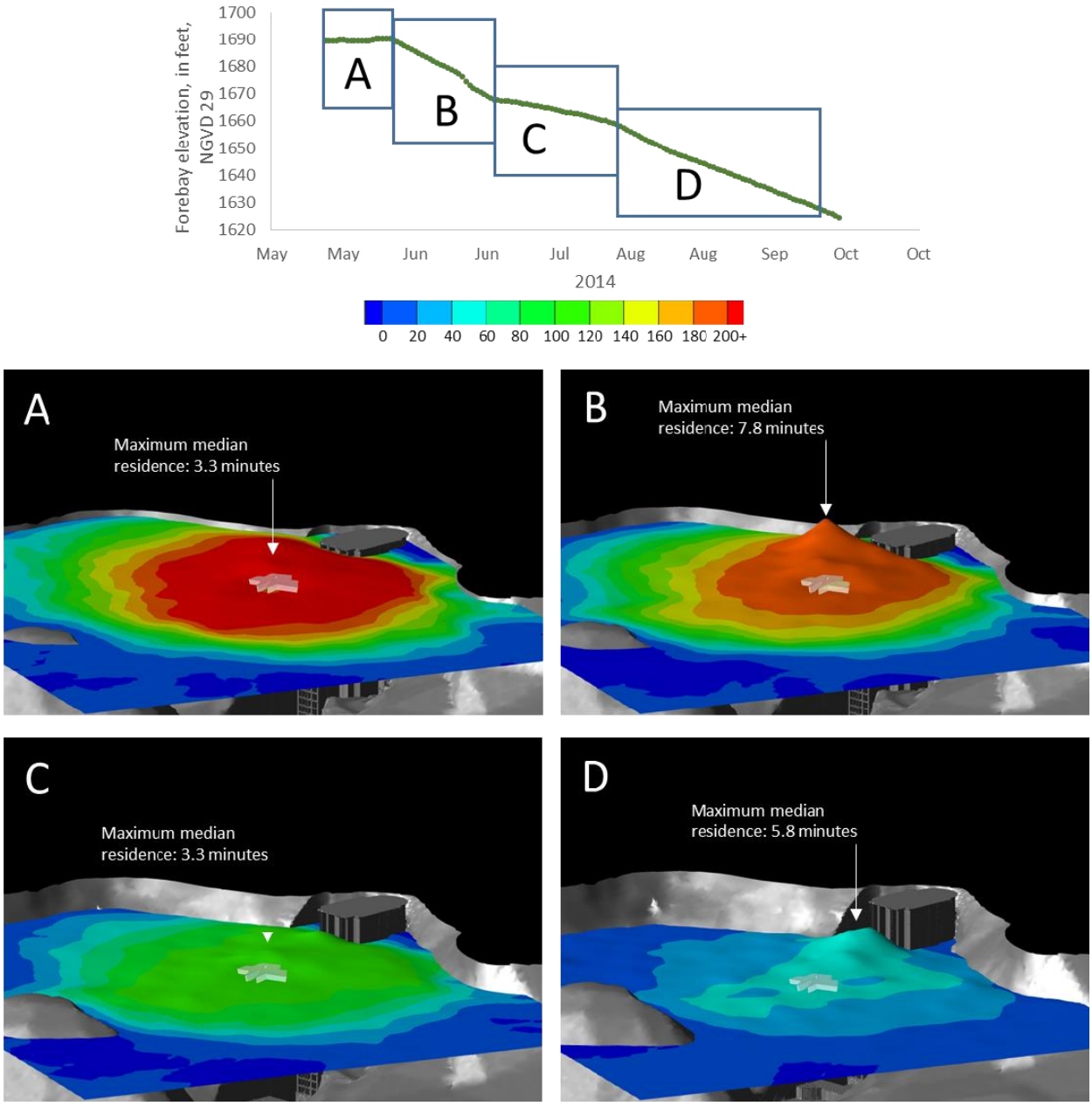

Figure 6. Spatiotemporal density plots of juvenile hatchery and wild Chinook salmon positioned within about 200 m from the water temperature control tower (WTC) during all attraction flow conditions of the Portable Floating Fish Collector (PFFC) from May 16 through October 11, 2014 at Cougar Reservoir. The inset shows the reservoir elevations during full reservoir (A, median elevation 1,689 feet, *N* = 271), the beginning of drawdown (B, median elevation 1,680 feet, *N* = 207), mid-spring season drawdown (C, median elevation 1,664 feet, *N* = 136), and late spring season drawdown (D, median elevation 1,642 feet, *N* = 69) periods. Colors of the interpolated surface indicate the number of tagged fish present and the height of the surface indicates the median cumulative residence time of individual fish based on 10 m x 10 m cells. The representation of the PFFC (near center in flood plots) is an approximation of the actual location during these periods.

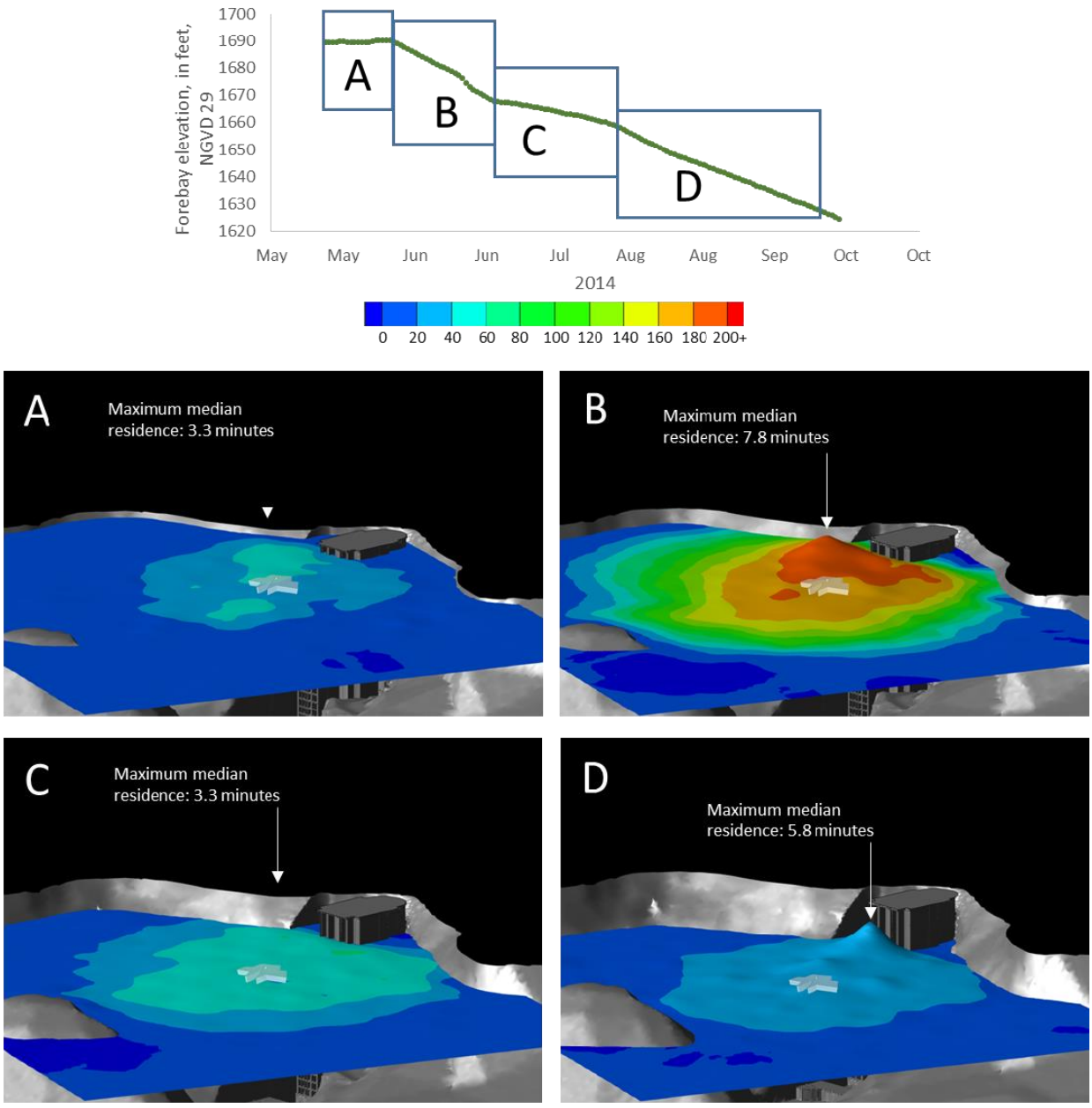

Figure 7. Spatiotemporal density plots of juvenile hatchery and wild Chinook salmon positioned within about 200 m from the water temperature control tower (WTC) during the high attraction flow condition of the Portable Floating Fish Collector (PFFC) during the 2014 spring study period at Cougar Reservoir. The inset shows the reservoir elevations during full reservoir (A, median elevation 1,689 feet, *N* = 127), the beginning of drawdown (B, median elevation 1,680 feet, *N* = 206), mid-spring season drawdown (C, median elevation 1,664 feet, *N* = 93), and late spring season drawdown (D, median elevation 1,642 feet, *N* = 58) periods. Colors of the interpolated surface indicate the number of tagged fish present and the height of the surface indicates the median cumulative residence time of individual fish based on 10 m x 10 m cells. The representation of the PFFC (near center in flood plots) is an approximation of the actual location during these periods.

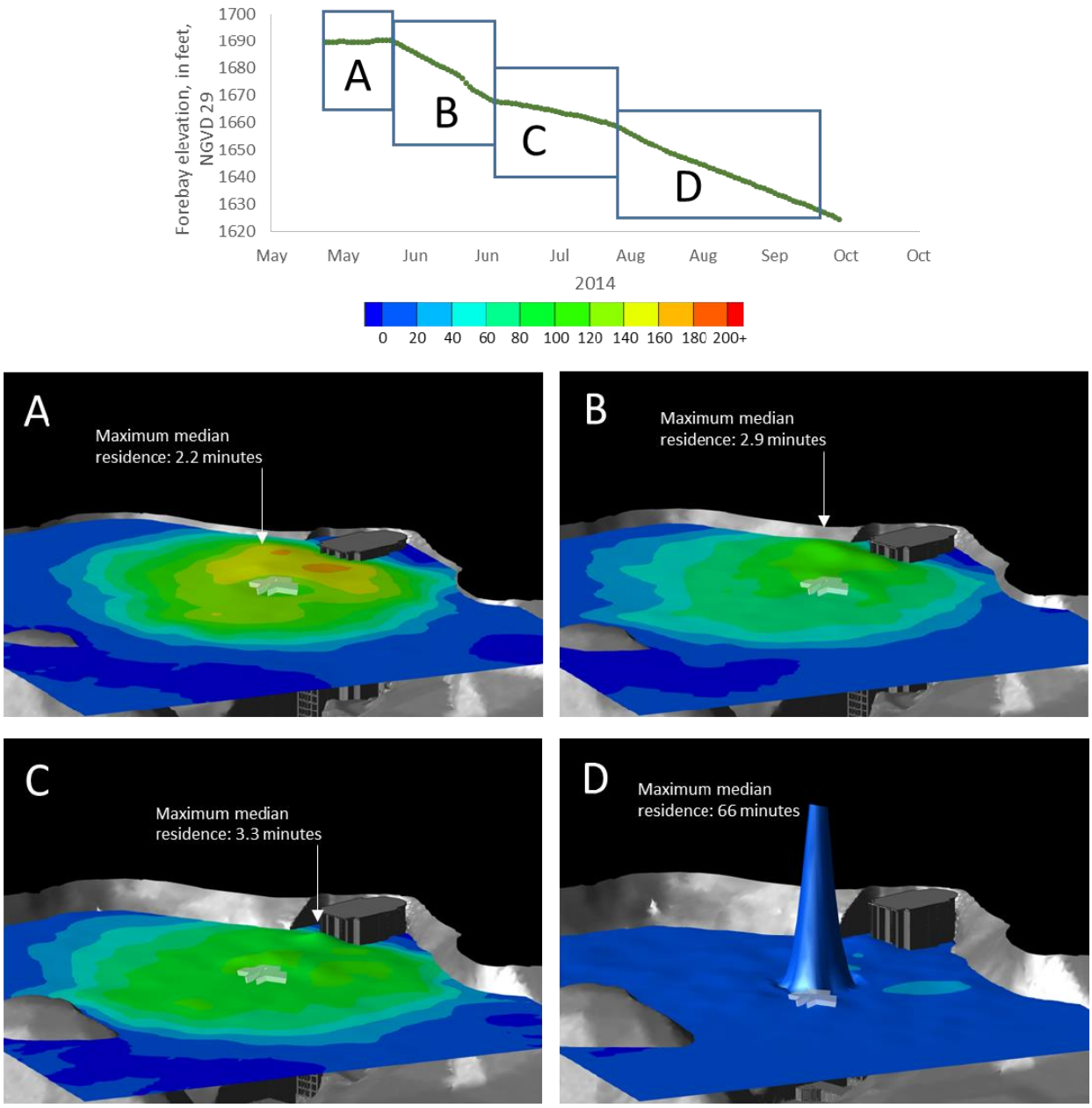

Figure 8. Spatiotemporal density plots of juvenile hatchery and wild Chinook salmon positioned within about 200 m from the water temperature control tower (WTC) during the low attraction flow condition of the Portable Floating Fish Collector (PFFC) during the 2014 spring study period at Cougar Reservoir. The inset shows the reservoir elevations during full reservoir (A, median elevation 1,689 feet, *N* = 196), the beginning of drawdown (B, median elevation 1,680 feet, *N* = 140), mid-spring season drawdown (C, median elevation 1,664 feet, *N* = 130), and late spring season drawdown (D, median elevation 1,642 feet, *N* = 42) periods. Colors of the interpolated surface indicate the number of tagged fish present and the height of the surface indicates the median cumulative residence time of individual fish based on 10 m x 10 m cells. The representation of the PFFC (near center in flood plots) is an approximation of the actual location during these periods.

Acoustic Camera

Preliminary analysis of data collected with the acoustic cameras has identified the presence of fish near the entrance of the PFFC (fig. 9). During the study period, we collected approximately 6,000 hours of data over the 138 days that the cameras have been recording. Acoustic camera data are currently being collected and are simultaneously being processed to remove background acoustic noise from valid target detections. Following processing, manual fish target tracking is implemented to obtain counts and movements of individual fish, along with their associated behavioral and morphometric data. Although laborious, manual tracking ensures that fish targets are accurately determined and that targets from woody debris and noise are excluded from analysis. Presently, DIDSON data from May 30 through October 1 has been completely processed and manually tracked. Due to the extensive time required to process ARIS files, the ARIS data has been processed at a 50% subsampling rate by randomly selecting two 15 minute files within each hour sampled. To date, ARIS data from June 20 through October 1 have been processed and fish target tracking has not yet commenced.

Summary statistics of fish targets derived from manual tracking (e.g., mean length, direction, speed, angle, orientation) will be combined with datasets of dam operations and environmental conditions. Data will be proofed to eliminate non-valid records or records that did not provide measurable morphometric or behavioral data. We will then use statistical modeling of these datasets for each camera type and deployment location to describe the behavior of fish near the entrance of the PFFC (fig. 10).

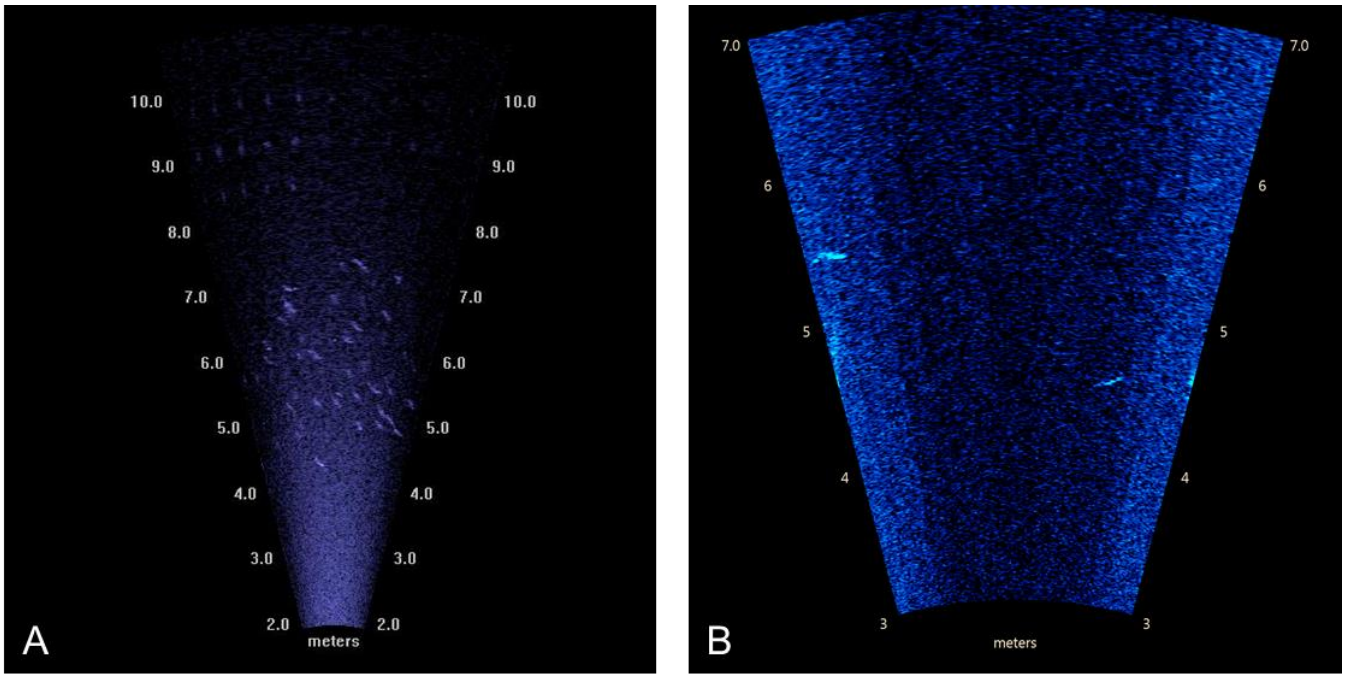

Figure 9. Example images of fish observed using acoustic cameras near the entrance of the PFFC at Cougar Reservoir, 2014. A DIDSON recording of a school of approximately 75 fish with mean target length of ~175 mm (A). Solitary ~80 mm fish followed by a ~230 mm fish observed with the ARIS acoustic camera (B).

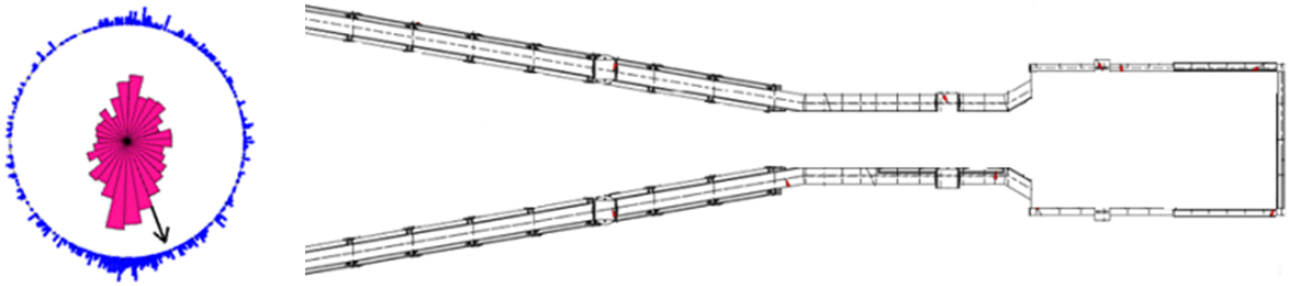

Figure 10. Proposed analysis and graphical representation of directional fish movements using actual measured fish movements (center radial distribution) and model predicted movements (outer distribution) near the entrance of the PFFC at Cougar Reservoir.

References

Beeman, J.W., Hansel, H.C., Hansen, A.C., Evans, S.D., Haner, P.V., Hatton, T.W., Kofoot, E.E., Sprando, J.M., and Smith, C.D., 2014, Behavior and dam passage of juvenile Chinook salmon at Cougar Reservoir and Dam, Oregon, March 2012–February 2013: U.S. Geological Survey Open-File Report 2014-1177, 52 p., *http://dx.doi.org/10.3133/ofr20141177*.