DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

29 September 2023

TO: Alaska Department of Fish and Game

FROM: Colette Brandt, Biologist
Fisheries Program Manager
673 CES/CEIEC
Joint Base Elmendorf-Richardson, AK 99506

Memorandum for Annual Call for Nominations – 2024 Update to Anadromous Waters Catalog (AWC)

The following information is provided to update and add species information and waters to the Anadromous Waters Catalog (AWC) located on Joint Base Elmendorf-Richardson within the Southcentral Region.

Otter Creek (247-50-10110-2010) and Otter Lake (247-50-10110-2010-0010); S014N003W 24, 13, 18; ANCB8. Currently, Otter Creek and Lake are included in the AWC.

1. Requested addition to add Chinook salmon presence to Otter Creek and Lake

   a. Adult migration into Otter Lake is monitored at the lake outlet via a video weir which was operated from 9 June to 27 September in 2022. Visual surveys in the form of canoe surveys were conducted from 3 August to 27 September 2022. The canoe surveys took place every seven (7) to ten (10) days so that best weather days could be selected for surveys. Surveys were conducted along the entire edge of lower Otter Lake, supplemented by brief foot surveys along upper Otter Lake. A total of 18,319 objects were detected moving in either direction through the video weir system from 11 June to 27 September. These objects were classified into the following categories: Sockeye, Coho, Pink, Chum, Chinook, Other Fish Species (including, but not limited to, rainbow trout and Dolly Varden), Debris, Otter, Bear, No Video/Error, and Unknown Salmon. The net total upstream travel of all salmonids through the video weir was 2,300 individuals, with 23 (0.01%) fish categorized as unknown. Of the net upstream total of fish species observed in 2022, coho constituted 2,003 (87.10%), sockeye 263 (11.43%), and pinks seven (7) (0.30%). Finally, preliminary net upstream recordings this season of Chinook totaled three (3) or 0.13%, and net upstream recordings of chum totaled one (1) or 0.04%. Lake spawning surveys were effective at confirming that the salmon are generally spawning in the areas of the lakebed with gravel substrates. These areas are almost all located at the South-Southwest edge of the lake, and after the runs began, salmon were frequently seen kicking up sediment in these areas. No salmon were observed in upper Otter Lake- the body of water consists of primarily all fine sand and thick aquatic vegetation and is exceptionally shallow.

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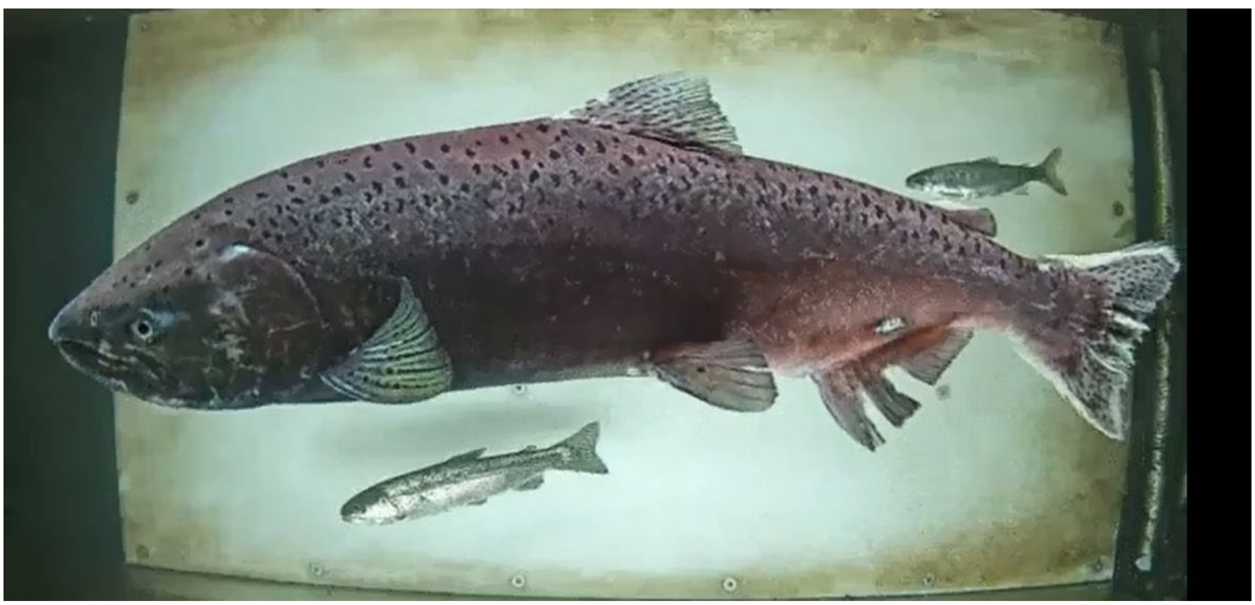
After review of the video weir by the JBER Fisheries Biologist of potential chinooks, it was determined that there were two distinct, possibly three, female chinooks that entered Otter Lake. See images below.

Chinook female upstream on 25 August 2022 at 14:14:17



Chinook female upstream on 26 August 2022 at 02:01:30

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Chinook female and coho male upstream on 8 Sept 2022, at 17:35:38

For questions, please contact the JBER Fisheries Program Manager at (907) 384-3380, or via email at colette.brandt@us.af.mil.

Colette Brandt, GS-12, DAF
Biological Scientist, 673 CES/CEIEC

References:

AERC. 2023. Management, Species, Salmon, Otter Lake Drainage Joint Base Elmendorf-Richardson, Alaska. Prepared for 673 CES/CEIEC, JBER by Applied Environmental Research Center, University of Alaska Anchorage.

MANAGEMENT, SPECIES, SALMON, OTTER LAKE DRAINAGE
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

Final Report

Prepared for:

673d Civil Engineer Squadron, Civil Engineer Installation Management,

Environmental Conservation Section

Prepared by:

Applied Environmental Research Center
University of Alaska Anchorage

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W911KB-22-2-0011

3 April 2023

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Acknowledgements

We would like to thank University of Alaska Anchorage (UAA) Assistant Professor Timothy Miller for assisting with swift water, first aid and other related training for the AERC staff. A thank you as well to our Joint Base Elmendorf-Richardson (JBER) Fisheries Program Manager and point of contact (POC), Colette Brandt for her continued support throughout the project.

List of Contributors

The project team for the 2022 Sixmile System Salmon Monitoring project included the following: Research Principal Investigator and Applied Environmental Research Center (AERC) Director, Jeff Libby; Alaska Biological Resources Incorporated (ABR), John Seigle; Institutional Animal Care and Use Committee (IACUC) project lead, Jonathan Stecyk; UAA Community and Technical College (CTC), Welding Department Chair, Professor, Greg Russo, AERC Project Manager, Cameron Wilson; AERC Research Technicians, Natasha Chenot, Alta Dean, Samuel Franklin, Jacob Hart, Connor Keesecker, and Kori Orion; AERC Field Participants, Jessica Byrd, Danny Casner, Dan Fenton, D'Lynn Gleason, Samantha Golden, Ashley Hearn, Caitlin Kollander, Blake Meador, Cloda O'Neill, Alexa Todd, and Mark Wing.

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Executive Summary

Salmon are a critical environmental, economic, and cultural resource for Alaska. National programs such as the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), seek to ensure conservation, facilitate long-term protection of essential fish habitats, prevent overfishing, rebuild overfished stocks, and to realize the full potential of U.S. fishery resources (National Oceanic and Atmospheric Administration [NOAA], 2007). According to the Joint Base Elmendorf-Richardson Integrated Natural Resources Management Plan (INRMP) in 2021, the water systems and streams on the installation are spawning habitat to all five (5) species of Pacific salmon. When the Cook Inlet Beluga Whale (CIBW) was listed as endangered under the Endangered Species Act (ESA) by the National Marine Fisheries Service (NMFS) in 2008, four (4) out of the five (5) species of Pacific salmon were listed collectively as a primary constituent element (PCE) to the whales' conservation.

The Otter Creek watershed, located within the JBER boundaries is a tributary of Eagle River, and all five (5) species of Pacific salmon have been observed in the creek. Stream walks of the creek and canoe surveys of the lake, work in conjunction with a remote camera and fish counter, the Vaki Riverwatcher. The Riverwatcher was implemented in 2020 by the University of Alaska (UAA) Applied Environmental Research Center (AERC) as a method of accurately identifying and enumerating salmon as they move through Otter Creek into Otter Lake, and remains in use today. The unit records between 15,000 and 20,000 unique instances of objects moving through the creek between June and September annually, many of them being adult salmon migrating through, and spawning in, the watershed. The estimated net total of salmon remaining upstream of the Riverwatcher in 2022 is 2,300 individuals, primarily coho salmon

1.0 Introduction

Salmon are a critical environmental, economic, and cultural resource for Alaska. National programs such as the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), seek to ensure conservation, facilitate long-term protection of essential fish habitats, prevent overfishing, rebuild overfished stocks, and to realize the full potential of U.S. fishery resources (NOAA, 2007). Joint Base Elmendorf-Richardson water systems and streams are spawning habitat to all five (5) species of Pacific salmon (JBER INRMP, 2021).

In 2010, JBER and the Alaska Department of Fish and Game (ADF&G) initiated the Otter Lake and Creek restoration project with the specific goal of restoring Otter Lake and Creek back to a healthy anadromous system. The aim of this restoration is to encourage sockeye and coho salmon to return and spawn in the system. The project was designed to treat Otter Lake and Creek with rotenone to remove northern pike *(Esox lucius*), remove obstructions to salmon passage, and reintroduce salmon into the entire system. By working to restore an anadromous salmon run in the Otter Lake system, ADF&G and JBER personnel envisioned an indirect benefit to the Cook Inlet Beluga Whale (CIBW) (*Delphinapterus leucas*) as Pacific salmon have been found to be a vital CIBW prey species (Quakenbush et al., 2015). When the CIBW was listed as endangered under the Endangered Species Act (ESA) by the National Marine Fisheries Service (NMFS) in 2008, four out of the five species of Pacific salmon were listed collectively as a PCE to their conservation: Chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), chum salmon (*O. keta*), and coho salmon (*O. kisutch*) (U.S. Army Corps of Engineers, Alaska District [USACE], 2013).

The UAA AERC was contracted by JBER in an effort to assess the effectiveness of restoration activities to monitor adult salmon escapement into Otter Lake, and in the future salmon smolt outmigration. In past years, surveys have been conducted through Otter Creek stream walks during the salmon spawning season. Because of the new placement of the Vaki Riverwatcher in Otter Creek, lake spawning surveys were used in lieu of stream walks. The lake surveys were supplemented by autonomous fish counting capabilities of the Riverwatcher to continuously monitor salmon escapement into Otter Lake. JBER biologists have determined that both methods are necessary to most accurately assess salmonid escapement into Otter Lake.

1.1 Background

The Otter Creek watershed is a tributary of Eagle River, located within the JBER boundary. Otter Lake covers approximately 150 acres and connects to Eagle River via Otter Creek before flowing into Cook Inlet. Otter Creek connects to the lake's northern side, flowing north and northwest approximately 0.65 miles to the Eagle River flats. Otter Lake is an important recreational area serving military personnel. The military recreational development infrastructure has been maintained since the 1950s and consists of a dock, watercraft rental facilities, several cabins, picnic areas, chalet, and parking areas.

Pacific salmon have historically used Otter Creek to migrate into Otter Lake and have been observed as early as 1978 (JBER INRMP, 2021). In the 1960s, a series of beaver dams were observed downstream of the lake and were theorized to impede adult salmon movement through the creek and into the lake. Salmon that were able to bypass the beaver dams and move upstream encountered two (2) additional obstructions: 1) a culvert conveying Otter Creek beneath the Otter Lake Road which had insufficient flow for salmon passage; and 2), a concrete weir that blocked salmon passage at the lake outlet. ADF&G stocked Otter Lake with rainbow trout (*O. mykiss*) until 2006, causing the lake to function as a robust recreational fishing site for trout until the illegal introduction of northern pike around the year 2000 (POA, 2011).

Baseline data on fish presence were collected at Otter Creek and Otter Lake during the summers of 2011 through 2013. The restoration project was implemented from 2015 through 2017. Otter Lake and Otter Creek were treated with rotenone in 2015 to exterminate northern pike (Dunker, 2015). A portion of Otter Creek at the lake outlet was then re-routed to remove the concrete weir and the culvert beneath Otter Lake Road was replaced for fish passage. Rainbow trout stocking resumed in 2016 after the successful rotenone effort and is once again a thriving recreational trout fishery. Following the restoration activities, coho salmon were observed in the fall of 2017 during the first year of initial salmon monitoring after restoration activities were completed. These observations, conducted by stream walks and temporary camera at lake outlet, suggested that the initial habitat restoration efforts to support anadromous salmonids had been successful. Juvenile salmonids now appear to use the lake and majority of the creek as rearing habitat, including tidally influenced reaches downstream, and the upstream sessions adjacent to beaver dams (JBER INRMP, 2021).

1.1.1 Goals and Objectives

The goal of this project is to continue to monitor the effectiveness of the stream and lake outlet restoration activities, as well as monitoring the continued establishment of salmon in Otter Lake and Creek. This includes monitoring activities aimed at quantifying the presence of anadromous salmonids using canoe surveys to observe salmon in Otter Lake. The 2022 season also continued the monitoring protocol developed in 2020, using the automated optical monitoring equipment, the Vaki Riverwatcher, to record salmonids entering Otter Lake.

Objectives for this project are as follows:

- Deploy the Vaki Riverwatcher camera monitoring system, weir materials, and associated equipment in Otter Creek to enumerate adult salmon escapement;
- Estimate an annual abundance of salmon escapement by species into Otter Lake;
- Monitor and assess long term trends;
- Determine run timing of salmonids in Otter Creek and Lake;
- Identify the distribution of spawning habitat(s) in Otter Lake, and;
- Provide data that will support future management decisions.

2.0 Methods

2.1 Vaki Riverwatcher

During the 2022 field season, the UAA AERC team installed a Vaki Riverwatcher fish counting device just upstream of the culvert passing under Otter Lake Road, just east of the recreational area (Figure 1). The Riverwatcher is configured with object-detecting panels placed on each side of the unit's enclosed channel. The unit is also equipped with an underwater camera, with both visible and infrared lighting to allow for video recording as objects pass within the enclosed channel. The arrangement of the weir panels and Riverwatcher forces migrating fish to pass in front of the object-detecting panels before continuing upstream. These panels have two (2) sets of vertically oriented infrared light beams, each with 96 diodes arranged in a linear pattern. As objects interfere with any given light beam, sensors record the interference and provide a date/time stamp, the direction of movement, and the general shape and size of the object as it moves through the enclosed channel. Additionally, when sensors are activated, the Riverwatcher records a video clip of the area immediately preceding the panel, enabling visual identification of the fish or object by technicians. These video recordings and object sizes/shapes can assist data reviewers in identifying fish species and length. The videos are then reviewed using the Winari application, which allows for time, date, and length to be calculated for the objects passing through the unit.

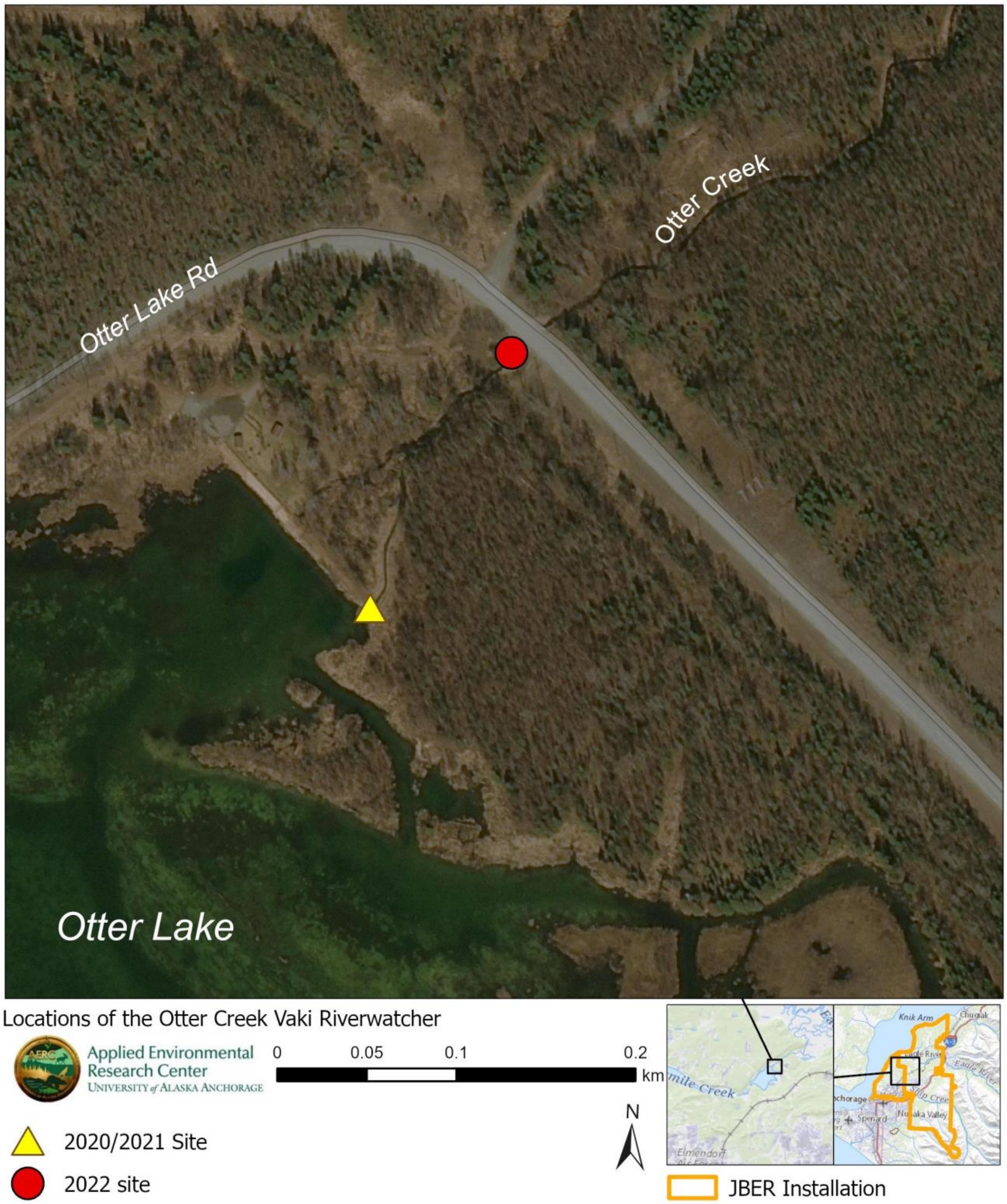

Figure 1. Vaki Riverwatcher locations on Otter Creek in 2020/2021 and 2022.

Once the Vaki Riverwatcher was in position near the culvert, picket weir panels were put on either side of the device, pointing downstream toward shore to funnel fish through the enclosed channel. The panels, developed by the UAA AERC and the UAA Community and Technical College for the 2021 field season, are an improvement over the previously used wire fencing. The new design has higher integrity and easily adapted to the unevenness of the substrate of the creek bottom (Figure 2). An internal computer box and supplemental power equipment were installed in a locked Knaack Box onshore nearby. The Riverwatcher system received alternating current (AC) power provided from an inverter connected to four (4) parallel deep-cycle 12-volt (V) batteries. A 200-watt solar panel array with an automatic charge controller assembly provided supplemental power to the batteries. A schematic of battery and solar panel wiring is provided in Figure 3. A second set of four (4) 12 V batteries was retained in the laboratory on a trickle-charger so that fully charged batteries were always available in the case of insufficient solar charge in the field.

Figure 2. Vaki Riverwatcher Installation. AERC, 2022

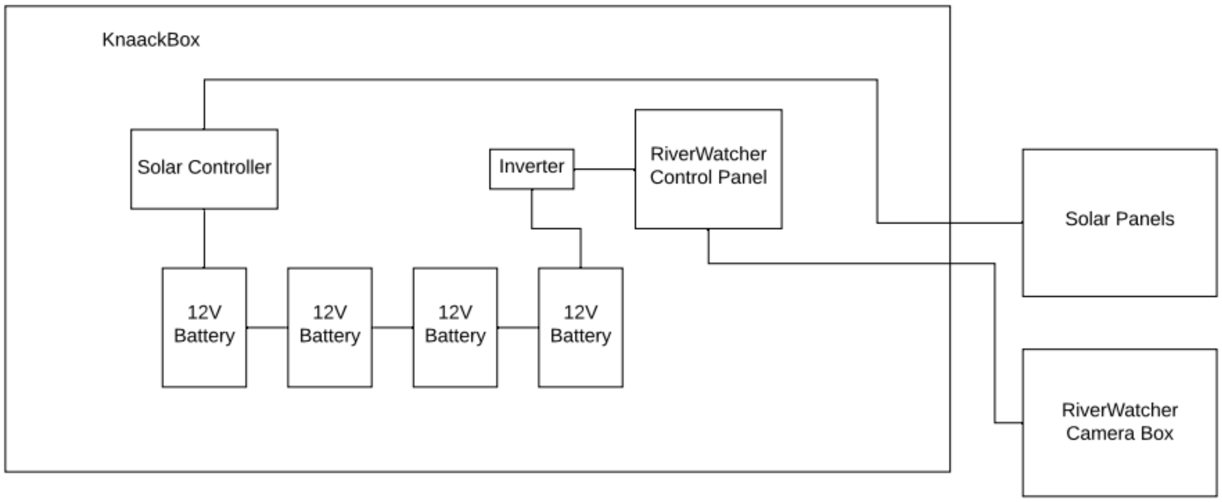

Figure 3. Schematic of the Vaki Riverwatcher setup. AERC, 2022.

The Riverwatcher operated from 9 June to 27 September 2022. The setup was checked daily for adequate voltage in the batteries, proper visibility and recording conditions on the PC, and for any disturbances to the weir. Batteries were swapped if the voltage was below 12.15 mid-season, and below 12.20 late season to ensure data continuity. Sensors and the viewing glass in front of the camera were cleaned on a daily basis. Once adult salmon were observed in Otter Creek, data was downloaded weekly from the PC for data review.

After converting to 110 V AC, the system pulled a measured 0.43 amps of current while the viewing lights were turned on. This equates to approximately 5 amps drawn from the batteries assuming an 80% inverting efficiency. The usable storage capacity of the four batteries is 320 amp-hours, or only 64 hours of runtime. If there is enough sunlight during the day to illuminate the submerged enclosure for the video, the viewing lights can be turned off, halving the power consumption. Solar panels provided supplemental power, further increasing the runtime of the batteries.

2.2 Otter Lake Spawning Surveys

Visual surveys in the form of canoe surveys were conducted from 3 August to 27 September 2022. The canoe surveys took place every seven (7) to ten (10) days so that best weather days could be selected for surveys. Surveys were conducted along the entire edge of lower Otter Lake, supplemented by brief foot surveys along upper Otter Lake. When beginning a survey, the time, date, observer initials, and weather conditions were recorded on a data sheet. Canoes were paddled around the entire shoreline of lower Otter Lake, approximately ten (10) meters from the edge. When salmon were visually observed, the canoes were stopped for five (5) minutes to record behaviors and the approximate number of individuals present. Behaviors were classified under one or more of the following: Fish digging (1); Female on redd (2); Female defending (3); Deteriorating female (4); Male and female on redd (5); Female circling (6); Eggs present (7), and; other wildlife or fish species at site (8).

3.0 Analysis

Riverwatcher data was processed in Winari and broken out into the following categories: Sockeye, Coho, Pink, Chum, Chinook, Other Fish Species (including, but not limited to, rainbow trout and Dolly Varden), Debris, Otter, Bear, No Video/Error, and Unknown Salmon. All objects that move through the Riverwatcher are marked as "Generic" by default, and marked as either upstream or downstream based on the direction they moved through the scanner plates. Silhouettes of fish that did not appear in any accompanying video clips could not be identified by species and were therefore marked as "No Video/Error"- an example of this can be found in Appendix A. Fish confirmed as salmon observed moving through the scanner plates in a video clip, that were not automatically marked by the system, were manually added to the counter. If fish with specific identifiers were noted having gone one direction through the scanner, and going through a second time without having been marked going the opposing direction, they were added to the counter going in the opposite direction in order to maintain accuracy of total fish counts. Fish that were marked as "Unknown" were typically difficult to identify precocial salmon, or due to not enough light in the unit for positive ID. Footage of salmon that were not easily speciated was reviewed a second time by technicians.

Events marked as Debris, Otter, or Bear were removed from the analysis. Error rates due to both the unit not recording video, and because of adding entries due to stacking or missing fish, were additionally calculated.

A length index for coho and sockeye was generated, excluding all added entries, as they do not have a proper calculated length from the Riverwatcher. The unit selects the previous entry as its metric for length, which is correlated to a different fish measured by the scanner, and is thus not accurate.

4.0 Results

4.1 Vaki Riverwatcher

A total of 18,319 objects were detected moving in either direction through the Vaki Riverwatcher system from 11 June to 27 September. These objects were classified into the following categories: Sockeye, Coho, Pink, Chum, Chinook, Other Fish Species (including, but not limited to, rainbow trout and Dolly Varden), Debris, Otter, Bear, No Video/Error, and Unknown Salmon. The total number of objects that passed through the Riverwatcher, including their direction of travel, is summarized in Table 1 and Figure 4. The majority of salmon species observed were coho (n = 12,053 or 87.04%). Sockeye were the second most numerous species observed (n = 1,419 or 10.25%). Occurrences of pink salmon were minimal, with only 29 observations made (0.002%). Potential observations of Chinook (preliminarily n = 31 or 0.002%, still under review) and Chum salmon (one [1] or < 0.001%), were recorded in Otter Creek during the 2022 season; both these species also had very low percent of occurrence . Including all fish, other fish species accounted for nearly one quarter of all observations made (3,618 or 20.71%). In addition to the fish species identified, land mammal activity was also observed in the Riverwatcher recorded data clips, such as otter and bear.

The Riverwatcher data was reviewed for the upstream and downstream salmon movement into Otter Lake. These movement numbers are estimates due to the possibility of salmon traveling in and out of Otter Lake resulting in a double count of fish. To understand how many salmon are entering Otter Lake, the net total escapement was calculated by removing fish who were traveling downstream from the total of fish moving upstream. The net total upstream travel of all salmonids through the Riverwatcher was 2,300 individuals, with 23 (0.01%) fish categorized as unknown. Of the net upstream total of fish species observed in 2022, coho constituted 2,003 (87.10%), sockeye 263 (11.43%), and pinks seven (7) (0.30%). Finally, preliminary net upstream recordings this season of Chinook totaled three (3) or 0.13%, and net upstream recordings of chum totaled one (1) or 0.04% (Figure 5). Once the preliminary Chinook observations are reviewed, data will be updated via corresponding memo by the JBER Fisheries Biologist.

Table 1. Number of objects that passed through the Riverwatcher during the 2022 field season, sorted by identification and direction of travel. JBER, Alaska.

Direction	Salmon							Other Fish Spp.	Otter / Bear	Debris
	Chinook[1]	Coho	Sockeye	Chum	Pink	Unk.	All	—	—	—
Upstream	17	7,028	841	1	18	169	8,074	2,202	2 / 0	363
Downstream	14	5,025	578	0	11	146	5,774	1,416	1 / 1	486
Cumulative Total Travel	31	12,053	1,419	1	29	315	13,848	3,618	4	849
Net Total Upstream Travel	3	2,003	263	1	7	23	2,300	786	—	—

[1]*Chinook numbers are preliminary and currently under review by the JBER Fisheries Biologist. Once finalized, numbers will be updated via corresponding memo.*

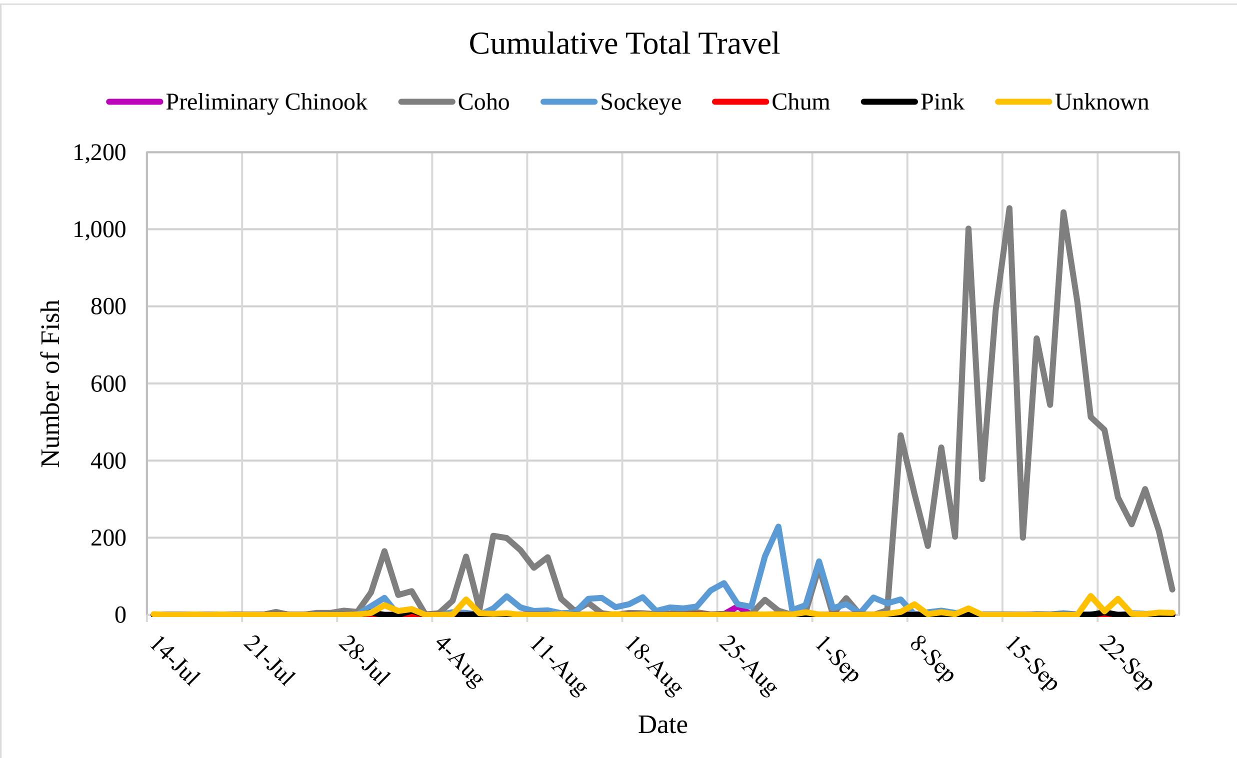

Figure 4. Combined upstream and downstream cumulative counts from the Riverwatcher (Chinook counts under review). JBER, Alaska, 2022.

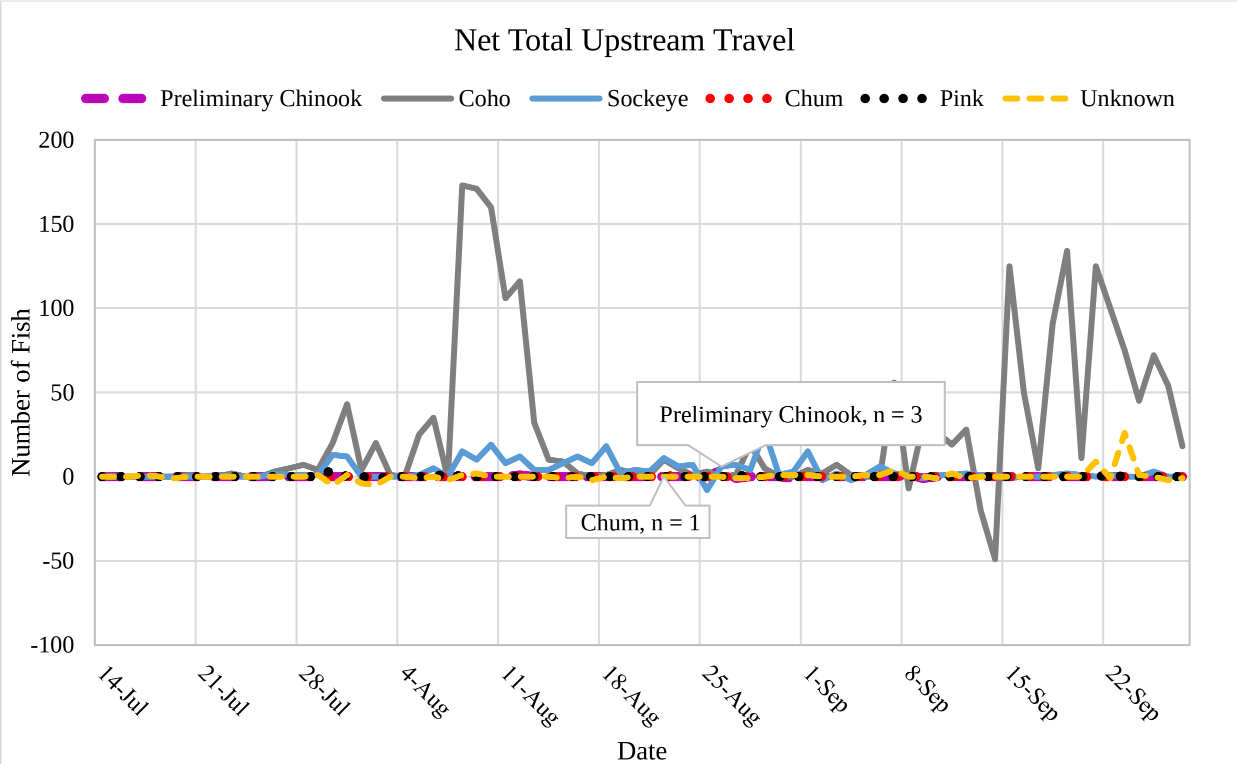

Figure 5. Upstream minus downstream travel from the Riverwatcher (Chinook counts under review). JBER, Alaska, 2022.

Coho had the highest number of observed net total upstream movement (upstream subtracted by downstream) with a first observation on 22 July 2022. By 1 September, 50% of coho total net upstream travel had taken place and 95% by 25 September (Figure 6). Sockeye were first observed on 20 July 2021. By 1 September, 50% of the sockeye net total upstream travel had taken place and 95% by 28 September (Figure 7). Pink were first observed on 30 July, with 50% of net total upstream by 30 July and 95% by 22 September (Figure 8). Chinook were first preliminarily observed on 12 August, with 50% of net total upstream by 26 August and 95% by 8 September. The single observation of chum occurred on 23 August.

Further comparing salmon species observed in both 2021 and 2022, peak movement of coho in 2022 occurred on 8 August with 173 individuals counted traveling upstream. In 2021, peak upstream travel occurred on 27 August, with 106 coho. The 2022 upstream peak for coho occurred 19 days earlier than in 2021, with a 38.7% count increase. The highest downstream activity for coho in 2022 occurred on 14 September with 49 individuals; in 2021, the highest downstream count was 72 on 19 September (Figure 9). The peak upstream movement of sockeye in 2022 occurred on 29 August, with 27 individuals counted. In 2021, peak upstream travel occurred on 10 August, with of 57 fish. The 2022 peak for sockeye occurred 17 days later than in 2021, with a 47.4% count decrease. The highest downstream movement for sockeye in 2022 occurred on 25 August with eight (8) individuals, while in 2021 the highest downstream count was 35 on 15 September (Figure 10). The peak upstream movement of pink salmon in 2022 occurred on 30 July, with four (4) individuals counted. In 2021, peak upstream travel occurred on 13 August, with five (5) fish observed. The 2022 peak occurred 14 days earlier than in 2021. The number of pinks observed between years was comparable (Figure 11).

Table 2. 2022 vs. 2021 net upstream observations of salmon from the Vaki Riverwatcher.

Salmon Upstream Travel Summary	Chinook[1]		Coho		Sockeye		Chum		Pink	
	Date	Count	Date	Count	Date	Count	Date	Count	Date	Count
2022 Peak Migration	26-Aug	4	8-Aug	173	29-Aug	27	23-Aug	1	30-Jul	4
2021 Peak Migration	—	—	27-Aug	106	10-Aug	57	—	—	13-Aug	5
2022 - 50%	26-Aug	1.5	1-Sep	1,001.50	1-Sep	65.75	23-Aug	1	30-Jul	3.5
2021 - 50%	—	—	3-Sep	540.00	3-Sep	356.50	—	—	7-Sep	9
2022 - 95%	8-Sep	2.85	25-Sep	1,902.85	25-Sep	249.85	23-Aug	1	22-Sep	6.65
2021 - 95%	—	—	28-Sep	1,026.00	28-Sep	677.35	—	—	11-Sep	17.1
2022 Total	—	3	—	2003	—	263	—	1	—	7
2022 1st Observation	26-Aug	1	20-Jul	1	20-Jul	1	23-Aug	1	30-Jul	4
2021 1st Observation	—	—	26-Jun	1	10-Jul	1	—	—	13-Aug	4

[1]*Chinook numbers are currently preliminary and under review. Dates may change once Chinook numbers are finalized.*

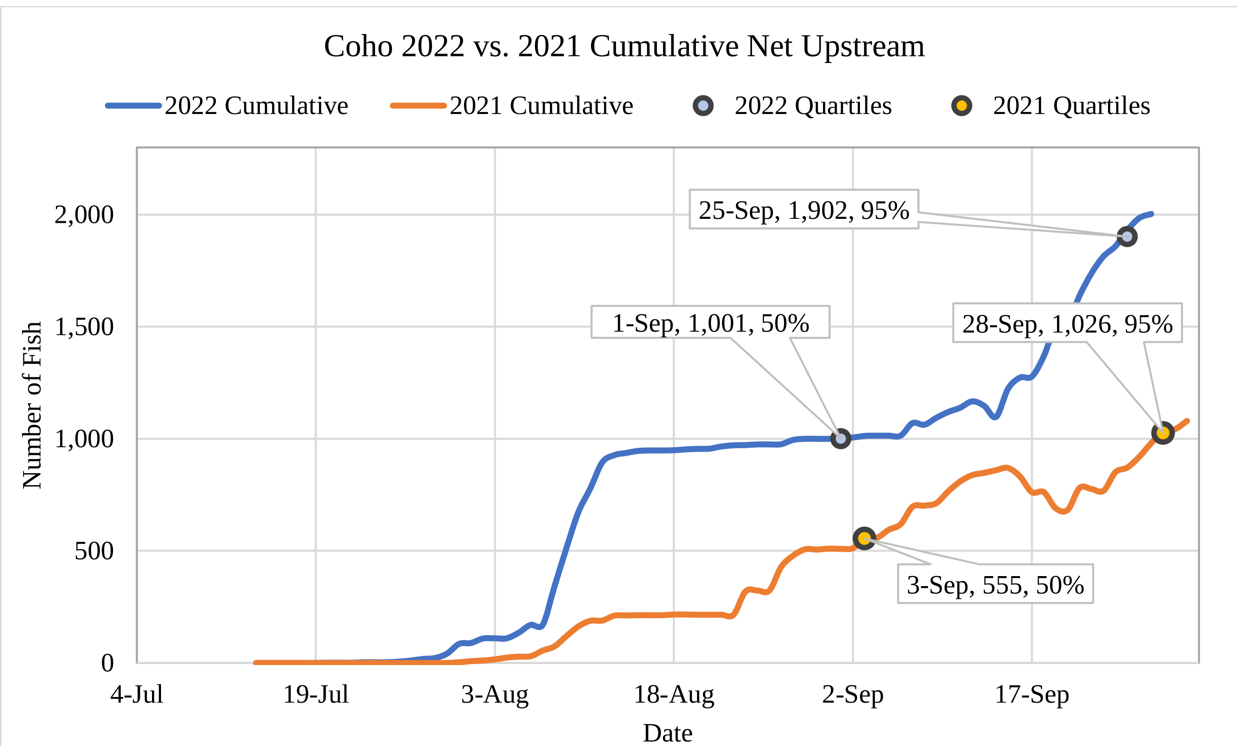

Figure 6. Coho cumulative net upstream counts, 2022 vs. 2021. JBER, Alaska.

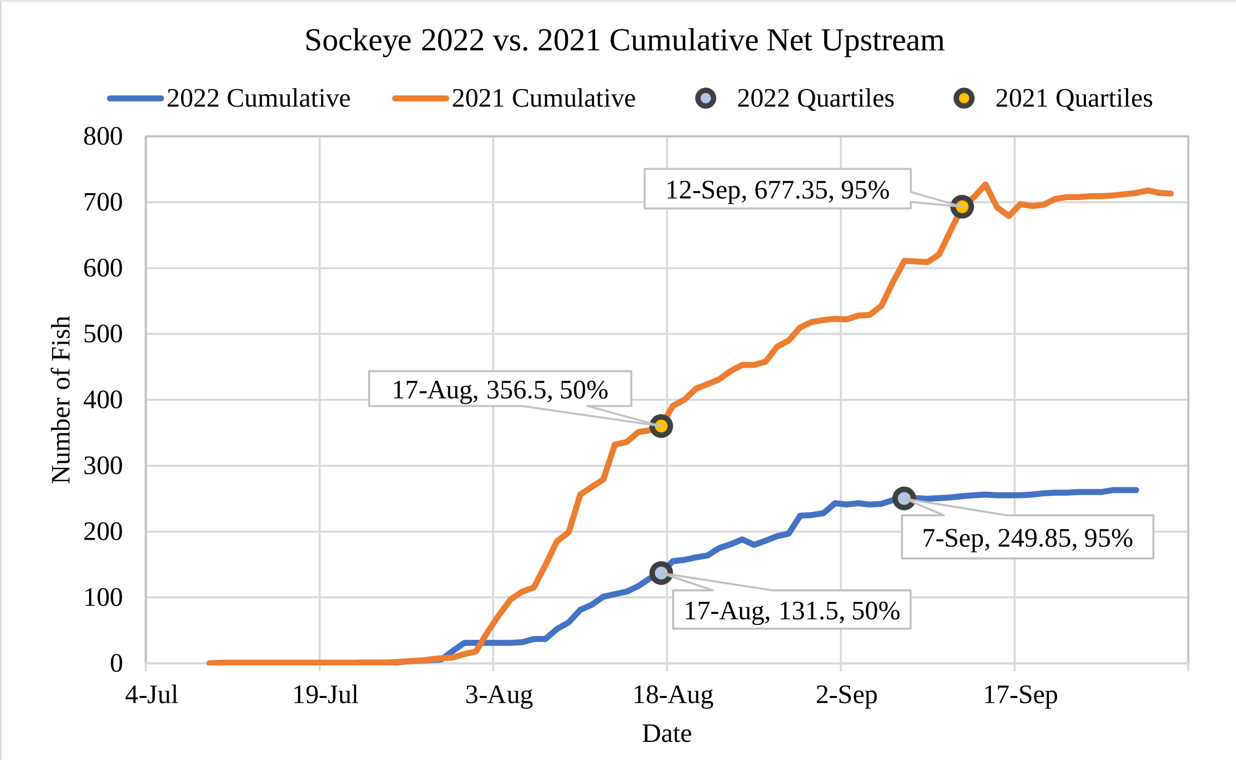

Figure 7. Sockeye cumulative net upstream counts, 2022 vs. 2021. JBER, Alaska.

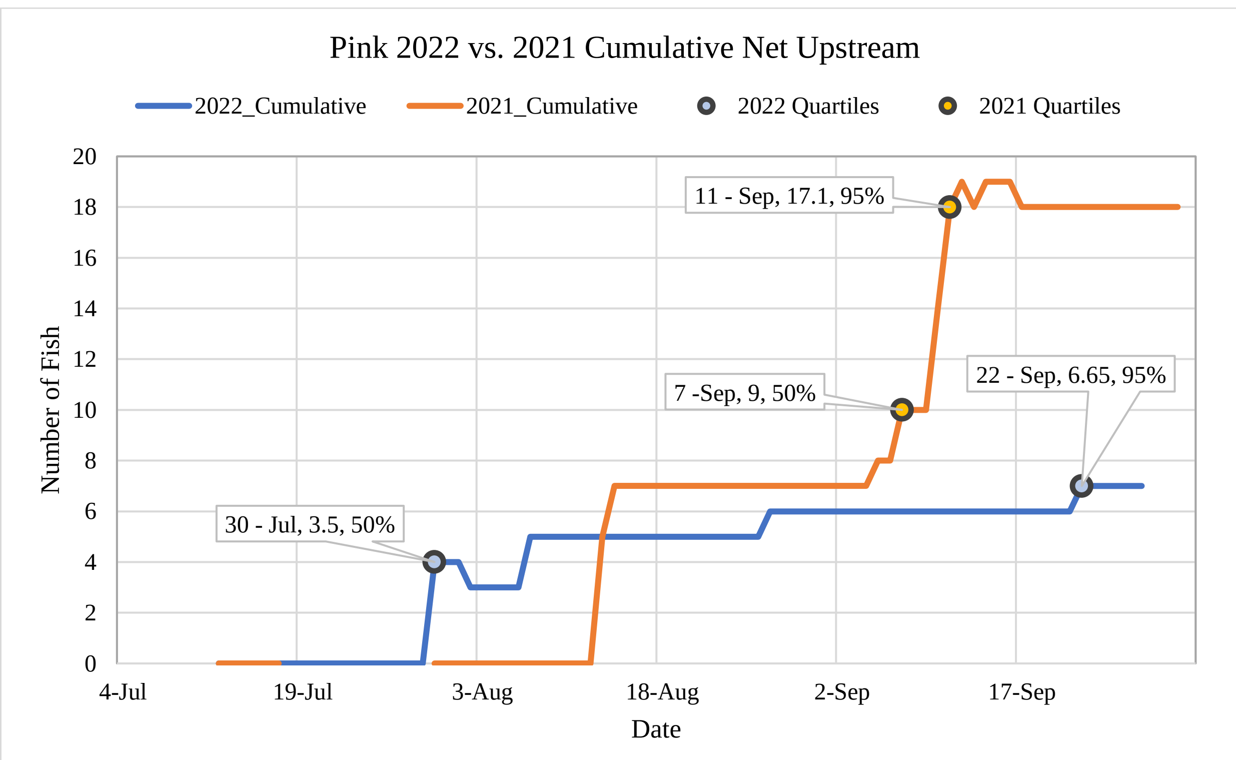

Figure 8. Pink cumulative net upstream counts, 2022 vs. 2021. JBER, Alaska.

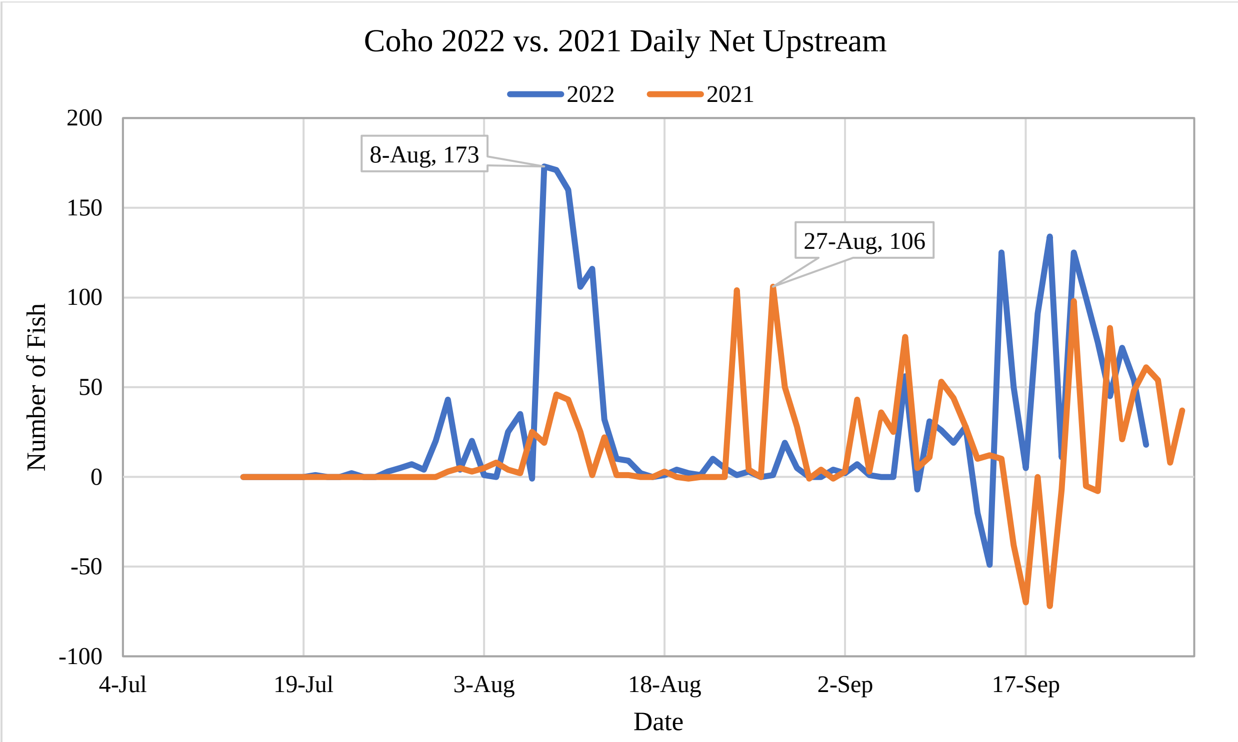

Figure 9. Coho daily net upstream counts, 2022 vs. 2021. JBER, Alaska.

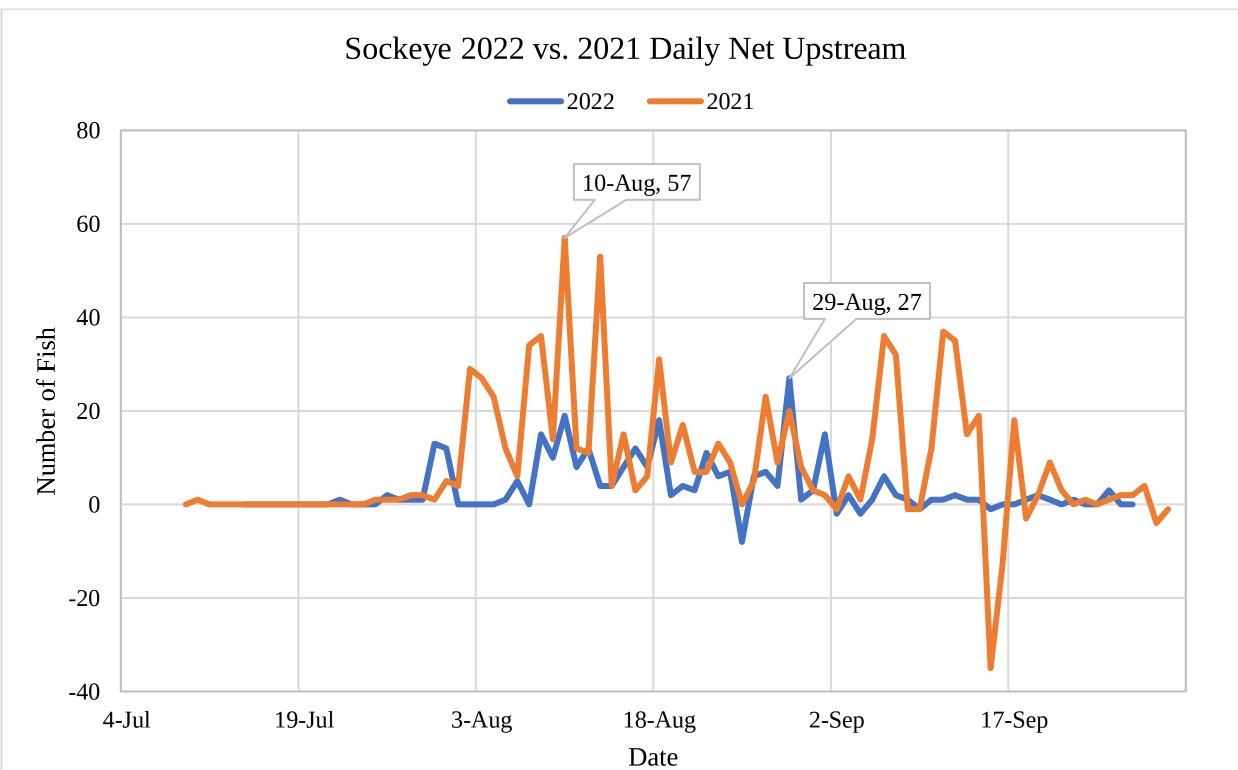

Figure 10. Sockeye daily net upstream counts, 2022 vs. 2021. JBER, Alaska.

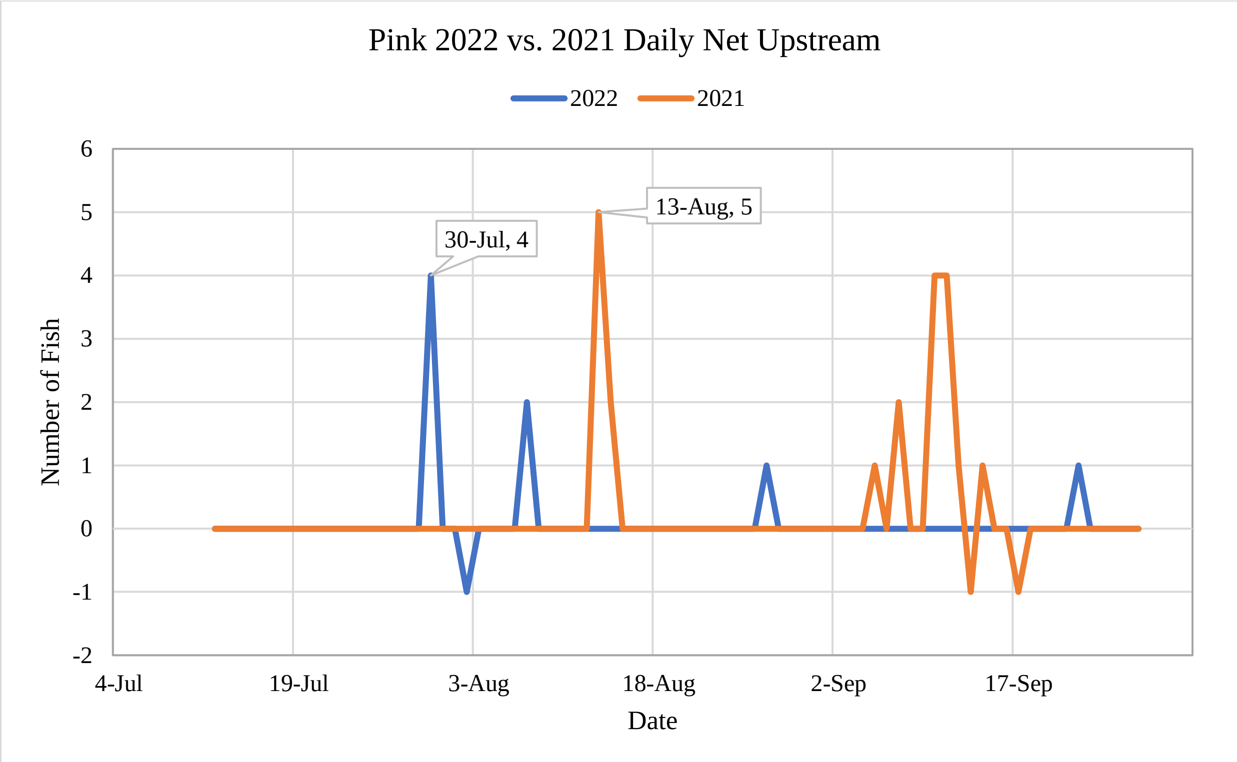

Figure 11. Pink daily net upstream counts, 2022 vs. 2021. JBER, Alaska.

The Vaki Riverwatcher also recorded the time of day at which an object moves through the counter. The observation timing data in Figure 12 shows the hourly distribution of total salmon movement. Positive numbers indicate the fish that have travelled upstream within that hour, and negative numbers indicate the fish have travelled downstream within that hour. Salmon that travel back and forth are subjected to possible double-counts for the upstream totals. The net total count was overall positive throughout most hours of the day, with the greatest net upstream movement observed between the hours of 15:00 and 20:00 (1,201 or 52.2%), with an hourly average of 200.16 or 8.7%. Peak timing of net upstream movement across all species occurred at 19:00 (241 individuals or 10.5%), with coho as the predominant species. Lowest net values were observed between the hours of 0:00 and 4:00 with an hourly net average of 29.8 individuals (1.3%) and total net sum of 149 salmon (6.4%).

Between the two (2) main salmon species, peak net upstream movement occurred at 18:00 for coho with 229 individuals (11.6% of coho net hourly total), and at 15:00 for sockeye with 22 individuals (8.9% of sockeye net hourly total). The highest activity observed for sockeye, including both up and downstream travel, occurred consistently between the hours of 0:00 to 05:00, with an hourly average of 62.33 upstream individuals (7.8%) and 48 downstream individuals (8.8%) (Figure 11).

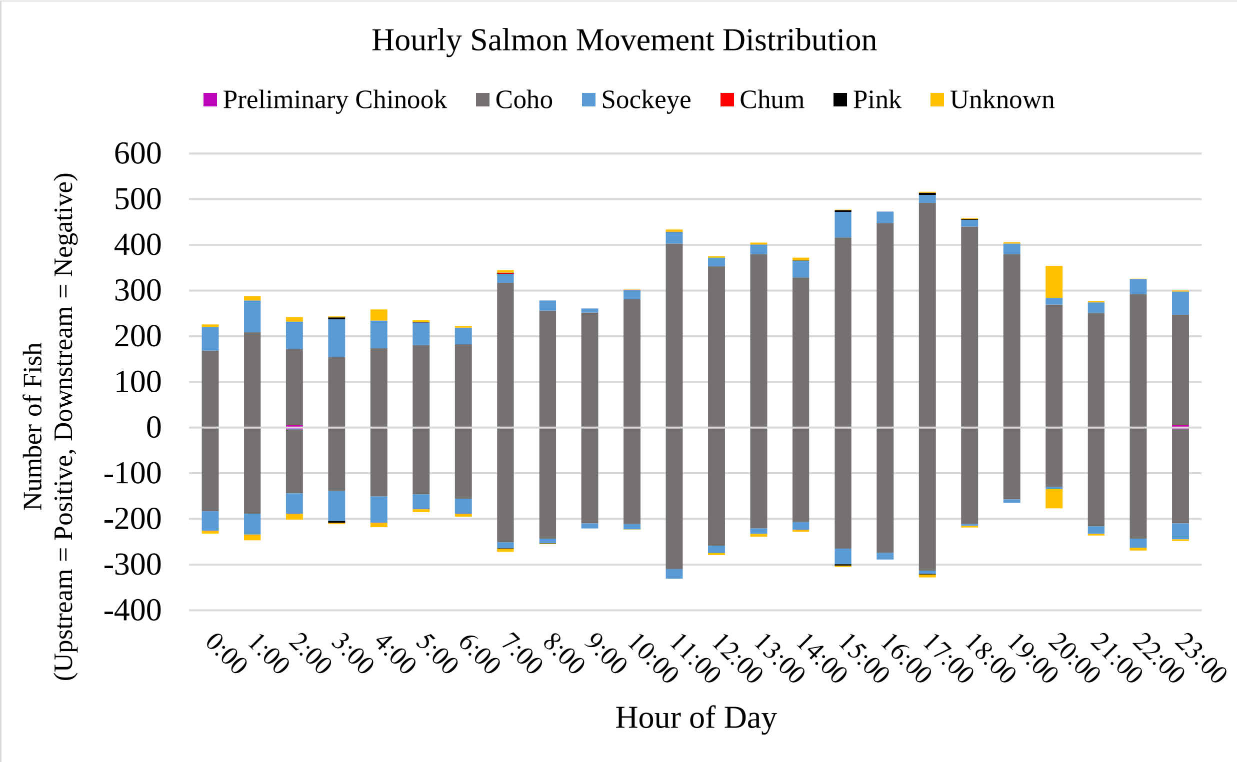

Figure 12. Distribution of salmon movement (upstream as positive numbers, downstream as negative numbers) by hour of the day at the Riverwatcher (Chinook counts under review). JBER, Alaska, 2022.

Using the Winari program, the length of each object passing through the Riverwatcher was calculated. A summary of the length of fish traveling through the Riverwatcher can be found in Table 3. From the calculated lengths derived from the Winari program, the average lengths for salmon going upstream were as follows: 59.40 cm Chinook, 67.04 cm coho, 61.68 cm sockeye, 78.00 cm chum, and 46.88 cm pink. The average lengths for salmon going downstream were: 61.31 cm Chinook, 61.43 cm coho, 59.50 cm sockeye, and 43.00 cm pink. Examining both upstream and downstream lengths, coho and sockeye displayed normal distributions with a slight left skew (Figure 13 andFigure 14). The length distribution of solely upstream coho and sockeye also reflected a normal distribution, with a small left skew (Figure 15 andFigure 16). The statistical analysis showed coho and sockeye distribution values falling within the acceptable range for kurtosis and skewness (kurtosis = 1.69 and 1.5, skewness = -0.5 and -0.7, respectively).

Table 3. Descriptive statistics of lengths of salmon observed by the Riverwatcher at Otter Creek. JBER, Alaska, 2022.

Direction	—	**Chinook[1]**	**Coho**	**Sockeye**	**Chum**	**Pink**
Up (lengths in cm)	Mean	59.40	67.04	61.68	78.00	46.88
	Median	64	67	63	78	45
	Min	28	24	24	78	33
	Max	67	141	106	78	121
	Variance	—	137.48	128.72	—	—
	St. Dev.	—	11.73	11.35	—	—
	Fish Ct.	17	7,028	841	1	18
Down (lengths in cm)	Mean	61.31	61.43	59.50	—	43.00
	Median	59.5	63	60	—	42
	Min	55	24	24	—	25
	Max	73	131	102	—	55
	Variance	—	194.63	148.07	—	—
	St. Dev.	—	13.95	12.17	—	—
	Fish Ct.	14	5,025	578	0	11
Cumulative Total (lengths in cm)	Mean	60.29	64.77	60.96	78.00	45.36
	Median	64	66	62	78	45
	Min	28	24	24	78	25
	Max	73	141	106	78	121
	Variance	84.36	168.17	137.60	—	—
	St. Dev.	9.18	12.97	11.73	—	—
	Fish Ct.	31	12,053	1,419	1	29
Net Upstream Total		3	2,003	263	1	7

[1]*Chinook numbers are preliminary and currently under review.*

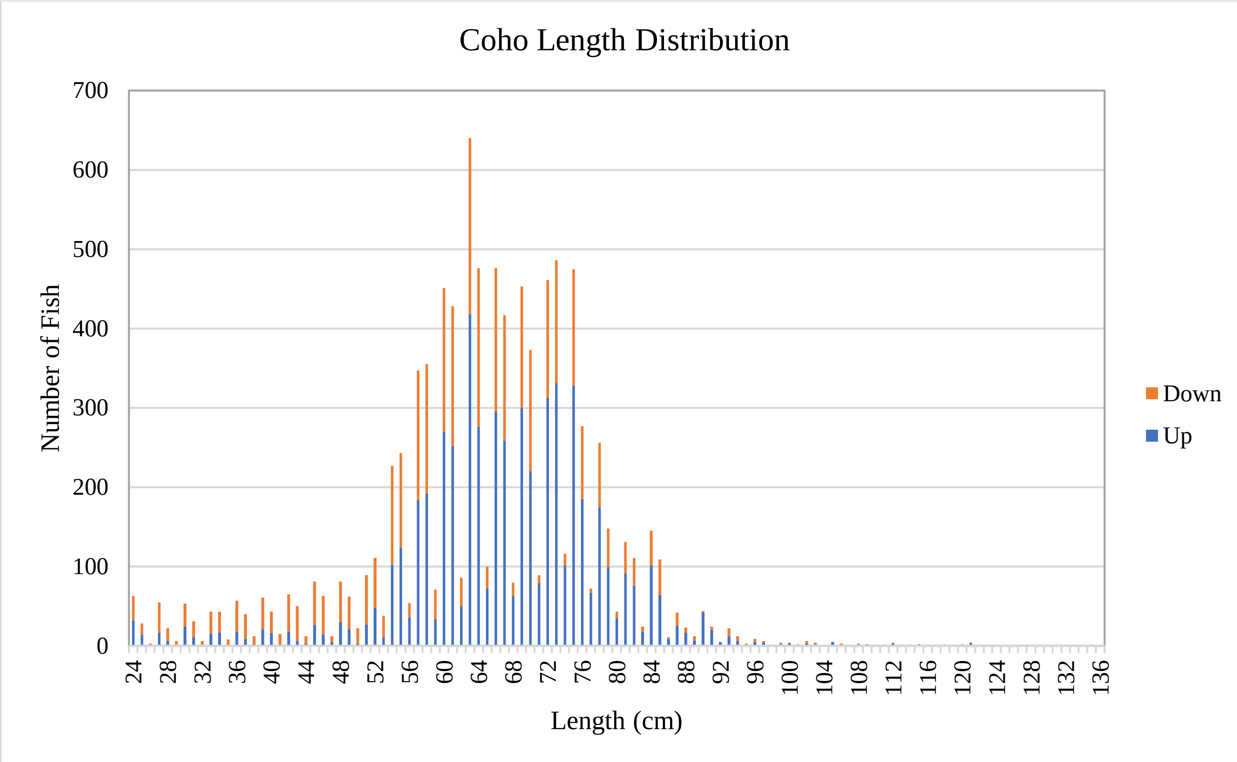

Figure 13. Distribution of coho lengths measured by the Riverwatcher. JBER, Alaska, 2022.

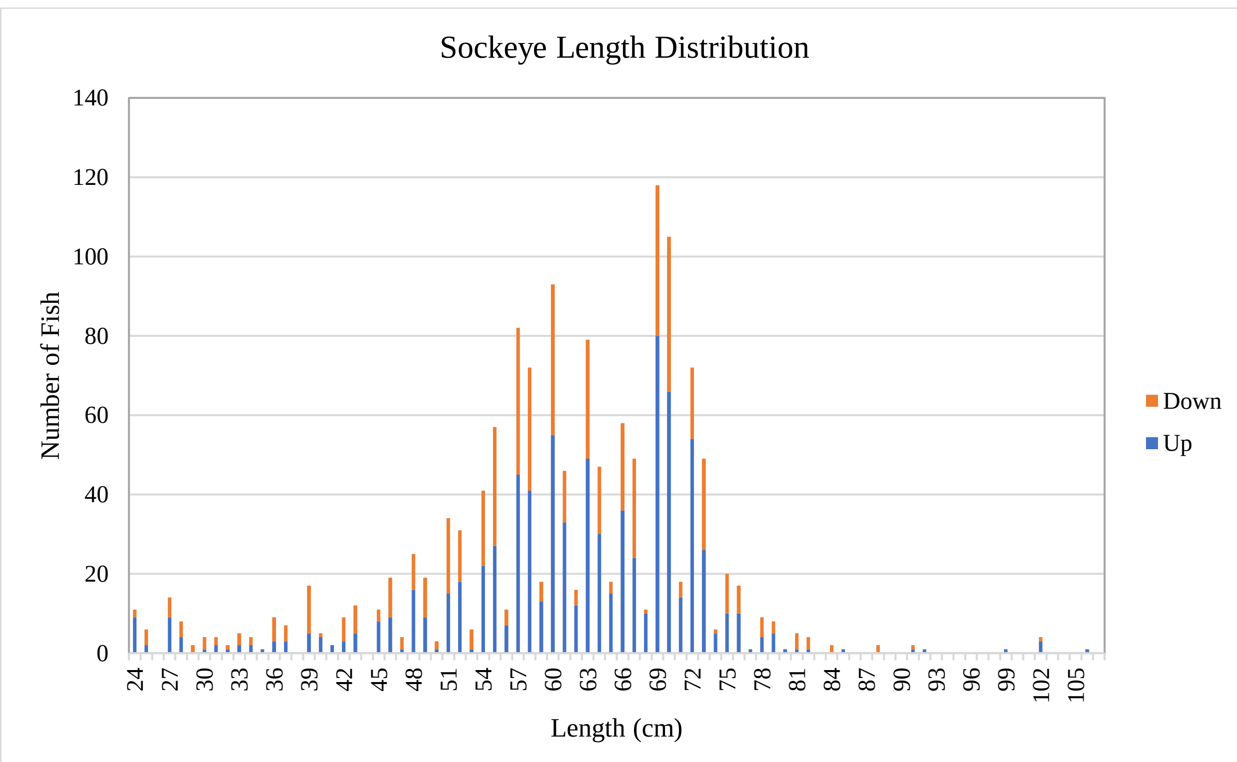

Figure 14. Distribution of sockeye lengths measured by the Riverwatcher. JBER, Alaska, 2022.

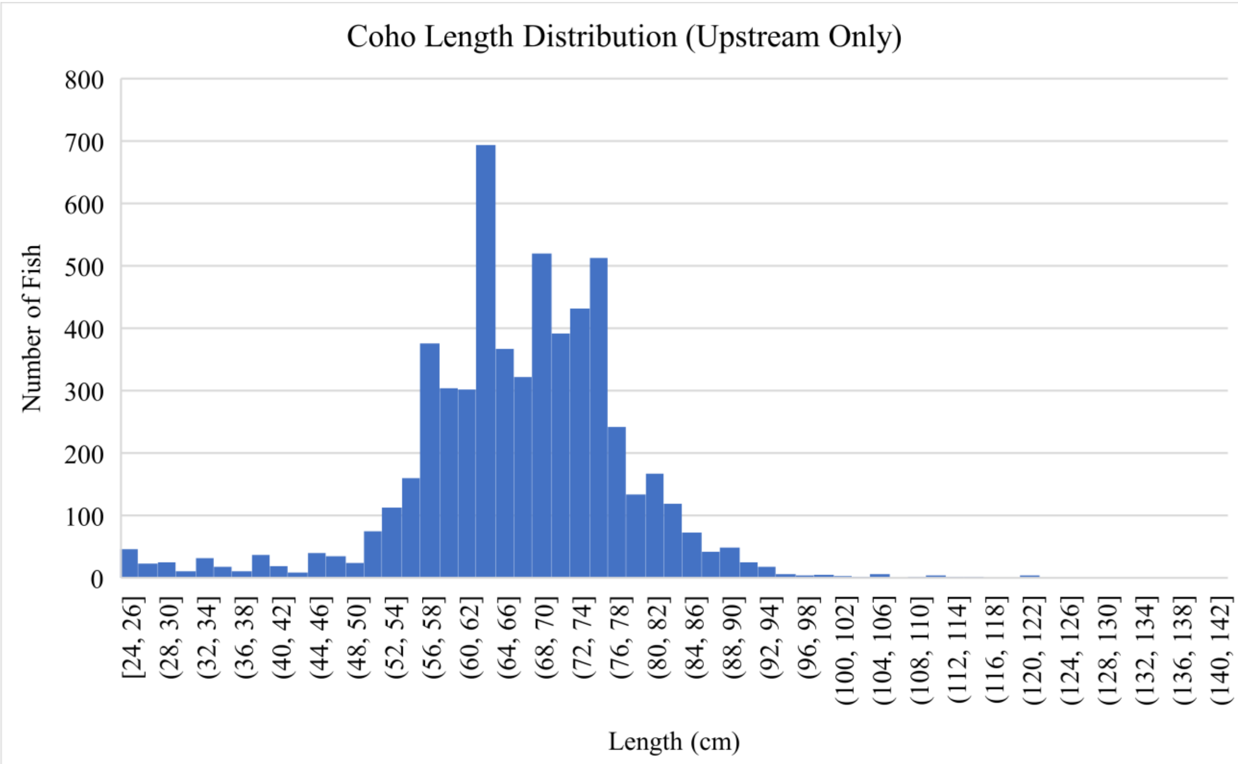

Figure 15. Distribution of upstream coho lengths measured by the Vaki Riverwatcher. JBER, Alaska, 2022.

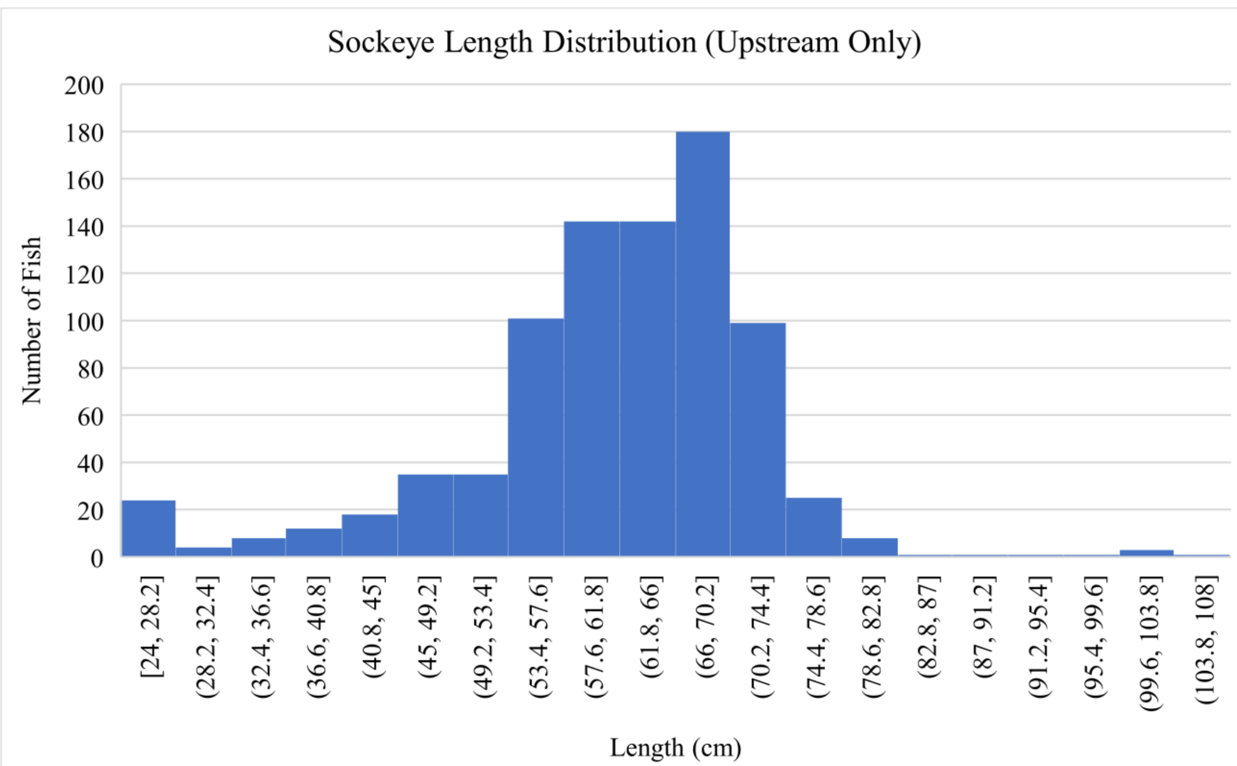

Figure 16. Distribution of upstream sockeye lengths measured by the Vaki Riverwatcher. JBER, Alaska, 2022.

4.1.1 System Performance

The system ran from 9 June to 8 July without needing a battery swap. From 8 July to 27 September (when the Riverwatcher was removed for the season), the average swap time was once every 2.9 days (Figure 17).

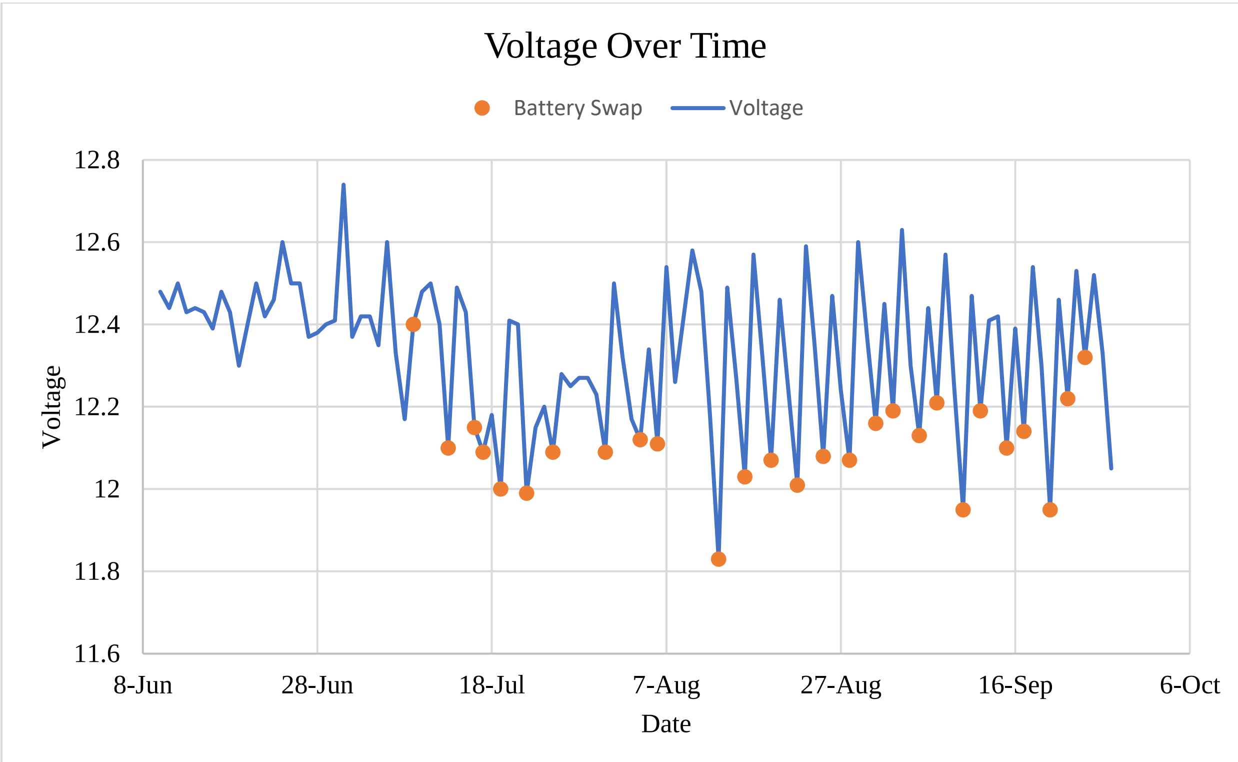

Figure 17. Voltage of the Riverwatcher by date. JBER, Alaska, 2022.

4.2 Otter Lake Spawning Surveys

During the 2022 field season, the UAA AERC team conducted a total of eight (8) canoe surveys from 3 August to 27 September. No fish were observed in foot surveys along upper Otter Lake. The field teams observed approximately 605 live adult salmon in lower Otter Lake (Table 3). The first sockeye and coho salmon were observed on 10 August, and the last observation of both species was on 27 September. The largest number of salmon observed was a school of approximately 200 coho on the southern edge of the lake (Figure 18).

Table 3. Results from Otter Lake salmon spawning surveys. JBER, Alaska, 2022.

Survey Number	Date	Count	Species Observed	Lat	Long	Behavior Code(s)*
1	8/3/2022	0	—	—	—	—
1	8/3/2022	0	—	—	—	—
2	8/10/2022	60	coho, sockeye	61.28619	149.7388	6
2	8/10/2022	30	coho, sockeye	61.2939	149.7312	6
2	8/10/2022	1	coho, sockeye	61.286	149.734	NA
3	8/20/2022	1	sockeye	61.29351	149.7303	NA
4	8/25/2022	40	coho, sockeye, chum	61.28687	149.741	1, 4, 6
5	9/2/2022	40	coho	61.29353	149.7306	NA
5	9/2/2022	200	coho	61.28569	149.7385	NA
5	9/2/2022	1	sockeye	61.29031	149.7421	4
5	9/2/2022	3	unknown	61.28936	149.7432	4, 6, 8
5	9/2/2022	40	sockeye	61.287	149.7416	4, 5, 6, 8
5	9/2/2022	55	coho, sockeye, chum	61.28625	149.7386	1, 4, 5, 6, 8
6	9/10/2022	10	sockeye	61.28716	149.7422	6
6	9/10/2022	30	sockeye	61.28698	149.7414	4, 6
6	9/10/2022	30	sockeye	61.28609	149.7388	6
6	9/10/2022	40	coho, sockeye	61.28568	149.7385	NA
6	9/10/2022	3	sockeye	61.29378	149.731	6
6	9/10/2022	50	coho, sockeye	61.29355	149.736	6
6	9/10/2022	20	coho, sockeye	61.29313	149.7321	6

7	9/18/2022	5	sockeye	61.28738	149.7423	6
7	9/18/2022	5	sockeye	61.28727	149.7424	6
7	9/18/2022	10	coho, sockeye	61.28695	149.7415	4, 6, 8
7	9/18/2022	6	coho, sockeye	61.28697	149.7413	4, 6
7	9/18/2022	4	sockeye	61.28538	149.7368	4, 6
7	9/18/2022	0	—	—	—	—
8	9/27/2022	4	coho	61.28746	149.7429	6
8	9/27/2022	6	coho, sockeye	61.28687	149.7416	4, 6
8	9/27/2022	10	coho, sockeye	61.28611	149.7387	4, 6
8	9/27/2022	0	—	—	—	—

Behaviors Key

(1) Fish digging **(2) Female on redd** **(3) Female defending**

(4) Deteriorating female **(5) Male and female on redd** **(6) Female circling**

(7) Eggs present **(8) Other wildlife or fish species at site**

***Fish marked as NA were milling or traveling through an area without exhibiting spawning behaviors.**

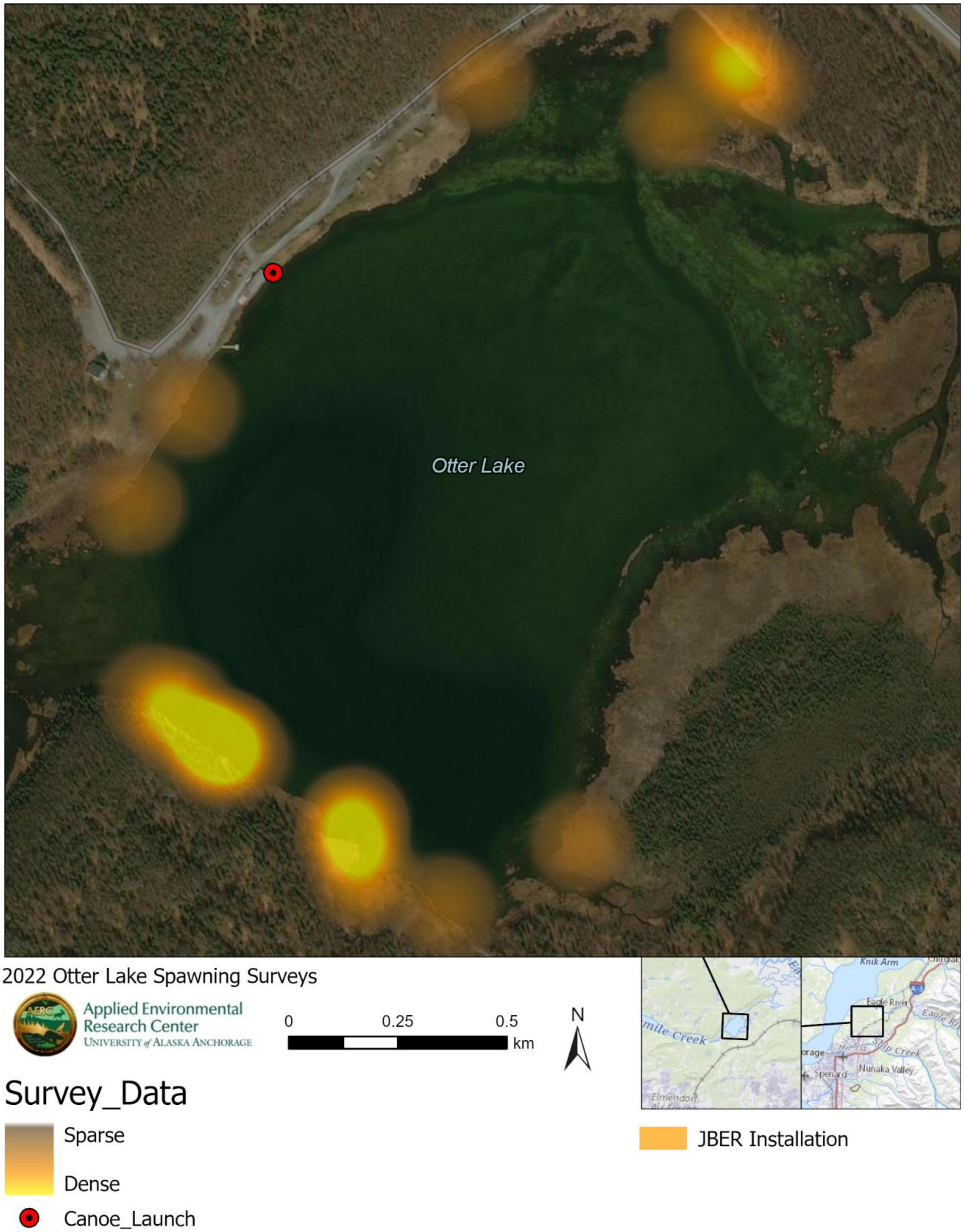

Figure 18. Heat map of salmon observed during lake spawning surveys.

5.0 Discussion

The Riverwatcher was deployed just upstream of the culvert at Otter Lake Rd., rather than the stream outlet at Otter Lake. The main purpose of this change was to determine if this would help with reducing overall numbers of back-and-forth movement by salmon and trout through the unit, without restricting passage in one direction. Total upstream and downstream salmon events combined in 2022 were 13,848, vs. a total salmon event count of 10,793 in 2021. This is an increase of total events by 3,055 (an increase of over 28%), rather than a decrease in events. There were more total salmon however, with 2,300 remaining in the lake in 2022, vs. 1,811 in 2021; this is a total increase of approximately 27%, close to the percent increase in total events. This means that on a given year, fish that remain upstream of the Riverwatcher account for ~17% of the total event count. Overall, the total events vs. salmon remaining upstream at this location was approximately the same between locations/years; i.e., no substantial difference in performance between locations. There were a handful of problems with this location however, the first of which is the debris buildup, which is notably worse than when the assembly was at the outlet; particularly, leaves accumulating overnight on the weir increased the surface area on the bars so much that they tended to be pulled over by the current. Driving additional t-posts into the stream bed or otherwise reinforcing the bottom edges of the weir panels could potentially alleviate this. The second was disturbances by wildlife; there is direct evidence from the footage that larger mammals were getting into the assembly, and likely pushing the panels around in the process (Figure 19). An additional occurrence of note is salmon were observed in a handful of videos to be going over top of the box. The top access hatch was left open to allow additional daylight into the enclosure, and fish were seen in a handful of instances coming in through the hatch from either direction. It can be inferred that these fish may have been going over the top of the box while the hatch was closed.

Figure 19. Bear paw swiping through a group of trout in the Riverwatcher. JBER, Alaska, 2022.

The third issue is that coho started spawning all around the Riverwatcher, building redds both upstream and downstream of the box. In several cases, the fish were seen excavating the upstream redds, and kicking the majority of the debris into the box along with some eggs. This creates issues for both maintenance and eventual removal of the assembly, as it not only increases the amount of cleaning and maintenance during peak runs, but means that disturbing spawning activities is somewhat inevitable. Technicians took additional care to avoid disturbing the creek bed further once the behavior was observed (Figure 20).

The Riverwatcher did display some issues this field season, particularly the scanners not detecting all the salmon that moved through the unit; fish slowly drifting back downstream in the current often resulted in no scanner trigger (the fish were observed as part of a separate video clip, not seen by the scanner). Fish stacked either vertically or horizontally in the channel, relative to the camera, characteristically resulted in missing entries, as the scanner cannot differentiate between the silhouettes of the various fish. The best results from the unit are invariably when fish move quickly upstream through the sensor, one-by-one; several video sequences, combined with their respective scanner entries, achieved a hit rate of 100% under these circumstances. There were a number of instances where an object was detected on the scanner, but there was not an associated video. These errors, labeled as "No Video/Error" entries, totaled 1,961, or ~15% of the total number of salmon entries. There were also a number of salmon manually added to the counter. These instances occurred when there was a video showing the fish passing through the scanner, but it was not automatically counted by the software. The added fish totaled 2,400, or ~17% of the total salmon entries.

On 26 August, a possible Chinook salmon was observed moving through the Riverwatcher (Figure 21). The fish was preliminarily IDed as a Chinook by the JBER Fisheries Biologist and the individual was seen moving through the Riverwatcher multiple times after the first observation. The JBER Fisheries Biologist is currently reviewing all 31 observations of potential Chinook Salmon seen during the 2022 season. It is possible that some or all of the observations were the same individual and will be confirmed by the ongoing review.

Lake spawning surveys were effective at confirming that the salmon are generally spawning in the areas of the lakebed with gravel substrates. These areas are almost all located at the South-Southwest edge of the lake, and after the runs began, salmon were frequently seen kicking up sediment in these areas from the canoes (Figure 22). No salmon were observed in upper Otter Lake- the body of water consists of primarily all fine sand and thick aquatic vegetation, and is exceptionally shallow.

Figure 20. Coho salmon attempting to excavate a redd in the Riverwatcher. JBER, Alaska, 2022.

Figure 21. Potential Chinook salmon in the Riverwatcher. JBER, Alaska, 2022.

Figure 22. Sockeye salmon observed exhibiting spawning behaviors in Otter Lake (picture taken through polarized lens). AERC, 2022.

6.0 Conclusion and Recommendations

A total of 13,848 salmon observations were documented during this field season, with approximately 2,300 remaining upstream of the Riverwatcher. Approximately 11,548 salmon observations by the Riverwatcher were attributable to the fish moving back and forth through the scanner. The Riverwatcher did display some issues this field season, particularly the scanners not detecting all the salmon that moved through the unit; fish slowly drifting back downstream in the current often resulted in no scanner trigger (the fish were observed as part of a separate video clip, not seen by the scanner). Fish stacked either vertically or horizontally characteristically resulted in missing entries, as the scanner cannot differentiate between the silhouettes of the various fish. The best results from the unit are invariably when fish move quickly upstream through the sensor, one-by-one; several video sequences, combined with their respective scanner entries, achieved a hit rate of 100% under these circumstances, as noted previously. A system that encourages this type of movement would be an improvement.

Using the Vaki Riverwatcher in combination with stream walks and boat surveys in future monitoring efforts, will likely result in a more comprehensive understanding of salmon populations in the Otter system. The Riverwatcher allows for in-depth identification of salmon that enter and exit Otter Lake. Otter Creek stream walks allow for supplementary data for fish that do not reach the lake as well as behavior of the fish found in the creek and the condition of the connected waterways. Continuing to monitor the Otter Lake and Creek system for salmonid activity is a crucial component of the ability to assess the overall health of salmon populations in this system and the prey resource to support the recovery of the CIBW.

6.1 Recommendations

The Vaki Riverwatcher was effective at documenting both fish and non-fish that passed through the instrument's sensors. The software allowed the UAA AERC team to categorize, measure, and identify salmon by species and size. One challenge that occurred during the 2022 field season was the amount of data that the Riverwatcher obtained. The system counts objects that pass through the box which includes fish that enter, turn around, and swim back through the instrument. The Riverwatcher also counts fish that enter and sit inside the box for prolonged periods of time. The new area in which the Riverwatcher was placed, like 2021, has excessive activity from both salmon and trout; the UAA AERC team recommends moving the unit back to the 2020/2021 location and developing a method to deter fish from swimming back through the detector, especially backwards with the current. This will reduce the number of entries needing to be added, as fish are less likely to be missed by the scanner. For future installations, incorporating a barrier extending above the Riverwatcher would help to prevent fish from going over the top of the unit.

References

Anadromous Waters Catalog, ADF&G. 2017. Otter Creek, Nomination #170291. https://www.adfg.alaska.gov/FDDDOCS/NOM_PDFs/SCN/17-291.PDF

Dunker, K. 2015. *MEMORANDUM State of Alaska Department of Fish and Game Division of Sport Fish*. http://www.jber.afmil/environmental/index.mm.

Edo, K., and Suzuki, K. 2003. Preferable summering habitat of returning adult masu salmon in the natal stream. Ecol. Res. **18**(6): 783–791.

Gende, S. M., Quinn, T. P., & Willson, M. F. 2001. Consumption choice by bears feeding on salmon. *Oecologia*, **127**(3), 372– 382. https://doi.org/10.1007/s004420000590

Fish Regulations, ADF&G. 2018. Pacific Salmon Identification Guide. https://www.adfg.alaska.gov/static/regulations/fishregulations/PDFs/southcentral/2018sc_sfregs_salmon_id.pdf 12/8/20

JBER INRMP. 2021. Joint Base Elmendorf-Richardson 673d Civil Engineer Group (JBER). Interim Joint Base Elmendorf-Richardson Integrated Natural Resource Management Plan (INRMP). June 1. https://www.jber.jb.mil/Portals/144/Services-Resources/environmental/public-Docs/(U)%20JBER%20Integrated%20Natural%20Resources%20Management%20Plan%20(INRMP)%2021%20January%202021.pdf

Lariviere, S., Huot, J., and Samson, C. 1994. Daily activity patterns of female black bears in a northern mixed-forest environment. Journal of Mammalogy 75:613–620.

National Marine Fisheries Service (NMFS). 2008. Endangered and Threatened Species; Endangered Status for the Cook Inlet Beluga Whale. Final Rule. 50 CFR Part 224, Federal Register 73:205 (2018) p. 62919. Available at: https://www.fisheries.noaa.gov/resource/educational-materials/cook-inlet-beluga-whale-brochure.

NOAA National Oceanic and Atmospheric Administration. 2006. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT: MSA. In *U.S. Government (2007) Public Law 94-265*. Combining Fishery Reforms, Rights-Based Fisheries Management, and Marine Reserves.

POA. 2011. Port of Anchorage Wetland Mitigation Proposal, Joint Base Elmendorf-Richardson Otter Creek Anadromous Fish Habitat Rehabilitation. March 4, 2019

Southcentral Alaska Northern Pike Control Committee. ADF&G. Management Plan for Invasive Northern Pike in Alaska. https://www.adfg.alaska.gov/static/species/nonnative/invasive/pike/pdfs/invasive_pike_management_plan.pdf 12/9/2020

Quakenbush, L.T., Suydam, R.S., Bryan, A.L., Lowry, L.F., Frost, K.J. and Mahoney, B.A., 2015. Diet of beluga whales, *Delphinapterus leucas*, in Alaska from stomach contents, March-November. *Marine Fisheries Review*, *77*(1), pp.70-85.

University of Alaska Anchorage, Applied Environmental Research Center. 2021. Otter Creek Salmon Escapement Monitoring on Joint Base Elmendorf Richardson, Alaska.

University of Alaska Anchorage, Applied Environmental Research Center. 2020. Otter Creek Salmon Escapement Monitoring on Joint Base Elmendorf-Richardson, Alaska.

Vaki Riverwatcher Fish Counter. 2020. Riverwatcher Guide. http://www.riverwatcher.is/media/PDF/Riverwatcher_Hardware_Manual_ENG.pdf 12/8/2020

Virbickas, T., Stakėnas, S., & Steponėnas, A. 2015. Impact of beaver dams on abundance and distribution of anadromous salmonids in two lowland streams in Lithuania. PloS One, 10(4), e0123107-e0123107. https://doi.org/10.1371/journal.pone.0123107

Symbols and Abbreviations

Alternating Current	AC
Alaska Department of Fish and Game	ADF&G
Alaska Biological Resources — Inc.	ABR
Applied Environmental Research Center	AERC
Centimeter	cm
Cook Inlet	CI
Cook Inlet Beluga Whale	CIBW
Endangered Species Act	ESA
Identification	ID
Institutional Animal Care and Use Committee	IACUC
Integrated Natural Resource Management Plan	INRMP
Joint Base Elmendorf-Richardson	JBER
Kilometers	km
Miles	mi
National Oceanic and Atmospheric Administration	NOAA
National Marine Fisheries Service	NMFS
Point of Contact	POC
Primary Constituent Element	PCE
University of Alaska Anchorage	UAA
U.S. Army Corps of Engineers	USACE
Volts / Voltage	V

Appendix A: Riverwatcher Video Error

An example of a typical error with the Riverwatcher, in which there are three (3) recorded instances in the database, each with their own distinct silhouette. There is however only one (1) associated video within the timeframe, and only one (1) fish observed moving through the scanner plates. The last two (2) entries have no associated video imagery, even though they were automatically marked. Note the lack of a video feed on the second image- these additional silhouettes did not appear in the only associated video within the appropriate time frame.