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EAGLE RIVER ADULT SALMON MONITORING ON JOINT BASE ELMENDORF-RICHARDSON, ALASKA

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EAGLE RIVER ADULT SALMON MONITORING ON JOINT BASE ELMENDORF-RICHARDSON, ALASKA

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LIST OF ACRONYMS AND ABBREVIATIONS

Term/ Unit of Measurement	*Symbol/Abbreviation*
degrees (angular)	°
degrees Celsius	˚C
degrees Fahrenheit	°F
percent	%
Alaska Department of Fish and Game	ADF&G
Amp Hours	Ah
Cook Inlet Beluga Whale	CIBW
Convolved Samples Over Threshold	CSOT
cubic feet per second	CFS
dual-frequency identification sonar	DIDSON
digital video recorder	DVR
Eagle River boat take out	ERBTO
Eagle River Flats	ERF
feet	ft
frames per second	fps
Integrated Natural Resources Management Plan	INRMP
Joint Base Elmendorf-Richardson	JBER
light emitting diode	LED
meter	m
National Oceanic & Atmospheric Administration	NOAA
DIDSON count for all species of salmon recorded daily	N_d
DIDSON total seasonal count for all species of salmon	N_s
National Marine Fisheries Service	NMFS
Primary Constituent Elements	PCEs

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INTRODUCTION

The Cook Inlet Beluga Whale (CIBW, *Delphinapterus leucas*) was listed as endangered by the National Marine Fisheries Service (NMFS) in 2008 (NMFS 2008). Beluga whales are predatory in nature and follow eulachon (*Thaleichtys pacificus*) into Upper Cook Inlet during the spring, then switch their diets to salmon (*Oncorhynchus* spp.) as eulachon numbers decline during summer (NMFS 2009). When the CIBW was listed as endangered, four out of the five species of Pacific salmon were listed as primary constituent elements (PCEs): Chinook (*Oncorhynchus tshawytscha*), sockeye (*Oncorhynchus nerka*), chum (*Oncorhynchus keta*), and coho (*Oncorhynchus kisutch*) (U.S. Army Corps of Engineers, Alaska District [USACE] 2013). As PCEs, these fish are considered necessary for the recovery of the CIBW (USACE 2013).

Pacific salmon spawn in five waterways on Joint Base Elmendorf-Richardson (JBER). Therefore, establishing a baseline for salmon escapement and run timing in these waterways, specifically Eagle River, is an important component to understanding the presence and abundance of CIBW at the mouth of Eagle River. On-going monitoring of the salmon species within Eagle River provides key insights to the natural resources on JBER, which support management decisions to ultimately ensure sustainable practices and recovery efforts for CIBW. In addition, monitoring efforts in the lower extension of the river will lead to a better understanding of the health of the upriver ecosystem.

The entirety of Upper Cook Inlet, including the Knik Arm, was designated as critical habitat for CIBW recovery in 2011(NMFS 2011). While Joint Base Elmendorf-Richardson (JBER) is adjacent to the Knik Arm, no portion of JBER property is included in the critical habitat designation. The Endangered Species Act (ESA) Section 4(a)(3)(B)(i) states "…*Secretary shall not designate as critical habitat any lands or other geographical areas owned or controlled by the Department of Defense, or designated for its use, that are subject to an integrated natural resources management plan prepared under section 670a of this title…*". JBER's Integrated Natural Resources Management Plan (INRMP) outlines monitoring salmon and anadromous waterways on JBER. Shortly after the critical habitat designation of Upper Cook Inlet, a salmon monitoring project was implemented for the Eagle River (USACE 2013).

Starting in 2011, dual frequency identification sonar (DIDSON) and a fish wheel with videography were used to enumerate and identify salmon species migrating upstream into the Eagle River drainage. In 2015, counting methods were modified to use two DIDSON sonars simultaneously, by means of synchronizing them via DIDSON top-side software, to achieve a continuous view of the entire sampling area. This methodology allowed for a more accurate enumeration of fish travelling upstream. In 2016, the fish wheel was decommissioned because the data acquired from its operation did not have the resolution to adequately classify species composition for fish traveling past the DIDSONs. Replacement methods for fish species apportionment are currently under consideration. During the 2018 season, it was determined that synchronizing of the DIDSON top-side software was unnecessary to operate efficiently and without interference and that both DIDSONs could operate individually. Guidelines for synchronized and individual DIDSON operation are provided in Appendix 1.

GOALS and OBJECTIVES

The primary goal of this project is the correlation of upstream movement of CIBW into Eagle River relative to Pacific adult salmon spawning migration.

The objectives for the project are as follows:

1) Deploy two (2) DIDSONs sonars and associated picket weir in Eagle River to enumerate the adult salmon return.
2) Process the data for total abundance, diurnal patterns, and riverbank preference.
3) Compare peak run timing to previous years.

STUDY LOCATION

Eagle River is a glacially-fed river approximately 24 kilometers (15 miles) north of Anchorage, Alaska. The lower 14.5 kilometers (nine river miles) flow through JBER property (Figure 1). The last 6.4 kilometers (four river miles) are located within the JBER Eagle River Flats Impact Area (ERF Impact Area). The study site location of the weir/DIDSONs is approximately 6.4 kilometers upriver from the mouth of Eagle River, just above the ERF Impact Area and Bravo Bridge.

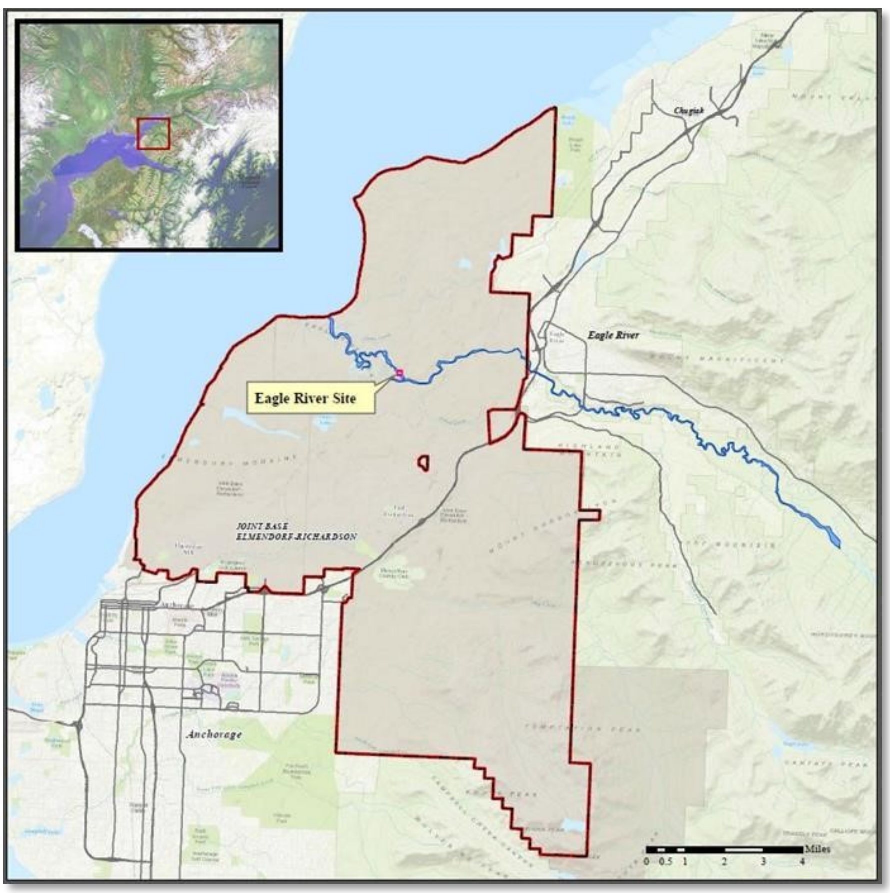

Figure 1. Location of Eagle River and JBER relative to Anchorage, AK, and Knik Arm.

The DIDSON's have been enumerating adult salmon migrating into the Eagle River at the same location since 2012. This site was selected because it met stream morphology, access, and land use restriction criteria for optimal operation. It was desirable for the weir site to be as far downstream as possible while remaining upstream of tidal influence and to have access from the existing road system and to electrical utilities. The study site was required to remain upstream of the ERF Impact Area, and downstream of the recreational boat take-out (USACE 2013).

Since 2012, the DIDSONs have been seasonally operational along the river left bank ("river left" and "river right" are defined as the left or right side of the river, respectively, as the viewer is looking downstream) approximately 500 m upstream of the ERF Impact Area boundary and immediately downstream of the boat take-out (Figure 1). This site was selected because it has 1) a single channel, 2) a wedged-shaped river cross section that matches the shape of the sonar beam, 3) a uniform slope without deep depressions or boulders that can create blind spots, and 4) easy access via road and an accessible power source (USACE 2013). Figure 2 shows the approximate DIDSON and weir locations on the river left bank.

Figure 2. Location of the 2018 Eagle River adult salmon monitoring equipment (weir and DIDSONs).

METHODS

DIDSON Deployment

Two long-range model 300 DIDSON sonars were used to passively monitor migrating salmon moving upstream into the Eagle River. DIDSON is an acoustic sonar device that uses a transducer that emits 48 acoustic beams in a wedge-shaped array, forming a field-of-view 29° wide by 14° tall that can reach 60 m (Sound Metrics Corp 2008). The two DIDSONs were placed in silt exclusion boxes mounted to a metal-framed tripod placed perpendicular to the river current. The tripod frame featured an arm that extended out from the frame to allow manual adjustments in the horizontal and vertical angle of the DIDSONs' "view." The DIDSONs aim was adjusted so that the river bottom and surface could be seen in the display.

The DIDSONs were attached to the tripod arm via a stainless-steel plate with two threaded rods attached to it. Each DIDSONs had its own stainless-steel plates attached to the top of the silt boxes with threaded rods could be tightened with hex nuts. Both DIDSONs were attached to the same tilt adjustment plate (Figure 3).

A 3° concentrator lens was used to help optimize the DIDSON transducer to the river's profile (USACE 2013). A modular A-frame type picket weir was also installed approximately 1 m downriver and extended approximately 1 m past the DIDSONs toward the river right bank to ensure that fish passed through the ensonified area and were detectable.

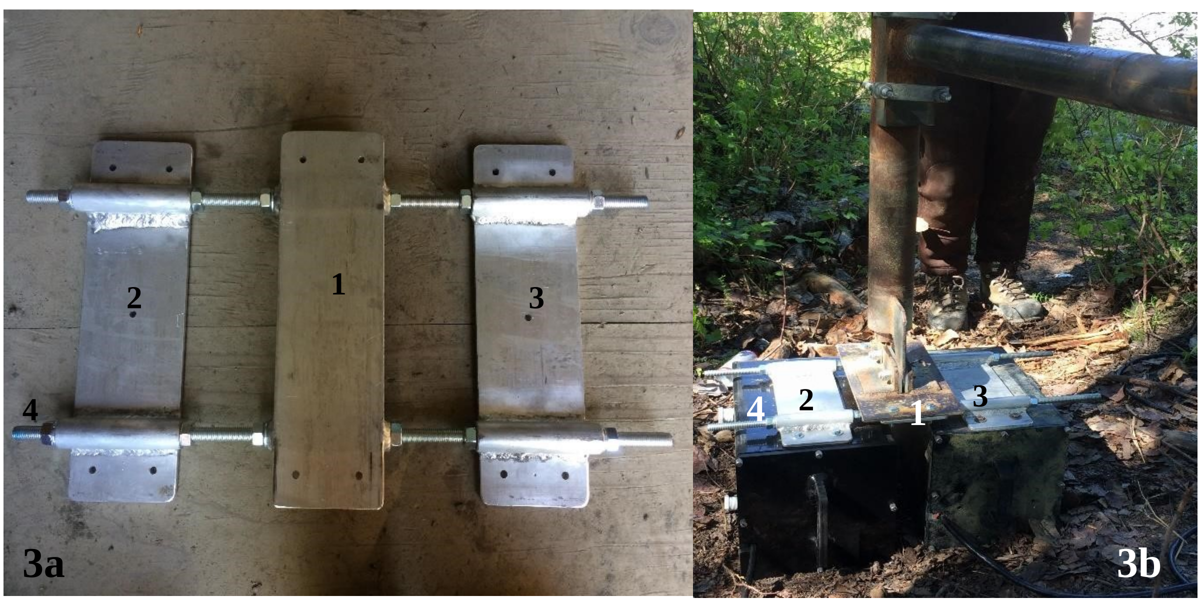

Figure 3. (a) Plate and rod system used for installing the two sonars to the tripod arm. (b) The sonars attached to the tripod arm via the plate and rod system. (1) Where the base of the arm attaches. (2) Where sonar one silt box is attached using 4 bolts. (3) Where sonar two silt box is attached using 4 bolts. (4) Threaded rod with hex nuts for sonars to hang from. Also allows for lateral motion of the sonars if needed for view or to minimize interference.

Specific components required for the DIDSON operation included the following:

- 2 DIDSON LR300 units
- 2 silt exclusion boxes
- 2 concentrator lenses (3°)
- Data transmission cable (60 and 150 m)
- Tripod with dual sonar customized plate
- 2 DIDSON top side controller boxes with power and data connections
- Net-gear 4 Port 10 Base 10-T 10 megabyte per second (mbps) Ethernet Hub
- Data capture computer with DIDSON Control and Display software
- External storage device (Seagate two terabyte solid-state external hard drive)
- Data review computer with DIDSON Viewer software
- Transducer stream mount with manual pan and tilt adjusters
- Fish exclusion weir

The two DIDSONs were installed along the river left bank, aimed perpendicular to the river current towards the river right bank. Once both DIDSONs were synchronized, they were able to view a total of 40m (one DIDSON viewing between 0-20 m and the other between 10-40 m) spanning the entire width of the river. As water levels in Eagle River fluctuated, the DIDSONs were moved closer to river left bank or deeper into the river to ensure they were fully submerged at all times.

Because of seasonal river stage fluctuations, the DIDSON sonar transducer was mounted approximately 20 m from the shoreline. Fish migrating close to shore were directed offshore with the use of a weir to insure they pass through the sonar transducer beam at a range where the beam width was large enough to detect the fish; therefore, the weir extended out 1 m past the DIDSON. A modular A-frame type picket weir was constructed of tubular steel (Figure 4). As the river stage increased, weir sections were installed to prevent fish from getting behind the sonar. During periods of high flow, when the DIDSON was removed from the water, the weir was deconstructed to avoid being damaged by floating debris.

Figure 4. Installation of fish exclusion weir in Eagle River, JBER.

DIDSON Site Setup and Schedule

During the summer field season, a wooden shed at the study site housed a computer with DIDSON viewer software and a two-terabyte external hard drive. The computer was used solely to manipulate the DIDSONs' window lengths, frame rates, file durations, recording, and to save the data to the external drives. Once the hardware was configured, the DIDSONs were placed in the water. The DIDSONs were set to collect data continuously, with image files saved in 15-minute intervals.

During 2018, the DIDSONs were deployed on 14 May and removed on 12 October. Operation was continual 24-hours/day, five days/week (but not operational on weekends). On average, the DIDSON's were operational from 9:00 am on Monday mornings to 3:00 pm om Friday afternoons except during periods of maintenance, high water events, military training, and other unforeseeable events. These out-of-water events were documented and are presented in Appendix D.

DIDSON Data Analysis

The DIDSON view is a pie-shaped wedge within the river that has marks that measure the distance (in meters) that a fish is from the DIDSON (Figure 4). All DIDSON files were manually reviewed in video mode, and each fish that was observed was marked and manually measured using the software measuring function. Upstream ("Up") fish were defined as those that were visibly traveling upstream and moved forward before the end of the DIDSON file. Downstream ("Dn") fish were defined as those that visibly traveled downstream and did so before the end of DIDSON file. Holding fish were defined as those that stayed in one position within the DIDSON view and never moved upstream or downstream. Horizontally moving fish were defined as those that were seen in the view, moving closer or farther from the DIDSON, but did not move upstream or downstream.

All fish viewed migrating upstream or downstream were counted, while holding fish and those that were moving horizontally through the river profile were carefully observed between files and subsequently counted only if they traveled upstream or downstream. By marking and measuring fish, a "Fish Count" file was generated that included date, time, range, length, and direction of travel ("Up" or "Dn").

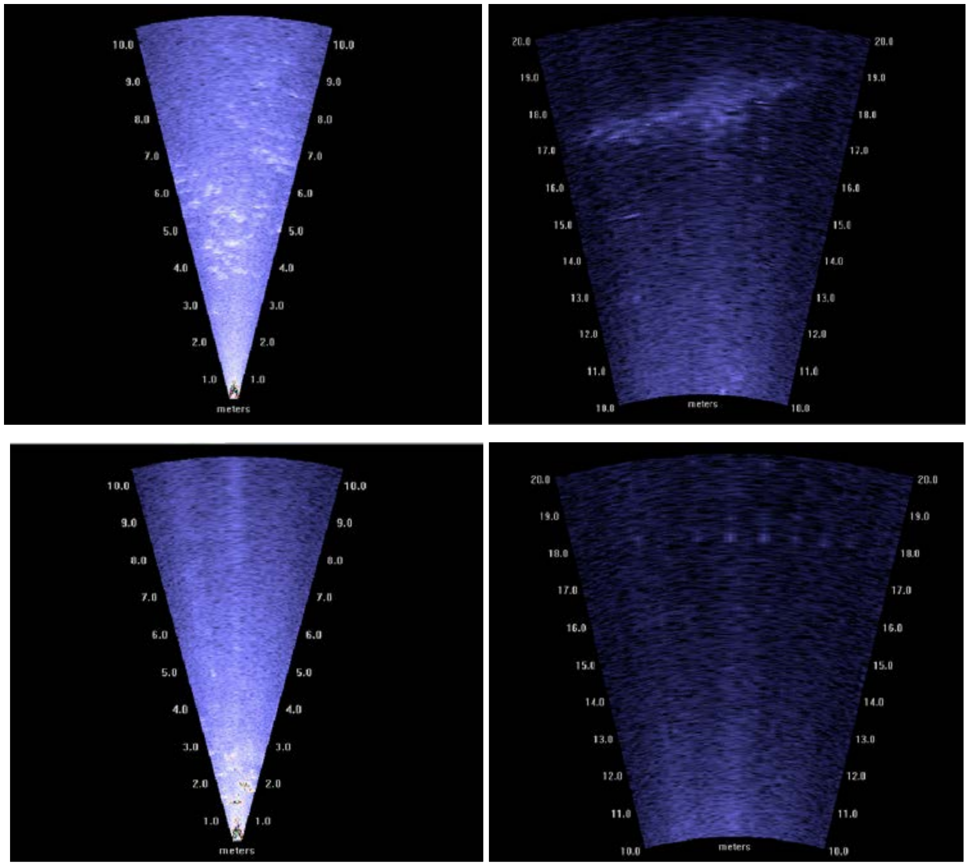

Figure 5. Examples of good near and far images for DIDSON review (top left and right) and bad near and far images (bottom left and right) at Eagle River. This is ideal conditions where the near and far images are spanning the entire river in a combined 20 meters.

RESULTS

Effort

2018 marked the seventh consecutive season for the Eagle River Salmon Monitoring Project. The DIDSON sonars were operational 5 days/week from 14 May until 12 October, 2018, which equates to a sampling window of approximately 112 days (2,688 hours). The DIDSONs were operational 70 (62.5%) of the 112-day sampling period. On several occasions data collection was disrupted for more than one day. The sonars were taken out of the water to avoid equipment damage during flooding for 27 days (24.0 % of total effort) and for 15 days (13.4%) due to military training, from 28 August to 21 September (Table 1, also see Appendix D for more specific details on sampling effort). Sonar operations ended on October 12, once numbers had been < 2 for over a week.

Total Abundance, run timing, and run strength

A total of 1,370 salmon were counted passing in front of the DIDSON's between 14 May and 12 October. Of these, 20 fish were traveling downstream, and 1,350 fish were traveling upstream. Run strength was low from 14 May to 29 July, with daily totals below 100 fish and averages less than 7 fish/day (Table 1). Numbers began to increase near the end of July and persisted through early August, with peak daily passage of 154 fish on 30 July and 183 fish on 2 August (Table 1). Due to a combination of high-water events and military training, the sonars were not operational from 4 August until 2 September. It is highly probable that we missed counting during the peak of the run (based on historical trends). Run strength tapered off during the months of September and October. Thus, the total of 1,370 fish reported is an absolute minimum escapement count.

Table 1. Summary of 2018 Eagle River DIDSON sonar counts including the number of days actively sampled, total number of fish counted, average number of fish per day, peak number of fish counted by month and peak date, and number of days out of the water. Out of water reasons included high water events (HW) and military training (MT).

	May	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Total**
# active sample days	14	14	18	4	10	10	70
Total fish	23	99	822	352	69	5	1370
Avg. # fish/day	1.6	7.1	45.7	88.0	6.9	0.5	25.0
Peak # fish	5	18	154	183	4	2	183
Peak date	31-May	6-Jun	30-Jul	2-Aug	4-Sep	4-Oct	2-Aug
# days out of water	1	7	4	19	11	0	42
Out of water reason	1 HW	7 HW	4 HW	15 HW, 4 MT	11 MT		27 HW, 15 MT

The first salmon was recorded on 14 May 2018. Highest daily totals in May were five fish on 31 May (Table 1). During the month of June, the passage rate increased to an average of 7.1 fish per day, with a peak daily passage of 18 fish on 6 June. The month of July had the highest number of days sampled (n = 18), with a total of 822 total fish reported and an average passage rate of 45.7 fish per day. The month of August had the highest peak day of 183 fish on 2 August and passage rates of 88.0 fish/day. Unfortunately, only 4 days were sampled in August due to high water and military training and these totals are minimum estimates at best. In September, passage rates averaged 6.9 fish per day. September counts were highest near the beginning of the month and dropped to zero on the 25, 27, and 28. The DIDSONs were operational through 12 October, with a total of five fish observed over 10 days. Figure 7 shows the DIDSON fish counts and out of water events for the entire 2018 season.

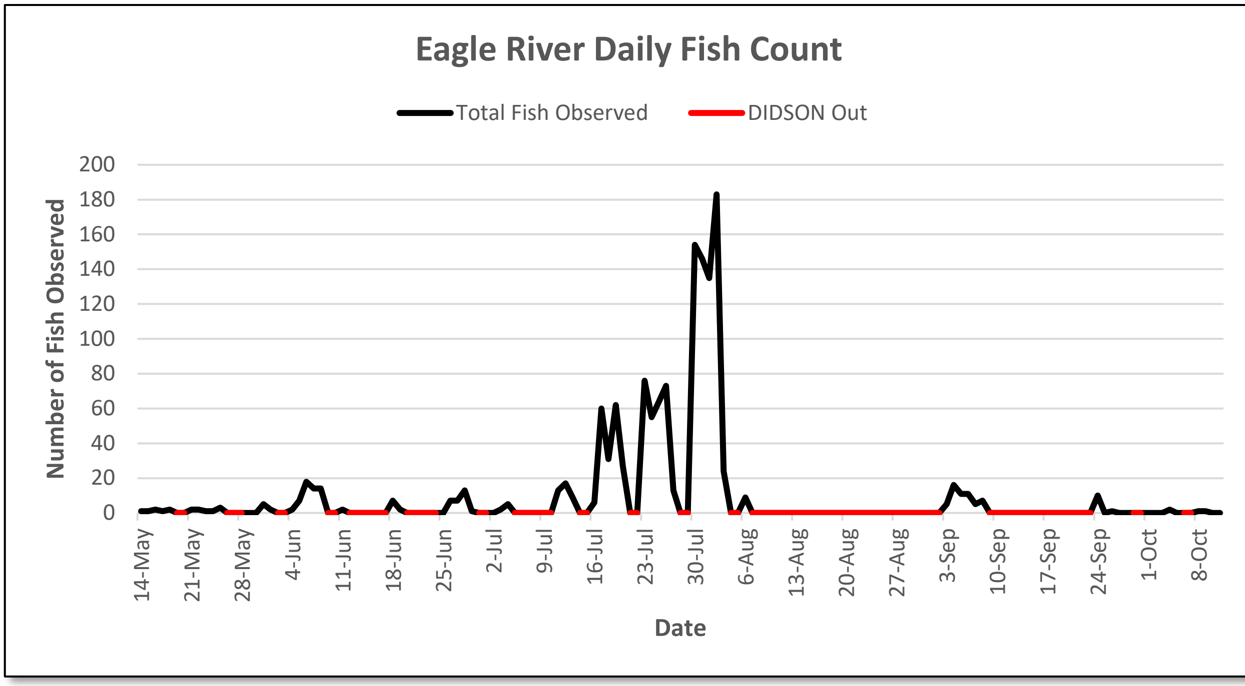

Figure 6. Eagle River DIDSON 2018 daily observations of fish passage. See Appendix A and B for more information on the total daily observations. Note: Includes downriver fish observed.

Between the period of 14 May and 19 July only 25% of the salmon had migrated past the DIDSONs. On 30 July approximately 50% of the salmon had passed, and by 2 August a total of 90% of the 2018 salmon run was complete. Peak daily passage occurred on 2 August at 183 salmon. Figure 8 shows the cumulative DIDSON fish counts for 2018.

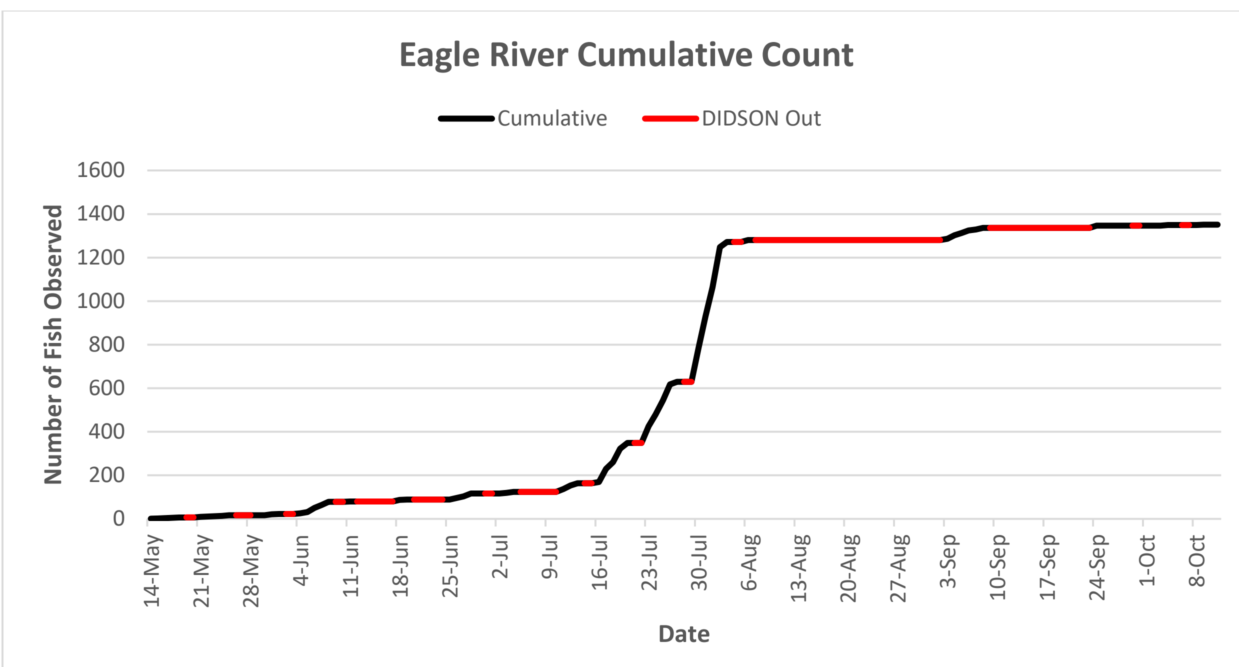

Figure 7. Cumulative daily upriver observations for the 2018 season. Note: Includes downriver fish observed.

Diurnal Patterns

Diurnal movement patterns for all fish observed were plotted against a 24-hour day (Figure 9). Plotting the time of the entire DIDSON data set shows a trend of passage rates being lowest in the early morning, from midnight to 9 a.m. then gradually increasing with highest passage rates from 6 p.m. (18hr) to 11 p.m. (23hr).

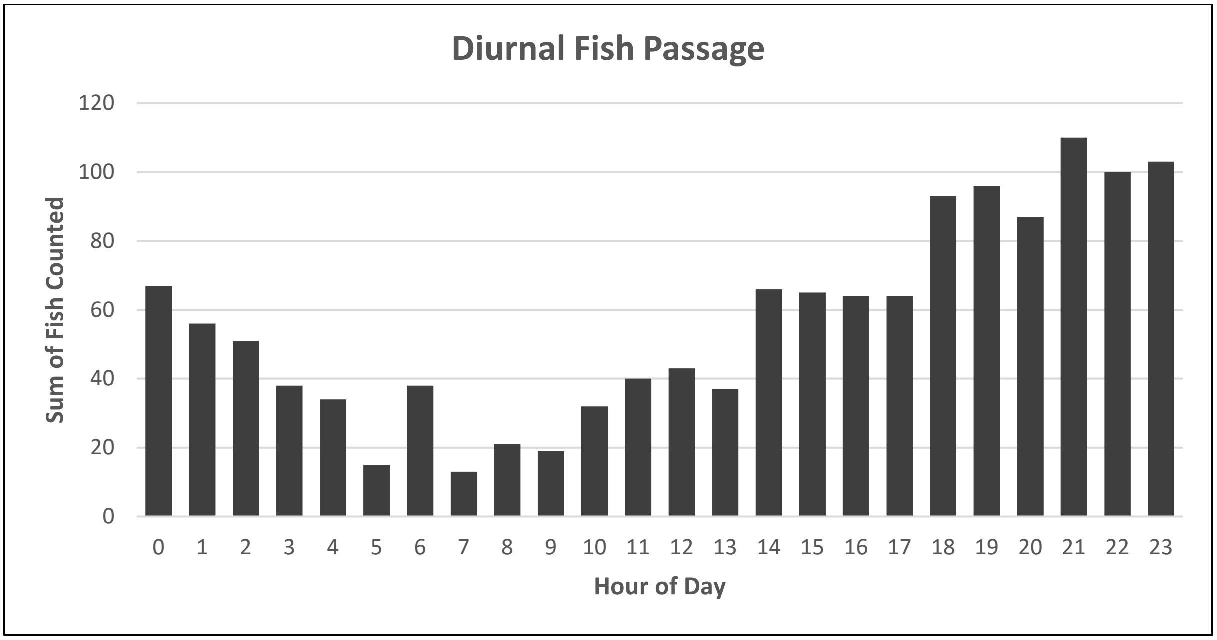

Figure 8. Diurnal pattern of hourly movement (0 to 24 hours) for all fish observed by dual-DIDSON's, Eagle River Weir, JBER, 14 May to 15 October, 2018.

Cross Channel Distribution

The range (i.e., distance from the transducer) distribution of all fish recorded on the DIDSON images varied over time (Figure 10). With two DIDSONs, we were able to adjust the viewing ranges so that they were continuously sampling the entire span of the river. It is important to note that because the range of the DIDSONs fluctuated with river height, the range does not start at a fixed point from the bank.

In May through early June, the majority of fish passed offshore, at a range of 10 m or more. Through the remainder of June and July the fish were relatively uniformly distributed within the first 10 m. Towards mid-August and for the remainder of the season, fish were more concentrated within the first 5 m of range. Overall, 93% of total fish enumerated traveled within 0-6 m range of the DIDSONs; the remaining 7% were observed within the 6-22 m range.

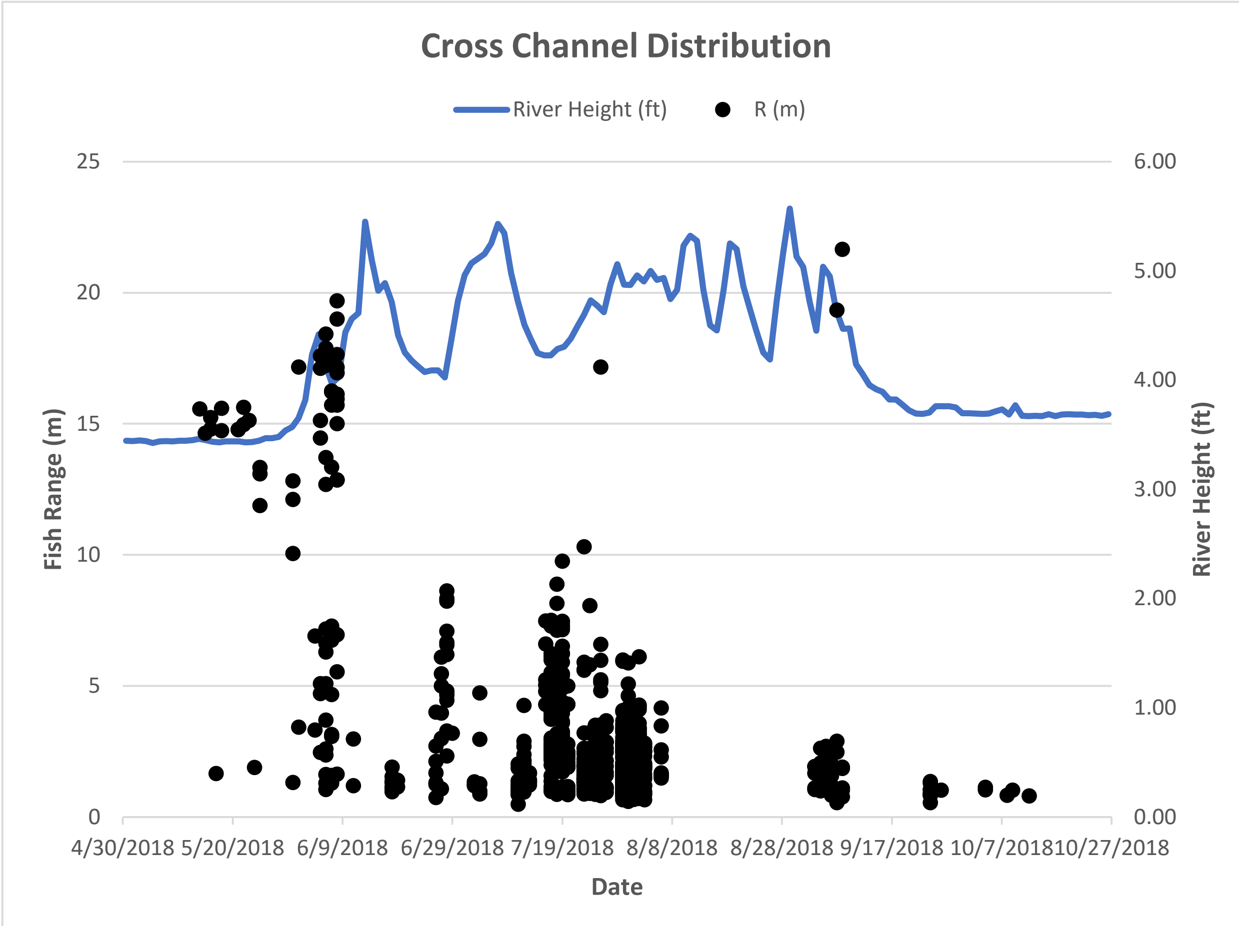

Figure 9. Cross channel distribution of all fish observed plotted against the NOAA staff gauge in Eagle River.

Annual Comparative Data

Adult salmon migrating up the Eagle River have been enumerated annually since 2012. Over this six year period, enumeration techniques have been modified, so counts between years may not be directly comparable. Highest cumulative counts were recorded in 2017 (n = 12,842) and 2015 (n = 12,755) and lowest counts in 2012 (n = 1,646) and 2018 (n = 1,377) (Figure 11).

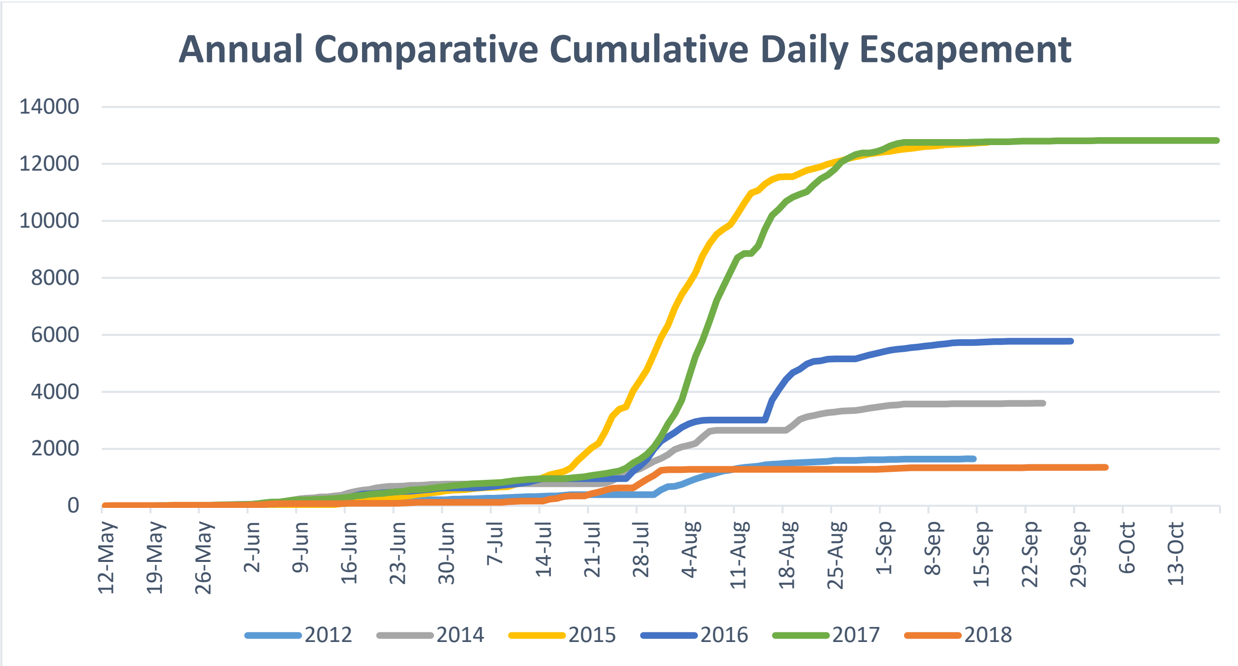

Figure 10. Daily cumulative comparison of adult salmon counts from 2012-2018. [1]

Comparison of daily escapement across years indicates that the adult salmon run into Eagle River begins in mid-May, increases in June, peaks in mid-to-late-July and continues through August, and then tapers off throughout September and October. The daily peak for 2012 occurred on 31 July with 171 fish; in 2014 on 6 August with 227 fish; in 2015 on 2 August with 598 fish; in 2016 on 16 August with 700 fish; in 2017 on 4 August with 798 fish; and in 2018 on 2 August with 183 fish. The earliest date a fish was documented was14 May 2018 and the latest a fish was recorded was 18 October 2017.

[1] In 2013, the DIDSON equipment was damaged due to flooding and data was not able to be collected for the season.

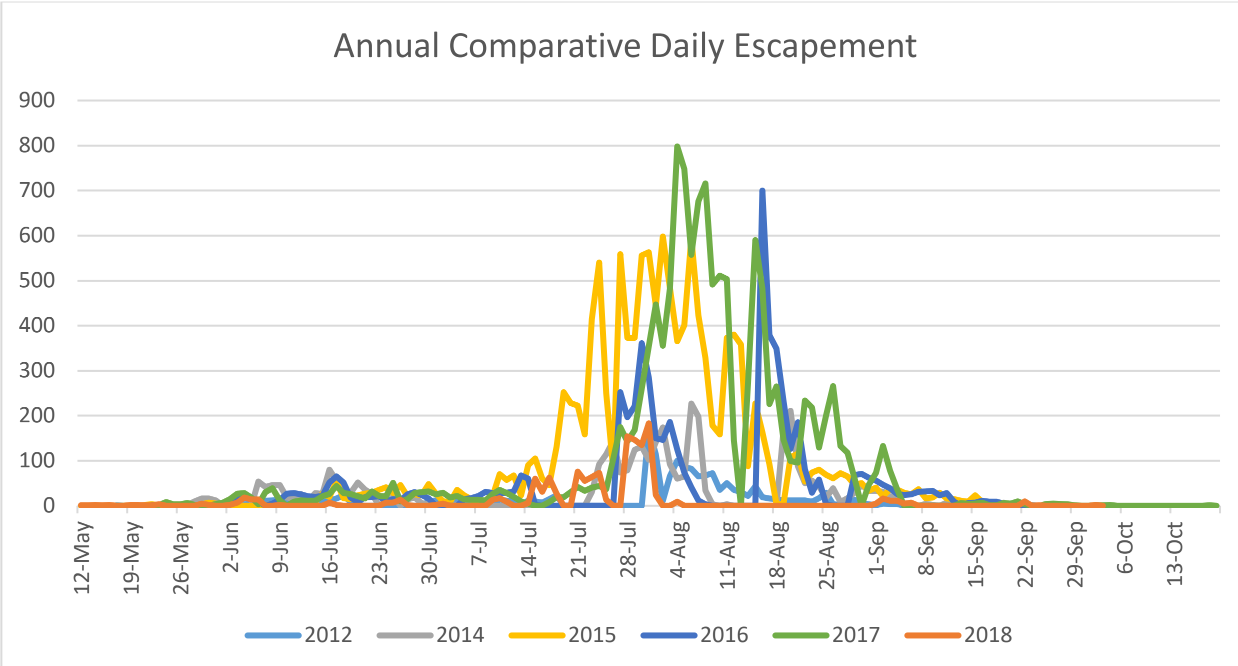

Figure 11. Daily comparison of adult salmon counts from 2012-2018. [2]

Site Staff Gauge

The National Oceanic and Atmospheric Administration (NOAA) maintains a staff gauge on Eagle River located at the Glenn Highway Bridge that records river height hourly. This information is available in real time at: https://water.weather.gov/ahps2/hydrograph.php?gage=erba2&wfo=pafc.

A staff gauge with two HOBO data loggers attached to it is also maintained at the weir site. The HOBOS record water temperature, air temperature, and water depth every hour on the hour. Although there is a 2-foot difference in height between the weir site and the NOAA Eagle River gauges, comparison of data from the two sites indicates the two gauges were highly correlated and followed the same trend line (Figure 12). As a general rule, the DIDSONs were removed from the water anytime the staff gauge rose above 4.3 ft. Gauge height over 5 ft. was too dangerous to deploy crews to retrieve the DIDSONs (Figure 13).

[2] In 2013, the DIDSON equipment was damaged due to flooding and data was not able to be collected for the season.

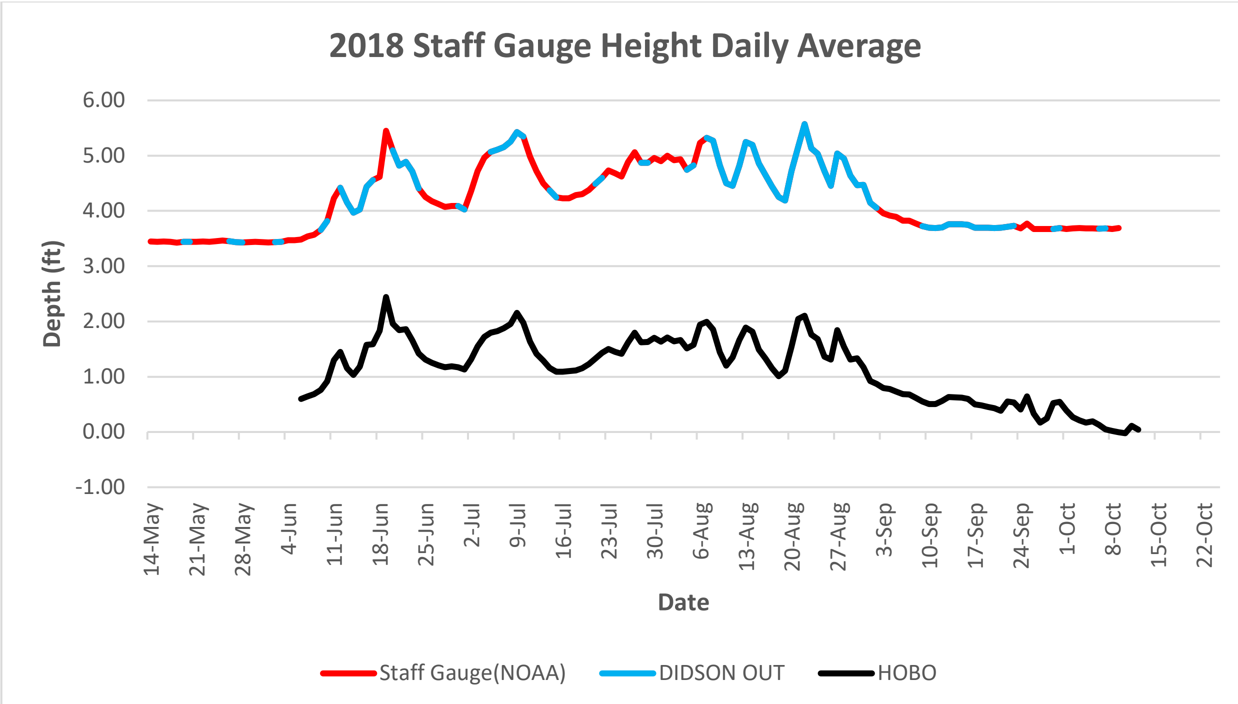

Figure 12. Comparison of Eagle River water depth (daily average) at the Glenn Highway Bridge site, and the on-site location HOBO.[3]

[3] On site location staff gauge readings were taken once a day in the morning at varying times and therefore are not daily averages. However, without adequate data from the staff gauge, the HOBO data was used instead, which was a daily average from each hour of the day. NOAA staff gauge depths were also averaged from each hour measurements.

Figure 13. These images are examples of what damage can occur in a matter of hours at the weir site due to high water events. Flooding compounded with very large debris can result in catastrophe if the equipment is not secured properly. Removal of this equipment in these conditions is dangerous and should be avoided if possible.

DISCUSSION

Enumerating adult salmon in Eagle River is challenging, requires specialized equipment, and the proper selection of sampling techniques. Deployment of field equipment in a safe and effective manner is often difficult due to the seasonally high flow rates and water level fluctuations regularly occurring at this site. Eagle River discharge is driven by high elevation snowmelt, glacier melt, and periods of heavy rain. Increasing river height caused by warming ambient air temperatures melting ice from Eagle Glacier is the trend throughout the summer months. Runoff from this watershed eventually reduce light levels and increase turbidity levels as the drainage becomes littered with debris and sediments. Monitoring fish abundance in this type of environment would normally be an extremely time consuming and invasive procedure though sonars technology has been used in recent years as a measure to overcome many of the difficulties which arise from working in this type of environment (Boswell et al. 2008; Burwen et al. 2010).

While sonars are able to produce fish count estimates with a high degree of accuracy and precision, the ability to consistently monitor progress throughout each week was greatly reduced by various factors out of the control of the expected study design protocol. There have been numerous changes to the operational procedures for this project since its inception, which may account for inconsistencies in fish population estimates across the six-year duration of the project. From 2012 to 2014, a standardized technique was initiated involving a single DIDSON sonar to estimate salmonids in the river. The primary methods for enumerating fish consisted of recording 15-minute intervals in the near followed by 15-minutes in the far. Alternating cycles was done here as a means to capture fish passage across the entire span of the river. The methods employed to review the data files used a system integrated in the DIDSON software called Convolved Samples Over Threshold (CSOT). The CSOT program reviewed files and consolidated fish passage information into files and was subsequently reviewed by technicians. To account for the interval between recordings, the daily fish passage data files were doubled to fill gaps in the data resulting from the use of one sonar.

To improve upon the existing enumeration process, two DIDSON sonars were deployed in 2015 which increased the overall coverage area. The implementation of the second DIDSON allowed for a comprehensive view (100% when both sonars were deployed, working properly, and with good field of view) of the river, ultimately improving upon the accuracy and precision of the results. In addition, a number of further changes were introduced in respect to data review and enumeration. After review of the CSOT output, it was determined that the program was not effectively identifying the entirety of the fish passage occurring at Eagle River. Eagle River is a glacial fed river system which discharges heavy loads of silt runoff and sedimentation. Other factors such as high turbidity, rapidly changing water depth, large debris, and other interference create a difficult environment for the CSOT to properly capture up and downstream movement of fish. Due to the poor quality of results generated by the CSOT, all data would need to be reviewed by technicians. Total fish counts increased substantially after the inclusion of an additional sonar followed by the raw data review. As such, this has continued to be the preferred methodology for assessing fish populations in the Eagle River system.

The 2018 field season was especially challenging due to the timing of multiple high-water events preventing the normal operation of the DIDSON sonars. One such disruption occurred between 7 August and 2 September, in which the sonars were removed from the system for a total of 671 hours. The event was caused by both high-water conditions and military training exercises. Military operations are a priority and often require any research in the area to cease until completed. This period coincided with a historically documented peak salmon run for this river and likely contributed to substantial inaccuracies in the final estimates. The gap in information created during these events can be interpolated based on prior and future fish counts, although will result in a degree of uncertainty when evaluating the overall health of the system. Estimating peak periods of abundance is essential to understanding the wellbeing of a species and an essential component when attempting to evaluate current health as well as predict future trends (Gresh et al. 2000; Roettiger et al. 2003).

Weir placement at this site was chosen due to criteria related to ease of access, level-bottom profile, and proximity to an electrical source. While other areas would be suitable considering the expectations given, other measures should be explored first before considering a reevaluation of weir site. One improvement to the existing system would be to integrate a debris blockade or deflector just up-river from the fish weir. Numerous trees and large brush became entangled in the system throughout this past season, resulting in a substantial time commitment placed towards removal and weir maintenance. Additional funding and time would be necessary though the added efforts would be a valuable addition to the proper functioning of this station. Further efforts should be placed towards developing methodologies which can better adapt to the landscape of a fluid environment, data analysis which evolves with available technologies, and continuing to coordinate timing with partners to ensure a comprehensive evaluation of our existing resources.

CONCLUSION

The adult salmon enumeration project in Eagle River on JBER concluded its seventh field season in 2018. A total of 1,352 salmon were observed moving upriver on the DIDSONs in 2018, which is considered a below average run size based on the DIDSONs deployment days during the sampling period. The single largest impediment for this project this season was the lack of deployment on weekends. The single largest challenge that this project faced was the rapid water fluctuations and high-water events throughout the peak migrations for the salmon. This season was a success while recording, utilizing two DIDSONs to sample the entire river continuously and providing an accurate representation of the number of salmon traveling upstream of the sample site while deployed.

RECOMMENDATIONS

1. One of the largest challenges this project faces is rapidly fluctuating water depths and high flow events. Two suggested options for this challenge are:
    a. Increase the DIDSON’s high water operational threshold as suggested in U.S. Army Corps of Engineers, Alaska District (USACE) 2013 report.
    b. Alternatively, adjust the gear in the river according to the weather forecasts and technician comfortability.
2. Water temperature plays a role in the migration of the salmon (Wilson and Kelly 1984). It is suggested that water temperature continue to be monitored using the HOBO’s on Eagle River to see if that is the case with salmon utilizing Eagle River.
3. It was observed during the 2018 season that 93.3% of fish travelled within 6 meters of the near bank DIDSON, which suggests a preferred near shore section of the river. It is recommended that the weir consistently block the entire area behind the sonar so fish are forced in front of the sonar for sampling.
4. A continuous view of the ensonified area of the river is critical to enumerate salmon accurately within the river. It is highly recommended that a dual DIDSON system continue to be used in the future. If only one image can be utilized, prioritize the near, especially 0-10m.
5. Continue start dates in mid-late May and end dates in October to ensure capturing the run of adult salmon in its entirety.
6. There are inconsistencies between years on how gap days are defined due to partial days being recorded. Going forward, using 24-hour increments and Julian dates will make a more accurate assessment of the amount of time sampled.

7. Recording 7 days a week would provide a more accurate enumeration of the run.
8. Having a larger crew on site with access to vehicles and having them available on a daily basis would provide for more assistance on emergency removal of equipment in the river.

ACKNOWLEDGEMENTS

This study would not have been successful without the efforts of the field technicians: Krystina Bottom, Nolan Schubert, and Anthony Adams. We would like to thank these technicians for their many hours in the cold water maintaining the equipment in challenging conditions, analyzing and organizing data, and many hours of data quality control. We would also like to thank Tracey Gotthardt and Colette Brandt for their guidance and assistance on the project.

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APPENDICE

Appendix A: DIDSON Daily Observed Fish Counts.

All Fish Observed				
	Near	Far	Near + Far	
Date	Fish Observed	Fish Observed	Total Fish Observed	Cumulative
14-May	1	SINGLE SONAR	1	1
15-May	1	SINGLE SONAR	1	2
16-May	2	SINGLE SONAR	2	4
17-May	1	SINGLE SONAR	1	5
18-May	2	SINGLE SONAR	2	7
19-May	0	SINGLE SONAR	0	7
20-May	0	SINGLE SONAR	0	7
21-May	2	SINGLE SONAR	2	9
22-May	2	SINGLE SONAR	2	11
23-May	1	SINGLE SONAR	1	12
24-May	1	SINGLE SONAR	1	13
25-May	3	SINGLE SONAR	3	16
26-May	0	SINGLE SONAR	0	16
27-May	0	SINGLE SONAR	0	16
28-May	0	SINGLE SONAR	0	16
29-May	0	SINGLE SONAR	0	16
30-May	0	SINGLE SONAR	0	16
31-May	5	SINGLE SONAR	5	21
1-Jun	1	1	2	23
2-Jun	0	0	0	23
3-Jun	0	0	0	23
4-Jun	2	0	2	25
5-Jun	3	4	7	32
6-Jun	10	8	18	50

All Fish Observed				
	Near	Far	Near + Far	
Date	Fish Observed	Fish Observed	Total Fish Observed	Cumulative
7-Jun	9	5	14	64
8-Jun	3	11	14	78
9-Jun	0	0	0	78
10-Jun	0	0	0	78
11-Jun	2	0	2	80
12-Jun	0	0	0	80
13-Jun	0	0	0	80
14-Jun	0	0	0	80
15-Jun	0	0	0	80
16-Jun	0	0	0	80
17-Jun	0	0	0	80
18-Jun	7	0	7	87
19-Jun	2	0	2	89
20-Jun	0	0	0	89
21-Jun	0	0	0	89
22-Jun	0	0	0	89
23-Jun	0	0	0	89
24-Jun	0	0	0	89
25-Jun	0	0	0	89
26-Jun	7	0	7	96
27-Jun	7	0	7	103
28-Jun	13	0	13	116
29-Jun	1	0	1	117
30-Jun	0	0	0	117
1-Jul	0	0	0	117
2-Jul	0	0	0	117
3-Jul	2	0	2	119

All Fish Observed				
	Near	Far	Near + Far	
Date	Fish Observed	Fish Observed	Total Fish Observed	Cumulative
4-Jul	5	0	5	124
5-Jul	0	0	0	124
6-Jul	0	0	0	124
7-Jul	0	0	0	124
8-Jul	0	0	0	124
9-Jul	0	0	0	124
10-Jul	0	0	0	124
11-Jul	13	0	13	137
12-Jul	17	0	17	154
13-Jul	9	0	9	163
14-Jul	0	0	0	163
15-Jul	0	0	0	163
16-Jul	6	0	6	169
17-Jul	60	0	60	229
18-Jul	31	0	31	260
19-Jul	62	0	62	322
20-Jul	27	0	27	349
21-Jul	0	0	0	349
22-Jul	0	0	0	349
23-Jul	76	0	76	425
24-Jul	55	0	55	480
25-Jul	64	0	64	544
26-Jul	73	0	73	617
27-Jul	13	0	13	630
28-Jul	0	0	0	630
29-Jul	0	0	0	630
30-Jul	154	0	154	784

All Fish Observed				
	Near	Far	Near + Far	
Date	Fish Observed	Fish Observed	Total Fish Observed	Cumulative
31-Jul	146	0	146	930
1-Aug	135	0	135	1065
2-Aug	183	0	183	1248
3-Aug	24	0	24	1272
4-Aug	0	0	0	1272
5-Aug	0	0	0	1272
6-Aug	9	0	9	1281
7-Aug	0	0	0	1281
8-Aug	0	0	0	1281
9-Aug	0	0	0	1281
10-Aug	0	0	0	1281
11-Aug	0	0	0	1281
12-Aug	0	0	0	1281
13-Aug	0	0	0	1281
14-Aug	0	0	0	1281
15-Aug	0	0	0	1281
16-Aug	0	0	0	1281
17-Aug	0	0	0	1281
18-Aug	0	0	0	1281
19-Aug	0	0	0	1281
20-Aug	0	0	0	1281
21-Aug	0	0	0	1281
22-Aug	0	0	0	1281
23-Aug	0	0	0	1281
24-Aug	0	0	0	1281
25-Aug	0	0	0	1281
26-Aug	0	0	0	1281

All Fish Observed				
	Near	Far	Near + Far	
Date	**Fish Observed**	**Fish Observed**	**Total Fish Observed**	**Cumulative**
27-Aug	0	0	0	1281
28-Aug	0	0	0	1281
29-Aug	0	0	0	1281
30-Aug	0	0	0	1281
31-Aug	0	0	0	1281
1-Sep	0	0	0	1281
2-Sep	0	0	0	1281
3-Sep	5	0	5	1286
4-Sep	16	0	16	1302
5-Sep	11	0	11	1313
6-Sep	11	0	11	1324
7-Sep	4	1	5	1329
8-Sep	6	1	7	1336
9-Sep	0	0	0	1336
10-Sep	0	0	0	1336
11-Sep	0	0	0	1336
12-Sep	0	0	0	1336
13-Sep	0	0	0	1336
14-Sep	0	0	0	1336
15-Sep	0	0	0	1336
16-Sep	0	0	0	1336
17-Sep	0	0	0	1336
18-Sep	0	0	0	1336
19-Sep	0	0	0	1336
20-Sep	0	0	0	1336
21-Sep	0	0	0	1336
22-Sep	0	0	0	1336

All Fish Observed				
	Near	Far	Near + Far	
Date	Fish Observed	Fish Observed	Total Fish Observed	Cumulative
23-Sep	0	0	0	1336
24-Sep	10	0	10	1346
25-Sep	0	0	0	1346
26-Sep	1	0	1	1347
27-Sep	0	0	0	1347
28-Sep	0	0	0	1347
29-Sep	0	0	0	1347
30-Sep	0	0	0	1347
1-Oct	0	0	0	1347
2-Oct	0	0	0	1347
3-Oct	0	0	0	1347
4-Oct	2	0	2	1349
5-Oct	0	0	0	1349
6-Oct	0	0	0	1349
7-Oct	0	0	0	1349
8-Oct	1	0	1	1350
9-Oct	1	0	1	1351
10-Oct	0	0	0	1351
11-Oct	0	0	0	1351
12-Oct	1	0	1	1352

Appendix A- Numbers highlighted in red denote that DIDSONS were out of the water or not recording.

Appendix B: DIDSON Daily Observed Downstream Fish Counts.

Downstream Fish Observed				
	Near	**Far**	**Near + Far**	
Date	**Fish Observed**	**Fish Observed**	**Total Fish Observed**	**Cumulative**
14-May	0	0	0	0
15-May	0	0	0	0
16-May	0	0	0	0
17-May	0	0	0	0
18-May	0	0	0	0
19-May	0	0	0	0
20-May	0	0	0	0
21-May	0	0	0	0
22-May	0	0	0	0
23-May	0	0	0	0
24-May	0	0	0	0
25-May	0	0	0	0
26-May	0	0	0	0
27-May	0	0	0	0
28-May	0	0	0	0
29-May	0	0	0	0
30-May	0	0	0	0
31-May	1	0	1	1
1-Jun	0	0	0	1
2-Jun	0	0	0	1
3-Jun	0	0	0	1
4-Jun	0	0	0	1
5-Jun	0	0	0	1
6-Jun	0	1	1	2

Downstream Fish Observed				
	Near	Far	Near + Far	
Date	Fish Observed	Fish Observed	Total Fish Observed	Cumulative
7-Jun	0	0	0	2
8-Jun	0	0	0	2
9-Jun	0	0	0	2
10-Jun	0	0	0	2
11-Jun	0	0	0	2
12-Jun	0	0	0	2
13-Jun	0	0	0	2
14-Jun	0	0	0	2
15-Jun	0	0	0	2
16-Jun	0	0	0	2
17-Jun	0	0	0	2
18-Jun	0	0	0	2
19-Jun	0	0	0	2
20-Jun	0	0	0	2
21-Jun	0	0	0	2
22-Jun	0	0	0	2
23-Jun	0	0	0	2
24-Jun	0	0	0	2
25-Jun	0	0	0	2
26-Jun	0	0	0	2
27-Jun	1	0	1	3
28-Jun	0	0	0	3
29-Jun	0	0	0	3
30-Jun	0	0	0	3
1-Jul	0	0	0	3
2-Jul	0	0	0	3
3-Jul	0	0	0	3

Downstream Fish Observed				
	Near	Far	Near + Far	
Date	Fish Observed	Fish Observed	Total Fish Observed	Cumulative
4-Jul	0	0	0	3
5-Jul	0	0	0	3
6-Jul	0	0	0	3
7-Jul	0	0	0	3
8-Jul	0	0	0	3
9-Jul	0	0	0	3
10-Jul	0	0	0	3
11-Jul	0	0	0	3
12-Jul	2	0	2	5
13-Jul	0	0	0	5
14-Jul	0	0	0	5
15-Jul	0	0	0	5
16-Jul	0	0	0	5
17-Jul	3	0	3	8
18-Jul	1	0	1	9
19-Jul	0	0	0	9
20-Jul	2	0	2	11
21-Jul	0	0	0	11
22-Jul	0	0	0	11
23-Jul	0	0	0	11
24-Jul	0	0	0	11
25-Jul	0	0	0	11
26-Jul	1	0	1	12
27-Jul	1	0	1	13
28-Jul	0	0	0	13
29-Jul	0	0	0	13
30-Jul	0	0	0	13

Downstream Fish Observed				
	Near	Far	Near + Far	
Date	Fish Observed	Fish Observed	Total Fish Observed	Cumulative
31-Jul	0	0	0	13
1-Aug	0	0	0	13
2-Aug	6	0	6	19
3-Aug	0	0	0	19
4-Aug	0	0	0	19
5-Aug	0	0	0	19
6-Aug	1	0	1	20
7-Aug	0	0	0	20
8-Aug	0	0	0	20
9-Aug	0	0	0	20
10-Aug	0	0	0	20
11-Aug	0	0	0	20
12-Aug	0	0	0	20
13-Aug	0	0	0	20
14-Aug	0	0	0	20
15-Aug	0	0	0	20
16-Aug	0	0	0	20
17-Aug	0	0	0	20
18-Aug	0	0	0	20
19-Aug	0	0	0	20
20-Aug	0	0	0	20
21-Aug	0	0	0	20
22-Aug	0	0	0	20
23-Aug	0	0	0	20
24-Aug	0	0	0	20
25-Aug	0	0	0	20
26-Aug	0	0	0	20

Downstream Fish Observed				
	Near	Far	Near + Far	
Date	Fish Observed	Fish Observed	Total Fish Observed	Cumulative
27-Aug	0	0	0	20
28-Aug	0	0	0	20
29-Aug	0	0	0	20
30-Aug	0	0	0	20
31-Aug	0	0	0	20
1-Sep	0	0	0	20
2-Sep	0	0	0	20
3-Sep	0	0	0	20
4-Sep	0	0	0	20
5-Sep	0	0	0	20
6-Sep	0	0	0	20
7-Sep	0	0	0	20
8-Sep	0	0	0	20
9-Sep	0	0	0	20
10-Sep	0	0	0	20
11-Sep	0	0	0	20
12-Sep	0	0	0	20
13-Sep	0	0	0	20
14-Sep	0	0	0	20
15-Sep	0	0	0	20
16-Sep	0	0	0	20
17-Sep	0	0	0	20
18-Sep	0	0	0	20
19-Sep	0	0	0	20
20-Sep	0	0	0	20
21-Sep	0	0	0	20
22-Sep	0	0	0	20

Downstream Fish Observed				
	Near	**Far**	**Near + Far**	
Date	**Fish Observed**	**Fish Observed**	**Total Fish Observed**	**Cumulative**
23-Sep	0	0	0	20
24-Sep	0	0	0	20
25-Sep	0	0	0	20
26-Sep	0	0	0	20
27-Sep	0	0	0	20
28-Sep	0	0	0	20
29-Sep	0	0	0	20
30-Sep	0	0	0	20
1-Oct	0	0	0	20
2-Oct	0	0	0	20
3-Oct	0	0	0	20
4-Oct	0	0	0	20
5-Oct	0	0	0	20
6-Oct	0	0	0	20
7-Oct	0	0	0	20
8-Oct	0	0	0	20
9-Oct	0	0	0	20
10-Oct	0	0	0	20
11-Oct	0	0	0	20
12-Oct	0	0	0	20

Appendix B- Numbers highlighted in red denote that DIDSONS were out of the water or not recording.

Appendix C: Daily Average River Sensor Depth, Ambient Air Temperature, and Water temperature.

Date	NOAA Height (ft)	HOBO Sensor Depth (ft)	Air Temperature (°C)	Water Temperature (°C)
14-May	3.45	N/A	N/A	N/A
15-May	3.44	N/A	N/A	N/A
16-May	3.45	N/A	N/A	N/A
17-May	3.44	N/A	N/A	N/A
18-May	3.43	N/A	N/A	N/A
19-May	3.44	N/A	N/A	N/A
20-May	3.44	N/A	N/A	N/A
21-May	3.44	N/A	N/A	N/A
22-May	3.45	N/A	N/A	N/A
23-May	3.44	N/A	N/A	N/A
24-May	3.45	N/A	N/A	N/A
25-May	3.46	N/A	N/A	N/A
26-May	3.45	N/A	N/A	N/A
27-May	3.44	N/A	N/A	N/A
28-May	3.43	N/A	N/A	N/A
29-May	3.44	N/A	N/A	N/A
30-May	3.44	N/A	N/A	N/A
31-May	3.44	N/A	N/A	N/A
1-Jun	3.43	N/A	N/A	N/A
2-Jun	3.43	N/A	N/A	N/A
3-Jun	3.44	N/A	N/A	N/A
4-Jun	3.47	N/A	N/A	N/A
5-Jun	3.47	N/A	N/A	N/A
6-Jun	3.48	0.60	14.4	8.2

Date	NOAA Height (ft)	HOBO Sensor Depth (ft)	Air Temperature (°C)	Water Temperature (°C)
7-Jun	3.54	0.64	14.6	9.1
8-Jun	3.57	0.68	15.2	9.5
9-Jun	3.65	0.76	16.2	9.7
10-Jun	3.82	0.92	14.8	9.6
11-Jun	4.23	1.30	13.0	8.6
12-Jun	4.42	1.45	11.8	6.7
13-Jun	4.15	1.15	14.2	8.2
14-Jun	3.97	1.03	17.2	9.4
15-Jun	4.03	1.18	12.2	8.2
16-Jun	4.44	1.57	12.3	7.0
17-Jun	4.56	1.59	14.4	7.8
18-Jun	4.61	1.83	13.2	7.7
19-Jun	5.45	2.44	12.1	7.3
20-Jun	5.10	1.96	15.4	7.5
21-Jun	4.82	1.84	12.1	7.7
22-Jun	4.89	1.86	11.5	7.3
23-Jun	4.71	1.66	12.7	7.4
24-Jun	4.41	1.42	11.6	7.0
25-Jun	4.25	1.31	11.9	7.2
26-Jun	4.18	1.25	14.5	7.6
27-Jun	4.12	1.21	14.7	8.7
28-Jun	4.07	1.17	13.9	8.1
29-Jun	4.09	1.19	13.8	8.3
30-Jun	4.09	1.17	14.6	8.7
1-Jul	4.02	1.13	15.6	8.7
2-Jul	4.36	1.32	18.8	10.0
3-Jul	4.72	1.55	19.4	10.2

Date	NOAA Height (ft)	HOBO Sensor Depth (ft)	Air Temperature (°C)	Water Temperature (°C)
4-Jul	4.96	1.72	17.2	9.8
5-Jul	5.07	1.80	18.6	9.7
6-Jul	5.11	1.83	19.2	9.4
7-Jul	5.16	1.88	18.0	9.5
8-Jul	5.25	1.95	15.1	9.0
9-Jul	5.43	2.15	11.3	7.2
10-Jul	5.35	1.98	10.7	6.5
11-Jul	4.98	1.63	11.4	6.6
12-Jul	4.72	1.41	12.9	7.1
13-Jul	4.50	1.29	13.4	8.0
14-Jul	4.37	1.16	12.7	7.9
15-Jul	4.25	1.09	14.3	8.2
16-Jul	4.23	1.09	13.2	8.2
17-Jul	4.23	1.10	15.9	8.6
18-Jul	4.28	1.11	15.5	8.8
19-Jul	4.31	1.16	15.8	9.4
20-Jul	4.38	1.23	13.2	9.1
21-Jul	4.49	1.33	16.6	9.7
22-Jul	4.60	1.43	15.0	9.5
23-Jul	4.73	1.50	13.9	9.0
24-Jul	4.68	1.45	13.1	8.2
25-Jul	4.62	1.41	11.7	7.7
26-Jul	4.88	1.62	12.3	7.7
27-Jul	5.06	1.80	13.1	7.5
28-Jul	4.87	1.62	14.0	7.9
29-Jul	4.87	1.63	15.4	7.6
30-Jul	4.96	1.70	15.5	8.3

Date	NOAA Height (ft)	HOBO Sensor Depth (ft)	Air Temperature (°C)	Water Temperature (°C)
31-Jul	4.90	1.63	15.5	8.0
1-Aug	5.00	1.71	13.3	8.0
2-Aug	4.92	1.64	10.6	7.1
3-Aug	4.93	1.66	14.9	7.3
4-Aug	4.74	1.51	14.3	7.9
5-Aug	4.83	1.58	13.0	8.0
6-Aug	5.23	1.94	15.1	7.5
7-Aug	5.32	1.99	10.7	6.8
8-Aug	5.27	1.85	10.9	6.8
9-Aug	4.83	1.45	12.9	7.2
10-Aug	4.50	1.20	12.6	7.0
11-Aug	4.45	1.35	12.7	7.9
12-Aug	4.82	1.66	14.3	8.0
13-Aug	5.25	1.89	11.6	7.3
14-Aug	5.20	1.81	10.5	6.4
15-Aug	4.86	1.49	10.7	6.5
16-Aug	4.64	1.33	11.5	7.0
17-Aug	4.45	1.15	11.6	7.2
18-Aug	4.25	1.01	9.1	6.5
19-Aug	4.19	1.11	10.4	7.1
20-Aug	4.72	1.54	10.5	6.8
21-Aug	5.16	2.05	9.3	6.2
22-Aug	5.57	2.10	12.2	6.4
23-Aug	5.13	1.76	8.9	6.5
24-Aug	5.04	1.68	11.3	6.3
25-Aug	4.72	1.36	10.1	6.4
26-Aug	4.45	1.31	10.7	7.1

Date	NOAA Height (ft)	HOBO Sensor Depth (ft)	Air Temperature (°C)	Water Temperature (°C)
27-Aug	5.04	1.84	10.7	6.9
28-Aug	4.95	1.54	11.5	6.7
29-Aug	4.64	1.31	9.5	7.0
30-Aug	4.47	1.34	11.3	7.3
31-Aug	4.47	1.17	11.0	6.5
1-Sep	4.14	0.92	10.0	7.0
2-Sep	4.05	0.87	9.3	7.0
3-Sep	3.96	0.79	9.2	6.9
4-Sep	3.92	0.78	9.4	7.0
5-Sep	3.89	0.73	8.9	7.1
6-Sep	3.82	0.69	10.7	7.7
7-Sep	3.82	0.68	10.5	7.6
8-Sep	3.77	0.61	9.1	6.9
9-Sep	3.72	0.55	8.2	6.7
10-Sep	3.69	0.50	8.9	6.9
11-Sep	3.69	0.51	8.7	6.8
12-Sep	3.70	0.56	9.9	7.1
13-Sep	3.76	0.63	9.4	6.9
14-Sep	3.76	0.63	8.9	6.7
15-Sep	3.76	0.62	9.6	7.0
16-Sep	3.75	0.60	10.3	7.1
17-Sep	3.70	0.50	10.4	7.0
18-Sep	3.70	0.48	10.4	7.5
19-Sep	3.69	0.46	10.7	7.5
20-Sep	3.69	0.43	10.5	7.4
21-Sep	3.70	0.38	9.5	7.1
22-Sep	3.71	0.55	9.9	7.0

Date	NOAA Height (ft)	HOBO Sensor Depth (ft)	Air Temperature (°C)	Water Temperature (°C)
23-Sep	3.73	0.53	8.9	6.2
24-Sep	3.68	0.40	10.9	7.2
25-Sep	3.77	0.64	10.4	6.5
26-Sep	3.67	0.33	5.0	5.7
27-Sep	3.67	0.17	6.5	5.7
28-Sep	3.67	0.24	9.0	6.6
29-Sep	3.67	0.52	7.8	6.8
30-Sep	3.69	0.55	5.0	5.6
1-Oct	3.67	0.39	3.5	4.7
2-Oct	3.68	0.27	5.2	5.0
3-Oct	3.69	0.21	6.7	5.8
4-Oct	3.68	0.17	6.0	5.9
5-Oct	3.69	0.19	7.2	6.0
6-Oct	3.68	0.13	6.2	5.6
7-Oct	3.68	0.05	5.0	5.2
8-Oct	3.67	0.02	5.7	5.5
9-Oct	3.69	0.00	4.7	5.1
10-Oct			8.0	6.7

Appendix C- Any blank cells that were not recorded by either NOAA or the fisheries crew were done for various reasons.

Appendix D: DIDSON Sample Times.

				Sampled		Not Sampled	
Date	**Time**	**Action**	**Comment**	**Days**	**Hours**	**Days**	**Hours**
5/14/18	12:55	Start					0.0
5/18/18	14:30	Stop	WEEKEND	4.1	97.6		
5/21/18	9:50	Start				2.8	67.3
5/25/18	14:15	Stop	WEEKEND/HIGH WATER	4.2	100.4		
5/29/18	14:25	Start				4.0	96.2
6/1/18	16:45	Stop	WEEKEND	3.1	74.3		
6/4/18	9:55	Start				2.7	65.2
6/8/18	14:45	Stop	WEEKEND	4.2	100.8		
6/11/18	9:00	Start				2.8	66.2
6/11/18	14:15	Stop	HIGH WATER/WEEKEND (2)	0.2	5.3		
6/18/18	10:50	Start				6.9	164.6
6/19/18	11:15	Stop	HIGH WATER/WEEKEND	1.0	24.4		
6/25/18	11:15	Start				6.0	144.0
6/29/18	14:15	Stop	WEEKEND	4.1	99.0		
7/2/18	11:30	Start				2.9	69.2
7/4/18	9:30	Stop	HIGH WATER/WEEKEND	1.9	46.0		
7/11/18	9:35	Start				7.0	168.1
7/13/18	14:00	Stop	WEEKEND	2.2	52.4		
7/16/18	9:40	Start				2.8	67.7
7/20/18	14:15	Stop	WEEKEND	4.2	100.6		

7/23/18	9:25	Start				2.8	67.2
7/27/18	10:30	Stop	WEEKEND	4.0	97.1		
7/30/18	10:10	Start				3.0	71.7
8/3/18	12:45	Stop	WEEKEND	4.1	98.6		
8/6/18	9:05	Start				2.8	68.3
8/6/18	15:15	Stop	HIGH WATER/WEEKEND (3)/MILITARY TRAINING	0.3	6.2		
9/3/18	14:10	Start				28.0	670.9
9/8/18	11:15	Stop	WEEKEND (3)/MILITARY TRAINING	4.9	117.1		
9/24/18	10:20	Start				16.0	383.1
9/28/18	15:15	Stop	WEEKEND	4.2	100.9		
10/1/18	10:10	Start				2.8	66.9
10/5/18	14:15	Stop	WEEKEND	4.2	100.1		
10/8/18	10:06	Start				2.8	67.8
10/12/18	14:45	Stop	WEEKEND. End of Season.	4.2	100.7		

TOTAL DIDSON STUDY PERIOD	151.1 DAYS	3625.8 HOURS
SAMPLED	55.1 DAYS	1321.4 HOURS
NOT SAMPLED	96.0 DAYS	2304.4 HOURS
PERCENTAGE SAMPLED	36.44%	

PERCENTAGE NOT SAMPLED	63.56%	