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EAGLE RIVER ADULT SALMON MONITORING ON JOINT BASE ELMENDORF-RICHARDSON, ALASKA, 2014

FINAL

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Eagle River Adult Salmon Monitoring on Joint Base Elmendorf-Richardson, Alaska, 2014

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LIST OF ACRONYMS AND ABBREVIATIONS

°	degrees (angular)
°F	degrees Fahrenheit
%	percent
ADF&G	Alaska Department of Fish and Game
Ah	Amp Hours
CIBW	Cook Inlet Beluga Whale
cm^2	centimeters squared
CPUE	catch per unit effort
CSOT	Convolved Samples Over Threshold
dB	decibels
DIDSON	dual-frequency identification sonar
DVR	digital video recorder
ft	feet
INRMP	Integrated Natural Resource Management Plan
JBER	Joint Base Elmendorf – Richardson
LED	light emitting diode
m	meter
NOAA	National Oceanic & Atmospheric Administration
N_d	DIDSON count for all species of salmon recorded daily
N_s	DIDSON total seasonal count for all species of salmon
NMFS	National Marine Fisheries Service
PCEs	Primary Constituent Elements
P_d	daily proportion of salmon species caught in fish wheel
P_s	seasonal proportion of salmon species caught in fish wheel
S_d	daily number of salmon species caught by the fish wheel
S_s	total seasons number of salmon species caught by the fish wheel
T_d	total daily escapement of all salmon species
T_s	total seasons escapement for each species

ABSTRACT

The Eagle River salmon enumeration study, located on Joint Base Elmendorf-Richardson (JBER) began in 2012 and completed its third season in 2014. The 2014 study was conducted from May 23 to September 24 lasting 124 days in total. The entire span of the study was successful at estimating the run timing, relative abundance, and species composition of all Pacific salmon (*Onchorhyncus* spp.) native to Eagle River, Alaska. In total 3,638 salmon were estimated to have passed a Long Range 300 m dual-frequency identification sonar (DIDSON) in 2014. Multiple data gaps exist due to frequent high water events that halted operations at the sonar site of which the largest gap existed from July 4 to July 22. During this interruption, a large number of sockeye are thought to have been missed. Both daily and seasonal apportionment methods were used to describe the species abundance based on catch-apportioned fish caught in a fish wheel that was equipped with a motion-triggered digital video recording camera system and a live box. In total, 135 salmon were captured in the fish wheel from its installation on June 20 and lasting to September 21. The seasonal apportionment method is most likely more representative of the actual abundance of all species counted in Eagle River, except for Chinook salmon (*O. tshawytscha*). Chinook salmon daily apportionment is most likely more representative of their abundance. Chinook salmon abundance using the daily apportioned method was 768 and the seasonal apportionment was 334. Sockeye salmon (*O. nerka*), abundance using the daily apportioned method was 296 and the seasonal apportionment was 567. Chum (*O. keta*) abundance using the daily apportioned method was 266 and the seasonal apportionment was 601. Pink salmon (*O. gorbuscha*) abundance using the daily apportioned method was 398 and the seasonal apportionment was 534. Coho salmon (*O. kisutch*) abundance from the daily apportioned method was 964 and the seasonal apportionment was 1,602. Coho were found to be the most prolific salmon in Eagle River. The total of 3,638 fish estimated to have passed the DIDSON site is considered a minimum escapement and the number of salmon that migrated upstream is likely higher.

INTRODUCTION

Establishing a baseline for salmon escapement and run timing in Eagle River is an important component in understanding the presence and abundance of beluga whales (*Delphinapterus leucas)* at the mouth of Eagle River. In 2008, National Marine Fisheries Service (NMFS) listed the Cook Inlet beluga whale (CIBW) as endangered (NMFS, 2008). Beluga whales are predatory in nature and follow eulachon (*Thaleichtys pacificus)* into the Upper Cook Inlet during the spring then switch to consuming salmon (*Oncorhynchus* spp.) as the eulachon numbers decline (NMFS, 2009). When the CIBW was listed as endangered, four out of the five species of Pacific salmon, Chinook (*Oncorhynchus tshawytscha*), sockeye (*Oncorhynchus nerka*), chum (*Oncorhynchus keta*), and coho (*Oncorhynchus kisutch*), were considered as primary constituent elements (PCEs) (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).

On April 11, 2011, the final ruling to designate critical habitat for the CIBW was announced (NMFS, 2011) with all of the upper Cook Inlet, including the Knik Arm, designated as critical habitat. Joint Base Elmendorf-Richardson (JBER) property is adjacent to the Knik Arm, but no portion of JBER property is listed as critical habitat. 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 of anadromous waterways on JBER.

In 2011, HDR Inc. was awarded a contract to design and implement a salmon monitoring project in Eagle River (USACE, 2013). The pilot season was conducted during the summer of 2012 when a dual-frequency identification sonar (DIDSON) and a fish wheel with videography were deployed in Eagle River.

OBJECTIVE

The primary goal of this project is to provide a baseline enumeration of adult salmon returning to Eagle River and describe Pacific salmon species composition, run timing, and relative run strength using a DIDSON sonar and fish wheel. A secondary goal of this project is to determine if there is a correlation between the timing of the CIBW in Eagle Bay and salmon entering Eagle River.

STUDY SITE

Eagle River is a glacially fed river approximately 15 miles north of Anchorage, Alaska, wherein the lower nine river miles flow through JBER property. The last four river miles are located with the Eagle River Flats Impact Area (Figure 1). The fish wheel and DIDSON locations are approximately 4 river miles up from the mouth of Eagle River (Figure 2).

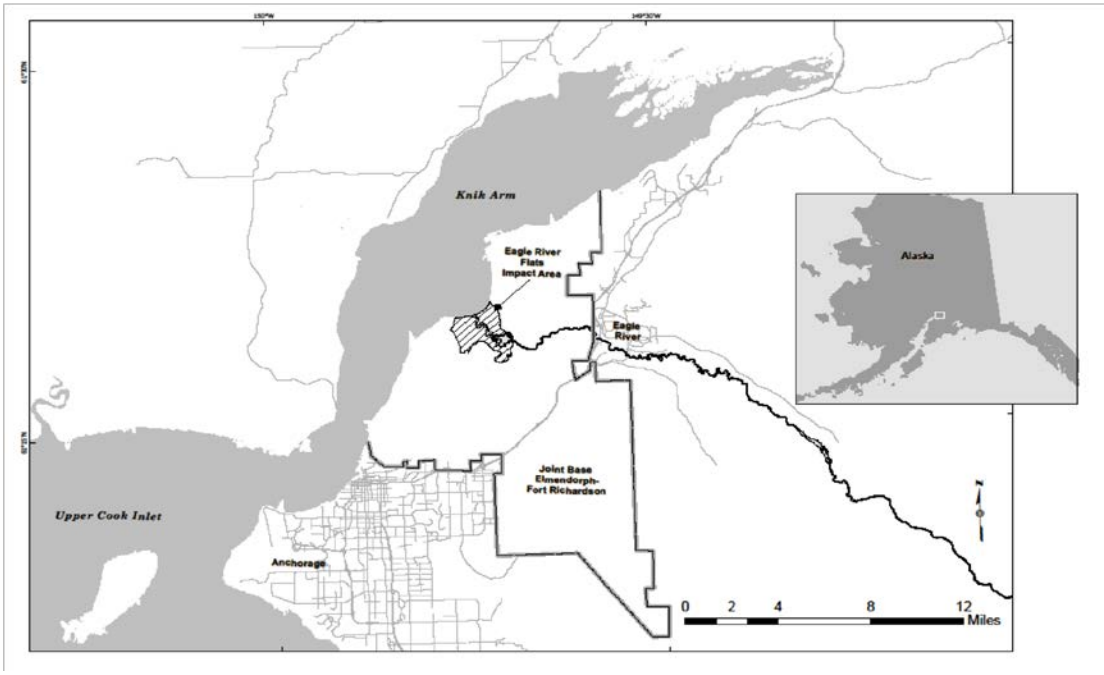

Figure 1. Location of Eagle River and JBER relative to Anchorage, AK, and Knik Arm (USACE, 2013).

Site selection for this project had multiple limiting criteria, including both stream geometry characteristics needed for the DIDSON and fish wheel equipment to operate properly, plus access and land use restrictions. It is desirable to be as far downstream as possible while remaining upstream of tidal influence, with access from the existing road system, and access to electrical utilities. The study site was required to stay upstream of the Eagle River Flats Impact Area, which contains the last four river miles, and downstream of the recreational boat take-out. These criteria limited potential sites to a 600 meter (m) section of the lower river, between Route Bravo Bridge and the boat take-out parking lot.

The DIDSON system was deployed from the left river bank approximately 500 m upstream of the Eagle River Flats Impact Area boundary and immediately downstream of the boat take-out. This site was selected because it has a single channel, wedged-shaped river cross section that matched the shape of the sonar beam, had a uniform slope without deep depressions or boulders that can create blind spots, has ease of access, and is within a reasonable distance of the suitable site for the operation of the fish wheel (USACE, 2013). The DIDSON system does not allow for accurate differentiation of species alone, therefore, a fish wheel operating concurrently is deployed to associate species and run timing with the DIDSON data collection. The fish wheel is deployed approximately 100 m downstream from the DIDSON, also on the left bank (Figure 2).

Figure 2. Location of the 2014 Eagle River adult salmon monitoring equipment (USACE, 2013).

METHODS

DIDSON Deployment

A long range model 300 DIDSON was used to passively sample moving salmon. A DIDSON is an acoustic sonar 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 DIDSON was installed on May 23, 2014 at 1454 on the river left bank and aimed 20 m towards the right bank perpendicular to the river current. A modular A-frame type picket weir was installed approximately 1 m downriver and extended approximately 1 m past the DIDSON toward the right bank to ensure that fish passed through the ensonified area and were detectable. When the water levels began to rise, the sonar was moved closer to river bank left to ensure quick and safe removal of gear when needed.

The DIDSON was placed in a silt exclusion box mounted to a metal framed tripod placed perpendicular to the river flow. The tripod frame allows for 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. A 3° concentrator lens was used to help optimize the DIDSON transducer to the river's profile (USACE, 2013).

Specific components required for the DIDSON Operation include the following:

- DIDSON LR300 unit
- Silt exclusion box
- Concentrator lens (3°)

- Data transmission cable (60 and 150 m)
- DIDSON top side controller box with power and data connections
- Data capture computer with DIDSON Control and Display software
- External storage device (Buffalo 8 terabyte drive configured Raid 10)
- Data review computer with DIDSON Viewer software
- Transducer stream mount with manual pan and tilt adjusters
- Fish exclusion weir

2014 DIDSON Data Collection and Analysis

On site, a wooden shed housed two computers and an eight terabyte external hard drive. The DIDSON viewer software (version 5.23) is installed on the first computer and used to solely manipulate the DIDSON's window length, frame rate, file duration, and sends the data to the external eight terabyte solid state hard drive. Every 15 minutes, the DIDSON would change the window length to ensure the whole river was being sampled. The near window length was from 0.48 to 10 m and the far window length was from 10 to 20 m. The DIDSON's sustained frame rate was 8 frames per second and operated in high frequency mode, 1.2 MHz.

The second computer also had DIDSON viewer software (version 5.23) installed and was used to process the raw data files into Convolved Samples Over Threshold (CSOT) format that were stored on the Buffalo external hard drive. The CSOT program uses the raw data files and writes a new file that contains only files that show motion (USACE, 2013). The user can define the parameters for the CSOT processing and during the 2012 pilot season the parameters were experimentally manipulated. The best processing parameters that resulted in the shortest files, but containing all fish contained a minimum cluster area of 200 centimeters squared (cm^2) and a minimum threshold for motion of 6.7 decibels (dB) (USACE, 2013). Once the raw data had been processed into CSOT files, the files were then reviewed. As part of the quality control process, dates with the greatest fish passage were reviewed by staff. Counts of fish were compared to a combination of echogram files and from the originals to ensure the CSOT processing was identifying all fish compared to the original raw data.

All CSOT files were reviewed in video mode, and each fish that was observed was marked and manually measured using the software. By marking and measuring fish, a Fish Count file was generated with information such as date, time, range, length, and direction of travel (upstream or downstream). Once the file reviewing was completed, the Fish Count file was merged into a Microsoft Excel worksheet with the redundant header removed (USACE, 2013).

Direction of travel of each fish was noted in the Excel worksheet; "+1" designating a fish traveling upstream and "-1" for fish traveling downstream. This Excel worksheet was also used to extrapolate and expand the fish counts. There was no overlap in the near and far field images, which resulted in the near field and far field each being sampled only 50 percent (%). Fish marked were multiplied by two to compensate for the 50% sampling rate (USACE, 2013).

2014 Fish Wheel Deployment

The DIDSON is unable to distinguish between fish species; therefore, a fish wheel is used in conjunction with the DIDSON to understand the species apportionment. The fish wheel operates

using the force of the river against the fish baskets which causes the wheel to rotate, therein capturing fish by scooping them out of the water and sliding them into either a live box or a video recorded chute that allows the fish to return to the river without handling The fish wheel was located approximately 110 m down river from the DIDSON on the left river bank. This site does not have any trees that could be used to secure the fish wheel, so a 4 feet (ft) by 4 ft gabion was constructed, filled with local river rock, and placed above the ordinary high water mark

The fish wheel consisted of the following components (Figure 3):

- Fish wheel (2 aluminum pontoons, 3 baskets (6 ft by 6 ft), pully-mounted vertically adjustable axle and sprocket assembly, and railings).
- Video chute (wood and rubber fish delivery system).
- Recording digital video system (camera, digital video recorder [DVR], and two deep-cycle 100 ampere hour [Ah] batteries).
- Electronics enclosure.
- Live box.
- Deployment system (spar poles, rebar, cables, ropes, and hardware).

The attached live box was operated only while personnel were on site. The digital video recorder and camera were used in hopes of eliminating unnecessary handling and holding of fish. Video was recorded of the fish as it slides through the primary chute prior to it being redirected to the river through the secondary chute which consists of ½ inch rubber sheeting, allowing the fish to bypass the live box.

2014 Fish Wheel Data Collection and Analysis

The fish wheel remained in one position throughout the 2014 season, although it was moved laterally as flow fluctuated to maintain adequate depth and current to rotate the baskets. The live box was operated during the day, when technicians were present, typically between 9 am and 4 pm. and was checked minimally twice daily for fish. Fish were identified by species and for Chinook, sockeye, chum and coho salmon an axillary fin clip was collected for genetic analysis by the Alaska Department of Fish and Game (ADF&G). The fish were then released promptly back into the river. During the evenings, the secondary rubber chute was put in place, the digital video recorder operated on motion detection and the fish were released immediately back into the river.

Personnel reviewed the video recording daily to identify fish that were captured and released while personnel were not on site. Fish that were easily identifiable were recorded by species and fish less easily distinguished were recorded as unknown. The unknown fish from the motion triggered video recorder were omitted from the seasonal apportionment method. Equipment maintenance and repositioning of the wheel was completed as needed throughout the season.

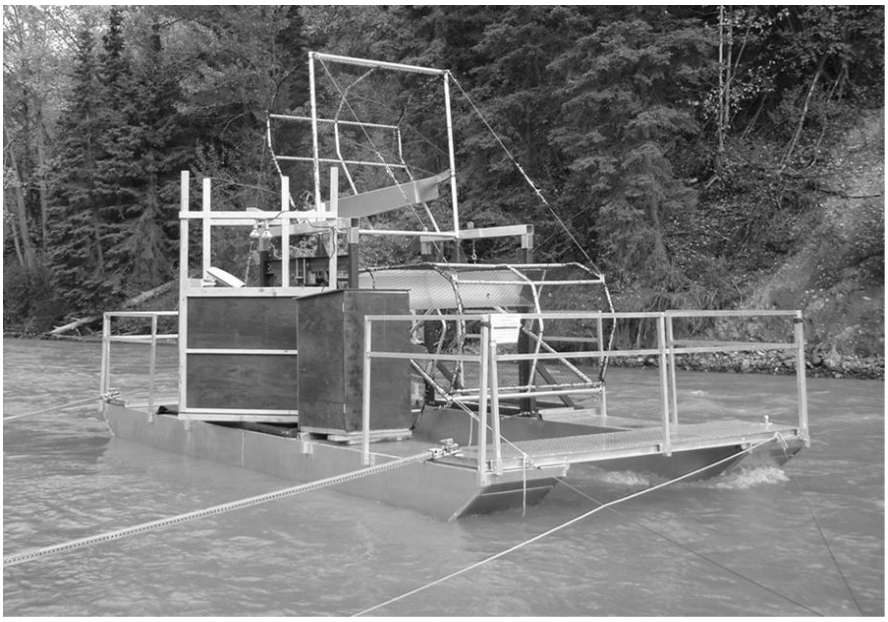

Figure 3. Photograph of the fish wheel equipped with the digital video system operating in the Eagle River (USACE, 2013).

2014 Species Proportion Estimates

The techniques for species apportionment were developed from the data collected during the 2012 season (USACE, 2013). The expanded net upstream DIDSON fish counts are calculated using both the daily and total seasonal fish wheel catch proportions. The daily apportionment is valuable to identify the run timing and relative run strength, but it can be limited because low capture success of the fish wheel. This can lead to significant discrepancies on days when large numbers of fish pass the sonar station but very few are sampled by the fish wheel. For example, during the 2014 field season on August 21, 88 salmon were estimated to have passed the DIDSON (Appendix A) station but only four fish, unknown salmon, were caught by the wheel (Appendix B) even though sockeye, chum, and coho salmon were caught in higher proportions than the unknown salmon in the days previous and following. Applying an overall seasonal apportion to the total DIDSON fish count is likely a more accurate representation of the total escapement of each salmon species. For the purposes of species apportionment it must be assumed that fish wheel species selectivity did not exist because no selectivity information is available for the sample site.

The total daily escapement for each species (T_d) was estimated by multiplying the total daily DIDSON count for all species (N_d) by the daily proportion of each species of salmon caught in the wheel on the same day (P_d) using the following equation.

$$\boldsymbol{T_d = P_d\ (N_d)}$$

Where P_d is the total number of each salmon species caught by the wheel on that day (S_d) divided by the total number of salmon caught by the wheel on that day (N_d).

$$\boldsymbol{P_d = S_d / N_d}$$

On days when no fish were captured in the fish wheel the daily species proportion *(P_d)* was interpolated by averaging the nearest one day previous (d_1) and one day following (d_2).

$$\mathbf{P_d = (d_1 + d_2)/ 2}$$

On days when the DIDSON was not operating the actual fish wheel catch (T_d) was considered as the daily passage (these days were greatly underestimated because the fish wheel typically caught ≤ 5% of the salmon counted by the DIDSON).

The total season's escapement for each species (T_s) was estimated by multiplying the total sonar season's count for all species (N_s) by the total season's proportion of each species of salmon caught in the wheel (P_s) using the following equation:

$$\boldsymbol{T_s = P_s\ (N_s)}$$

Where P_s is the total number of each salmon species caught by the wheel (S_s) divided by the total number of salmon caught by the wheel during the entire season (N_s).

$$\boldsymbol{P_s = S_s/N_s}$$

RESULTS

The DIDSON fish monitoring operation was conducted over 124 days from May 23 to September 24, 2014. On ten occasions data collection was disrupted for more than one day. The DIDSON was removed from the water several times during the 2014 season for either malfunctions, maintenance issues, or to avoid equipment damage during flooding. From May to July 2014, the DIDSON was removed for reasons such as power outages, software malfunctions and maintenance (Figure 4). Starting in July 2014, the DIDSON was removed from the water due to either expected high water events or actual high water events. The longest period of time that the DIDSON was removed from the water occurred on July 4 through July 22, 2014. Figure 4 shows that the DIDSON was operating for a period time between July 4 and July 22, 2014. This was a temporary location that occurred further downstream and was at the end of a rapid. The image that was produced from this location was not usable and the site was abandoned after a large tree knocked over the weir and DIDSON stand and broke the silt box. Once sampling started again, the far bank (river right) was unable to be sampled. According to the National Oceanic and Atmospheric Administration (NOAA) the peak river height occurred on September 14 with a height of 5.31 ft (Figure 4) (NOAA, 2015). The DIDSON operations ended on September 2, 2014 when the number of observed fish declined dramatically and access to the site was not feasible due to military training.

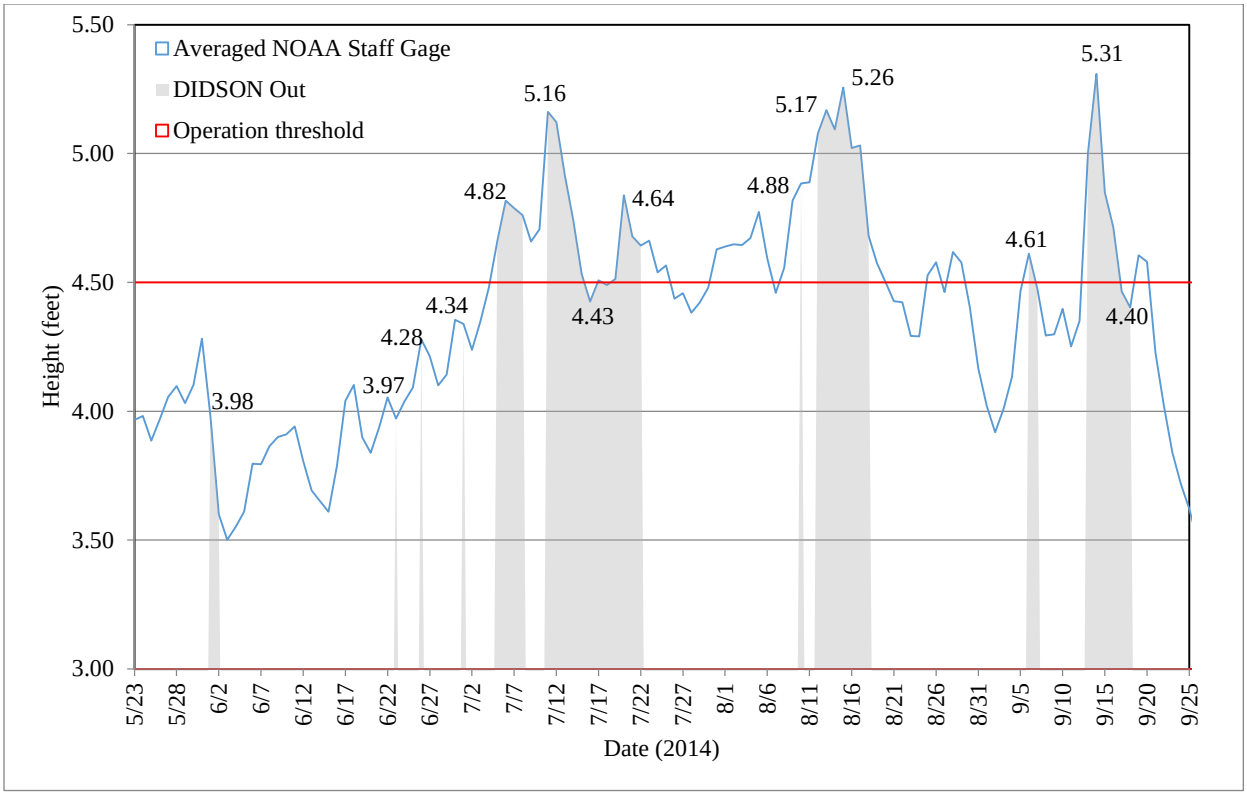

Figure 4. Daily average river height at Glenn Highway Bridge with grey bars showing when the DIDSON was not operating. Also, a red line at 4.5 ft shows the operation threshold for safely.

The DIDSON was deployed for a total of 77 days over the study period, a 62% deployment rate. The DIDSON alternated operation on 15 minute increments between near field and far field from May 23 to July 11. During this time it is thought that the entire Chinook run was adequately captured.

From the 2012 study, it was observed that following the Chinook run, approximately 98% of migrating salmon after July 23 used the near field and swam within 10 m of the left bank (i.e. the near field). From July 22, 2014 to the end of the season, the DIDSON was set to record only the near field. It is thought that a majority of the migrating salmon were captured during this period in the near field, however, an unknown number of fish were undoubtedly missed in the far field. Based on the 2012 data, it is presumed to be less than 5%.

Fish Passage

On May 27, 2014 the DIDSON recorded the first salmon. During the month of May only 56 fish where recorded by the DIDSON with an average of 6 per day and a peak of 16 fish on the 29th and 30th of May. June saw an increase in fish as 700 fish passed the DIDSON with a daily average of 23 fish per day and a peak occurring on the 16th of 80 fish. The average daily passage rate for July was 30 fish per day with a total of 917 fish passing the DIDSON during the month. A peak occurred on the 25th and 26th of July with 144 fish passing the DIDSON on both days. It is likely that the month of July would have had the largest fish passage; however, it does not, since the DIDSON was out of the river 17 of the 31 days due to high water events. This possibly led to

significant data gaps during the beginning of the sockeye run. The month of August saw the largest number of salmon pass the DIDSON, with a total of 1,820 fish for the month, an average of 59 per day and a peak occurring on the 6th with 227 fish passing in a single day. The month of September saw a decline in fish passage with a total of only 145 fish, a daily average of 6 fish and the peak occurring on the 1st of 33 fish. A total of 3,638 salmon were recorded by the DIDSON during 2014, only 67 of which were observed moving downstream. Figure 5 shows the expanded and non-expanded DIDSON fish counts for the entire season.

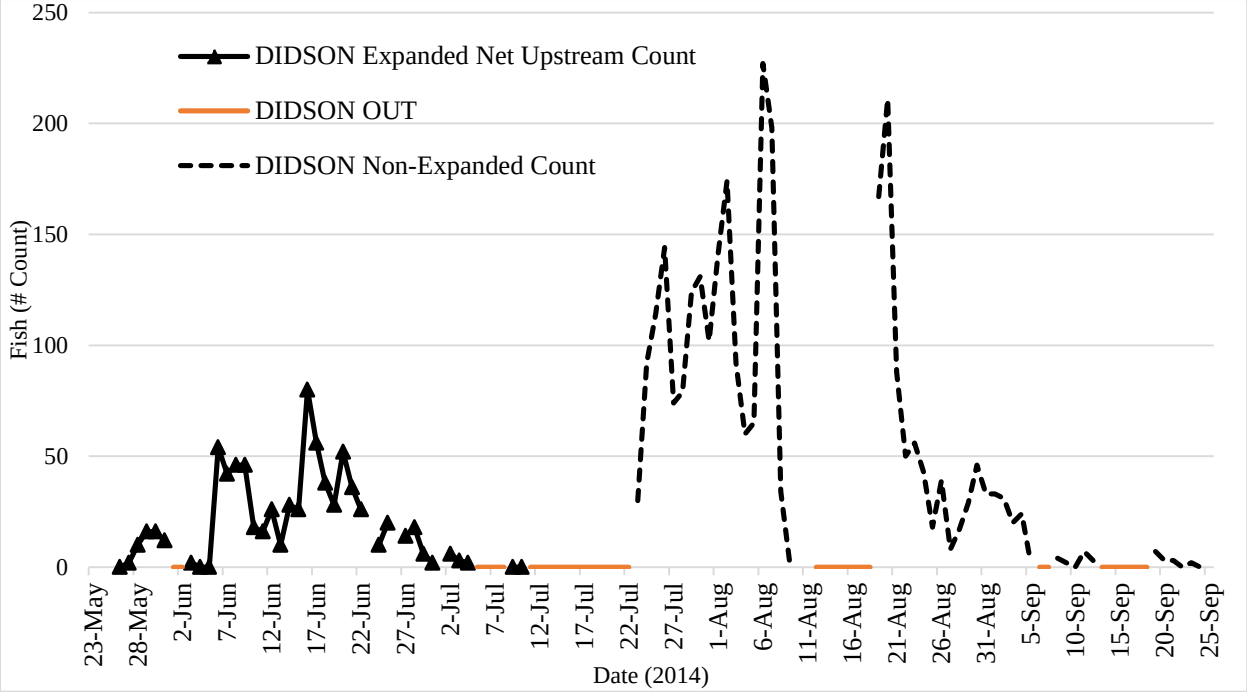

Figure 5. Eagle River DIDSON 2014 expanded & non-expanded net upstream count.

Between the period of May 14 and July 25 only 25% of the salmon had migrated past the DIDSON. This is thought to be underestimated since the DIDSON was not operating from July through July 22. On August 1 approximately 50% of the salmon had passed, and by August 23 a total of 90% of the 2014 salmon run was completed. Peak daily salmon passage occurred on August 6 at 227 salmon. Figure 6 shows the cumulative expanded and non-expanded DIDSON fish counts and percent total run passage for 2014. Appendix A contains a table of the DIDSON sonar daily observed and expanded fish counts.

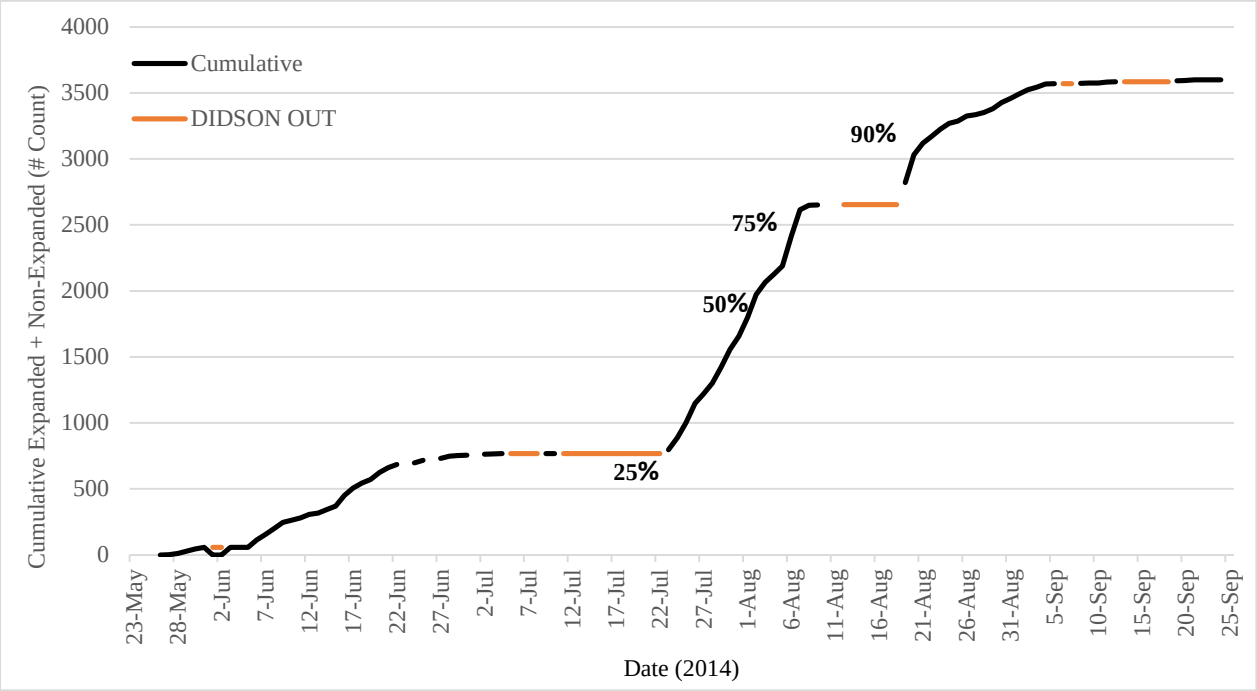

Figure 6. Cumulative daily salmon passage showing run complete percentiles for all fish recorded by the Eagle River DIDSON during 2014.

Diurnal Patterns

Diurnal movements of fish passage, sum of observed fish count per hour, were examined in 2014. The entire DIDSON dataset was plotted against the 24 hours found in a day. As seen in Figure 7, 4 a.m. to 11 a.m had the lowest passage rates. The highest passage rates occurred from 3 p.m. to 11 p.m. at night and decreased during the onset of morning.

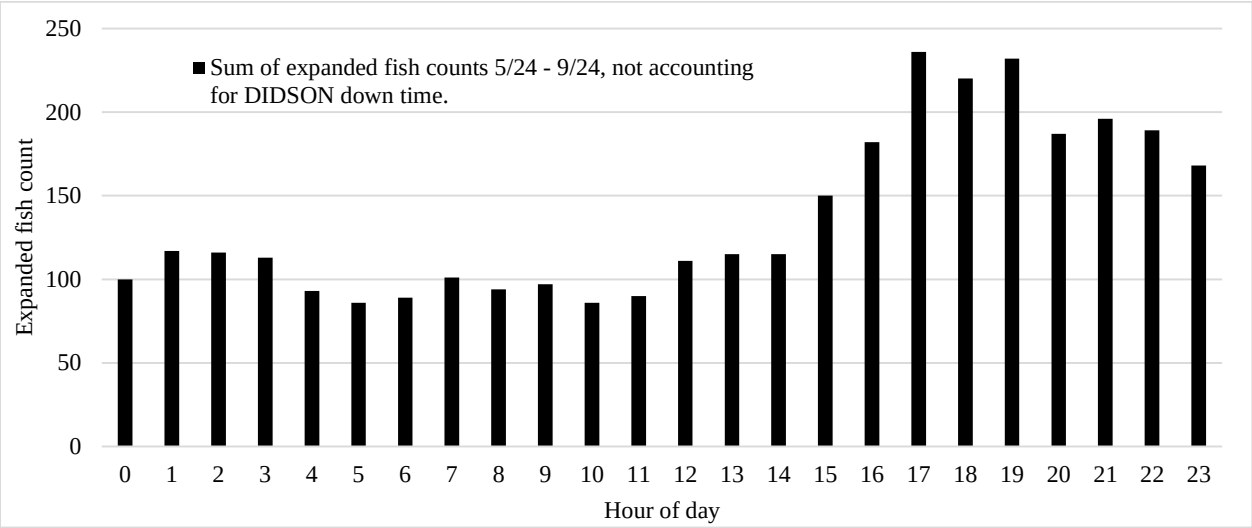

Figure 7. Diurnal pattern of fish passage by hour of day using the sum of expanded fish counts during the entire Eagle River data collection season (5/23 – 9/24) and not accounting for DIDSON down time.

Cross Channel Distribution

Figure 8 shows the range of distribution of fish as they move up river. This figure shows that early on in the season that the salmon, which are likely Chinook, use the whole stream to move up river. However, because the far range (river right) was not sampled from July 22 until the end of the season the graph is misleading because it does not depict any salmon using the far side. However, based on 2012 data, 98% of fish observed during that period were within the near field, or 10 m to the left bank.

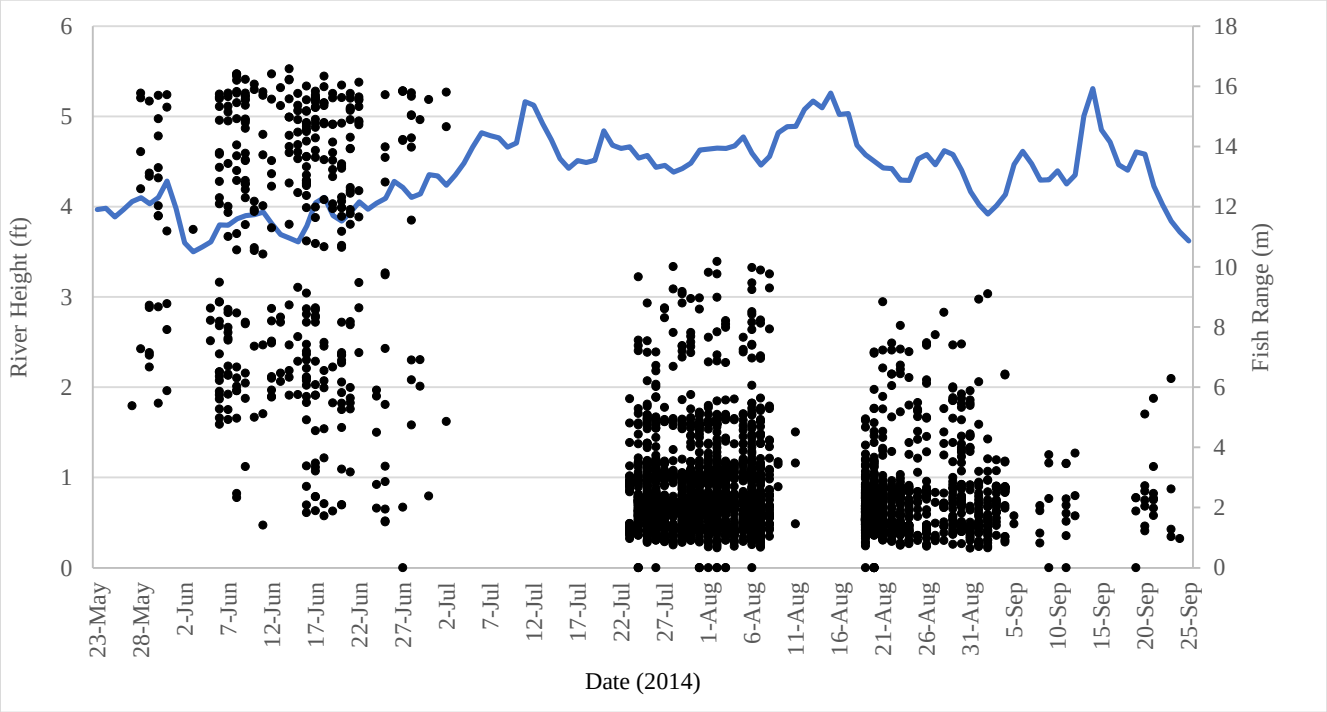

Figure 8. Range distribution over time of all fish recorded by the Eagle River DIDSON and river stage at the site during 2014.

Species Abundance and Run Timing

The fish wheel began operating June 20, 2014 with the last day of operation September 21, 2014. During this 93-day period the fish wheel operated 65.5 full days, 44 partial days where the wheel did not spin the entire day, and there were 3 times that the wheel was stopped for more than one day, the longest being July 7 to July 11. Partial operating days were due to the wheel being stopped at night by debris in three instances, and river stage dropping causing the wheel to hit the streambed and stall in five instances. An extreme high water event beginning July 12 to July 14 made working on the wheel unsafe. Mechanical issues also rendered the fish wheel inoperable for five partial days. Technical problems with the event-triggered camera system and batteries occurred, causing the fish wheel to be ineffective at identifying fish at night on 26 occasions. On August 13, a new DVR was installed and started to continuously record throughout the night. In conjunction with the continuously recording DVR, a 15-watt light emitting diode (LED) light was installed on August 26. This light helped with identification of fish that were caught in the fish wheel at night. There were a total of eight days when access to the site was restricted because of military training.

A total of 134 salmon, 3.7% of the total 2014 salmon run estimated by DIDSON were captured when the wheel was operating. Of these, 59 fish (44.0%) were captured exclusively in the holding box, 75 fish (56.0%) were identified exclusively with the digital video system. Coho salmon was the most abundant species captured in the fish wheel, comprising 35.8% (48 fish) of the total catch. 13.4% (18 fish) caught in the fish wheel were chums. While sockeye, made up only 12.7% (17 fish) of the fish caught in the fish wheel. Pink salmon made up 11.9% (16 fish) and Chinook made up 7.5% (10 fish) of the total catch. Finally, 18.7%, (25 fish) of the total fish caught in the fish wheel were not identifiable to species. These unidentifiable, unknown, fish were omitted during seasonal and daily apportionment. Table 1 summarizes the number of each species captured by the fish wheel and the method used to identify the species. Figure 9 shows the daily fish wheel catch by species related to the DIDSON daily expanded and non-expanded fish count. Table 2 shows abundance by species estimated for both seasonal apportioned and daily apportioned salmon. Appendix B contains all daily and cumulative fish wheel catch data apportioned to species.

Table 1. Number of fish captured in the fish wheel and the method used to identify the species.

Species Captured	Count per Identification Method		Total	
	Live Box	Video		
Chinook	5	5	10	7.5%
Sockeye	9	8	17	12.7%
Chum	8	10	18	13.4%
Pink	13	3	16	11.9%
Coho	24	24	48	35.8%
Unidentified	0	25	25	18.7%
Total	59	75	134	
	44%	56%		

Table 2. 2014 Daily and Seasonal Apportionments

Species	Daily Apportionment		Seasonal Apportionment	
Chinook	768	28.5%	334	9.2%
Sockeye	296	9.9%	567	15.6%
Chum	266	9.8%	601	16.5%
Pink	398	14.8%	534	14.7%
Coho	964	35.8%	1,602	44.0%

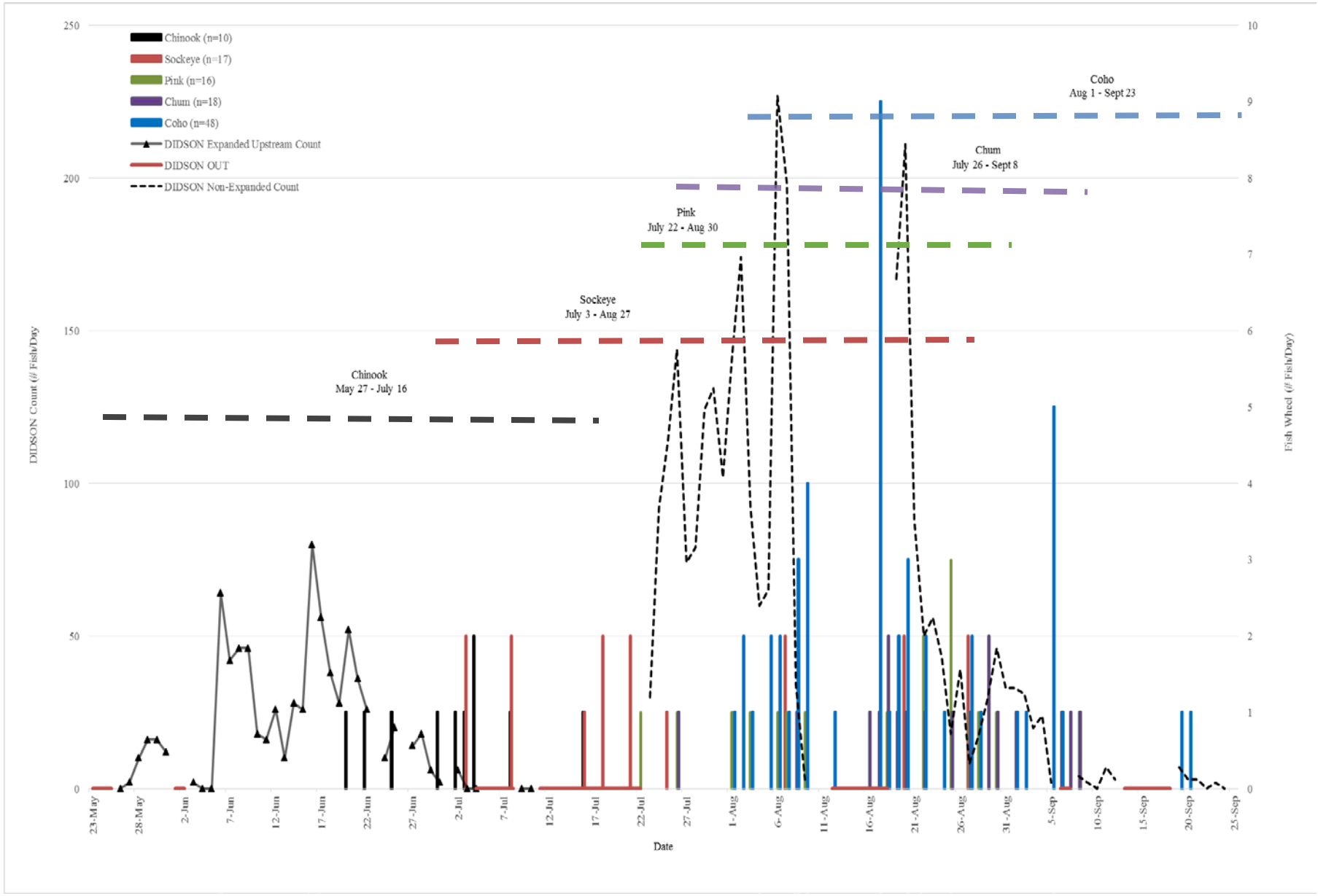

Figure 9. Daily DIDSON expanded & non-expanded net upstream count (n=3,638) and fish wheel catch (n=109) by species.

Chinook salmon

With the use of the DIDSON and the fish wheel, a daily apportionment estimate of 768 Chinook or 28.5% of the total salmon run occurred in 2014. When the seasonal apportionment method was applied, an estimate of 334 or 9.2% of the total salmon run where Chinook (Table 2). The first Chinook observed on the DIDSON was on May 27, while the first Chinook was caught in the fish wheel on June 20. The fish wheel was not operating from May 23 to June 20 to reduce the stress on the Chinook. It is implied from previous year's data and knowledge that the only species of salmon in Eagle River during this time are Chinook salmon. Chinook salmon were consistently captured by the fish wheel from June 20 through July 16. Out of the 134 salmon caught in the fish wheel 10 of them were Chinook or 7.5% of the total fish wheel catch (Table 1). Figure 10 shows the Chinook salmon daily DIDSON count plotted with the daily fish wheel catch rate.

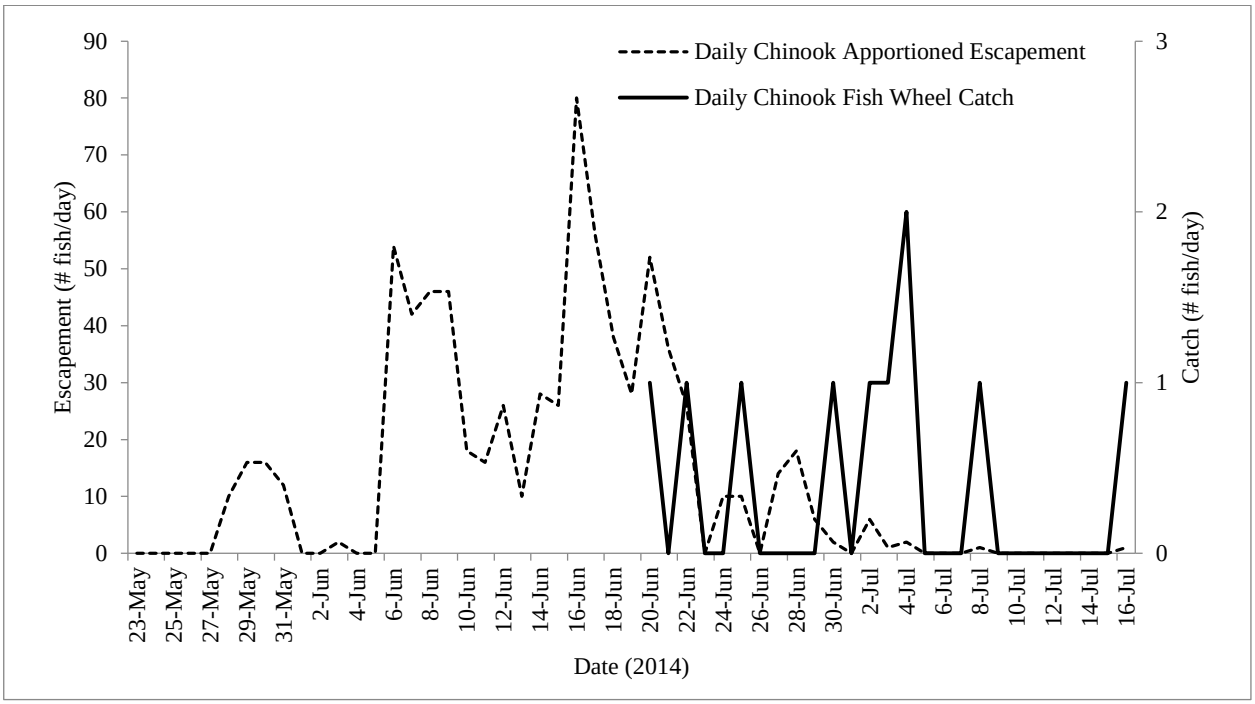

Figure 10. Chinook daily DIDSON passage estimate and fish wheel catch rate.

Sockeye salmon

With the use of the DIDSON and the fish wheel a daily apportionment estimate of 296 sockeye or 9.9% of the total salmon run occurred in 2014. When the seasonal apportionment method was applied, an estimate of 567 or 15.6% of the total salmon run where sockeye (Table 2). The first sockeye was caught in the fish wheel on July 3. The DIDSON was not operating when the first sockeyes entered the river due to a high water event. Thus, the estimated run strength was probably stronger that the estimated number. Sockeye salmon were consistently captured by the fish wheel from July 3 through August 27. Out of the 134 salmon caught in the fish wheel 17 of them were sockeye or 12.7% of the total fish wheel catch (Table 1). Figure 11 shows the sockeye salmon daily DIDSON count plotted with the daily fish wheel catch rate.

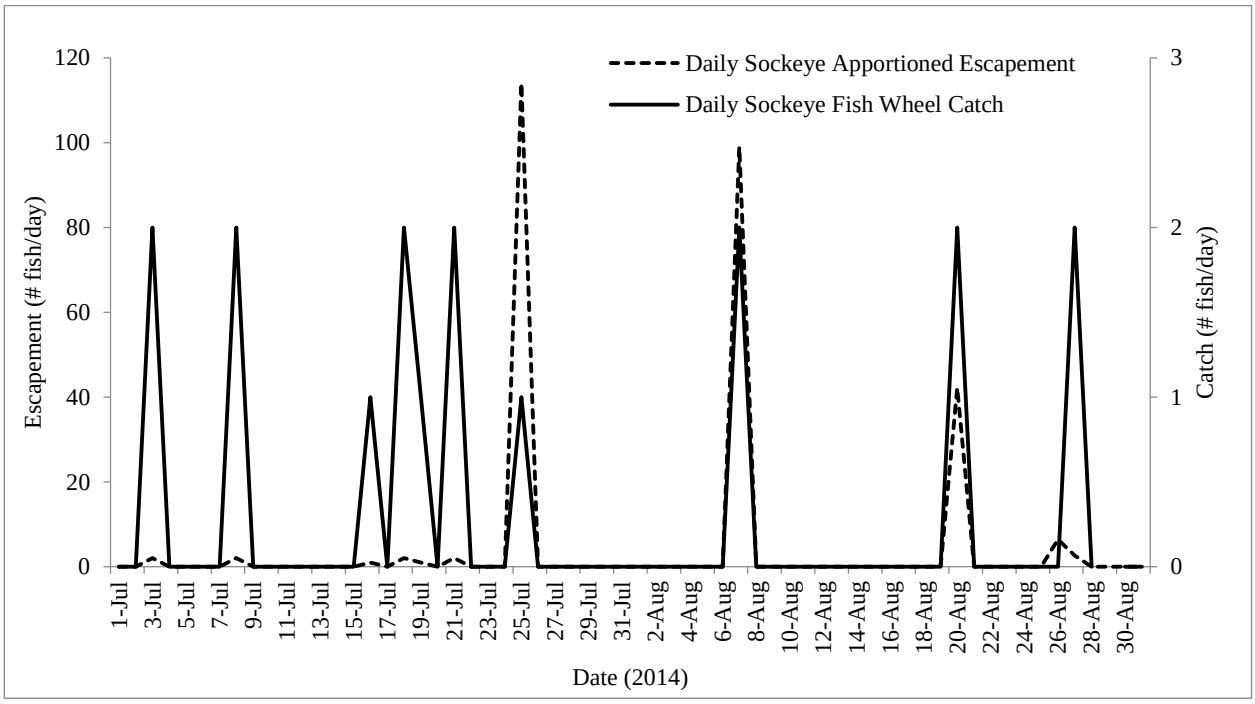

Figure 11. Sockeye daily DIDSON passage estimate and fish wheel catch rate.

Chum Salmon

With the use of the DIDSON and the fish wheel a daily apportionment estimate of 266 chum or 9.8% of the total salmon run occurred in 2014. When the seasonal apportionment method was applied, an estimate of 601 or 16.5% of the total salmon run where chum (Table 2). The first chum was caught in the fish wheel on July 26. The DIDSON was not operating because of a high water event during the period leading up to the peak chum salmon migration and therefore there are five days when chum salmon may be underestimated. Thus, the estimated run strength was probably stronger that the estimated number. Chum salmon were consistently captured by the fish wheel from July 26 through September 12. Out of the 134 salmon caught in the fish wheel 18 of them were chum or 13.4% of the total fish wheel catch (Table 1). Figure 12 shows the chum salmon daily DIDSON count plotted with the daily fish wheel catch rate.

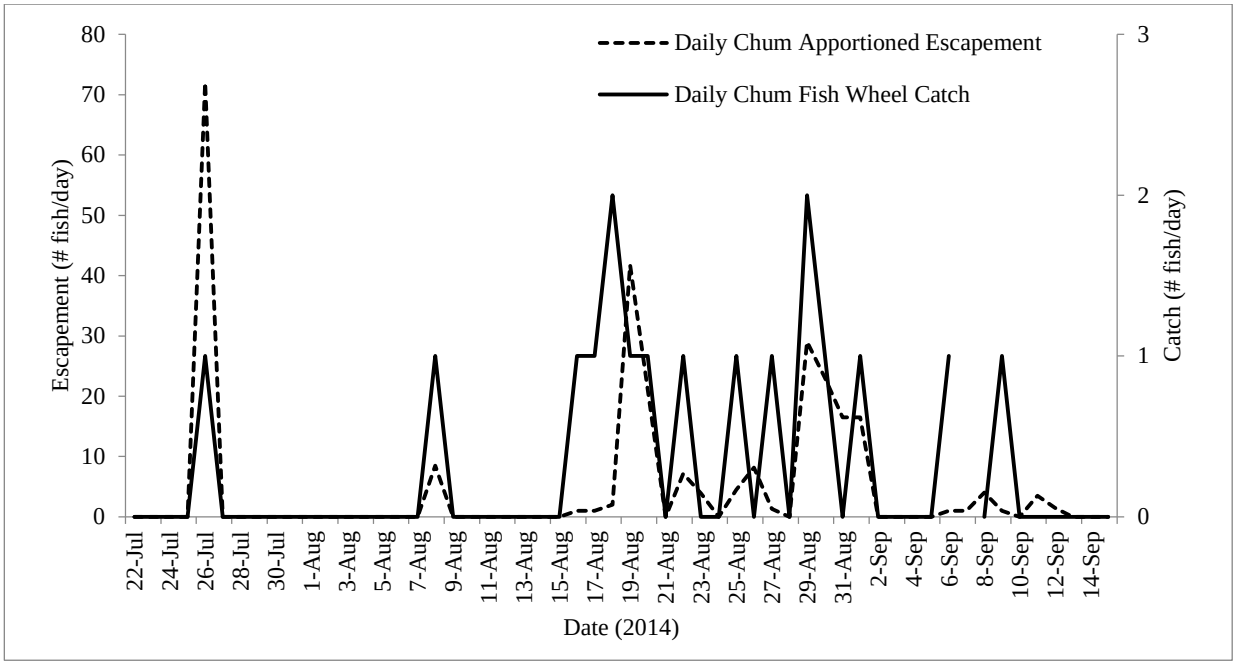

Figure 12. Chum daily DIDSON passage estimate and fish wheel catch rate.

Pink Salmon

With the use of the DIDSON and the fish wheel a daily apportionment estimate of 398 pink or 14.8% of the total salmon run occurred in 2014. When the seasonal apportionment method was applied, an estimate of 534 or 14.7% of the total salmon run where pink (Table 2). The first pink was caught in the fish wheel on July 25. The DIDSON was not operating because of a high water event during the period leading up to the peak pink salmon migration and therefore there are five days when pink salmon may be greatly underestimated. Thus, the estimated run strength was probably stronger that the estimated number. Pink salmon were consistently captured by the fish wheel from July 25 through August 31. Out of the 134 salmon caught in the fish wheel 16 of them were pink or 11.9% of the total fish wheel catch (Table 1). Figure 13 shows the pink salmon daily DIDSON count plotted with the daily fish wheel catch rate

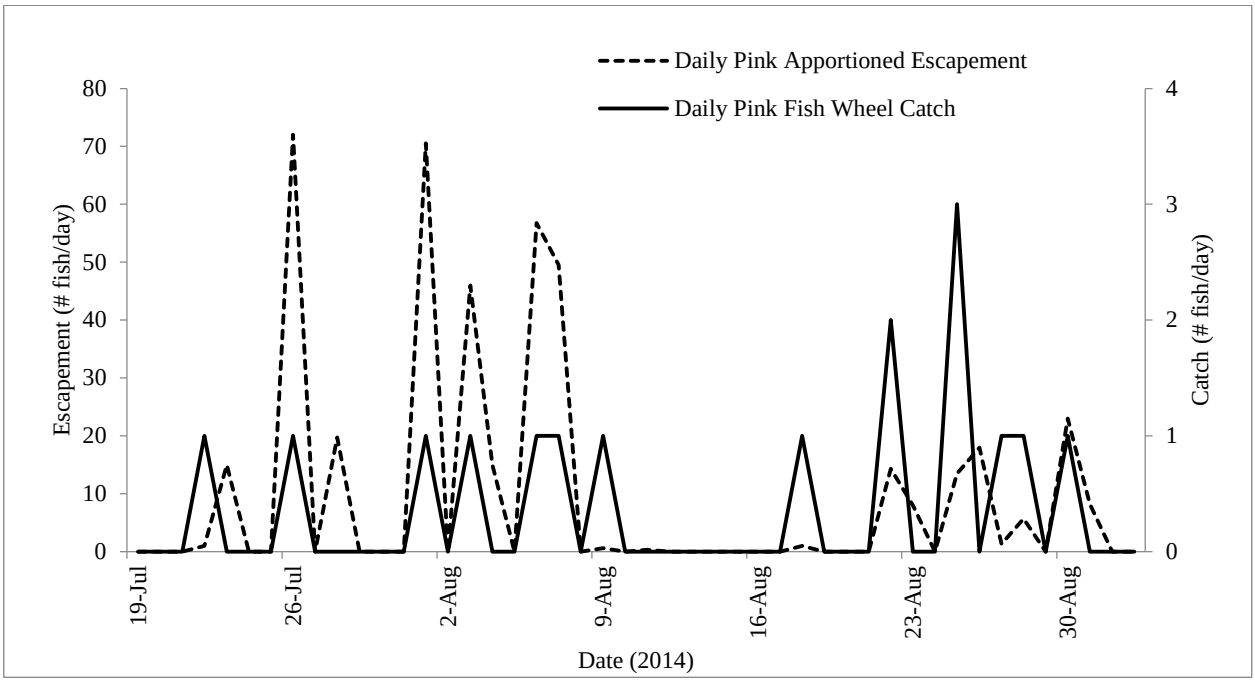

Figure 13. Pink daily DIDSON passage estimate and fish wheel catch rate.

Coho Salmon

With the use of the DIDSON and the fish wheel a daily apportionment estimate of 964 coho or 35.8% of the total salmon run occurred in 2014. When the seasonal apportionment method was applied, an estimate of 1,602 or 44.0% of the total salmon run where coho (Table 2). This is probably underestimated because salmon were still being captured on the DIDSON moving up river on the last day of operation. The first coho was caught in the fish wheel on August 1. Coho salmon were consistently captured by the fish wheel from August 1 through September 21. Out of the 134 salmon caught in the fish wheel 48 of them were coho or 35.8% of the total fish wheel catch (Table 1). Figure 14 shows the coho salmon daily DIDSON count plotted with the daily fish wheel catch rate

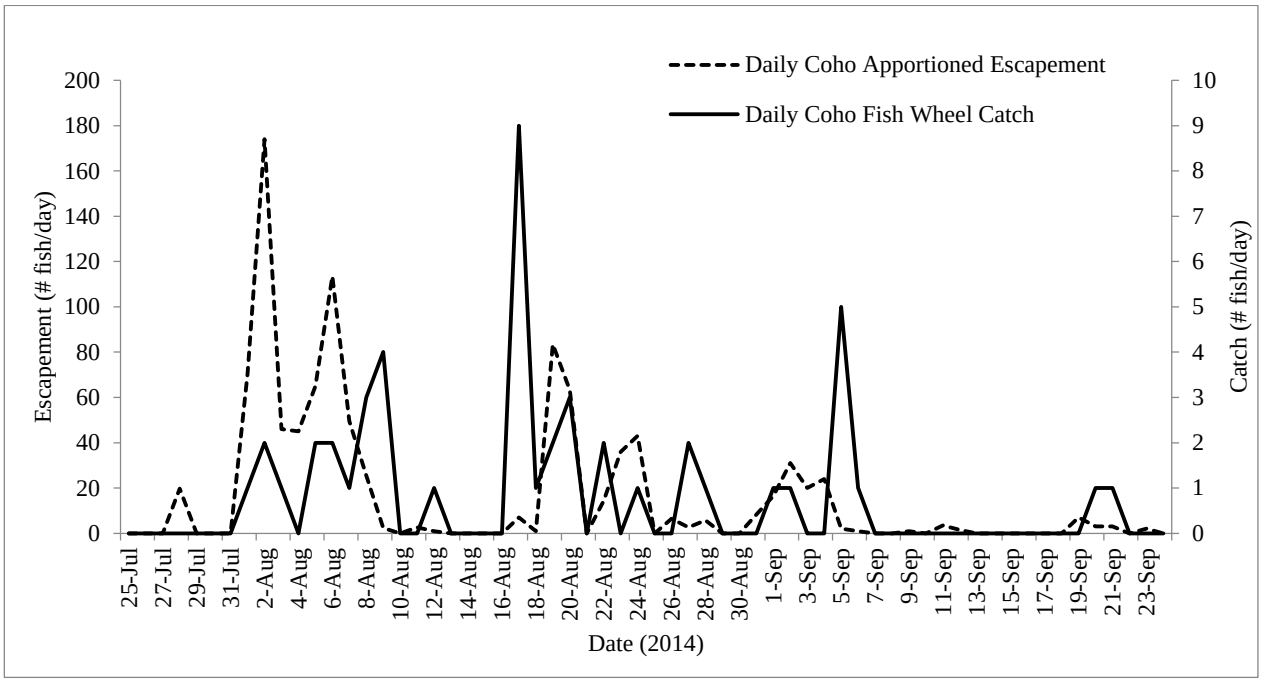

Figure 14. Coho daily DIDSON passage estimate and fish wheel catch rate.

DISCUSSION

Adult salmon enumeration in Eagle River is challenging and requires specialized in-river equipment and the proper selection of acoustic sampling techniques. Deployment of equipment is difficult in Eagle River because it has high current velocities and substantial fluctuations in water levels. Coordination between military training and sampling on Eagle River was communicated daily and all military training activities take precedence over fisheries sampling. There were only a few instances where the training took place during the day and that field crews could not access the site. However, the site could be accessed in the early morning hours prior to the training to record data and/or shut down the equipment. Site selection and equipment placement was critical to the successful use of the DIDSON and fish wheel. Establishment of the site, support equipment including mounts, weirs to direct fish away from the shoreline, enclosures for the equipment, and power supply was well established at the Eagle River site.

DIDSON Based Abundance Estimates

During the 2014 field season, the DIDSON was effective at enumerating adult salmon escapement in Eagle River. With the use of the DIDSON, a minimum estimate of 3,638 adult salmon passed upstream. This number is considered to be an underestimate because of the multiple times that the DIDSON was removed from the water. The longest interruption lasted 18 consecutive days from July 4 through July 22. From previous years data it is thought that the end of the Chinook run was missed and the starting of the sockeye, chum and pink run was also missed. Even with this large interruption it is thought that the Chinook and coho run were the most accurate of all five Pacific salmon species recorded.

Due to the high water event that occurred from July 4-July 22, river right was not captured for the rest of the season. This made it difficult to understand how salmon use different parts of the river. From the 2012 field season, it was observed that during the early part of the season from the middle of May to the beginning of July, Chinook distribution varied across the stream and was found to be more concentrated in the offshore deeper and faster waters (USACE, 2013). Following the Chinook run the sockeye, pink, chum, and coho used the near shore slower and shallower water that is closest to the DIDSON (USACE, 2013). During the 2014 study, this same pattern was also observed (Figure 8). Nevertheless, since the far field (river right) was not captured for the second half of the season, more data is needed before a true understanding of how the salmon utilize the stream as they migrate to spawning grounds.

The main limitation to 2014 DIDSON data is the data gaps during periods when the DIDSON was removed from the river because of high stream flow. Eagle River discharge is driven by high elevation snow and ice melt and/or periods of heavy rain. The trend throughout the summer months is an increasing river height as shown in Figure 4 with spring runoff conditions likely not to cause high water or flooding.

The DIDSON data collection was suspended when the elevation of Eagle River, as measured by the NOAA staff gage at the Glenn Highway, reached approximately 4.5 ft. High water reached peaks above 5 ft on three occasions, 5.16 ft (July 11), 5.26 ft (August 15), and 5.31 ft (September 14) (Figure 4). These elevations are not uncommon in Eagle River during the late summer and early fall. Increasing the deployment of the DIDSON during high water conditions should be further investigated. Also, it is beneficial to continue correlating NOAA's Glenn Highway staff gage data with the JBER staff gage that is located at the Eagle River sample site (Figure 15). This will allow field crews to make informed decisions on site, if the DIDSON should be left in the river or removed from the river.

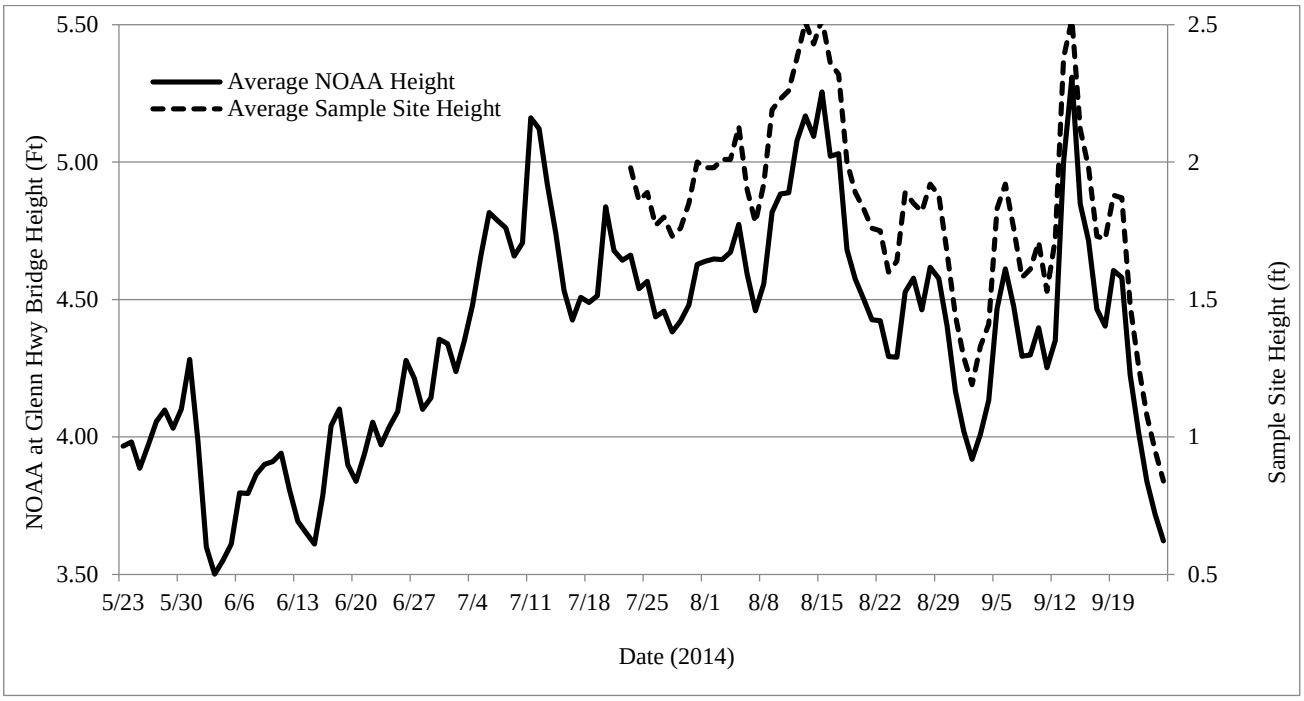

Figure 15. Comparison of Eagle River height from NOAA's stream gage at Glenn Highway and the river height from the sample location.

Fish Wheel Based Abundance Estimates

The fish wheel has the option to add on three additional paddles to create more surface area to spin the baskets. The fish wheel typically cannot spin the baskets around completely with a fish weighing over 30 pounds. Adding the paddles during the annual fish wheel assembly and allowing the paddles to stay on until July 15 has now become the new standard operating procedure. However, the fish wheel can spin too quickly sometimes with the additional paddles and might have caused the lower catch per unit effort (CPUE) during the Chinook run. As soon as the Chinook run is over, the paddles are removed to allow for a slower spinning wheel to capture more fish.

The fish wheel video image quality was sufficient to confidently count the number of adult salmon-sized fish. The fish wheel video footage was reviewed daily and was easily sped up to four times faster, to make reviewing quicker. This allowed for an entire night's video footage to be reviewed in less than an hour. The video footage was found to be efficient at capturing all salmon passing through the chute. On August 8th, the original event-triggered camera failed at capturing all fish passing through the chute and was subsequently replaced with a continuous digital video recording camera system. This allowed for recording all evening while the field crew was not present. Fish were still identifiable during review and this method of video recording proved to enhance the night time captures and possibly increase fish captures that were previously missed from the event trigger camera due to slow trigger speeds and other malfunctions. The use of a continuous camera system proved to be more reliable. Also, in early August, an LED light was added to the fish wheel to help capture and identify fish during the evenings. With the new camera system and light installed, there was a noticeable increase in fish being captured in the

evening and could have led to bias in the coho and chum apportionments due to increased catch rates in the fish wheel.

SUMMARY

The adult salmon enumeration project in Eagle River on JBER concluded its third field season in 2014. An estimated 3,638 salmon passed the DIDSON site in 2014. This is thought to be a low estimate compared to the actual number of salmon that returned to Eagle River this year. The single largest challenge that this project faces is the rapid water fluctuations and high water events during the peak migrations for the salmon. Developing modifications to the equipment and the procedures such as sampling 100% of the stream with the DIDSON, all the time versus only 50% will ensure the most accurate data is collected.

RECOMMENDATION

1. It is recommended to monitor the whole river instead of rotating between the near and far fields. This should make processing the data cleaner and easier to work with.
2. One of the biggest challenges that this project faces is rapid fluctuating water depths and high flow events. It is suggested to try and increase the DIDSON's high water operation as suggested in U.S. Army Corps of Engineers, Alaska District (USACE). 2013 report.
3. Water temperature plays a key role in the migration of the salmon. It is suggested that water temperature continue to be monitored on Eagle River to see if that is the case with salmon utilizing Eagle River.
4. With only 134 salmon captured in the fish wheel during the 2014 field season of which 18.7% were unidentified and all from the video. It is suggested that the event trigged video and the shoot be adjusted to help identify the salmon passing through when the live box is not in use.

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APPENDICES

Appendix A: DIDSON Daily Observed and Expanded Fish Counts

	Range Stratum R1 (RL)		Range Stratum R2 (RR)		R1+R2		
Date	Fish Observed	Expanded Net Count	Fish Observed	Expanded Net Count	Total Fish Observed	Total Expanded Net Count	Cumulative
23-May	0	0	0	0	0	0	0
24-May	0	0	0	0	0	0	0
25-May	0	0	0	0	0	0	0
26-May	0	0	0	0	0	0	0
27-May	1	2	0	0	1	2	2
28-May	1	2	4	8	5	10	12
29-May	5	10	3	6	8	16	28
30-May	2	4	6	12	8	16	44
31-May	3	6	3	6	6	12	56
1-Jun	-	-	-	-	-	-	56
2-Jun	0	0	0	0	0	0	56
3-Jun	0	0	1	2	1	2	58
4-Jun	0	0	0	0	0	0	58
5-Jun	0	0	0	0	0	0	58
6-Jun	16	32	11	22	27	54	112
7-Jun	12	24	9	18	21	42	154
8-Jun	9	18	14	28	23	46	200
9-Jun	5	10	18	36	23	46	246
10-Jun	2	4	7	14	9	18	264
11-Jun	3	6	5	10	8	16	280
12-Jun	8	16	5	10	13	26	306
13-Jun	3	6	2	4	5	10	316
14-Jun	7	14	7	14	14	28	344
15-Jun	4	8	9	18	13	26	370
16-Jun	19	38	21	42	40	80	450
17-Jun	14	28	14	28	28	56	506
18-Jun	9	18	10	20	19	38	544
19-Jun	3	6	11	22	14	28	572
20-Jun	14	28	12	24	26	52	624
21-Jun	7	14	11	22	18	36	660
22-Jun	3	6	10	20	13	26	686

	Range Stratum R1 (RL)		Range Stratum R2 (RR)		R1+R2		
Date	Fish Observed	Expanded Net Count	Fish Observed	Expanded Net Count	Total Fish Observed	Total Expanded Net Count	Cumulative
23-Jun	-	-	-	-	-	-	686
24-Jun	5	10	0	0	5	10	696
25-Jun	8	16	2	4	10	20	716
26-Jun	0	0	0	0	0	0	716
27-Jun	1	2	6	12	7	14	730
28-Jun	3	6	6	12	9	18	748
29-Jun	2	4	1	2	3	6	754
30-Jun	0	0	1	2	1	2	756
1-Jul	0	0	0	0	0	1	757
2-Jul	1	2	2	4	3	6	763
3-Jul	0	0	0	0	0	3	766
4-Jul	-	-	-	-	-	2	768
5-Jul	-	-	-	-	-	-	768
6-Jul	-	-	-	-	-	-	768
7-Jul	-	-	-	-	-	-	768
8-Jul	-	-	-	-	-	3	771
9-Jul	-	-	-	-	-	-	771
10-Jul	-	-	-	-	-	-	771
11-Jul	-	-	-	-	-	-	771
12-Jul	-	-	-	-	-	-	771
13-Jul	-	-	-	-	-	-	771
14-Jul	-	-	-	-	-	-	771
15-Jul	-	-	-	-	-	-	771
16-Jul	-	-	-	-	-	3	774
17-Jul	-	-	-	-	-	3	777
18-Jul	-	-	-	-	-	2	779
19-Jul	-	-	-	-	-	1	780
20-Jul	-	-	-	-	-	0	780
21-Jul	-	-	-	-	-	2	782
22-Jul	-	-	-	-	-	1	783
23-Jul	30	-	-	-	30	-	813
24-Jul	92	-	-	-	92	-	905
25-Jul	114	-	-	-	114	-	1019
26-Jul	144	-	-	-	144	-	1163

	Range Stratum R1 (RL)		Range Stratum R2 (RR)		R1+R2		
Date	Fish Observed	Expanded Net Count	Fish Observed	Expanded Net Count	Total Fish Observed	Total Expanded Net Count	Cumulative
27-Jul	74	-	-	-	74	-	1237
28-Jul	79	-	-	-	79	-	1316
29-Jul	124	-	-	-	124	-	1440
30-Jul	131	-	-	-	131	-	1571
31-Jul	102	-	-	-	102	-	1673
1-Aug	141	-	-	-	141	-	1814
2-Aug	174	-	-	-	174	-	1988
3-Aug	92	-	-	-	92	-	2080
4-Aug	60	-	-	-	60	-	2140
5-Aug	65	-	-	-	65	-	2205
6-Aug	227	-	-	-	227	-	2432
7-Aug	198	-	-	-	198	-	2630
8-Aug	34	-	-	-	34	-	2664
9-Aug	3	-	-	-	3	-	2667
10-Aug	0	-	-	-	0	-	2667
11-Aug	3	-	-	-	3	-	2670
12-Aug	-	-	-	-	1	-	2671
13-Aug	-	-	-	-	-	-	2671
14-Aug	-	-	-	-	-	-	2671
15-Aug	-	-	-	-	-	-	2671
16-Aug	-	-	-	-	1	-	2672
17-Aug	-	-	-	-	11	-	2683
18-Aug	-	-	-	-	5	-	2688
19-Aug	167	-	-	-	167	-	2855
20-Aug	211	-	-	-	211	-	3066
21-Aug	88	-	-	-	88	-	3154
22-Aug	50	-	-	-	50	-	3204
23-Aug	56	-	-	-	56	-	3260
24-Aug	43	-	-	-	43	-	3303
25-Aug	18	-	-	-	18	-	3321
26-Aug	39	-	-	-	39	-	3360
27-Aug	8	-	-	-	8	-	3368
28-Aug	17	-	-	-	17	-	3385
29-Aug	29	-	-	-	29	-	3414

	Range Stratum R1 (RL)		Range Stratum R2 (RR)		R1+R2		
Date	Fish Observed	Expanded Net Count	Fish Observed	Expanded Net Count	Total Fish Observed	Total Expanded Net Count	Cumulative
30-Aug	46	-	-	-	46	-	3460
31-Aug	33	-	-	-	33	-	3493
1-Sep	33	-	-	-	33	-	3526
2-Sep	31	-	-	-	31	-	3557
3-Sep	20	-	-	-	20	-	3577
4-Sep	24	-	-	-	24	-	3601
5-Sep	2	-	-	-	2	-	3603
6-Sep	-	-	-	-	2	-	3605
7-Sep	-	-	-	-	2	-	3607
8-Sep	4	-	-	-	4	-	3611
9-Sep	2	-	-	-	2	-	3613
10-Sep	0	-	-	-	0	-	3613
11-Sep	7	-	-	-	7	-	3620
12-Sep	3	-	-	-	3	-	3623
13-Sep	-	-	-	-	-	-	3623
14-Sep	-	-	-	-	-	-	3623
15-Sep	-	-	-	-	-	-	3623
16-Sep	-	-	-	-	-	-	3623
17-Sep	-	-	-	-	-	-	3623
18-Sep	-	-	-	-	-	-	3623
19-Sep	7	-	-	-	7	-	3630
20-Sep	3	-	-	-	3	-	3633
21-Sep	3	-	-	-	3	-	3636
22-Sep	0	-	-	-	0	-	3636
23-Sep	2	-	-	-	2	-	3638
24-Sep	0	-	-	-	0	-	3638

The blue highlights indicate that the DIDSON was not operation and the actual fish wheel catch was considered as the daily passage

Appendix B: Fish Wheel Daily Catch by Species

	Chinook		Sockeye		Chum		Pink		Coho		Unknown (Unk)			
Date	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Total w/o Unk	Total with Unk
20-Jun	1	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1
21-Jun	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
22-Jun	1	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1
23-Jun	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
24-Jun	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
25-Jun	1	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1
26-Jun	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
27-Jun	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
28-Jun	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
29-Jun	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
30-Jun	1	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1
1-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	1
2-Jul	1	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1
3-Jul	1	33.33%	2	66.67%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3	3
4-Jul	2	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	2
5-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
6-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
7-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
8-Jul	1	33.33%	2	66.67%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3	3
9-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
10-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	1
11-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
12-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0

	Chinook		Sockeye		Chum		Pink		Coho		Unknown (Unk)			
Date	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Total w/o Unk	Total with Unk
13-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
14-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
15-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
16-Jul	1	33.33%	1	33.33%	0	0.00%	0	0.00%	0	0.00%	1	33.33%	2	3
17-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3	100.00%	0	3
18-Jul	0	0.00%	2	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	2
19-Jul	0	0.00%	1	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1
20-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
21-Jul	0	0.00%	2	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	2
22-Jul	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	0.00%	0	0.00%	1	1
23-Jul	0	0.00%	0	0.00%	0	0.00%	0	50.00%	0	0.00%	0	50.00%	0	0
24-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	1
25-Jul	0	0.00%	1	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1
26-Jul	0	0.00%	0	0.00%	1	50.00%	1	50.00%	0	0.00%	0	0.00%	2	2
27-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	1
28-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
29-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
30-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
31-Jul	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
1-Aug	0	0.00%	0	0.00%	0	0.00%	1	50.00%	1	50.00%	0	0.00%	2	2
2-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	100.00%	0	0.00%	2	2
3-Aug	0	0.00%	0	0.00%	0	0.00%	1	50.00%	1	50.00%	0	0.00%	2	2
4-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
5-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	100.00%	0	0.00%	2	2
6-Aug	0	0.00%	0	0.00%	0	0.00%	1	25.00%	2	50.00%	1	25.00%	3	4
7-Aug	0	0.00%	2	50.00%	0	0.00%	1	25.00%	1	25.00%	0	0.00%	4	4
8-Aug	0	0.00%	0	0.00%	1	25.00%	0	0.00%	3	75.00%	0	0.00%	4	4

	Chinook		Sockeye		Chum		Pink		Coho		Unknown (Unk)			
Date	Count	%	Count	%	Count	%	Count	%	Date	Count	%	Count	Total w/o Unk	Total with Unk
9-Aug	0	0.00%	0	0.00%	0	0.00%	1	20.00%	4	80.00%	0	0.00%	5	5
10-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
11-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
12-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	0.00%	1	1
13-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
14-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
15-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
16-Aug	0	0.00%	0	0.00%	1	100.00%	0	0.00%	0	0.00%	0	0.00%	1	1
17-Aug	0	0.00%	0	0.00%	1	9.09%	0	0.00%	9	81.82%	1	9.09%	10	11
18-Aug	0	0.00%	0	0.00%	2	40.00%	1	20.00%	1	20.00%	1	20.00%	4	5
19-Aug	0	0.00%	0	0.00%	1	25.00%	0	0.00%	2	50.00%	1	25.00%	3	4
20-Aug	0	0.00%	2	20.00%	1	10.00%	0	0.00%	3	30.00%	4	40.00%	6	10
21-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	4	100.00%	0	4
22-Aug	0	0.00%	0	0.00%	1	14.29%	2	28.57%	2	28.57%	2	28.57%	5	7
23-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
24-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	0.00%	1	1
25-Aug	0	0.00%	0	0.00%	1	25.00%	3	75.00%	0	0.00%	0	0.00%	4	4
26-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
27-Aug	0	0.00%	2	28.57%	1	14.29%	1	14.29%	2	28.57%	1	14.29%	6	7
28-Aug	0	0.00%	0	0.00%	0	0.00%	1	33.33%	1	33.33%	1	33.33%	2	3
29-Aug	0	0.00%	0	0.00%	2	100.00%	0	0.00%	0	0.00%	0	0.00%	2	2
30-Aug	0	0.00%	0	0.00%	1	50.00%	1	50.00%	0	0.00%	0	0.00%	2	2
31-Aug	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
1-Sep	0	0.00%	0	0.00%	1	50.00%	0	0.00%	1	50.00%	0	0.00%	2	2
2-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	0.00%	1	1
3-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
4-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0

	Chinook		Sockeye		Chum		Pink		Coho		Unknown (Unk)			
Date	Count	%	Count	%	Count	%	Count	%	Date	Count	%	Count	Total w/o Unk	Total with Unk
5-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	5	100.00%	0	0.00%	5	5
6-Sep	0	0.00%	0	0.00%	1	50.00%	0	0.00%	1	50.00%	0	0.00%	2	2
7-Sep	0	0.00%	0	50.00%	1	50.00%	0	0.00%	0	0.00%	1	50.00%	1	2
8-Sep	0	0.00%	0	0.00%	1	100.00%	0	0.00%	0	0.00%	0	0.00%	1	1
9-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
10-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
11-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
12-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
13-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
14-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
15-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
16-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
17-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
18-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
19-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	0.00%	1	1
20-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%	0	0.00%	1	1
21-Sep	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0
Total Fish	10		17		18		16		48		25		109	134

The yellow highlights indicate that no fish were captured in fish wheel the daily species proportion was interpolated by averaging the nearest one day pervious and one day following.

Appendix C: Mean Daily Eagle River Height and Temperature, 2014.

Date	NOAA Height (ft)	Sample Site Height (ft)	Temperature (°F)
23-May	3.97	-	-
24-May	3.98	-	-
25-May	3.89	-	-
26-May	3.97	-	-
27-May	4.06	-	-
28-May	4.10	-	-
29-May	4.03	-	-
30-May	4.10	-	-
31-May	4.28	-	-
1-Jun	3.98	-	-
2-Jun	3.60	-	-
3-Jun	3.50	-	-
4-Jun	3.55	-	-
5-Jun	3.61	-	-
6-Jun	3.80	-	-
7-Jun	3.79	-	-
8-Jun	3.86	-	-
9-Jun	3.90	-	-
10-Jun	3.91	-	-
11-Jun	3.94	-	-
12-Jun	3.81	-	-
13-Jun	3.69	-	-
14-Jun	3.65	-	-
15-Jun	3.61	-	-
16-Jun	3.79	-	-
17-Jun	4.04	-	-
18-Jun	4.10	-	-
19-Jun	3.90	-	-
20-Jun	3.84	-	-
21-Jun	3.94	-	-
22-Jun	4.05	-	-
23-Jun	3.97	-	-
24-Jun	4.04	-	-
25-Jun	4.09	-	-
26-Jun	4.28	-	-
27-Jun	4.21	-	-
28-Jun	4.10	-	-

Date	NOAA Height (ft)	Sample Site Height (ft)	Temperature (°F)
29-Jun	4.14	-	-
30-Jun	4.35	-	-
1-Jul	4.34	-	-
2-Jul	4.24	-	-
3-Jul	4.35	-	-
4-Jul	4.48	-	-
5-Jul	4.66	-	-
6-Jul	4.82	-	-
7-Jul	4.79	-	-
8-Jul	4.76	-	-
9-Jul	4.66	-	-
10-Jul	4.71	-	-
11-Jul	5.16	-	-
12-Jul	5.12	-	-
13-Jul	4.92	-	-
14-Jul	4.74	-	-
15-Jul	4.53	-	-
16-Jul	4.43	-	-
17-Jul	4.51	-	-
18-Jul	4.49	-	-
19-Jul	4.51	-	-
20-Jul	4.84	-	-
21-Jul	4.68	-	-
22-Jul	4.64	-	-
23-Jul	4.66	1.98	47.32
24-Jul	4.54	1.86	47.02
25-Jul	4.57	1.89	46.06
26-Jul	4.44	1.77	46.34
27-Jul	4.46	1.80	46.22
28-Jul	4.38	1.73	45.94
29-Jul	4.42	1.76	46.56
30-Jul	4.48	1.85	48.58
31-Jul	4.63	2.00	48.17
1-Aug	4.64	1.98	47.51
2-Aug	4.65	1.98	47.76
3-Aug	4.64	2.01	47.14
4-Aug	4.67	2.01	46.02
5-Aug	4.77	2.13	45.17
6-Aug	4.59	1.90	46.20
7-Aug	4.46	1.78	45.73

Date	NOAA Height (ft)	Sample Site Height (ft)	Temperature (°F)
8-Aug	4.56	1.92	44.88
9-Aug	4.82	2.19	44.25
10-Aug	4.88	2.23	44.88
11-Aug	4.89	2.26	44.91
12-Aug	5.08	2.38	43.61
13-Aug	5.17	2.51	42.90
14-Aug	5.09	2.43	43.35
15-Aug	5.26	2.52	42.77
16-Aug	5.02	2.36	43.16
17-Aug	5.03	2.32	43.48
18-Aug	4.68	2.00	44.66
19-Aug	4.57	1.89	44.53
20-Aug	4.50	1.83	45.72
21-Aug	4.43	1.76	45.81
22-Aug	4.42	1.75	46.15
23-Aug	4.29	1.60	44.80
24-Aug	4.29	1.64	45.10
25-Aug	4.53	1.89	43.69
26-Aug	4.58	1.85	43.14
27-Aug	4.46	1.82	44.44
28-Aug	4.62	1.92	44.44
29-Aug	4.58	1.88	44.67
30-Aug	4.40	1.67	43.37
31-Aug	4.17	1.44	43.74
1-Sep	4.02	1.29	42.80
2-Sep	3.92	1.19	47.76
3-Sep	4.01	1.33	45.54
4-Sep	4.13	1.41	43.53
5-Sep	4.47	1.83	43.26
6-Sep	4.61	1.92	46.20
7-Sep	4.48	1.76	43.63
8-Sep	4.29	1.58	43.48
9-Sep	4.30	1.61	44.20
10-Sep	4.40	1.71	43.81
11-Sep	4.25	1.53	42.99
12-Sep	4.35	1.72	45.13
13-Sep	5.00	2.38	45.14
14-Sep	5.31	2.52	42.54
15-Sep	4.85	2.12	41.62
16-Sep	4.71	1.98	41.87

Date	NOAA Height (ft)	Sample Site Height (ft)	Temperature (°F)
17-Sep	4.46	1.73	42.32
18-Sep	4.40	1.72	42.37
19-Sep	4.61	1.88	41.67
20-Sep	4.58	1.87	42.40
21-Sep	4.23	1.48	42.32
22-Sep	4.02	1.26	42.09
23-Sep	3.84	1.08	41.65
24-Sep	3.72	0.95	40.30
25-Sep	3.62	0.84	39.30