# 2018 Kenai River Boat Count and Turbidity Monitoring

## FY 2018 Final Report

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*The Kenai Watershed Forum is dedicated to successfully identifying and addressing the needs of the region by providing high quality education, restoration, and research programs.*

KENAI WATERSHED FORUM

*"Working together for healthy watersheds on the Kenai Peninsula"*

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# Executive summary

The Kenai Watershed Forum (KWF) conducted boat count and turbidity monitoring on the lower Kenai River in July of 2018. The objective of this project was to gather data on current boating practices while conducting a turbidity assessment on the lower Kenai River. Hydrolabs were calibrated and installed for a two-week period in July at river mile (RM) 11.5 near the Eagle Rock Boat Launch as well as at RM 23, which served as a collection site for background data for turbidity. Boat counts were also conducted from fixed-wing aircraft and time lapse cameras were used at RM 11.5 in conjunction with the Hydrolabs that were deployed in order to gain further knowledge surrounding the impact of boat traffic on turbidity. Turbidity data was then analyzed by the Alaska Department of Environmental Conservation (DEC). KWF conducted temporal and spatial variation analyses using the aerial and time lapse boat count data from which trends in boat traffic were identified. Uniquely, there were several closures and fishing regulation amendments that occurred in July 2018 that likely affected the 2018 boat count and turbidity results. An additional project conducted during a summer with typical salmon escapement is advised.

# Introduction

The Kenai River is a glacially-fed river located in southcentral Alaska on the Kenai Peninsula. Beginning near Cooper Landing, Alaska, it flows 82 miles before emptying into Cook Inlet near Kenai, Alaska. The river supports a variety of wildlife and plays host to several resident species of fish as well as five species of Pacific salmon that migrate up the river to spawn annually. Each year, it draws thousands of fishermen, most of which utilize power boats in order to access various sections of the lower Kenai River during salmon runs.

The elevated use of power boats throughout the summer results in an increase in wake, which can affect the nearshore turbidity, and therefore fish habitat, within the river as well as the rate of erosion along the bank. If turbidity exceeds the mandated limits set for fresh water uses in Alaska, it can be listed as “impaired” under Section 303 (d) List of the Clean Water Act. While the majority of waters within Alaska remain unimpaired, a project conducted by KWF and DEC from 2008-2010 showed increased turbidity levels within the Kenai River during summer boat use. During a public comment period regarding the outcome of this project, many comments included information regarding changes in the recreational fishery (DEC, “Final 2018 Kenai River Turbidity Monitoring Project Report”). Some members of the public suggested that there has been an increase in sockeye salmon fishing while Chinook salmon fishing declined, resulting in a change in the weight as well as the way in which power boats are operated. In addition, some comments suggested that turbidity may have decreased due to the change in motor regulations in 2010.

In response, KWF worked with DEC to conduct a project on the Kenai River during the month of July 2018 to monitor turbidity levels and assess boating behavior from July 16, 2018 to July 31, 2018 using a DEC-approved Quality Assurance Project Plan (QAPP). Hydrolabs were deployed at a background data collection site at RM 23 as well as a monitoring site located at RM 11.5 where much of the Kenai River boating activity occurs. Six aerial boat count surveys were conducted from the mouth of the Kenai River to the outlet of Skilak Lake and two time lapse cameras were deployed for boat counts throughout the duration of the project near RM 11.5.

# Methods

## Time lapse cameras

Two time lapse cameras were used for two weeks throughout the second half of July near RM 11.5 near the Eagle Rock Boat Launch on the Kenai River. The intent of these cameras was to document boat traffic near the site at which turbidity monitoring was also occurring during that timeframe. The upstream camera at RM 11.5 was deployed at Hydrolab deployment site while the downstream camera was deployed just downstream of the Eagle Rock Boat Launch in order to capture the boat traffic accessing the boat launch from downstream. SD cards were formatted to FAT32 and the cameras were programmed to record photos every two seconds from 6:00 AM-6:00 PM each day. Time lapse cameras were monitored throughout the project period and visited three times post-deployment for video downloads and battery replacements.

*Site visit: July 16, 2018*

- The upstream camera was deployed at the Hydrolab deployment site around 11:00 AM at July 16, 2018 (Figure A). It was oriented on the tree so that the line of sight included the river and far river-left bank-a popular spot for fishermen to fish from shore. Prior to deployment, it was confirmed in the field that the camera was functioning properly and as programmed. There were few boats present at this time.
- Downstream camera: The downstream camera was deployed at 12:30 PM just downstream of the Eagle Rock Boat Launch on river right, not far from the boat launch parking lot (Figure A). It was oriented on the tree so that the line of sight included the river and far river-left bank. This second camera was deployed in an effort to capture boats utilizing the boat launch that may have been missed in the upstream camera. Prior to deployment, it was confirmed in the field that the camera was functioning properly and as programmed. There were few boats present at this time.

*Site visit: July 19, 2018*

- At 9:03 AM, the upstream camera was removed from the tree. Time lapse footage was successfully downloaded to a field laptop, the SD card was formatted, the camera was

programmed to include a timestamp, and the camera was redeployed at 9:33 AM. Boats were documented in the field book throughout the time period that the camera was not deployed.

*Site visit: July 23, 2018*

- At 1:59 PM, the upstream camera was removed from the tree. Time lapse footage was successfully downloaded to a field laptop, the SD card was formatted, batteries were replaced and the camera was redeployed at 2:15 PM.
- At about 2:45 PM, the downstream camera was removed from the tree. It was discovered that, when deployed, the camera did not successfully trigger to record so the camera was switched out with a new camera which was tested prior to deployment at about 2:56 PM.

*Site visit: August 1, 2018*

- At about 9:15 AM, the upstream camera was taken down. Time lapse footage was successfully downloaded to a field laptop, and the SD card was formatted.
- The downstream camera was taken down around 10:00 AM and footage was successfully downloaded.

## Aerial surveys

Throughout the second half of July, six aerial surveys for boat counts were conducted from a Cessna 180 floatplane over the Kenai River. Each survey began at the Kenai docks in Kenai, Alaska near the mouth of the Kenai River and ended at the outlet of Skilak Lake. Aerial boat counts were conducted within previously-determined sections of river for both power boats and drift boats (Table A, B). The intent of these aerial surveys was to gain further knowledge of the distribution of river use by river section and in turn compare this information to river use observed using two time lapse cameras deployed near RM 11.5 near the Eagle Rock Boat Launch. Each aerial survey conducted lasted, on average, 30 minutes and were conducted beginning in the afternoon (between 12:30 PM to 4:10 PM). Many of these single-pass surveys included video footage from either a recording device or a GoPro, although this did not always prove to be successful due to necessary flight elevation.

## Turbidity monitoring

Six MS5 Hydrolabs were used to conduct turbidity monitoring at two different sites along the Kenai River. The first site was selected at RM 23, about 300 feet upstream from the Donald E. Gilman Kenai River Center in Soldotna, Alaska on river left (Figure B). This site is not affected by ocean tides, so the turbidity data collected here served as background, or “natural conditions”, data and was used to compare and contrast data collected at RM 11.5. The Hydrolabs located at RM 11.5 were deployed upriver of the Eagle Rock Boat Launch on river right offshore of an island immediately adjacent to the main river channel (Figure B).

Prior to deployment, though, all Hydrolabs were calibrated in accordance with the DEC QAPP. Each Hydrolab received new batteries and were programmed to receive a unique name depending on deployment location. Each Hydrolab was calibrated to 1, 100, 200, and 1000 Nephelometric Turbidity Units (NTUs), and calibration efficacy assessed using 20 and 40 NTU solutions. When Hydrolabs were retrieved from the field, their accuracy was checked using 1, 100, 200, and 1000 NTU solutions and their reading was recorded and reported to DEC.

Two Hydrolabs were programmed to collect data throughout the duration of the monitoring period at RM 11.5 and RM 23 and were therefore deployed from July 16, 2018 to August 1, 2018 (Table C). Four Hydrolabs were programmed to collect data throughout half of the project period. Two were programmed to collect data from July 16, 2018 to July 23, 2018 at RM 11.5 and RM 23, while the other two Hydrolabs were programmed to collect data from July 23, 2018 to July 31, 2018 at RM 11.5 and RM 23 (Table C). These four Hydrolabs were intended to support two Hydrolabs deployed for the duration of the monitoring period, should one fail. They also supplemented the turbidity data collected using the two Hydrolabs that were deployed throughout the duration of the monitoring period.

*Site visit: July 16, 2018*

On Monday, July 16, 2018 two Hydrolabs were deployed at RM 11.5 at 12:00 PM upstream of the Eagle Rock Boat Launch out from the shoreline of an island adjacent to the main river channel. This site was accessed by boat. During deployment, the sensor end of each Hydrolab was kept hydrated. An anchor was used to keep the Hydrolabs in place in the river. The anchor was attached to two buoys using a chain, between which a chain was placed so that one buoy was downstream of the other. The Hydrolabs were connected in parallel along the chain between the two buoys. Before leaving the site, it was confirmed through "tug tests" that the anchor was anchored into the substrate along the bottom of the river. Boat activity was noted in the area. Low tide occurred 2:09 PM that day, the temperature was in the 50's and the sky was partly cloudy.

Two Hydrolabs were also deployed at RM 23 at 2:45 PM about 300 feet upstream of the Donald E. Gilman Kenai River Center. Deployment tactics for RM 23 mirrored those implemented at RM 11.5. There were several fishermen in the area along the shore, so the deployment site chosen was upstream of the river access near the Donald E. Gilman Kenai River Center in an effort to avoid the potential tampering of Hydrolabs by fishermen. This site also reduced any potential temporary increase in turbidity due to fishermen wading nearby.

*Site visit: July 18, 2018*

During an aerial boat count survey conducted for this project on July 18, 2018, it was noted that the Hydrolabs at RM 11.5 had moved downstream near the rock by the Eagle Rock Boat Launch. After reviewing time lapse footage from the upstream camera at RM 11.5, it was determined that

the Hydrolabs had moved between 6:00 PM on July 16, 2018 and 6:00 AM on July 17, 2018. Because the cameras were programmed to stop recording at 6:00 PM each day, the exact time and reason of the Hydrolab movement could not be determined. The Hydrolabs were moved back to their original position on July 18, 2018 around 5:00 PM. The anchor was tested for security before leaving the site. The skies were clear and sunny.

*Site visit: July 19, 2018*

The Hydrolabs at RM 11.5 moved downstream between 6:00 PM on July 18, 2018 and 6:00 AM July 19, 2018. Due to the timing of movement, the Hydrolab movement was not detected on the upstream time lapse camera. A site visit was conducted on July 19, 2018 in response to this movement. However, the Hydrolabs were deployed at a site around 10:00 AM about 40 feet upstream from their original deployment site and were cabled to a nearby, onshore tree to prevent future movement. This deployment technique was effective for the remaining monitoring period. High tide occurred at 10:00 AM, the temperature was in the upper 50's, and the skies were sunny. Boat activity was noted during this time.

*Site visit: July 20, 2018*

A site visit was conducted on July 20, 2018 at 6:15 AM to ensure that the Hydrolabs at RM 11.5 had not moved; this was confirmed. Hydrolabs were not removed from the water.

*Site visit: July 23, 2018*

A site visit was conducted on July 23, 2018 to both RM 11.5 and RM 23 turbidity monitoring sites in order to rotate out Hydrolabs intended to monitor for the first half of the monitoring period. A new, calibrated Hydrolab was deployed at each site and the two original Hydrolabs intended for continuous monitoring were redeployed alongside the new Hydrolabs.

The Hydrolabs redeployed at RM 11.5 were done so at the new, cabled site. Low tide occurred at 9:36 AM, and there was a steady rain throughout the day. However, the Hydrolabs redeployed at RM 23 were moved upstream about 100 yards. Heavy bank fishing was observed near the Hydrolabs during this site visit, so this movement upstream was determined necessary.

*Site visit: August 1, 2018*

During the morning of August 1, 2018, all Hydrolabs, buoys and anchors were removed from their sites at RM 11.5 and RM 23. High tide occurred at 7:36 AM and all Hydrolabs were removed from the most recent site they had been deployed to.

# Results

## Time lapse cameras

Boat traffic observed in time lapse cameras deployed at RM 11.5 from July 16, 2018 to July 31, 2018 (upstream camera) and from July 23, 2018 to July 31, 2018 (downstream camera) varied by date, time of day, and direction of boat travel. Boats traveling upstream resulted in the creation of significant wake while only under-power downstream travel resulted in significant wake, and therefore potential for increased, abnormal turbidity levels. For analysis, downstream movement of boats under power were considered while drifting boats or boats not under power were not considered, as there was no observable wake created by these types of boating behaviors.

### *Upstream camera*

Upstream and downstream boat travel counts throughout the duration of the project generally followed similar temporal trends. The highest counts for upstream travel were observed on Tuesday, July 17, 2018 (344 boats; Figure C) while the highest counts for downstream travel were observed on Saturday, July 21, 2018 and Saturday, July 28, 2018 (238 boats and 240 boats, respectively; Figure D). The lowest upstream and downstream counts both occurred on Monday, July 30, 2018 (28 boats, Figure C and 24 boats, Figure D respectively). When disregarding the partial day of observation on Monday, July 16, 2018, the second lowest boat count occurred on Monday, July 23, 2018 (114 boats traveling upstream, Figure C; 114 boats traveling downstream, Figure D).

Upstream and downstream boat counts observed in the upstream camera at RM 11.5 also varied by time of day. Data was split into two time periods for this analysis, simply for ease of interpretation: July 16, 2018 to July 23, 2018 and July 24, 2018 to July 31, 2018. Generally speaking, an increase in upstream boat travel was observed in the afternoon, particularly from 12:00 PM to 3:00 PM (Figures E and F). Upstream travel was generally consistent in the morning hours from 6:00 AM to 11:00 AM (Figures E and F). Downstream boat travel generally exhibited unimodality, with higher traffic observed midday from 10:00 AM to 3:00 PM (Figures G and H).

### *Downstream camera*

The highest counts observed for boats traveling upstream and downstream at the downstream camera were observed on Tuesday, January 24, 2018 (403 and 332 boats, respectively; Figure I) and Wednesday, January 25, 2018 (364 and 328 boats, respectively; Figure J). Boat counts for those traveling upstream and downstream at the downstream camera reached a minimum on Monday, July 30, 2018 (30 and 23 boats, respectively; Figures I and J, respectively).

As observed in the footage from the upstream time lapse camera, boat counts observed in the downstream time lapse camera varied by time of day. The highest period of upstream boat traffic noted in time lapse footage from the downstream camera generally occurred in the afternoon each day, from about 2:00 PM to 5:00 PM (Figure K), while increased boat traffic traveling downstream increased midday between 9:00 AM to 3:00 PM (Figure L). Decreased boat traffic moving both upstream and downstream was noted to decrease in the early morning and late afternoon (Figures K and L).

## Aerial surveys

### *Power boats*

During all six aerial boat count surveys conducted in 2018, a total of 1738 power boats were counted, and boats were consistently observed throughout the surveyed sections of the Kenai River during each survey (Figures M and N; Table A). However, the distribution of power boats observed throughout the stretch of river surveyed varied by section and by date.

The most heavily-used section of river was most often noted to be from the Kenai Docks to the Warren Ames Bridge (718 total boats, with the maximum number of 190 power boats observed on Wednesday, July 25, 2018; Table A). The section of river from the Pillars Boat Launch to the Soldotna bridge also experienced an elevated amount of boat traffic (370 total boats; Table A). This highest number of boats observed in this stretch occurred on Thursday, July 26, 2018 (94 boats; Table A). Two stretches of river that experienced the lowest amount of boating pressure included the stretch from the Warren Ames Bridge to the Chinook sonar site (52 total boats; Table A) and from the Soldotna bridge to the Moose River confluence (53 total boats; Table A).

Boat traffic observed also varied by date. The highest number of boats observed along the entire stretch of river surveyed occurred on Thursday, July 26, 2018 (358 total boats; Table A), while the second highest number of boats counted occurred one day prior, Wednesday, July 25, 2018 (387; Table A). The aerial survey conducted on Sunday, July 29, 2018 resulted in the lowest number of boats observed (190 total boats; Table A).

GoPro footage was intended as supplemental observation to each aerial count. However, counts conducted using this footage were inaccurate due to the elevation of each flight.

### *Drift boats*

During all six aerial boat count surveys conducted in 2018, a total of 136 drift boats were counted, though they were not consistently observed throughout the surveyed sections of the Kenai River during each survey (Table B). However, it was noted that the observed drift boat counts on Sunday, July 29, 2018 were significantly higher than those of any other day and no drift boats were observed on Saturday, July 28, 2018. It is likely that this was due to observer error, and results as follows will not incorporate the drift boat values from these days. When

considering this possible error, a more accurate value of 54 total drift boats were likely observed during the six aerial surveys conducted (Table B). Similar to power boat observations, though, the distribution of drift boats observed along the stretch of river surveyed varied by section and by date.

The section of river observed to have the highest number of drift boats throughout all six surveys was located between the Kenai Keys and the outlet of Skilak Lake (19 total boats; Table B). The majority of all drift boats counted were observed between the Pillars Boat Launch and the outlet of Skilak Lake (50 total boats; Table B) while only four boats were noted from the Kenai Docks to the Beaver Creek confluence (Table B). Uniquely, drift boats were likely never observed from Beaver Creek to the Pillars Boat Launch (Table B).

Like power boats, drift boat traffic varied by date. Of days surveyed, Wednesday, July 25, 2018 resulted in the highest number of drift boats observed (23 total boats; Table B), while Wednesday, July 18, 2018 resulted in the lowest number of drift boats observed (6 total boats; Table B).

GoPro footage was intended as supplemental observation to each aerial count. However, counts conducted using this footage were inaccurate due to the elevation of each flight.

## Turbidity monitoring

Turbidity monitoring results were downloaded from the six Hydrolabs used at RM 11.5 and RM 23. The raw data collected was organized in an Excel spreadsheet and submitted to DEC for analysis.

# Discussion

## Time lapse cameras

There are several factors that could impact the temporal and spatial variation of boat counts observed on any given day. Events like rain showers, cooler temperatures, or reports of low salmon escapement could potentially deter fishermen from fishing that day. There were some specific factors throughout July 2018, though, that may explain maximum and minimum boat counts observed.

*Upstream camera*

As noted, upstream and downstream boat travel varied by day. The highest number of boats observed moving upstream occurred on July 17, 2018, and was likely in response to a catch-and-release Alaska Department of Fish and Game (ADFG) fishing regulation amendment for Chinook that would be implemented the following day. The lowest under-power boat counts of upstream and downstream boat traffic both occurred on Mondays. Throughout the operation period, several boats observed were guide boats. ADFG has implemented a regulation the restricts the use of guiding services to bank fishing only on Sundays and Mondays during the month of July anywhere downstream of Skilak Lake. The reduction in guide boats present on the river on Mondays is likely the cause of the low numbers of boats observed on this day. Relatively speaking, the boat count for both upstream and downstream traffic conducted on Monday, July 30, 2018 was significantly lower than any other day, which was likely a response to the dipnetting closure that was implemented at 12:01 AM on that day (Tables A, B, and D).

Consistent upstream boat traffic observed in the morning hours each day could be attributed to fishermen that launch at or below the Eagle Rock Boat Launch and are going to utilize upstream fishing opportunities. The increase in upstream boat traffic in the afternoon could be the result of successful dipnetters that are returning to an upstream boat launch. Fishermen traveling downstream midday may be accessing the dipnetting fishery downstream of RM 11.5.

*Downstream camera*

The heightened level of upstream and downstream boat traffic on Tuesday, July 24, 2018 did not correspond with a direct implementation of an emergency closure or regulation amendment. However, it's possible that an increase in traffic was observed due to the prohibitive guiding regulations imposed on Mondays. In contrast, the lowest number of boats per day traveling both upstream and downstream observed on Monday, July 30, 2018 was likely a product of the emergency closure implemented for dipnetting on that date. Finally, the total number of boats observed in the downstream camera exceeded that of the number observed in the upstream camera, likely due to downstream boats utilizing the Eagle Rock Boat Launch that were not captured within the view of the upstream camera.

Increased boat traffic moving upstream in the afternoon throughout the study period may have resulted due to boats returning to boat launches post-dipnetting or traveling upriver to another fishing spot. Increased midday boat traffic moving downstream may have included fishermen returning for lunch, traveling downstream to access the dipnet fishery, or guides that were returning for client change-out.

*Camera use*

It is important to note that the original design of this project incorporated the use of volunteers for 12 hours each day for the duration of the project. However, due to personnel changes mid-

summer, it was agreed upon that the KWF would utilize time lapse cameras to instead conduct upstream and downstream boat counts during this time. The video that resulted allowed the observer to accurately count boats under power, as well as those parking along the bank across the river from each camera. However, it was difficult to determine the hull type and speed of boat from this video. For future projects, it is recommended that volunteers are utilized for in-person boat counts in addition to the use of time lapse cameras for quality control, as these have proven effective in boat enumeration.

The position of boats relative to one another as they passed others was noted in the video to have an effect on the type of wake they created (sloshing wake, consistent but bigger wake, etc…). Further data collection regarding the position of passing boats relative to one another should be considered, as the wake created likely influences the near-shore turbidity.

Continuing forward, it is also recommended that a similar study is conducted during a summer with typical Chinook escapement and therefore no emergency closures or fishing regulation amendments. This would provide a set of data more comparable to the set of data collected from 2008-2010.

Finally, it is important to note that the Eagle Rock Boat Launch was redone in 2018. While it is possible that this may have affected the number of boats that launched in 2018 in comparison to use in previous years, data could be retrieved from the State of Alaska regarding the number of pay stubs counted for launched boats each year.

## Aerial surveys

There are several factors that may have influenced the distribution of power boats and drift boats observed throughout the surveyed stretch of river, including changes in fishing regulations and proximity to boat launches or lodges.

### *Power boats*

Each year, thousands of fishermen participate in the Kenai River dipnet personal use fishery (PUF) throughout July 10 to July 31, from 6:00 AM to 11:00 PM each day. Depending on motor type, dipnetting from a boat is often permitted from an ADFG regulatory marker upstream from the Kenai Docks to the Warren Ames Bridge. The highest total number of boats observed during aerial surveys occurred between the Kenai Docks and the Warren Ames Bridge (Table A). It is highly likely that this elevated power boat presence is due the dipnet PUF. It is also possible that, due to several emergency closures and temporary changes to Chinook fishing regulations throughout July 2018, there was an increase in the number of power boats participating in the dipnet PUF, though this would need to be further researched. The sections from Pillars Boat Launch to the Soldotna Bridge as well as the Kenai Keys to the outlet at Skilak Lake also

experienced high numbers of power boats during aerial surveys, which may be due to their proximity to boat launches as well as lodges and private homes with river access. The stretch of river from the Warren Ames Bridge to the Chinook sonar site resulted in the fewest number of power boats observed. This stretch of river is often used simply as a thoroughfare for power boats launching at Pillars Boat Launch with the intent to participate in the dipnet PUF downstream.

### *Drift boats*

While recreationists in observed drift boats were likely also targeting salmon, it is possible they were also targeting rainbow trout. According to ADFG, one of the most popular stretches of river utilized by drift boats for rainbow trout begins at the Moose River confluence of the Kenai River and extends upstream to the outlet of Skilak Lake (ADFG, "The Kenai River: Kenai Peninsula Recreational Fishing Series"). This is a likely explanation for the increase in overall drift boat observations made during the aerial survey in the upper stretch of the Kenai River. Any drift boats observed in the lower stretch of river surveyed (Kenai Docks to Beaver Creek) were likely participating in the dipnet PUF or catch-and-release Chinook fishery.

### *Limitations*

It is important to consider limitations of this project and ways in which this project could improve upon or eliminate these limitations in the future. Aerial surveys conducted utilized a pilot and an observer. Due to inevitable human error during aerial boat counts, a second observer would be beneficial. The second observer would also be able to serve as the photographer, in order to capture detailed imagery of surveyed river sections.

The aerial surveys conducted were done so upon the notification of plane availability. In future studies, seven aerial surveys conducted on each day of the week would provide further insight into the temporal effects on boat distribution along the Kenai River. The limitations governing days on which clients can fish from guide boats likely impact the number of boats present and their distribution.

## Turbidity monitoring

Some considerations arose throughout the turbidity monitoring period of this project. The simultaneous deployment of two Hydrolabs at each site was effective. However, this only allowed for data collection from a single site. During future projects, the deployment of Hydrolabs at several sites within a section of river would provide a more comprehensive understanding of spatial variation in turbidity within that river section. In addition, it is advised that all future Hydrolabs are cabled to the shoreline using a safe method so as not to interfere with general river navigation. While the general timing of movement of Hydrolabs at RM 11.5 was known, the reason for this movement remains undetermined. It is possible that tampering by

fishermen or other extraneous occurrences resulted in this movement, but a time lapse camera programmed to run for 24 hours would capture any movement during daylight hours.

KWF advises that the data collected in July of 2018 is used with caution due to the limited timeframe of the 2018 study, the vast differences in escapement and therefore boat traffic observed in each of these datasets, emergency closures, and the significantly greater number of registered guides in 2008-2010. Considering these limitations to the 2018 datasets, it is recommended that any additional project conducted spans the duration of the summer to include both times of high and low boat traffic within the Kenai River to gain further knowledge surrounding broad, temporal turbidity trends. This would enable more solidified and representative conclusions to be made concerning any exceedances observed in turbidity levels in the Kenai River.

## Project limitations

Several emergency closures and fishing regulation amendments that occurred throughout this project may have affected the spatial and temporal distributions of boats, as well as the overall boat count each day, thus likely impacting turbidity levels. From July 1, 2018 to July 31, 2018, the Chinook fishing season was closed entirely from the ADFG regulatory marker near Slikok Creek upstream to the ADFG regulatory marker at the outlet of Skilak Lake (Table D). It is possible that this encouraged boaters to fish for sockeye in other stretches of river more heavily than they would throughout summers with elevated Chinook escapement. While sockeye fishing remained open in this stretch for the first part of the summer, though, early-run sockeye failed to meet escapement goals and sockeye fishing was ultimately closed Saturday, August 4, 2018 only to be reopened on Thursday, August 23, 2018 (Table D). The impact of consistently lower sockeye numbers throughout the summer may have also had an impact on the number of boats observed throughout the Kenai River during the 2018 boat count surveys.

The mouth of the Kenai River upstream to the ADFG regulatory marker near Slikok Creek also experienced changes in fishing regulations, when a no-bait rule was implemented for Chinook harvest from July 1, 2018 to July 31, 2018, which was then superseded by a catch-and-release (no-bait) rule implemented on July 18, 2018, lasting through July 31, 2018 (Table D). This did not appear to have a direct effect on boating pressure, as the majority of boats observed among all Kenai River sections surveyed occurred from the Kenai Docks to the Warren Ames Bridge where the dipnetting PUF was open. Finally, it is important to note that the dipnet PUF experienced an early closure on July 30, 2018, though aerial surveys were completed by this date.

# Conclusion

Spatial and temporal variation were identified within boating traffic along the Kenai River. The highest numbers of boats were observed daily from the Kenai Docks to the Warren Ames Bridge in conjunction with the dipnet PUF and the river experienced little boat traffic on Mondays, a likely result of guiding restrictions on this day. However, there were several closures and amendments to fishing regulations for Chinook fishing and the dipnetting PUF throughout the duration of this project. In response to these changes, it is highly recommended that future projects incorporate an assessment that spans the duration of the summer in order to collect data during a year with more representative salmon escapement, fishing regulations, and therefore boat traffic.

# Appendix

## Tables

Table A. Results from the Kenai River aerial boat count surveys conducted in 2018 throughout late July (power boats).

| 2018 Kenai River Boat Count (Aerial Surveys): Power boats | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Day of week | Date | Start time | Kenai Docks-Warren Ames Bridge | Warren Ames Bridge-Chinook Sonar Site | Chinook Sonar Site-Beaver Creek | Beaver Creek-Pillars Boat Launch | Pillars Boat Launch-Soldotna Bridge | Soldotna Bridge-Moose River | Moose River-Kenai Keys | Kenai Keys-Skilak Lake | Total |
| Wednesday | 7/18/2019 | 12:30 PM | 79 | 11 | 18 | 35 | 60 | 5 | 10 | 36 | **254** |
| Sunday | 7/22/2018 | 2:00 PM | 115 | 7 | 7 | 22 | 43 | 12 | 11 | 30 | **247** |
| Wednesday | 7/25/2018 | 12:30 PM | 190 | 6 | 26 | 21 | 77 | 17 | 10 | 40 | **387** |
| Thursday | 7/26/2018 | 2:00 PM | 144 | 8 | 19 | 31 | 94 | 5 | 12 | 46 | **359** |
| Saturday | 7/28/2018 | 1:54 PM | 40 | 15 | 20 | 57 | 88 | 11 | 24 | 46 | **301** |
| Sunday | 7/29/2018 | 4:10 PM | 150 | 5 | 2 | 7 | 8 | 3 | 3 | 12 | **190** |
| **Total** | | | **718** | **52** | **92** | **173** | **370** | **53** | **70** | **210** | **1738** |

Table B. Results from the Kenai River aerial boat count surveys conducted in 2018 throughout late July (drift boats).

| 2018 Kenai River Boat Count (Aerial Surveys): Drift boats | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Day of week | Date | Start time | Kenai Docks-Warren Ames Bridge | Warren Ames Bridge-Chinook Sonar Site | Chinook Sonar Site-Beaver Creek | Beaver Creek-Pillars Boat Launch | Pillars Boat Launch-Soldotna Bridge | Soldotna Bridge-Moose River | Moose River-Kenai Keys | Kenai Keys-Skilak Lake | Total |
| Wednesday | 7/18/2019 | 12:30 PM | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 2 | **6** |
| Sunday | 7/22/2018 | 2:00 PM | 0 | 0 | 0 | 0 | 1 | 8 | 4 | 2 | **15** |
| Wednesday | 7/25/2018 | 12:30 PM | 0 | 0 | 0 | 0 | 4 | 3 | 4 | 12 | **23** |
| Thursday | 7/26/2018 | 2:00 PM | 2 | 1 | 1 | 0 | 1 | 1 | 1 | 3 | **10** |
| Saturday | 7/28/2018 | 1:54 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Sunday | 7/29/2018 | 4:10 PM | 0 | 0 | 5 | 18 | 39 | 2 | 5 | 13 | **82** |
| **Total** | | | **2** | **1** | **6** | **18** | **48** | **15** | **14** | **32** | **136** |
| **Total (excluding 7/28-7/29/18)** | | | **2** | **1** | **1** | **0** | **9** | **13** | **9** | **19** | **54** |

Table C. Hydrolab deployment locations for turbidity monitoring along the Kenai River during late July 2018.

| 2018 Kenai River Hydrolab Deployment | | | |
|---|---|---|---|
| Deployment date | Retrieval date | River mile (RM) | Hydrolab Serial Number (ID) |
| 7/16/2018 | 8/1/2018 | RM 11.5 | 64822 (A) |
| 7/16/2018 | 7/23/2018 | RM 11.5 | 65979 (B) |
| 7/23/2018 | 8/1/2018 | RM 11.5 | 64821 (C) |
| 7/16/2018 | 8/1/2018 | RM 23 | 64823 (A) |
| 7/16/2018 | 7/23/2018 | RM 23 | 64819 (B) |
| 7/23/2018 | 8/1/2018 | RM 23 | 46440 (C) |

Table D. Emergency closures and fishing regulation amendments that were issued for stretches of the Kenai River for the Chinook season and dipnetting PUF throughout July 2018.

| 2018 Kenai River Emergency Closures and Fishing Regulation Amendments | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date issued** | **Start Date** | **End date** | **Mouth of Kenai River upstream to ADFG regulatory marker near Slikok Creek** | **ADFG regulatory marker near Slikok Creek upstream to ADFG regulatory marker at outlet of Skilak Lake** | **Personal use dip net fishery** | **Mouth of Kenai River upstream to outlet of Skilak Lake** | **Mouth of Kenai River upstream to Sterling Hwy Bridge (Kenai Lake outlet) except Upper Kenai River, Russian River, Russian River confuence** |
| 6/11/2018 | 7/1/2018 | 7/15/2018 | | Catch-and-release/no bait (Chinook) | | | |
| 6/18/2018 | 7/1/2018 | 7/31/2018 | | No fishing (Chinook) | | | |
| 6/21/2018 | 7/1/2018 | 7/31/2018 | No bait (Chinook) | | | | |
| 7/16/2018 | 7/18/2018 | 7/31/2018 | Catch-and-release/no bait (Chinook) | | | | |
| 7/26/2018 | 7/30/2018 | 12/31/2018 | | | Early closure (12:01 AM; Chinook) | | |
| 7/26/2018 | 7/30/2018 | 12/31/2018 | | | | Reduced bag and possession limits (sockeye) | |
| 8/1/2018 | 8/4/2018 | 12/31/2018 | | | | | Early closure (12:01 AM; sockeye) |
| 8/21/2018 | 8/23/2018 | 12/31/2018 | | | | | Fishing reopened (12:01 AM; sockeye) |
| No guides may guide from boats on Sundays or Mondays on the Kenai River downstream of Skilake Lake during July | | | | | | | |

# Figures


Figure A. Map of locations at which two time lapse cameras (upstream and downstream) were deployed near the Eagle Rock Boat Launch, RM 11.5 for two weeks in late July 2018.


Figure B. Hydrolab deployment sites used for turbidity monitoring in late July 2018 along the Kenai River.

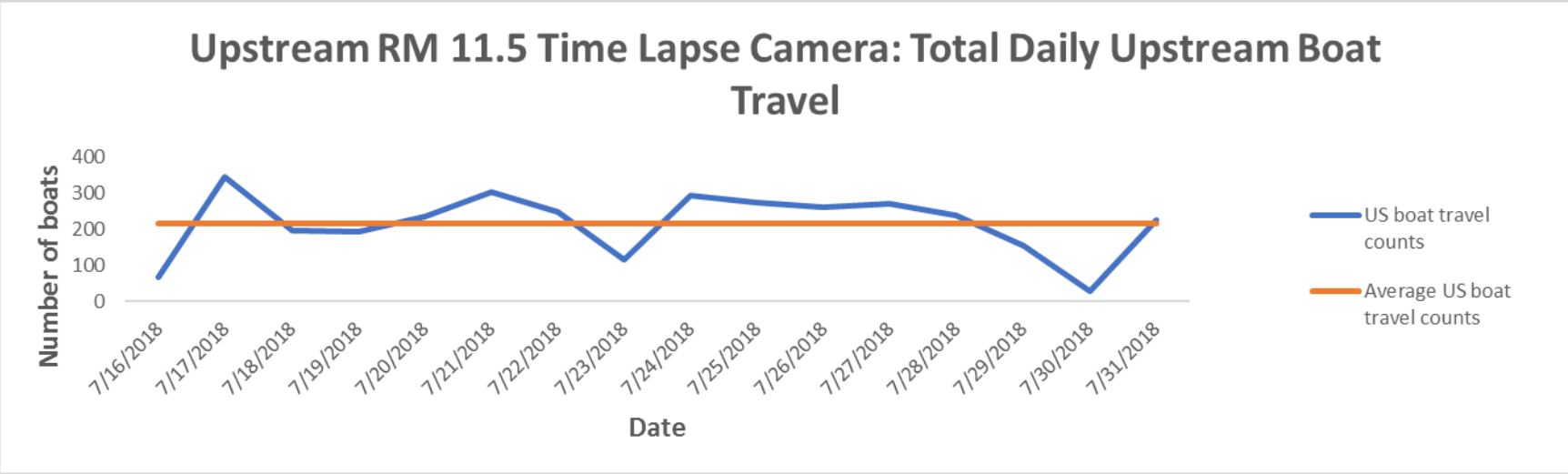


Figure C. Daily counts of upstream (US) boat travel observed from 6:00 AM to 6:00 PM in the upstream time lapse camera at RM 11.5 in 2018.

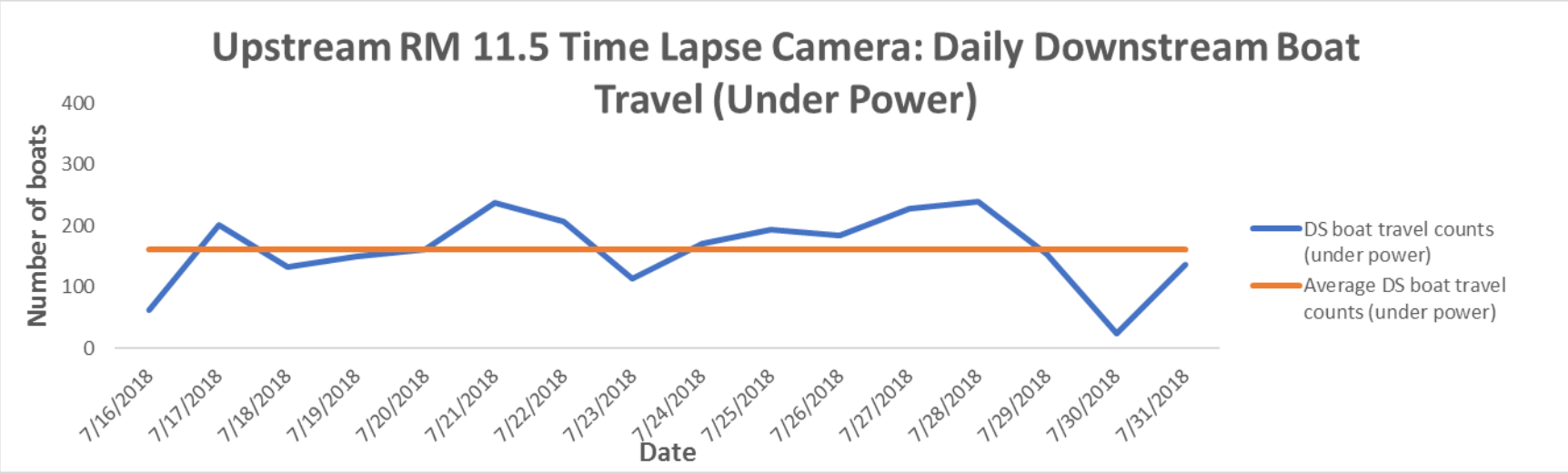


Figure D. Daily counts of downstream (DS) boat travel (under power) observed from 6:00 AM to 6:00 PM in the upstream time lapse camera at RM 11.5 in 2018.

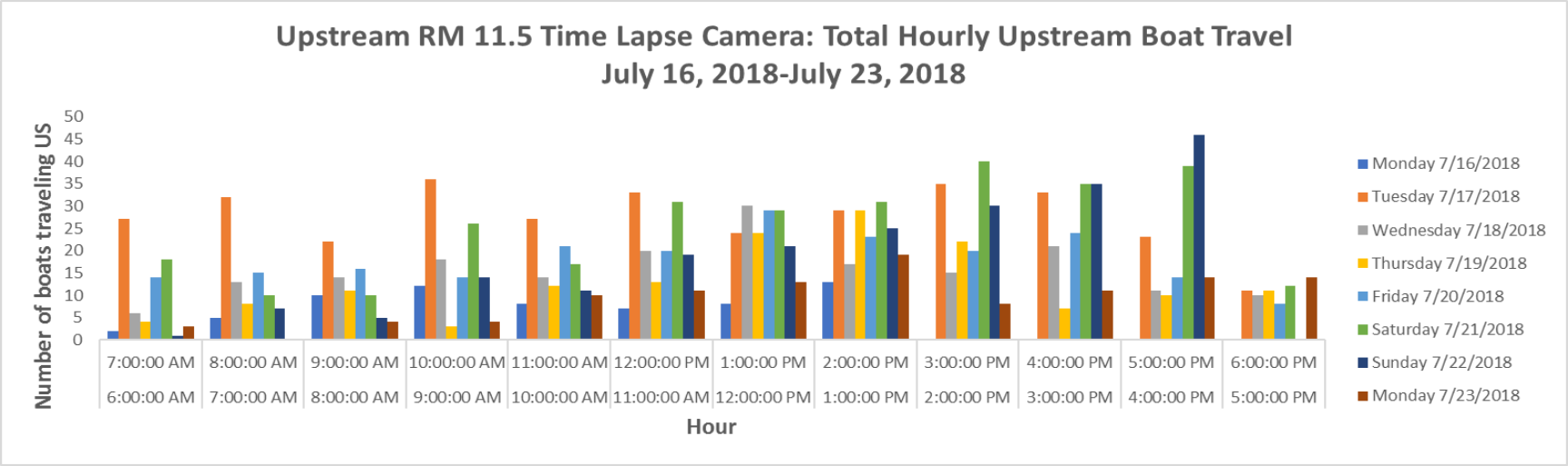


Figure E. Hourly counts of upstream (US) boat travel observed from 6:00 AM to 6:00 PM on July 16,2018 to July 23, 2018 in the upstream time lapse camera at RM 11.5 in 2018.

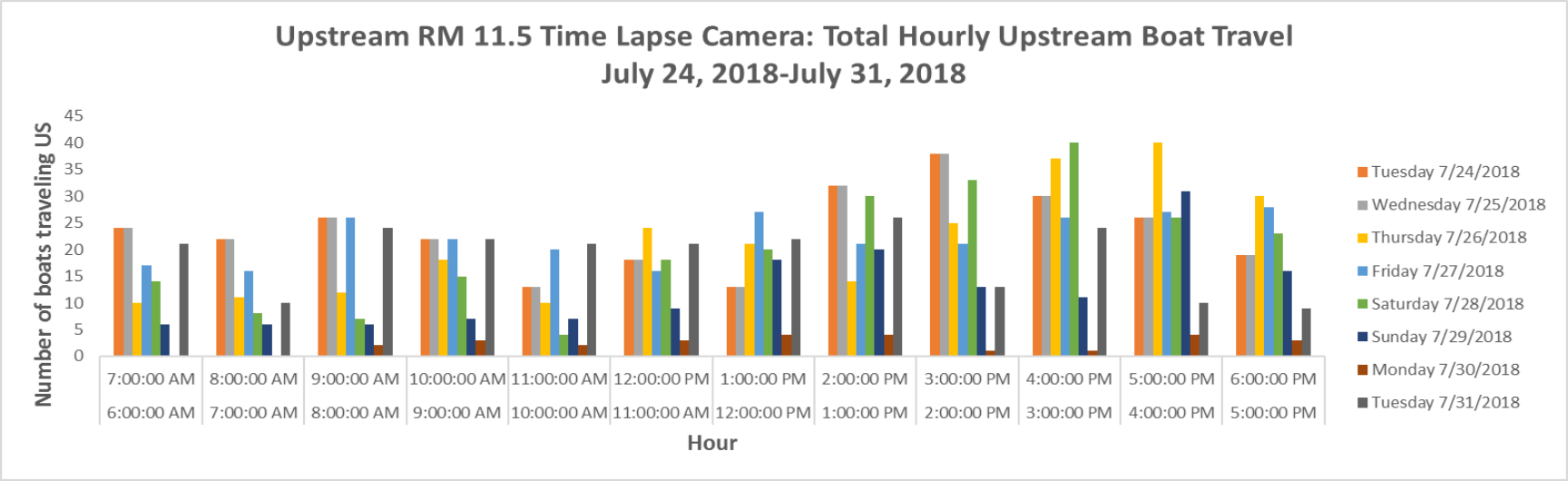


Figure F. Hourly counts of upstream (US) boat travel observed from 6:00 AM to 6:00 PM on July 24,2018 to July 31, 2018 in the upstream time lapse camera at RM 11.5 in 2018.

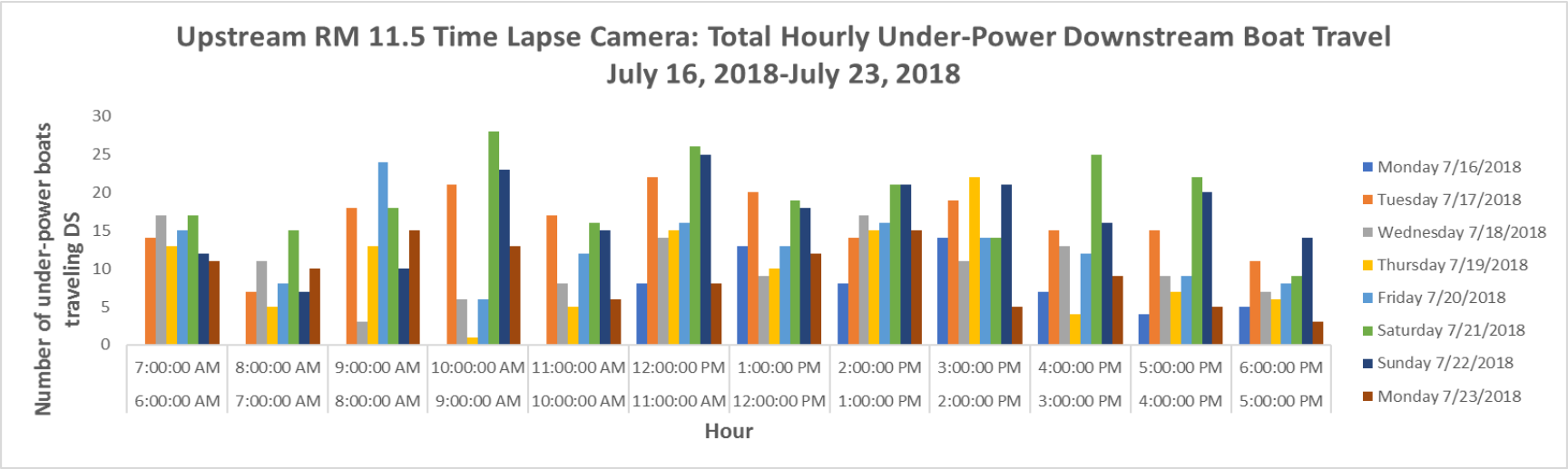


Figure G. Hourly counts of under-power downstream (DS) boat travel observed from 6:00 AM to 6:00 PM on July 16,2018 to July 23, 2018 in the upstream time lapse camera at RM 11.5 in 2018.

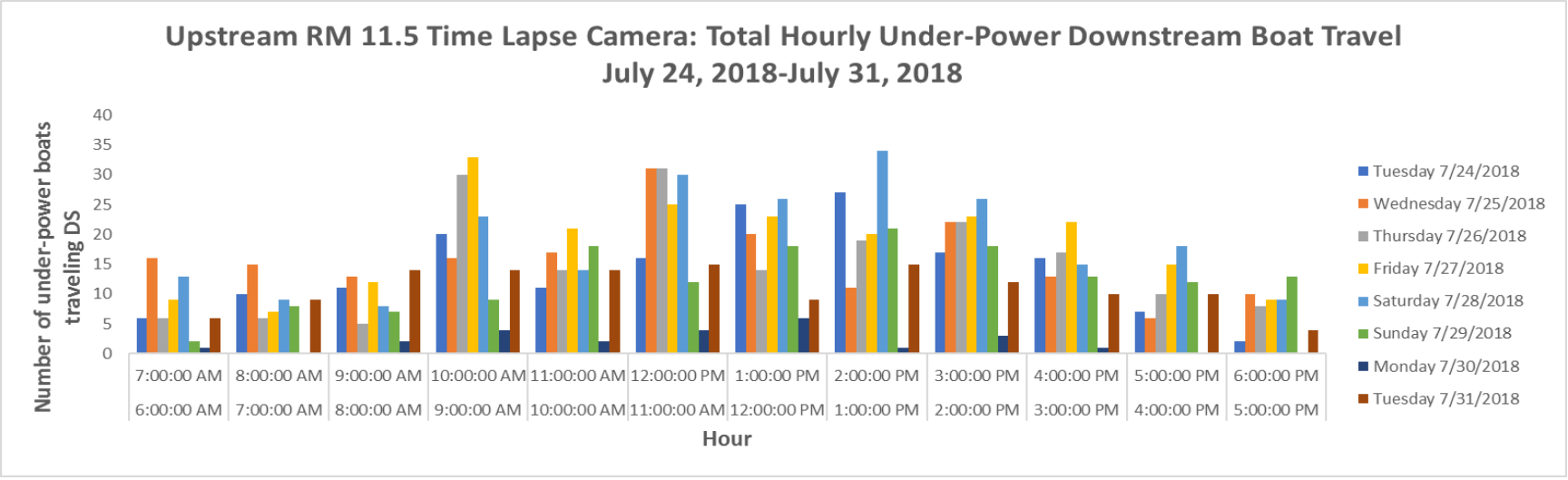


Figure H. Hourly counts of under-power downstream (DS) boat travel observed from 6:00 AM to 6:00 PM on July 24,2018 to July 31, 2018 in the upstream time lapse camera at RM 11.5 in 2018.

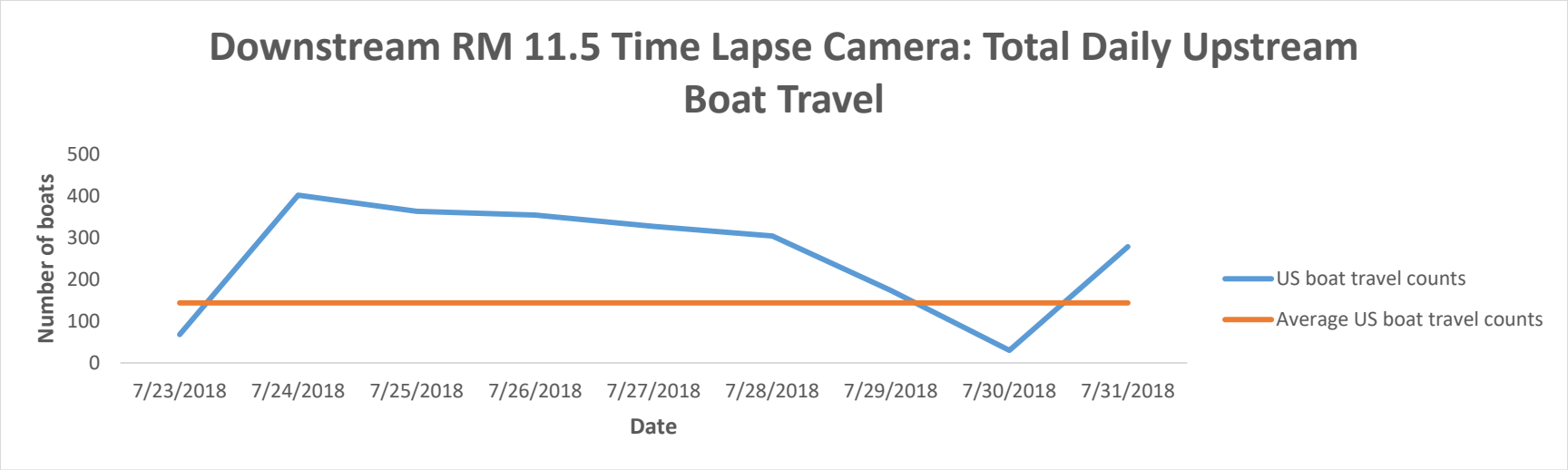


Figure I. Daily counts of upstream (US) boat travel observed from 6:00 AM to 6:00 PM in the downstream time lapse camera at RM 11.5 in 2018.

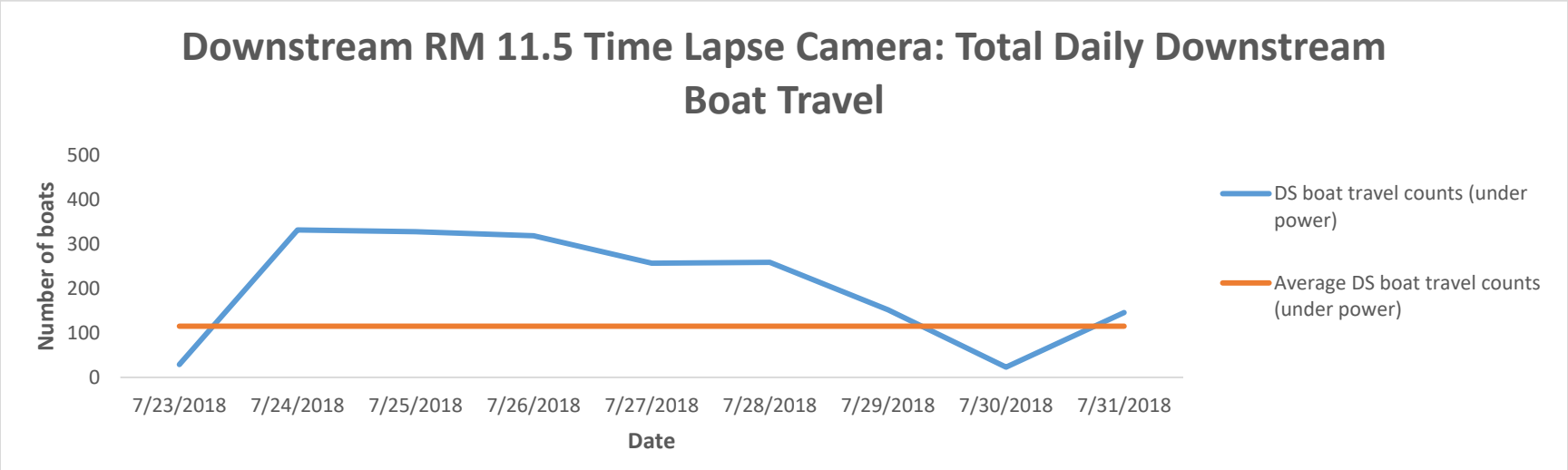


Figure J. Daily counts of downstream (DS) boat travel observed from 6:00 AM to 6:00 PM in the downstream time lapse camera at RM 11.5 in 2018.

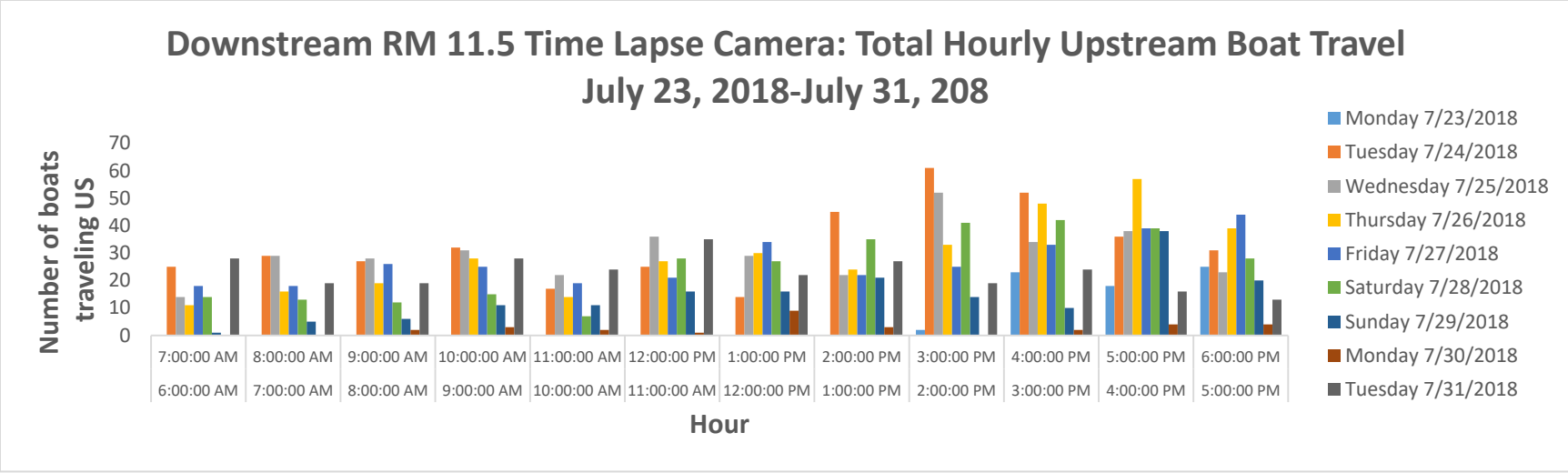


Figure K. Hourly counts of upstream (US) boat travel observed from 6:00 AM to 6:00 PM on July 23,2018 to July 31, 2018 in the downstream time lapse camera at RM 11.5 in 2018.

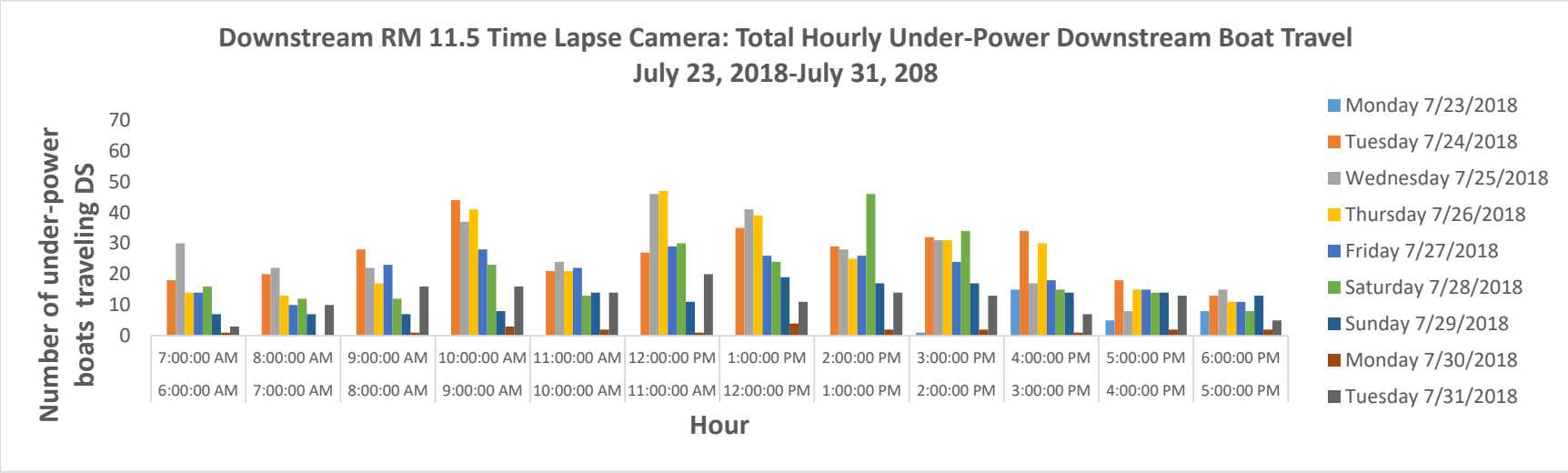


Figure L. Hourly counts of downstream (DS) boat travel observed from 6:00 AM to 6:00 PM on July 23,2018 to July 31, 2018 in the downstream time lapse camera at RM 11.5 in 2018.


Figure M. Western section boundaries of the Kenai River that were surveyed for boat enumeration during aerial surveys in late July 2018.

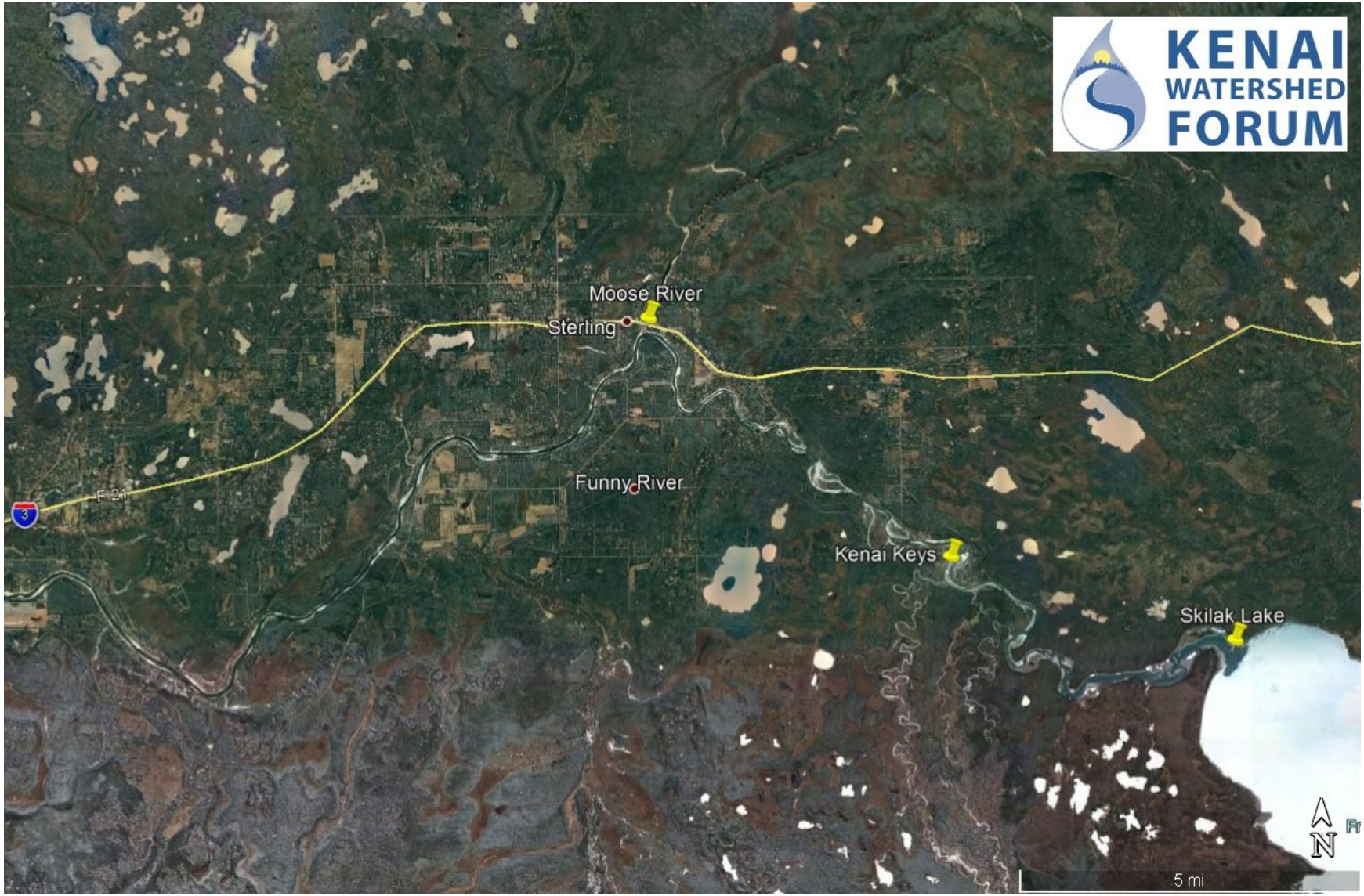


Figure N. Eastern section boundaries of the Kenai River that were surveyed for boat enumeration during aerial surveys in late July 2018.

# References

ADFG. The Kenai River: Kenai Peninsula Recreational Fishing Series. Retrieved November 6, 2018, from https://www.adfg.alaska.gov/static-sf/Region2/pdfpubs/kenairiver.pdf

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