Little Susitna River: Total Aromatic Hydrocarbon Monitoring

Summary Report 2019 - 2020

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Aquatic Restoration & Research Institute

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Cover Photograph. Boat launching at the Little Susitna River Public Use Facility.

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Summary

Concentrated motor boat use in the lower Little Susitna River has resulted in total aromatic (TAH) concentrations that exceeded Alaska water quality criteria (WQC) leading to a water quality impairment designation in Alaska's 2014/2016 Integrated Report for 8.5 river miles during the month of August. In order to reduce TAH concentrations and protect water quality, sport-fishing regulations restricted fishing from a boat using a 2-cycle motor beginning in 2017. Follow-up water quality sampling for TAH analyses were conducted in the lower Little Susitna River in August 2019 and 2020 to determine if regulations were effective at reducing TAH concentrations.

Water samples were collected 5 times a day for 4 days (96-hours) at two locations in the Little Susitna River during the Coho salmon sport fishery in August 2019 and 2020. Average 96-hour TAH concentrations for both years and sites were between 2 and 3 µg/L and the maximum single sample concentration was 8.60 µg/L. Four-day average TAH concentrations were below state WQC and less than expected based on the number of motor boats operating.

Introduction

The Little Susitna River, located in Southcentral Alaska, supports all five species of Pacific salmon and a popular salmon sport fishery from its mouth 63 miles upstream to the Parks Highway. This river segment also is a popular recreational area for motorized and non-motorized boating and camping. The Public Use Facility (PUF) boat launch located approximately 40 km (25 miles) upstream from Cook Inlet is the primary motorized boat access point to the lower Little Susitna River. Sport fishing is concentrated near the PUF and concentrated motor boat activity associated with the sport fishery has resulted in the discharge of TAH as gasoline to the river that in the past approached or exceeded state WQC.

Water sampling to evaluate TAH concentrations relative to Alaska WQC began in 2007 and extended through 2014. Initial studies were designed to determine if a single measure, or acute values, exceeded numeric WQC. High TAH concentrations in water samples prompted the Department of Environmental Conservation (DEC) to evaluate the TAH impairment listing methodology. The resulting listing criteria were developed to determine if average TAH concentrations over a 96-hour period, or chronic values, exceeded numeric values. Current TAH studies were developed to determine chronic (96-hour average) rather than acute values.

Historic Sampling

Weekly water sample collection for TAH analyses was conducted beginning in 2007 at sites distributed from 1 km (0.6 miles) upstream to 0.5 km (0.3 miles) downstream of the PUF boat launch. Subsequent sampling through June 2011 was designed to verify the magnitude, exposure duration, and frequency of the TAH exceedances. Additional sample sites were added as the project progressed in order to determine the longitudinal extent of TAH pollution from upstream to downstream of the PUF. Downstream sites extended to 32 km (20 miles) below the PUF and upstream to 12 km (6 miles). From July 2007-June 2011, the majority of the sampling was

conducted once per week on either Saturday or Sunday (generally the highest use days of the week) between 12:00 and 16:00 during May – September.

ARRI also conducted intensive sampling for DEC to determine the temporal variability of the TAH pollution over two- and three-day sample periods. This intensive sampling occurred on anticipated heavy-use weekends with samples taken every three hours between 06:00 and 21:00 at the sample site located immediately downstream of the PUF boat launch (LS-0). The two (2)-day intensive sample events were conducted in June 2010 and June 2011 coinciding with the king salmon fishery. The three (3)-day intensive sample events were conducted in August 2009 and August 2010 during the more popular silver salmon fishery. A 96-hour sampling event took place in August 2012 to determine a 96-hour average concentration of TAH. However, poor fish returns led to the Alaska Department of Fish and Game (ADFG) closing the fishery and no further TAH sampling occurred in 2012.

In 2014, ARRI sampled water in the lower Little Susitna River for DEC during the king salmon (May – June) and silver salmon fisheries (July – September). Samples were collected during 96-hour sampling events over weekends from May 21 to June 9 during the Chinook salmon fishery, and during 96-hour (4-day) to 120-hour (5-day) sampling events over weekends from August 1 to August 25 during the coho salmon fishery. Samples were collected 5 times in 24 hours at sites located at the PUF boat launch (LS-0) and 4 km (2.5 miles) downstream of the PUF boat launch (LS-4kmdn). These two sites typically had the highest TAH concentrations in previous sampling efforts. Additional TAH samples were collected once in 24 hours at sites located from 4 km (2.5 miles) upstream to 12 km (7.5 miles) downstream from the PUF boat launch.

TAH exceedances were observed primarily in the months of June and August. TAH exceedances ranged from slightly over 10 µg/L to over 75 µg/L (recorded below the PUF in spring 2008) (Table 1). TAH concentrations were highest downstream from the PUF boat launch. TAH concentrations greater than 10 µg/L were recorded at sites located from 4 km (2.5 miles) upstream from the PUF boat launch to 12 km (7.5 miles) downstream. The source of the petroleum hydrocarbons in the Little Susitna River is from motorized boats.

Results of 2014 sampling supported previous results, concluding that the operation of motor boats in the lower Little Susitna River causes an increase in TAH concentrations. Daily average TAH concentrations are correlated with the total number of boats operating. Individual sample TAH concentrations often exceeded 10 µg/L, but the 96-hour average TAH concentrations did not.

The Alaska Board of Fisheries implemented a new regulation effective January 2017 that prohibits fishing from a motorized boat unless the motor is a 4-stroke or direct fuel injected 2-stroke. This action, along with DEC's Clean Boating public outreach campaign, is expected to reduce the petroleum hydrocarbon levels in the river. The State of Alaska included 8.5 river miles of the Little Susitna River on the 2014/16 list of impaired waters for petroleum hydrocarbon pollution coming from motorized boats. The river is in Category 4(b) in the 2014/16 Integrated Report with a plan in place to address the pollution (the 2017 boat motor restriction). Once the water quality sampling demonstrates the Little Susitna River is meeting

allowed limits, DEC will remove the impairment designation for petroleum hydrocarbons in a future Integrated Report.

Table 1. Summary of TAH sampling results from 2007 through 2014.

WQS	Max Observed Value (µg/L)	# Samples Exceeding WQC	Total # Samples	Sampling Period
10 µg/L	10.17	1	15	July – Sept 2007
	75.2	29	72	May - Aug 2008
	12.7	2	49	May - June 2009
	27.2	11	70	July - Sept 2009
	15.8	4	52	May - June 2010
	30.4	14	40	Aug-2010
	20.5	5	12	Jun-2011*
	4.4	0	50	Aug-2012*
	5.29	0	180	May-June 2014
	38.72	51	285	August 2014
Total	75	116	647	

* The Chinook fishery was closed in June 2011 and the Coho fishery closed in August 2012 due to low returns.

This current study was conducted to determine if regulations limiting the use of 2-stroke motors have been effective in reducing TAH concentrations to meet WQC. Sampling was conducted over a single 96-hour period during the Coho Salmon fishery in August of 2019 and 2020.

Methods

Field sampling followed the sampling design and methods described within the approved Little Susitna River: Total Aromatic Hydrocarbon Monitoring Quality Assurance Project Plan version 2.0 (June 2019).

Sampling locations

TAH sampling was conducted at two previously established sites (Table 2). One sampling site was located immediately downstream from the Public Use Facility (PUF) (LS-0 PUF) and at a second site 2.5 miles (4 km) downstream (LS-4kmdn) of the PUF. Sampling locations were selected based upon previous sampling results and to be consistent with previous multi-day sampling events.

TAH Sampling

Sampling in 2019 was conducted over 96-hours from August 9 through August 12, and in 2020 from August 6 through August 9. Sampling was scheduled to overlap with the usually heavy use period surrounding the time period when bait is authorized for use during the Coho Salmon fishery. Samples were collected during 5 time periods per day for a total of 20 samples per 96-hour sampling event at each site. Samples were collected at approximately 08:00, 10:00, 12:00, 15:00 and 18:00 at both monitoring locations.

Table 2. Little Susitna River sampling 2019 turbidity, temperature sampling and hydrocarbon sampling locations. Discharge measured at LS-1kmup. Semi-continuous turbidity loggers installed at 4kmdn and 8kmdn in 2020.

Site ID	Description	Distance from PUF Launch km/mi	Latitude	Longitude
LS-1kmup	Sampling station 1.0 km upstream from the PUF. Location where discharge is measured. Site located upstream of My Creek. Location of Pro V2 water temperature logger.	1.15/0.71	61.44238	-150.16205
LS-0PUF	Sampling location located immediately downstream from the PUF boat launch. Intensive TAH sampling site. Temperature and turbidity site. Location of Pro V2 water temperature logger.	0.00	61.43721	-150.17657
LS-4kmdn	Sampling location 4.0 km downstream from the PUF. Intensive TAH sampling site. Temperature and turbidity site. Location EXO turbidity logger.	-3.87/-2.40	61.42336	-150.19395
LS-8kmdn	Sampling location 8.0 km downstream from the PUF. Location EXO turbidity logger.	-8/-4.97	61.40973	-150.20883

Samples were collected using a volatile organic carbon (VOC) sampler in accordance with the USGS report "Field guide for collecting samples for analysis of volatile organic compounds in stream water for the national Water Quality Assessment Program (USGS Open File Report 97-401)." Prior to sample collection, the VOC sampler was decontaminated with Alconox.

Samples were collected in hydrocarbon-free sample bottles obtained from the contract laboratory (AM Test, Kirkland, WA). Each sample was collected in two 40 ml vials from each lowering of the sampler. Samples were collected at least 12 cm below the water surface and away from any observable sheen. The boat was anchored and the motor turned off for 5 minutes prior to a sample being collected. The samples were collected adjacent to the thalweg by lowering the sampler into the flowing water off of the bow of the boat, upstream of the motor, until the sampler opening was at 0.5 stream depth. Hydrochloric (HCl) acid, provided by the contract laboratory, was added to each vial after sample collection for preservation (~1 drop) and bottles were capped. Clean exam gloves were worn at all times when handling sample bottles. The samples were checked to ensure that there are no air bubbles after capping. The sample bottles were refrigerated below 6°C until shipped to the analytical laboratory. Sample temperatures were recorded by the contract laboratory upon receipt. Field replicates were collected daily and field blanks were collected at the end of each sampling event by submerging the sampler in a stainless-steel pot filled with artesian well (hydrocarbon-free) water.

Boat Use Surveys

A camera was installed with a view of the public boat launch and mooring area at the PUF. Time-lapse photography was used to document motorized boat use. The camera was set to take an exposure every 5 minutes from 05:00 to 22:00 during sampling events. In 2019, the camera was downloaded at the end of the first day and at the end of the sampling period. In 2020, the camera was downloaded daily at approximately 18:00. The number of unique boats present in each photograph were counted to obtain a measure of boat use (Photograph 1). The number of boats using 2-cycle motors observed during sampling was recorded.

Photograph 1. Example of time-lapse photograph used to obtain counts of motor boats operating at the PUF during the 96-hour sampling period.

Discharge, Temperature, and Turbidity

Stream discharge was measured once each day during the four sampling days at LS-1kmup. Stream water temperature and turbidity were measured concurrent with water sample collection for TAH analyses. Water temperature was measured using ProV2 temperature loggers deployed at LS-0 PUF and LS-4 kmdn. The temperature loggers recorded water temperatures every half hour. Water turbidity was measured with a LaMotte turbidimeter from a grab sample collected 0.25 m below the water surface concurrent with TAH sampling.

Turbidity was also measured using YSI EXO Sondes. YSI EXO Sondes with turbidity sensors were deployed at two locations; LS-4kmdn and LS-8kmdn. Sondes were checked for accuracy

prior to deployment using 0 and 100 NTU standards. The Sondes recorded turbidity every 0.5 hours from August 15 through September 9, 2020.

Results

Project Quality Assurance

Water samples collected for TAH analyses were preserved and maintained at temperatures below 6°C until analyzed by the contract laboratory. Samples were analyzed within the 14-day hold time. All analyzes meet the quality objectives for laboratory accuracy and precision. All field blanks were below method detection limits. Three of the four 2019 field replicates met the precision quality assurance objectives. There was a difference of 2.53 µg/L between replicate TAH measures on August 10, 2019. Neither of the 2020 field replicates met the precision quality assurance objective. Sample replicates differed by 2.19 µg/L on August 7, 2020 and 2.94 µg/L on August 9, 2020. The difference between replicates may be due to variations in concentrations, as TAH are not soluble in water. The difference in concentrations between replicates, at higher concentrations would meet quality assurance objectives since precision is calculated as the difference between replicates relative to average concentrations.

The completeness objective for boat counts was not met in 2019. Stop action cameras did not function during the high air temperatures. We obtained complete boat counts on August 9, 2019; but only partial counts on the remainder of the sampling dates.

TAH Concentrations

TAH concentrations are shown in Table 3. Average daily TAH concentrations in 2019 ranged from 1.78 to 2.82 at LS-0 PUF with a 96-hour average of 2.40 µg/L. Average daily TAH concentrations at LS-4kmdn ranged from 2.47 µg/L to 3.14 µg/L with a 96-hour average of 2.77 µg/L. There was very little variability among the 4 sampling dates at either site. In 2020 average daily TAH concentrations at LS-0 PUF ranged from 2.68 to 3.73 µg/L with a 96-hour average of 3.34 µg/L. At LS-4kmdn average daily TAH concentrations ranged from 1.72 to 4.86 µg/L with a 96-hour average of 3.06 µg/L.

Boat Use Surveys

In 2019 and 2020, motor boats were first observed between 04:00 and 05:00 and the last boat was off the water between 20:00 and 22:00. On August 9, 2019, one or more boats were present on 78 of the 217 (33.2%) photographs taken at 5-minute intervals from 04:00 to 22:00 representing 52 distinct boats. The camera was only operational a portion of August 10, 2019; however, there were fewer motor boats observed between 04:00 and 13:00 on August 10th (25 boats) compared to August 9th (37 boats). The percentage of photographs taken when boats were present also declined from 33% on August 9th to 22.5% on August 10th. There were similar declines in boat use on August 11th and 12th, with motor boats present in 20% and 10% of the photographs, respectively. While total daily boat counts in 2019, were only obtained on August 9th, total motorized boats were estimated for the remaining days by multiplying the number of individual boats on August 9 (52) by the portion of photographs with boats on a subject day divided by the portion of photographs with boats on August 9. So, for August 10 total boats was estimated as 52 x (22.49/33.2) = 35.2. The total number of motorized boats was estimated to be

135 for the 96-hour time period (Table 4). This count is similar to 2014 boat counts using the same method. In 2014, 138 unique boats were counted from August 6 through August 9, 2014, and 142 from August 7 through August 10, 2014.

More boats were counted during the 2020 sampling period compared to 2014 and 2019. Daily boat counts ranged from 65 on Sunday August 12, 2020 to 88 on Saturday August 11, 2020. A total of 314 motor boats were counted operating at the Little Susitna River PUF boat launch over the 4-day sampling period (Table 4).

Boats by motor type also were counted when observed during sampling. Motor boats using 2-cycle motors were observed on all sampling dates in 2019 but not all sampling time periods. The number of motor boats observed while sampling that were using 2-cycle motors ranged from 1 to 5 each day, with the greatest number on August 10th. However, it is unlikely that these observations were an accurate measure of 2-cycle boat motor use. In 2020 only 1 motor boat using a 2-cycle motor was observed during the 4-day sampling period.

Table 3. Concentrations of TAH (µg/L) on each sampling date and time for the site below the PUF, LS-0 PUF and 4 km downstream, LS-4 kmdn. In 2019 maximum TAH concentration was 6.41 µg/L and in 2020, 8.60 µg/L both recorded at LS-4kmdn.

LS-0 PUF	8:00	10:00	12:00	15:00	18:00	Average
8/9/2019	4.60	3.07	3.24	2.52	0.12	**2.71**
8/10/2019	0.10	1.60	2.09	1.30	3.83	**1.78**
8/11/2019	3.30	1.82	4.65	1.66	0.10	**2.31**
8/12/2019	4.05	4.69	2.54	2.81	0.00	**2.82**
Average	**3.01**	**2.80**	**3.13**	**2.07**	**1.01**	**2.40**
LS-4 kmdn	**8:00**	**10:00**	**12:00**	**15:00**	**18:00**	**Average**
8/9/2019	2.20	3.06	5.51	2.48	1.35	**2.92**
8/10/2019	2.19	1.29	5.04	2.28	4.89	**3.14**
8/11/2019	4.06	2.61	3.03	2.64	0.00	**2.47**
8/12/2019	0.10	3.03	6.41	2.44	0.87	**2.57**
Average	**2.14**	**2.50**	**5.00**	**2.46**	**1.78**	**2.77**
LS-0 PUF	**8:00**	**10:00**	**12:00**	**15:00**	**18:00**	**Average**
8/6/2020	1.00	2.36	1.00	3.66	5.36	**2.68**
8/7/2020	3.09	2.18	2.82	2.18	8.60	**3.77**
8/8/2020	2.84	1.94	4.51	3.98	2.58	**3.17**
8/9/2020	3.18	1.56	3.03	5.16	5.70	**3.73**
Average	**2.53**	**2.01**	**2.84**	**3.75**	**5.56**	**3.34**
LS-4 kmdn	**8:15**	**10:15**	**12:15**	**15:15**	**18:15**	**Average**
8/6/2020	1.00	1.00	2.16	3.07	1.37	**1.72**
8/7/2020	1.30	3.95	2.23	3.45	1.33	**2.45**
8/8/2020	3.73	3.70	8.11	5.13	3.63	**4.86**
8/9/2020	1.47	2.18	3.71	2.53	6.20	**3.22**
Average	**1.88**	**2.71**	**4.05**	**3.55**	**3.13**	**3.06**

Table 4. Individual boats observed on stop-action photographs at the boat launch on August 9, 2019, and estimated for remaining 2019 dates when camera was only operational for a portion of the day. In 2020 boat counts were obtained from photographs for each sampling date. Boat/Total is the number photographs with boats present (Boats)/total number of photographs taken (Total).

Sample Date (2019)	2019 Boats/Total	2019 Boat Count (estimate)	Sample Date (2020)	2020 Boats/Total	2020 Boat Count
8/9/2019	0.33	52	8/6/2020	0.38	77
8/10/2019	0.23	35.2	8/7/2020	0.41	84
8/11/2019	0.20	31.8	8/8/2020	0.43	88
8/12/2019	0.11	16.6	8/9/2020	0.32	65
Total		136			314

Discharge, Temperature, and Turbidity

Little Susitna River turbidity from grab samples are in shown in Table 5. In 2019, maximum average daily turbidity was 2.1 NTU at LS-0 PUF and 2.7 at LS-4kmdn. Turbidity was slightly higher in 2020 with daily average values from 2.1 to 4.6 NTU at LS-0 PUF and from 2.9 to 6.3 NTU at LS-4kmdn. Turbidity tended to be lowest at both sites at 08:00 and increased during the day (Figure 1). From August 15 through September 1, 2020, average daily turbidity from EXO Sondes was at or below 5 NTU at both sampling sites. Turbidity increased to 14 to 16 NTU with an increase in water depth, as indicated by an increase in pressure, with a single high value of 45 NTU (Figure 2).

Water levels were low and water temperature was high during the 2019 sampling period. Daily discharge was near 200 cfs on all sampling dates (Table 6). Maximum daily water temperatures were over 20°C and average daily temperatures near 19°C (Table 6). Flows were higher and water temperatures approximately 3°C cooler during 2020 sampling (Table 7).

Estimated 96-hour TAH Concentrations

Previous sampling conducted in 2014 resulted in a regression relationship between 96-hour average TAH concentrations and total boat counts (Figure 3) (Burns et al. 2014). The 96-hour average TAH concentrations in 2019 and 2020 were less than expected when using the equation developed in 2014. The discharge of hydrocarbons into the Little Susitna River was less than expected for the number of motor boats operating and below WQC.

Table 5. Stream water grab sample turbidity (NTU) for all sampling dates and times.

LS-0 PUF	**8:00**	**10:00**	**12:00**	**15:00**	**18:00**	**Average**
8/9/2019	1.0	1.6	2.9	2.1	3.0	2.1
8/10/2019	1.3	1.0	1.3	1.0	2.8	1.5
8/11/2019	0.8	1.4	1.3	1.6	3.0	1.6
8/12/2019	1.0	0.9	1.0	1.6	2.8	1.5
Average	1.0	1.2	1.6	1.6	2.9	1.7
LS-4kmdn	**8:00**	**10:00**	**12:00**	**15:00**	**18:00**	**Average**
8/9/2019	1.7	3.2	2.1	2.2	3.0	2.4
8/10/2019	1.5	2.1	2.4	3.9	3.4	2.7
8/11/2019	1.4	1.7	1.7	2.4	2.3	1.9
8/12/2019	1.6	1.8	2.2	2.6	4.8	2.6
Average	1.5	2.2	2.1	2.8	3.4	2.4
LS-0 PUF	**8:00**	**10:00**	**12:00**	**15:00**	**18:00**	**Average**
8/6/2020	3.4	5.8	4.4		4.9	4.6
8/7/2020	5.2	6.0	4.5	5.0	3.4	4.8
8/8/2020	0.3	0.2	4.7	2.9	2.3	2.1
8/9/2020	2.6	4.1	4.5	5.0	4.7	4.1
Average	2.9	4.0	4.5	4.3	3.8	3.9
LS-4kmdn	**8:15**	**10:15**	**12:15**	**15:15**	**18:15**	
8/6/2020	8.4	5.0	8.9		2.9	6.3
8/7/2020	7.2	4.1	5.0	6.9	3.4	5.3
8/8/2020	0.0	0.7	5.1	3.4	5.5	2.9
8/9/2020	2.5	3.0	7.8	5.6	5.2	4.8
Average	4.5	3.2	6.7	5.3	4.2	4.8

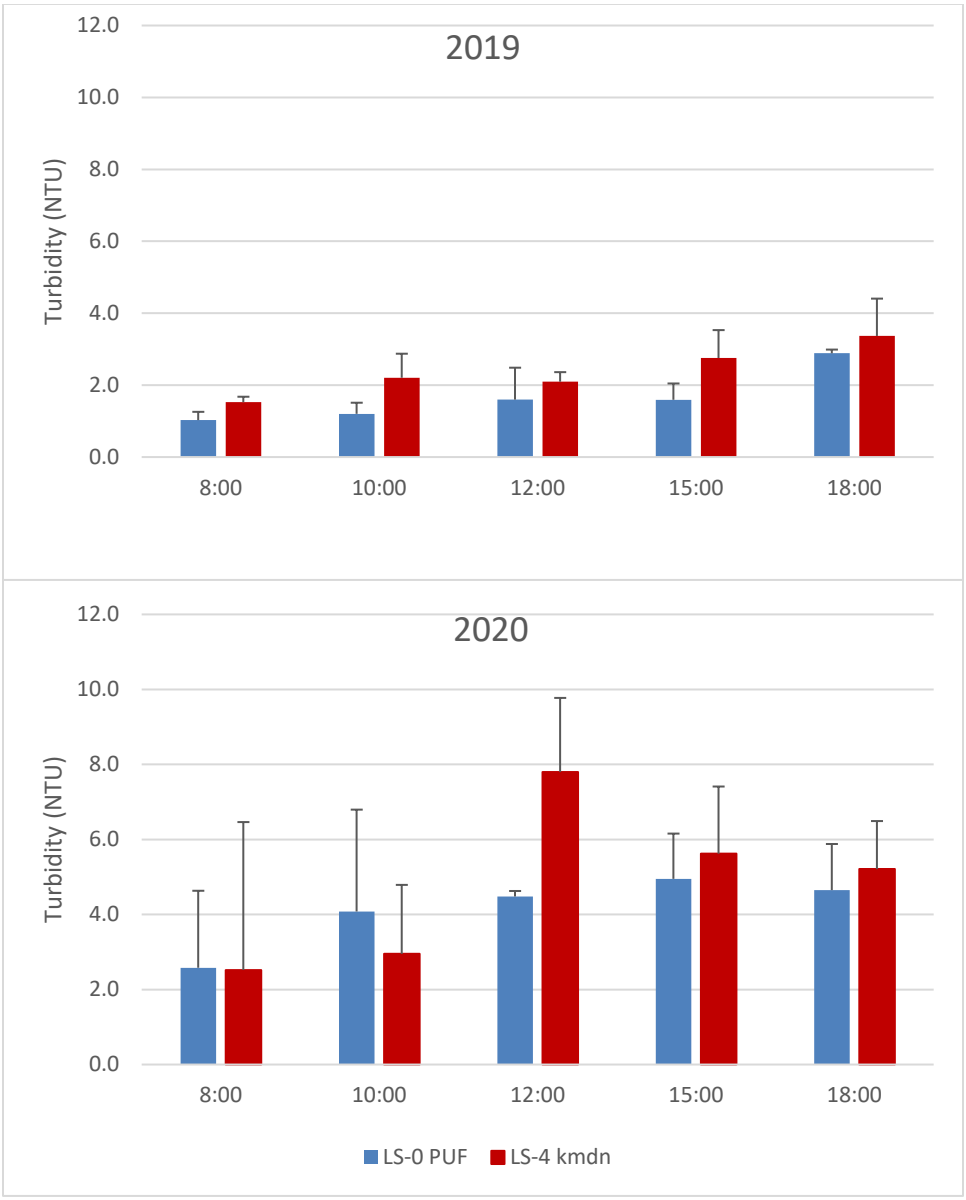


Figure 1. Average grab sample turbidity over the 96-hour sampling event by sampling times. Error bars are one standard deviation.

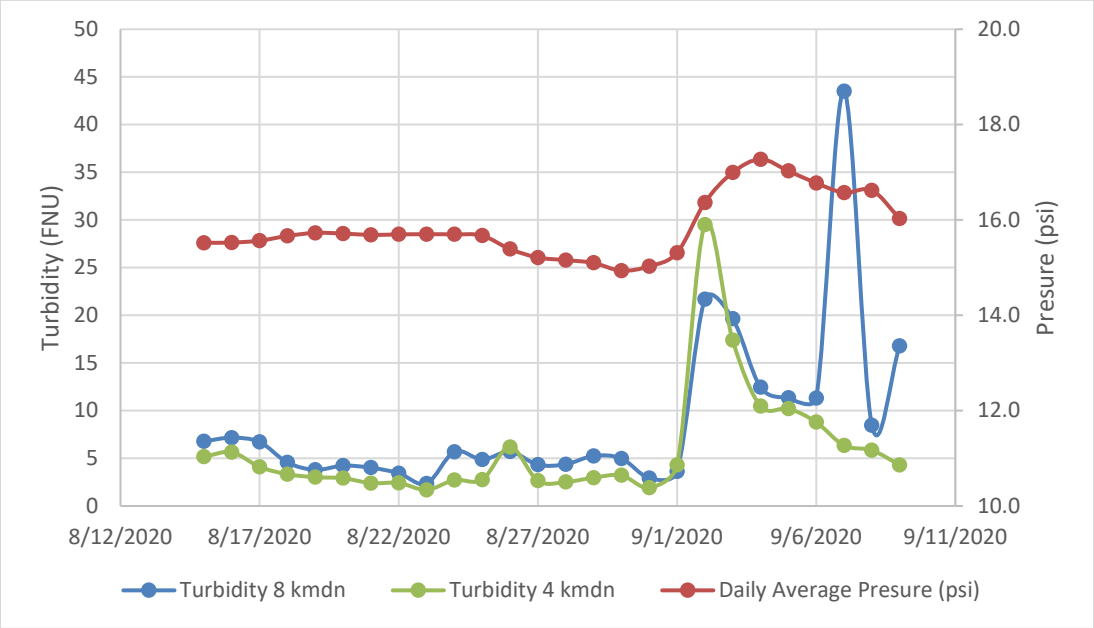


Figure 2. Average daily turbidity from XOS meters installed at 4kmdn and 8kmdn and average daily logger pressure.

Table 6. Daily discharge and maximum, minimum, and average daily water temperatures (°C)

Date	Discharge	Max T	Min T	Ave T	Date	Discharge	Max T	Min T	Ave T
8/9/2019	221	21.3	16.7	19.4	8/6/2020	366	17.6	15.2	15.8
8/10/2019	203	21.1	16.7	18.9	8/7/2020	347	17.9	13.5	15.4
8/11/2019	203	21.3	16.7	18.9	8/8/2020	320	17.9	13.4	15.3
8/12/2019	204	20.8	16.2	18.5	8/9/2020	338	18.2	13.2	15.3

Table 7. Water temperature statistics for the Little Susitna River at the PUF.

Year	2007	2008	2009	2010	2011	2020	
Start Date	5/9/07	5/13/08	5/18/09	5/15/10	5/1/11	6/11/20	Average
End Date	9/30/07	9/30/08	9/30/09	9/30/10	9/30/11	9/8/20	
Season Maximum	20.3	16.3	20.9	18.4	18.8	19.9	19.1
Max Daily Range	5.35	5.50	5.81	6.19	5.48	5.93	5.7
Total Days	145	141	136	116	153	90	130
Days Max>13	87	52	85	60	65	78	71.2
Percent of Total	60.0	36.9	62.5	51.7	42.5	86.7	56.7
Days Max>15	47	5	43	27	36	53	35.2
Percent of Total	32.4	3.5	31.6	23.3	23.5	58.9	28.9
Days Max>20	1	0	7	0	0	0	1.3
Percent of Total	0.7	0.0	5.1	0.0	0.0	0.0	1.0
Jun Cumulative Degree Days	380	333	366	359	368		361
Jul Cumulative Degree Days	457	377	501	129	461	458	397
Aug Cumulative Degree Days	416	373	410	394	353	459	401
Sept Cumulative Degree Days	266	261	274	254	252		261

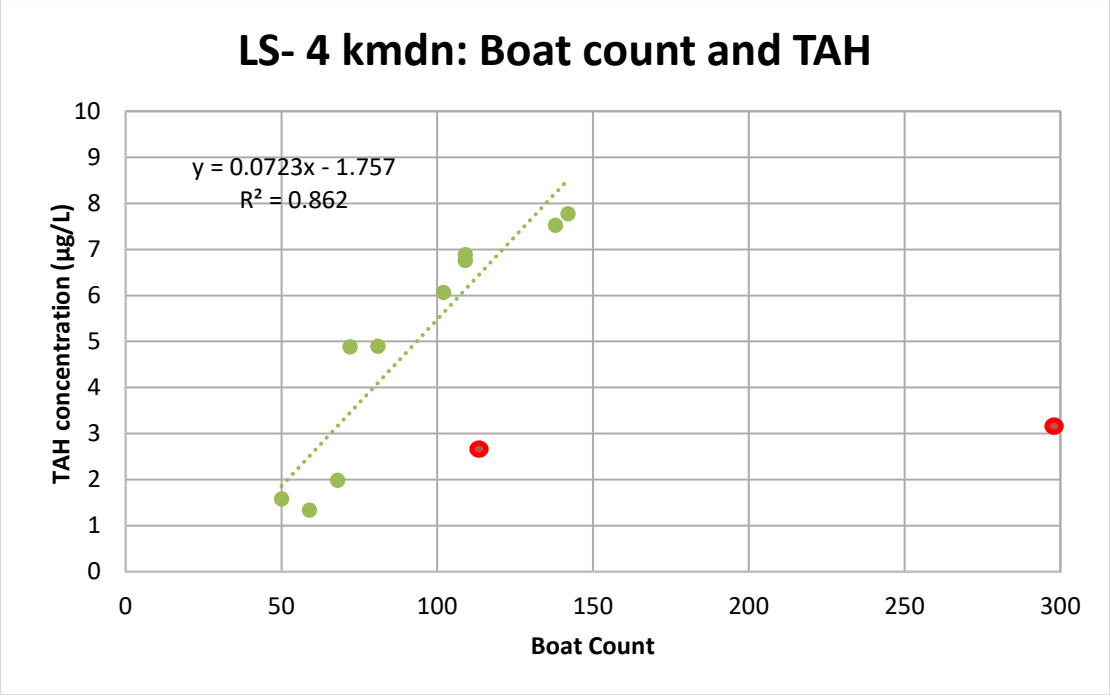


Figure 3. Relationship between the total number of motor boats operating and 96-hour average TAH concentrations from 2014 sampling. Results from 2019 (135 motor boats and TAH of 2.77 µg/L) and 2020 (314 motor boats and TAH of 3.06 µg/L) sampling are added using the red markers.

Discussion

TAH concentrations in the Little Susitna River near the PUF in August 2019 and 2020 were below Alaska WQC and lower than expected based on the number of boats operating on the river. River flows were low in August 2019 and are not the cause of lower than expected TAH concentrations. Water temperatures were extremely high in 2019, which may have increased the evaporation of TAH from the water surface. Lower flows also would be expected to increase the suspension of bed sediments and turbidity as motor boats contacted or disturbed the stream bed more often; however, turbidity levels increased daily but only by a small amount. TAH concentrations remained low and below WQC in 2020 even with an increase in the number of motor boats operating. Slightly higher flows may have helped reduce concentrations. Turbidity during the 96-hour sampling event was higher in 2020 than 2019.

The maximum TAH concentration measured was 6.41 in 2019 and 8.60 µg/L in 2020, therefore none of the 80 samples collected exceeded Water Quality Standard criteria of 10 µg/L (Table 8). The 96-hour average concentrations were less than the maximum value and expected values based on the number of motor boats operating. This suggests that the current regulations to limit the use of 2-cycle motor has been effective at reducing concentrations.

Because of partial camera failure on 3 of the 4 sampling days in 2019, total motor boat numbers had to be estimated. Using the equation developed in 2014, approximately 70 motor boats would result in average 96-hour TAH concentrations of 2 to 3 µg/L. Even if the number of motor boats was overestimated, with 52 counted on the first day the 4-day total clearly exceeded 70.

Low stream flows should result in higher TAH concentrations, without changing TAH discharge per motor boat, but this was not observed in August 2019. Stream flows during August 2019 sampling were very low compared to previous sampling. Discharge during TAH sampling in August 2014 was near 300 cfs or 100 cfs higher than August 2019 and fewer boats were counted in 2014, yet the 96-hour TAH concentration average was higher. In 2020 discharge during the sampling event was similar to flows in 2014.

Water temperatures were much warmer during August 2019 sampling, which may have reduced TAH concentrations. Average water temperatures in August 2014 were from 14 to 16°C and in August 2019 average water temperatures were 19°C. High water temperatures may act to reduce TAH concentrations but we are unable to quantify the effect.

Table 8. Summary of cumulative individual TAH sampling results.

WQS	Max Observed Value (µg/L)	# Samples Exceeding WQS	Total # Samples	Sampling Period
10 µg/L	10.17	1	15	July – Sept 2007
	75.2	29	72	May - Aug 2008
	12.7	2	49	May - June 2009
	27.2	11	70	July - Sept 2009
	15.8	4	52	May - June 2010
	30.4	14	40	August 2010
	20.5	5	12	June 2011*
	4.4	0	50	August 2012*
	5.29	0	180	May-June 2014
	38.72	51	285	August 2014
	6.41	0	40	August 2019
	8.60	0	40	August 2020
Total	75	116	727	

References

Alaska Department of Environmental Conservation. 2018. 18 AAC 70, Water Quality Standards. Juneau, Alaska.

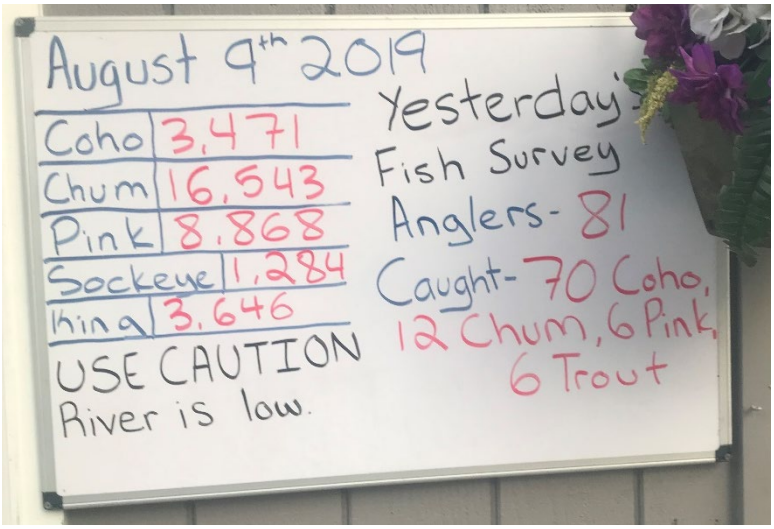
Alaska Department of Environmental Conservation. 2010. Alaska's Final 2010 Integrated Water Quality Monitoring and Assessment Report—July 2010. Juneau, Alaska.

Burns, R., J.C. Davis, and G.A. Davis. 2015. Lower Little Susitna River Water Quality Assessment: May, June and August 2014. Final Report for the Alaska Department of Environmental Conservation. Contract No. 18-6002-12-07. Aquatic Restoration and Research Institute, Talkeetna AK.

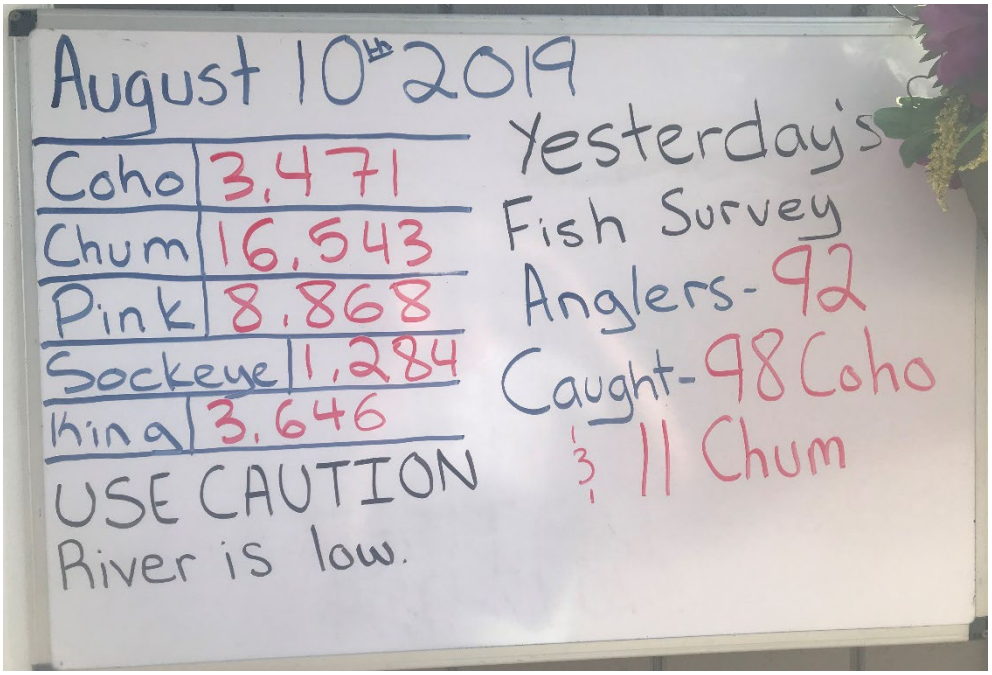
Appendix A. Project Photographs

Photograph A1. Sampling site LS-0 PUF looking downstream.

Photograph A2. Sampling site LS-0 PUF looking upstream.



Photograph A3. Summary of sport fish harvest, and fish weir counts on August 9, 2019.



Photograph A4. Summary of sport fish harvest and fish weir counts on August 10, 2019.

Photograph A5. View of the Little Susitna River upstream from the PUF.

Photograph A6. Sampling site LS-4kmdn looking upstream.

Photograph A7. Sampling site LS-4 kmdn looking downstream, Laura Eldred, DEC project manager.