ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Deshka River Screening Level Water Quality Sampling for Petroleum Hydrocarbons;

June 7, 13, 15 and 21, 2014

Findings Report

dated January 2016

This project was conducted under contract #18-6002-12-08 with the Aquatic Restoration and Research Institute (ARRI) of Talkeetna, AK.

SUMMARY

Petroleum hydrocarbon sampling was conducted for the Department of Environmental Conservation (DEC) at five sampling sites on the Deshka River on four separate sampling days during June 2014. This sampling was conducted subsequent to initial findings from 2011 of petroleum hydrocarbons in the river in excess of State Water Quality Standards (WQS).

The samples were laboratory analyzed for total aromatic hydrocarbons (TAH). Additionally, a subset of samples were analyzed for polycyclic aromatic hydrocarbons (PAH) to measure total aqueous hydrocarbons (TAqH). Results were compared against WQS in 18 AAC 70.

Of the 46 TAH samples taken, 10 (or 22%) exceeded the state water quality criterion of 10 micrograms per liter (µg/L). TAH concentrations ranged from 1.63 µg/L to over 17 µg/L. June 15 had the highest TAH results with 8 of 12 samples exceeding 10 µg/L. No samples in the study exceeded the TAqH criterion. Surface water sheening was observed at two sampling sites on multiple sampling dates and times.

INTRODUCTION

The Deshka River is located in south-central Alaska and is the largest king salmon and silver salmon producing tributary of the Susitna River. The Deshka River can only be accessed by boat or plane. The major route of access is by motor boat from Deshka Landing which is located on the Susitna River approximately three miles upstream of the mouth of the Deshka River (aerial photo in Appendix A).

Looking upstream from the mouth of Deshka River at boats fishing for king salmon.

The Deshka River is a popular fishery due to abundant salmon returns. The king salmon fishery is busiest during the month of June (Appendix B) and the silver salmon fishery in the month of August. Fishing activity is largely conducted using motorized boats.

King salmon that migrate up the Susitna River from Cook Inlet leave the turbid mainstem Susitna River and enter the clear-water mouth of the Deshka River. King salmon mill in this area at the mouth of the Deshka River prior to continuing their migration to spawning locations in the upper drainage. Fishing is concentrated in this milling fish area with only a portion of boats traveling farther upstream to fish. Also located in the lower Deshka River are a float plane air strip and a Matanuska-Susitna Borough campground with a dock and fish cleaning stations. There are also several cabins, residences and a lodge. The Alaska Department of Fish and Game (ADF&G) maintains a fish counting weir site on the Deshka River approximately six miles upstream of the mouth.

PROJECT BACKGROUND

The heavy boat use traffic on the lower Deshka River raised concerns about water quality and petroleum hydrocarbon pollution coming from the motorized boats. DEC has investigated petroleum pollution from motorized boats in other south-central Alaska waters including the Kenai River, Little Susitna River and Big Lake. The physical characteristics of the lower Deshka River with a wide, deep and slow moving channel along with the no-wake-zone in the area of concentrated motorized boat use (boat motors are less efficient when idling or operating at slower speeds and petroleum discharge can increase) led DEC to begin investigating the level of petroleum pollution.

Through a contract with the Aquatic Restoration and Research Institute (ARRI), DEC conducted screening level petroleum hydrocarbon sampling in the Deshka River on one day in June 2011 and on four non-consecutive sampling days in June 2014.

2011 TAH SAMPLING

2011 Methods

Water sampling was conducted at four lower Deshka River sampling locations on June 18, 2011 during the king salmon fishery. Sampling had initially been planned to be conducted on the nearby Little Susitna River (under a DEC approved Quality Assurance Project Plan (QAPP)) but when the fishery closed, the sampling was shifted to the Deshka River. Sampling followed similar procedures as had been approved for the Little Susitna River. Deshka River sampling locations were distributed from near the confluence with the Susitna River (site "Deshka 4") to 3.7 miles upstream (site "Deshka 1"). See Table 1.

2011 Sample Results

Deshka River water physical properties and TAH concentrations from the one day of sampling in June 2011 are shown in Table 1. Stream water discharge was 308 cubic feet per second (cfs). Stream water turbidity and specific conductivity were highest at site "Deshka 4", which likely reflected partial mixing with the Susitna River. TAH concentrations were above state water quality criterion (10 µg/L) at three of the four sampling sites. Five of the eight samples taken exceeded state criteria with a maximum TAH concentration of over 24 µg/L. A total of 98 boats were counted during sampling. Surface oil sheens were observed during sampling at site "Deshka 3".

Table 1. Summary of June 18, 2011 TAH sampling results. Sites "Deshka 3" and "Deshka 4" were within the concentrated fishing area.

Site	Latitude	Longitude	Channel Width (ft)	Water Temp. (C)	Turbidity (NTU)	Specific Cond. (µS/cm)	Morning -TAH (µg/L)	Afternoon -TAH (µg/L)
Deshka 1	61.73986	-150.32202	233	17.0	4.66	74.5	3.75	6.89
Deshka 2	61.71056	-150.32594	415	16.2	4.21	74.4	7.00	15.10
Deshka 3	61.70040	-150.32158	277	16.2	4.33	74.4	24.21	23.37
Deshka 4	61.69706	-150.31766	394	16.3	7.11	84.9	10.52	11.74

The results of this initial sampling led to further TAH sampling conducted in June 2014 under a DEC approved QAPP. The remainder of this report focuses on the 2014 study and results.

2014 SAMPLING METHODS

2014 Sampling Locations

The sampling locations used in 2014 are distributed from the mouth of Deshka River (DR- 0) to three miles upstream (DR-3.0). A majority of the sampling sites are within the lower one mile of the river since this is the area with the concentrated boat use. Sample site distribution also serves to determine the longitudinal extent of TAH in the river. Figure 1 shows the sampling locations and Table 2 provides a description. Note that the 2014 sample site names refer to the river mile where the sample site is located. This is a different naming convention than that used in 2011 and more sites were sampled in 2014.

Sampling at site DR-3.0 was only conducted on June 7. For safety reasons in motoring to this site, it was removed from the project after June 7.

2014 Sampling Frequency

Water samples were collected for TAH analyses at 08:00, 10:00, 12:00, 14:00, and 17:00 at the intensive sampling locations DR-0 and DR-0.25 on each sampling date.

Water samples were collected for TAH analyses at sites DR-1.0, DR-2.0, and DR-3.0 once between 15:00 and 17:00 on each sampling date.

Water samples were collected for TAqH at site DR-0 and DR-0.25 at 14:00 on each sampling date. See Table 3.

Figure 1. Deshka River sampling locations from the confluence with the Susitna River to 3 miles upstream on the Deshka River.

Table 2. June 2014 Deshka River sampling sites.

Site Name	Description	Latitude	Longitude
DR – 0	Site located at the mouth of the Deshka River. Site has some mixing with Susitna River waters. Lentic area.	61.69845	-150.31871
DR – 0.25	Site 0.25 miles upstream of the mouth of the Deshka River and part of the concentrated fishing area. Lentic area.	61.70162	-150.32215
DR – 1.0	Site 1 mile upstream of the mouth and at the upper end of lentic water reach. Site upstream of the floatplane runway and adjacent to the Deshka River lodge.	61.71241	-150.32532
DR – 2.0	Site located 2 miles upstream from the mouth and within the lotic reach.	61.72662	-150.32160
DR – 3.0	Site located 3 miles upstream from the mouth and the most upstream sampling site. Lotic reach. Site only sampled June 7.	61.73868	-150.32278

Table 3. Sampling schedule for Deshka River TAH and TAqH monitoring.

Sampling Date	TAH Sample Time DR-0 and DR-0.25	TAqH Sample Time DR-0 and DR-0.25	TAH Sample Time DR-1.0, DR-2.0, and DR-3.0
Saturday, June 7, 2014	08:00, 10:00, 12:00, 14:00, 17:00	14:00	Between 14:00 and 17:00
Friday, June 13, 2014	08:00, 10:00, 12:00, 14:00, 17:00	14:00	Between 14:00 and 17:00
Sunday, June 15, 2014	08:00, 10:00, 12:00, 14:00, 17:00	14:00	Between 14:00 and 17:00
Saturday, June 21, 2014	08:00, 10:00, 12:00, 14:00, 17:00	14:00	Between 14:00 and 17:00

2014 Field Collection Techniques

TAH water samples were collected 20 cm below the water surface using a U.S. Geological Survey (USGS) volatile organic carbon sampler. The samples were packed in coolers with gel packs and shipped to a laboratory for analysis. Samples were analyzed for benzene, toluene, ethyl-benzene, and xylene (BTEX). BTEX results were summed to provide TAH concentrations. TAH concentrations were evaluated relative to state water quality criteria.

Water samples for TAqH were collected in the river channel at 0.5 times the water depth. Samples were collected in 1 liter amber glass bottles, packed in coolers with gel packs and shipped to the laboratory for analysis. TAqH concentrations were evaluated relative to state water quality criteria.

Observations for water surface sheening were made at each sample site and time. If a sheen was observed, basic testing methods were used to differentiate an oil sheen from a biogenic sheen by using a stick to break up the sheen ("stick test"). If the sheen swirled and quickly re-coalesced it was documented in the field notes as a petroleum sheen.

Stream discharge was measured using a Swoffer 3000 Velocity meter on each sampling day at the farthest upstream site. On June 7 this was at the site located 3 miles upstream from the mouth (DR-3.0) and for the remaining sampling dates discharge was collected 2 miles upstream from the mouth (DR-2.0). Stream discharge information allows for evaluation of dilution due to changes in water volume.

Stream water temperature was measured concurrent with water sample collection. Water temperature was measured using a temperature specific thermistor and meter at 0.1 meter depth intervals at DR-0 and DR-0.25 due to deeper water depth. All other sites measured water temperature at 0.5 times the water depth.

Channel width and water depth were measured at all sampling locations. Stream water pH, specific conductivity, dissolved oxygen, and turbidity were measured at each location.

Weather conditions were recorded during each sample event and photographs were taken at each sample site (Appendix A).

2014 Boat Use Surveys

Boat use data is necessary to calculate TAH loading to the river and to investigate relationships between TAH discharge and boat motor type. Boat use data was obtained by using a transect survey to count the number of boats operating in the lower river (between DR-0 and DR-1.0) during each sampling event. Transect surveys were conducted by counting each boat or other watercraft passed while driving upstream from DR-0 to DR-1.0. Boat count transect surveys were conducted approximately every two hours on each sampling date for a total of five counts each date.

Data collected included total boat counts distinguished between inboard and outboard motors (4-stroke, 2-stroke, or 2-stroke direct fuel injected (DFI)). If discernable, outboard motor size was documented. Photographs were taken at each sampling site and sampling time to assist in documenting boat density on each sampling date (Appendix A).

2014 RESULTS and DISCUSSION

Total Aromatic Hydrocarbons

Of the 46 TAH samples taken, 10 (or 22%) exceeded water quality criteria of 10 μg/L. TAH concentrations ranged from 1.63 μg/L to over 17 μg/L (Figure 2). If concentrations were below Practical Quantitation Limits, a value of 0.5 times the detection limit was used to calculate TAH

concentration. The highest TAH concentrations were on Sunday, June 15 with 8 of 12 samples exceeding 10 µg/L. The lowest TAH concentrations were on Friday, June 13.

Combining all of the TAH samples from each site taken per day, a daily average TAH concentration was calculated (Figure 3). Daily average TAH concentrations exceeded criteria on Sunday, June 15 with the daily average of 13.80 µg/L.

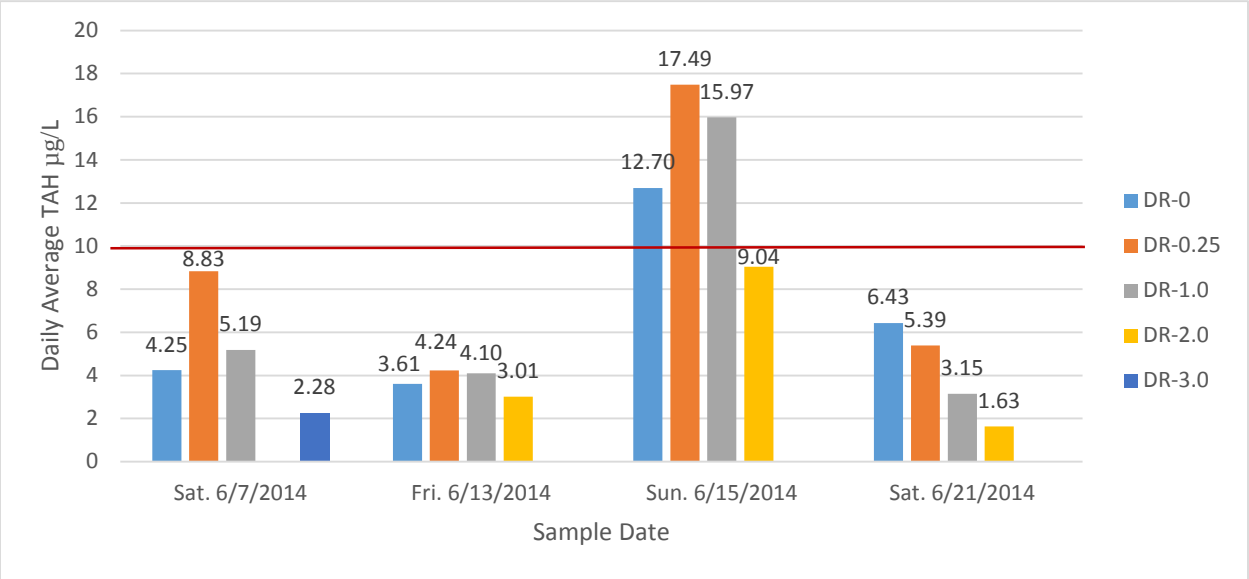

Figure 2. Deshka River TAH concentrations averaged for each sampling date and site. The red line notes the state water quality criterion of 10 µg/L.

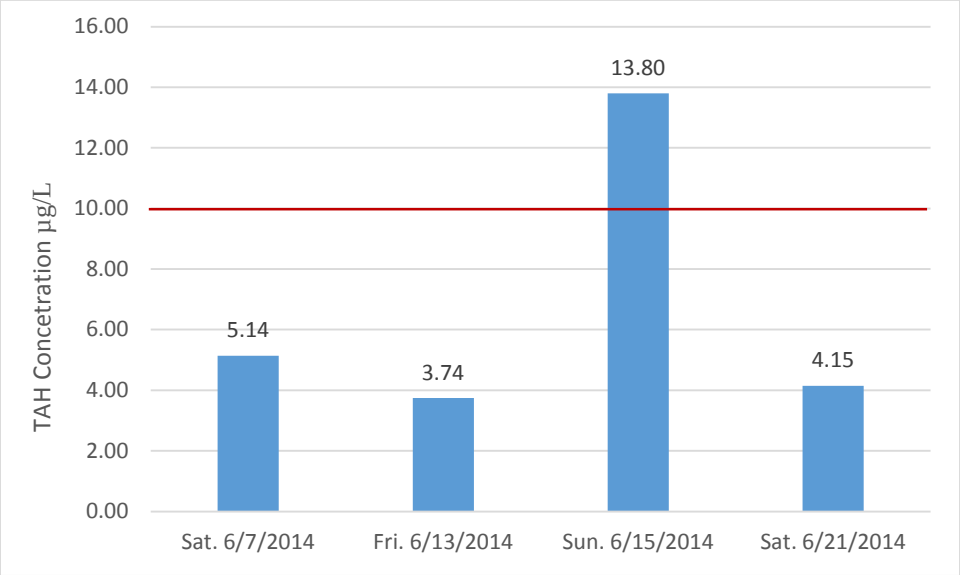

Figure 3. Deshka River daily average TAH concentration for each sampling date. The red line notes the state water quality criterion of 10 µg/L.

Total Aqueous Hydrocarbons

TAqH concentrations were all below the water quality criterion of 15 µg/L on all sampling dates, times and locations. PAH constituents of TAqH were all non-detected.

Surface Sheening

Surface sheening was observed at the two lower most sampling sites (DR-0 and DR-0.25). No sheens were observed at the upper sampling sites (DR-1.0, DR-2.0 or DR-3.0). Sheens were observed at site DR-0 on two sampling days; sheens were observed at site DR – 0.25 on three sampling days (Table 4). Site DR-0 had observed sheening at all sample times on June 15. Site DR-0.25 had sheening on four out of five sampling times on this same date. Site DR-0.25 had the most recorded sheens of the sites sampled in the project.

Table 4. Petroleum hydrocarbon sheening was observed on the surface of the water at two Deshka River sampling sites on 3 sampling dates.

Sampling Date	# Times Sheen Observed During Sampling DR-0	# Times Sheen Observed During Sampling DR-0.25
6/7/2014	0	3
6/13/2014	1	1
6/15/2014	5	4
6/21/2014	0	0

Boat Use Surveys

Table 5 shows the boats counted between river mile zero (DR-0) and river mile 1 (DR-1.0) for each sampling date. Counting boats operating and anchored up in this mile captured a majority of boats operating on the river since this is the area of most concentrated use. The results are broken down by inboard, outboard 4-stroke, 2-stroke, or 2-stroke DFI. Engine horsepower proved difficult to gather depending on the orientation of boats anchored while fishing. The field notes record horsepower information as much as possible (available from DEC).

A majority of the boats counted were 4-stroke or inboard motors. Carbureted 2-stroke motors accounted for 26 percent of the total boats counted.

Table 5. Deshka River boat counts by motor type for each sampling date.

Date	2-Stroke	2-Stroke DFI	4-Stroke	Inboard	Total Boat Count
6/7/2014	29	8	56	51	144
6/13/2014	26	7	49	39	123
6/15/2014	56	6	39	49	150
6/21/2014	10	1	18	29	58

Other Field Parameters

Discharge

River discharge measures the volume rate of water flow. Discharge (cfs) was measured once during each sampling event at the upper most sample site. On June 7 this was at site DR-3.0 and for the

remainder of sample dates discharge was measured at DR-2.0 (Table 6). Water levels were lower on the last day of sampling June 21.

Table 6. Deshka River measured discharge during each sampling event.

Date	Sample Site	River Discharge (cfs)
6/7/2014	DR-3.0	519
6/13/2014	DR-2.0	579
6/15/2014	DR-2.0	571
6/21/2014	DR-2.0	399

Water Depth and Channel Width

The depth of the water column down to the surface of the river bottom was measured at each sampling site during each sampling time. The lower one mile of the Deshka River is wide and deep and more lake like in nature. Average bottom depths at each sampling site are shown in Table 7.

The width of the channel was measured at each sampling site and sampling time. Channel width was not measured at site DR-3.0. The channel is widest in lower one mile and in general becomes narrower as you travel upstream. Averaged channel widths are shown in Table 7.

Table 7. Average depth to bottom and average channel width measured at each sampling site on the Deshka River.

Sample Site	Average Depth to Bottom (feet)	Average Channel Width (feet)
DR-0	8.5	428
DR-0.25	10.2	289
DR-1.0	6.2	338
DR-2.0	2.8	278
DR-3.0	3.3	not measured

Weather

Weather conditions during sampling varied between mostly sunny with high temperatures in the 60's to raining with cooler temperatures (Table 8).

Table 8. Weather conditions for each sampling date.

Date	Weather Conditions	Daily High Air Temperature
6/7/2014	Partly sunny	68 °F
6/13/2014	Overcast with a trace of rain	60 °F
6/15/2014	Partly sunny	66 °F
6/21/2014	Overcast with rain, heavy at times	55 °F

Turbidity

Turbidity was measured at each sampling site during each sampling time through grab samples. Daily average turbidity values for each sample site are shown in Figure 4.

Turbidity WQS are determined by comparing the natural condition value to an impacted area's value. The most stringent water quality criteria requires that the two values be within 5 NTU of each other. Because all of the samples measured were less than 5 NTU, this means WQS have been met.

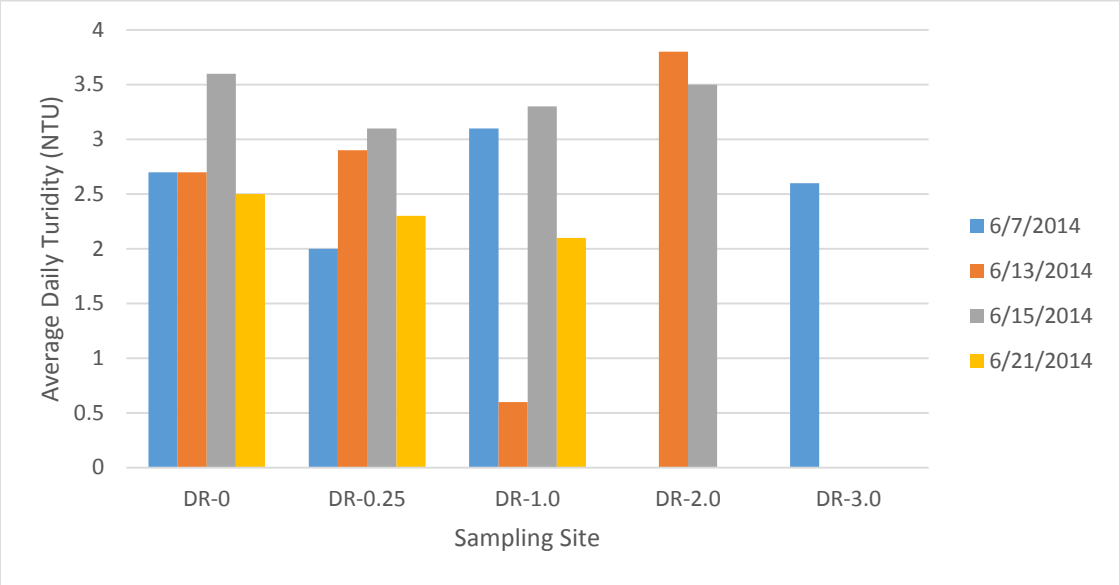

Figure 4. Daily average turbidity for each sampling site and date. Turbidity was only measured during one sampling event at site DR-3.0 and two sampling events at DR-2.0.

Water Temperature

Water temperature was measured at each site during each sampling time. Coolest temperatures were on June 13 at each site. Warmest water temperatures varied by sample date and site. Daily average water temperatures are shown in Figure 5. Daily average water temperatures were above water quality criteria for fish spawning and egg and fry incubation (13 C°); fish migration and rearing (15 C°) at certain sites and dates.

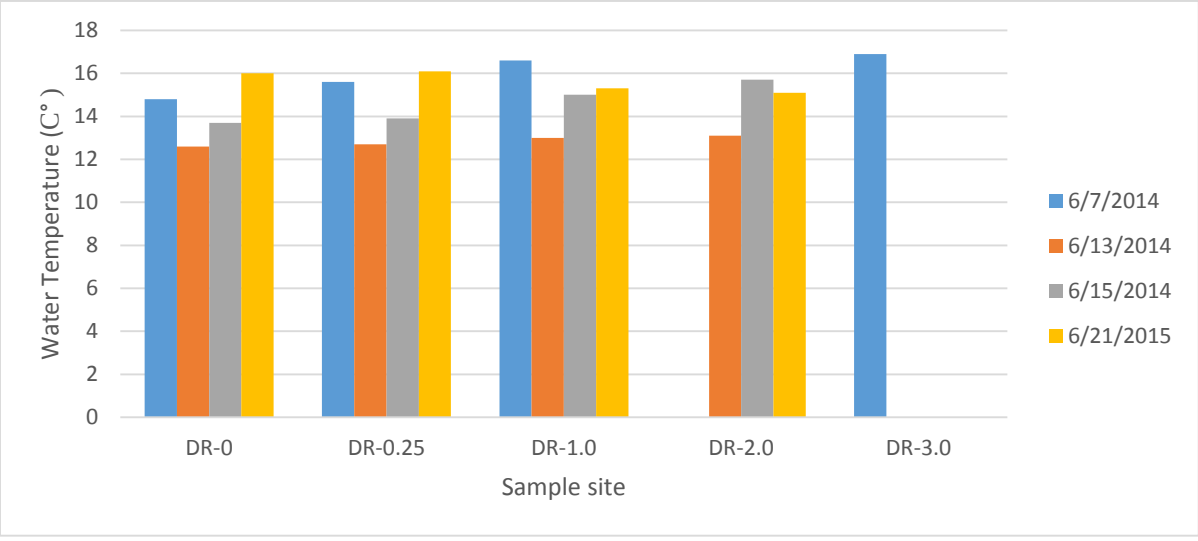

Figure 5. Daily average water temperature for each sampling site and date. Temperature was only measured during one sampling event at site DR-3.0.

Other Field Parameters

Specific conductivity, pH and dissolved oxygen were collected at each sampling site during each sampling time using a calibrated meter. All results met WQS.

CONCLUSIONS

Screening level water quality sampling was conducted for TAH and TAqH in the lower 3 miles of the Deshka River during the king salmon fishery in June 2014. TAH concentrations exceeded the water quality criteria with observed surface sheening and measured TAH concentrations above the aquatic life criterion of 10 μg/L. June 15 had the highest TAH concentrations and also the highest boat counts. TAqH levels were non-detected.

Boat count surveys show that carbureted 2-stroke motors make up approximately 26% of the boats operating on the lower Deshka River. Inboard motors and 4-stroke outboard motors made up the majority of boats counted. Of the dates sampling was conducted, June 15 had the highest number of boats counted.

River discharge was high at the beginning of June but started to drop off by the end of the month. Discharge and water volume generally impact TAH concentrations by dilution in higher flows. The highest recorded TAH concentrations were on June 15 when water volume was also high. This may indicate that the TAH loading for that day was particularly high.

Turbidity grab sampling results were all less than 5 NTU. Even though a natural condition was not established, no WQS exceedances occurred. The grab sampling focused more within the lower one mile reach of the river which is hydrologically different than the upper reaches of the river where the river channel becomes narrower and shallower. Boat traffic may have a greater impact on water quality by increasing turbidity levels in the upper reaches of the river.

Water temperature results exceeded state water quality standards on certain dates and locations. This result is in agreement with other recent temperature studies conducted on the Deshka River. As part of the National Water Quality Assessment Program, the USGS identified the Deshka River as being likely to experience more extreme temperature increases as climate changes (Kyle and Brabets, 2001).

RECOMMENDED NEXT STEPS

More intensive TAH sampling during the king salmon fishery in early summer (primarily the month of June) is needed to determine whether the Deshka River is water quality impaired. While no TAH sampling has occurred during the silver salmon fishery, based on the results from the king fishery and the popularity of fishing during the silver salmon fishery, collecting TAH data during the silver salmon fishery in late July – August is warranted. Sampling should follow the DEC's *Listing Methodology for Determining Water Quality Impairments from Petroleum Hydrocarbons, Oils and Grease. Final Guidance* (2015). TAqH sampling is not recommended. Concurrent with water sampling, conducting observations for surface sheening is recommended.

Boat count data should be collected either through transect surveys or some other approved method to determine the number of boats operating in the sample reach. Motor type (2-stroke, 2-stroke

DFI, 4-stroke or inboard), engine horsepower (if discernable) and whether the boat is anchored with engine off, trolling or traveling on the river should all be collected.

Recommended water temperature sampling should use continuous reading data loggers and at a minimum follow protocols outlined in *"Stream Temperature Data Collection Standards and Protocols for Alaska: Minimum Standards to Generate Data Useful for Regional-scale Analyses, 2014".*

Other basic field measurements (temperature, pH, dissolved oxygen, and specific conductivity) should also be collected and compared against WQS. Discharge measurements should also be collected during each sampling event and should be used to calculate TAH loading to the river.

Turbidity sampling should be conducted using continuous reading data loggers at a reference site and downstream site(s) impacted by motorized boat use. Recommended river miles are between river mile 1 and river mile 6. Turbidity sampling should follow the DEC's latest turbidity listing methodology policy for project design and data analysis guidance.

All water quality sampling must be conducted under a DEC approved QAPP.

REFERENCES

Alaska Department of Environmental Conservation (ADEC). 2003. *18 AAC 70 Water Quality Standards*. As amended through June 26, 2003. Juneau, Alaska.

ADEC. 2008. *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances*, as amended through December 12, 2008. Juneau, Alaska.

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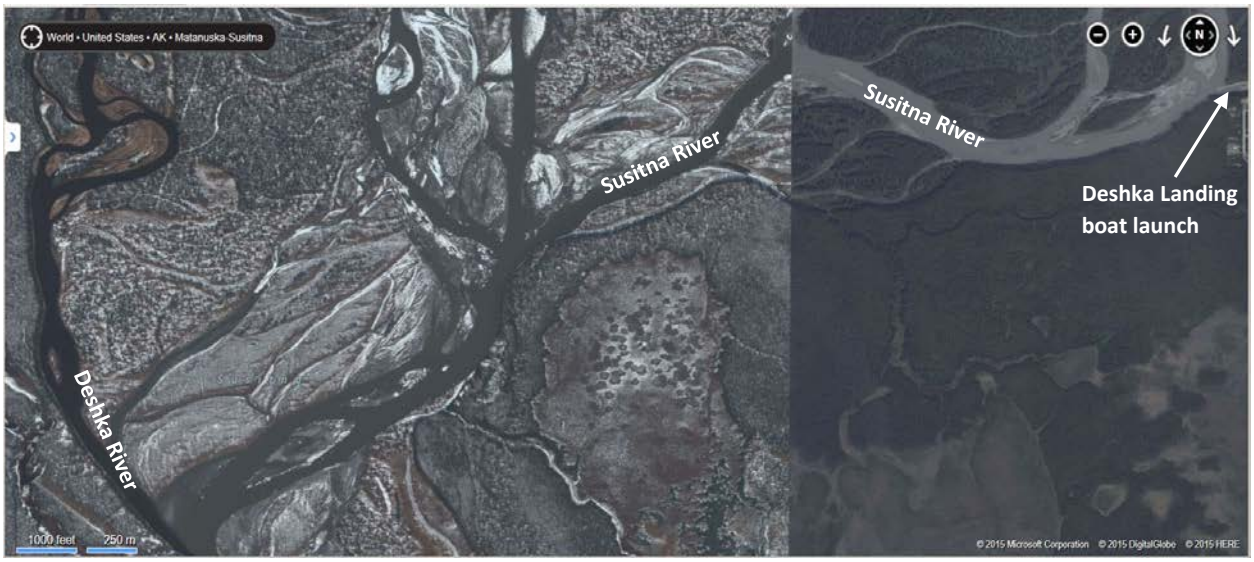
Davis, J.C., and G.A. Davis. 2014. *Deshka River Water Quality Sampling as Related to Petroleum Hydrocarbon Pollution; Quality Assurance Project Plan: Version 1.1 Final.* Aquatic Restoration and Research Institute for ADEC under Contract #18-6002-12. Talkeetna, AK.

Kyle, R.E. and T.B. Brabets, 2001. Water temperature of streams in the Cook Inlet basin, Alaska, and implications of climate change. U.S. Geological Survey Water-Resources Investigation Report 01-4109.

Mauger, S., R. Shaftel, E.J. Trammell, M. Geist, and D. Bogan. 2014. Stream temperature data collection standards and protocol for Alaska: minimum standards to generate data useful for regional-scale analyses. Cook Inletkeeper, Homer, AK and Alaska Natural Heritage Program, UAA, Anchorage, AK. 53 pp.

APPENDIX A: Project Photographs



Aerial photograph showing the Deshka Landing boat launch on the Susitna River approximately 3 miles upriver of the confluence with the Deshka River.

Sample site photos

Sampling site DR-0 on June 7, 2014 looking upstream. This is where the Deshka River empties into the Susitna River. There is a side branch of the Susitna River at the very right side of photo.

Sampling site DR-0.25 on June 15, 2014 looking downstream. Most boats are anchored up to fish in this area as the salmon mill before moving further upstream. This site had the highest TAH concentration measured.

Sampling site DR-1.0 looking upstream on June 15, 2014.

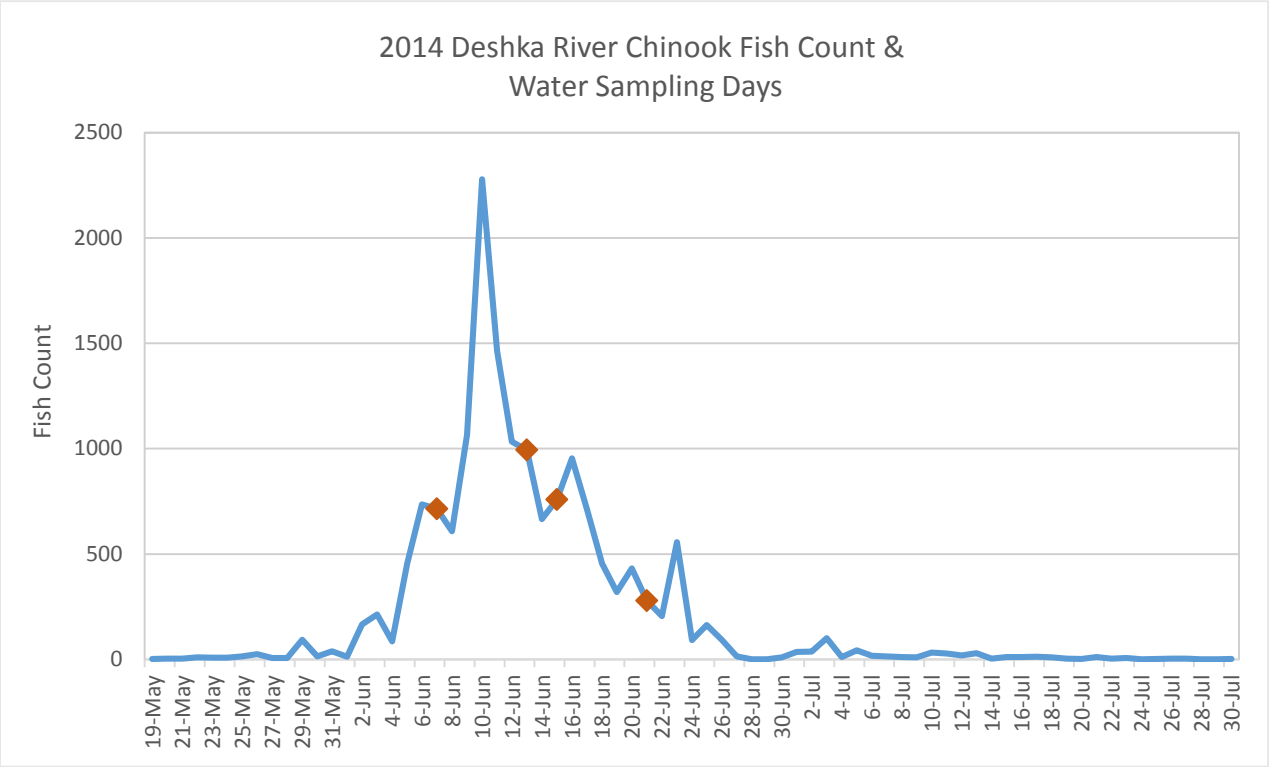
Sampling site DR-2.0 looking upstream on June 13, 2014. The river has a tight bend and hidden gravel bars that boats navigate through to get further upstream.

Sampling site DR-3.0. Furthest upstream sample site and only measured on June 7, 2014. The ADF&G weir site and fish counting station is located 3 river miles further upstream from this sampling site.

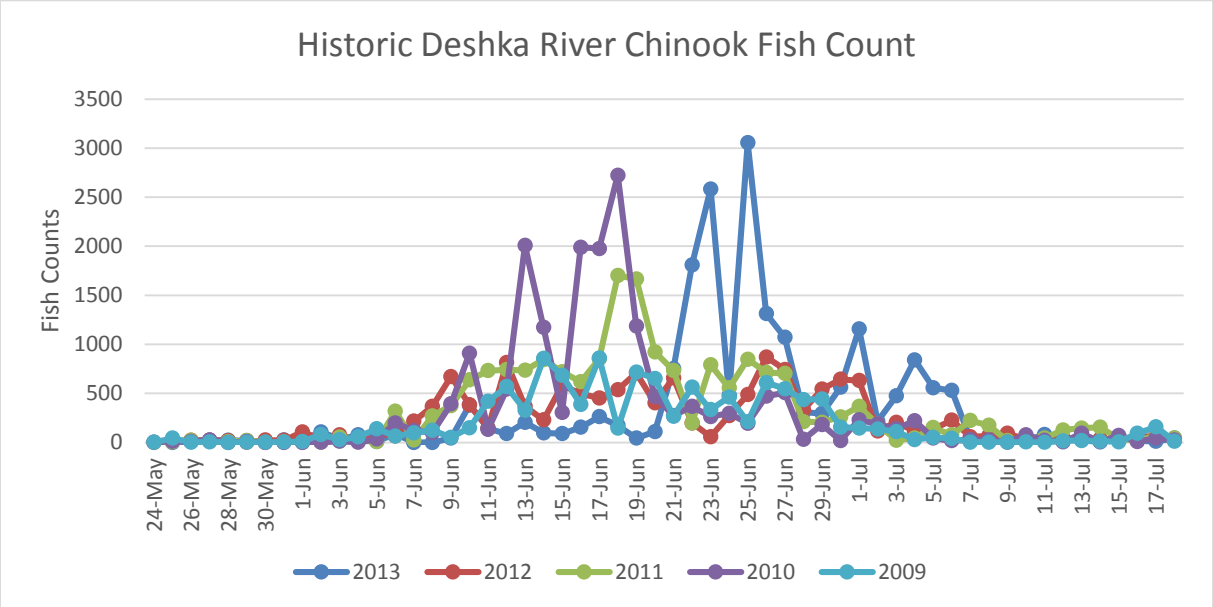
Example of a petroleum surface sheen observed on June 15, 2014 at site DR-0.

Process of collecting a TAH sample. The vials are preserved with hydrochloric acid, kept in a cooler at less than 6 degrees Celsius and then shipped to the laboratory for analysis.

APPENDIX B: Deshka River Fish Count Information



2014 king salmon fish counts at the Deshka River weir. Orange diamonds represent water quality sampling dates. (Fish count data downloaded from ADF&G/Sport fishing website and graphed by DEC with water sampling dates.)



Historic king salmon fish counts at the Deshka River weir 2009 through 2013. (Information downloaded from ADF&G/Sport fishing website with no changes.)