2009

# Yukon River Condition Summary

Prepared jointly by:

Alaska Department of Environmental Conservation,
Alaska Monitoring and Assessment Program;

Yukon River Inter-Tribal Watershed Council; and

University of Alaska Anchorage, Alaska Natural Heritage Program

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## *Executive Summary*

The purpose of the field study was to conduct a water quality and habitat assessment of the Yukon River main-stem. The Yukon River Inter-Tribal Watershed Council and the Alaska Department of Environmental Conservation conducted the synoptic survey using protocols consistent with National Rivers and Streams Assessment protocols and the United States Geological Survey Techniques of Water Resource Investigations Book 9 standards. In situ, Secchi disk transparency, water chemistry, sediment enzymes, chlorophyll-a, benthic macroinvertebrate assemblage, fish tissue chemistry, physical habitat assessment, fecal indicators, and site characteristics were evaluated at each station. The survey was designed to provide representative condition to compare against future surveys, and help build State and Tribal capacity for monitoring and assessing its waters. The Yukon River is a dynamic, high velocity system that supports a relatively pristine ecosystem and multiple uses. Overall results do not indicate water quality, sediment, biological, or habitat concerns.

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The document can be downloaded at the following URL:
http://www.dec.alaska.gov/water/wqsar/monitoring/2009YukonRiver.htm

***Disclaimer***

Note that the design supports probability based estimates of the percent area of the target population surveyed for particular ecological condition. However, this design does not provide for detailed assessments of ecological conditions for individual sites.

## Acknowledgments

This project was funded in part by the Unites States Environmental Protection Agency (US EPA) grant #96086901. Other support came from match or in-kind donations from the Bureau of Land Management, Nowitna National Wildlife Refuge, United States Geological Survey, and National Park Service. Several individuals were also critical to the success of the project. The support, encouragement, and technical guidance provided by Lil Herger and Gretchen Hayslip of the US EPA Region 10 office was invaluable. Richard Carroll Jr., of the Council of Athabascan Tribal Governments, provided exceptional river guide services and made sure camp was secure each night. Lastly, Bryan Maracle with the Yukon River Inter-Tribal Watershed Council was instrumental in organizing remote supplies and personnel. Without the support of these and numerous other people, we would not have safely completed the survey.

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## 1.0 Introduction

Through a culture of collaboration, a 600 mile synoptic survey of the Yukon River main-stem between Fort Yukon and Kaltag, Alaska was accomplished during the summer of 2009. The survey was completed during a two week field campaign from July 5th through July 18th. The collaboration involved partnerships between the Yukon River Inter-Tribal Watershed Council (YRITWC), State of Alaska Department of Environmental Conservation (DEC), Environmental Protection Agency's National Rivers and Streams Assessment Program (NRSA), United States Geological Survey (USGS), Council of Athabascan Tribal Governments (CATG), Koyukuk National Wildlife Refuge (KNWR), and the University of Alaska Anchorage Alaska Natural Heritage (AKNHP) program (Figure 1).

**Figure 1. Three teams work simultaneously to complete the survey. Left: The water quality team was from the YRITWC; Middle: The upper reach team was made up from the CATG, AKNHP and DEC; Right: The lower reach team was from the KNWR and AKNHP.**

Yukon means "great river" in Gwich'in. The river is believed to be the human migration route to North America, it also served as the transportation route for the Klondike Gold Rush. Although the Yukon River has a history of pollution from gold mining, military activities, unregulated dumps, and wastewater discharges recent environmental studies describe a relatively intact ecosystem. Climate change and the effects from thawing permafrost and glacial runoff are the main stressors to the Yukon River (Richter-Menge, et al., 2009).

Before the year 2001 there was no comprehensive hydrological dataset for the Yukon River Basin. The USGS conducted the first comprehensive examination of water quality in the Yukon Basin between 2000 and 2005. YRITWC worked directly with USGS, using a Community Participatory Approach, to streamline the USGS study and protocol in an effort to make a smooth transition to future YRITWC led studies from 2005 to 2009. The partnership between the DEC, YRITWC, and USGS was a direct result of USGS and YRITWC's existing partnership and the previous work by DEC in the basin. Results from the nine years of baseline, the 2007 Healing Journey profile, and the 2006 DEC Tanana River survey showed that the Tanana-Yukon River confluence has a significant influence on water chemistry of the Yukon main-stem.

The underlying methodology we applied used a unique approach to large scale data collection. A melding of protocols, from the NRSA protocol and a Community Participatory Research approach was used to implement the survey. The EPA Quality Assurance Project Plan and Field Manual were followed. Additionally, USGS samples were taken following protocols consistent with the USGS Techniques of Water-Resources Investigations Book 9 Standard and are outlined in the YRITWC Quality Assurance Project Plan. The foundation of the methodology was to create verifiable data that can be used by community, science and regulators alike. This report outlines the survey design, observed results and a discussion of the results.

The YRITWC built on previously established relationships to engage the communities directly with information and training resources; while DEC used their previous relationship with AKNHP to conduct large scale habitat assessment. Community members learned how to conduct scientific field campaigns through on-site experiential training and public outreach was conducted through public service announcements about the survey. The public service announcements were aired across the region in English, Gwich'in and Cup'ik.

**Figure 2. The Yukon River experienced severe flooding in the spring of 2009. Above average ice formations and snow packs combined with unseasonably warm spring temperatures caused rapid melting and large ice flow movement downstream. Water levels were very high and ice choked the river; several communities along the Yukon River experienced catastrophic flooding. By July, most of the debris had been swept away but trees were still falling into the river due to undercut banks caused by the flooding and ice scouring.**

## 2.0 Characteristics of the Yukon River

2.1 Physical setting

The Yukon River is the largest free flowing river in the world (Nilsson et al., 2005) and the 4th largest river basin in North America. While climate change is having a drastic and rapid effect on ecosystems around the globe, the most dramatic effects are being displayed in the Arctic and Sub-Arctic (Arctic Climate Impact Assessment, 2004; National Academy of Sciences, 2010). The climates in these regions also present many challenges to the acquisition of long-term (or short-term) data sets. The watershed, which consists of the main-stem Yukon River and all tributaries, covers a vast portion of Alaska and the Yukon Territory in Canada. Temperatures across the watershed on average will range from over 30° Celsius in the summer to temperatures lower than 40° below Celsius in the winter.

The Yukon River Basin is approximately 330,000 $mi^2$ in area and 1,980 miles in length. It has an annual discharge of over 200,000 $ft^2$ per second at its mouth (Brabets, 2000). The River is characterized by annual winter freeze-ups and summer thaws. It supports various activities including residential development, subsistence lifestyles, mining, tourism, and military activity. Nearly all the people in the basin depend to varying degrees on fish and game resources for livelihood and subsistence use. The Yukon River Basin can be divided into five distinct physiographic descriptions: (1) rolling topography and gentles slopes, (2) low mountains-generally rolling, (3) plains and lowlands, (4) moderately high rugged mountains, (5) and extremely high rugged mountains (figure 3). The Yukon Basin is split between two countries: the United States and Canada. Our survey focused on the Alaskan side with work beginning in the Yukon-Tanana Upland region and ending in the Nowitna Lowland region.

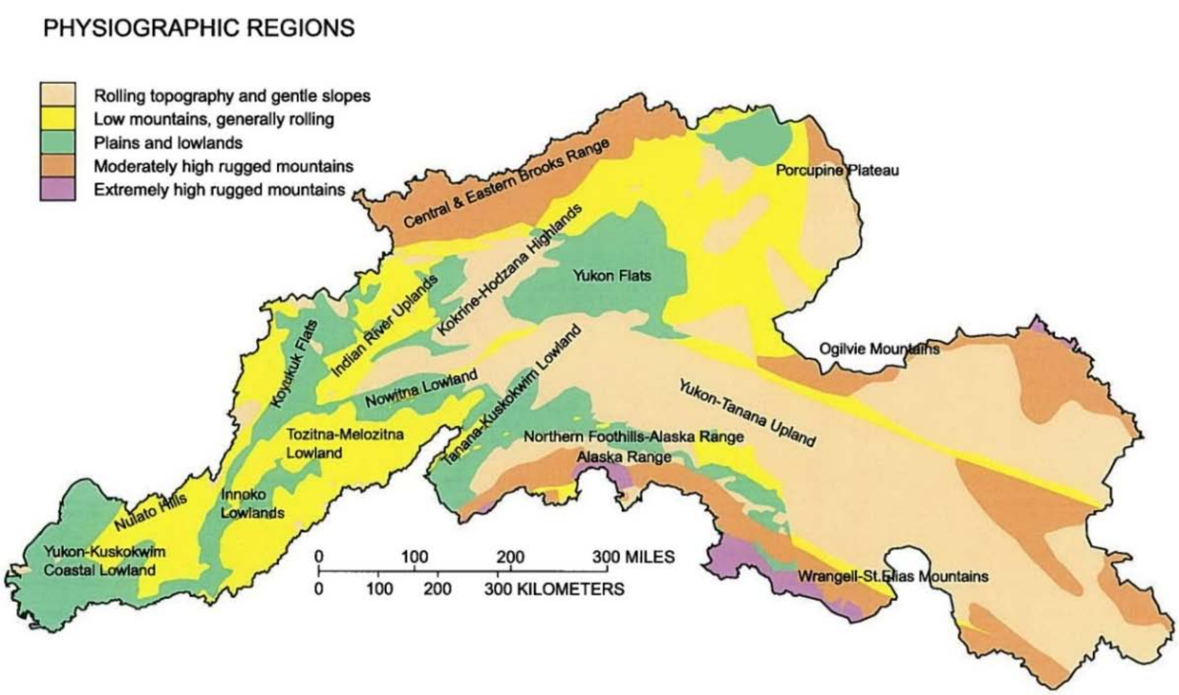


**Figure 3. Physiographic regions of the Yukon River Basin (Brabets 2000).**

There are four distinct regions within our survey area:

Yukon-Tanana Upland-rounded even topped ridges, flat-alluvium floored streams, no glaciers presents, discontinuous permafrost present.

Tanana-Kuskokwim Lowland-broad depression, drained by the Tanana River, thaw lakes presents, braided glacial streams, permafrost covers entire area.

Yukon Flats-marshy lake dotted flats, gently sloping outwash fans to broad gentle outwash fans are contributing tributaries, flat flood plains, braided meandering course, many sloughs.

Nowitna Lowland- rolling silt-covered tableland, drained by the Yukon River in the northern boundary, confluence of the Yukon River and Tanana River in eastern part.

Tanana-Kuskokwim Lowland-broad depression, drained by the Tanana River, thaw lakes presents, braided glacial streams, permafrost covers entire area.

*2.2 Biological setting*

The Yukon Basin has a relatively intact ecosystem with high-quality habitat for birds, mammals, fish, invertebrates and one amphibian. Thousands of lakes, ponds, sloughs, wetlands, and river and stream miles provide habitat. White spruce, paper birch, and quaking aspen forests, willow and alder thickets, grasslands, meadows and alpine tundra round out the potential habitats. In the Yukon Flats National Wildlife Refuge an estimated 1.5 million ducks breed annually. Bird, mammal and fish species checklists have been completed for the National Wildlife Refuges in the Basin, but no comprehensive list of invertebrates has been completed. More than 150 bird species, 40 mammal, and 18 fish species can be found within the Basin. The one amphibian, the wood frog, is able to survive by increasing glucose in its cells, the glucose acts as antifreeze allowing the frog to survive the winters.

The Yukon River has one of the longest salmon runs in history. Chinook, coho and chum salmon return each year to spawning streams in Alaska and Canada. Yukon River salmon must build up large fat reserves for their long journeys. Because of this they prized for their rich and oily meat. Salmon are an important subsistence resource for villages along the river and are traditionally dried, smoked and frozen. Subsistence, recreation, and commercial fisheries are actively managed by the Alaska Department of Fish and Game as well as several national and international treaties.

**Figure 4. Fish wheels can be found along the Yukon River and provide a means of subsistence harvest. A Federal Disaster Declaration was in place for commercial Chinook fisheries' in 2008 and 2009. Addition subsistence restrictions were in place in 2009.**

## 2.3 Human Influence

Within Alaska, the Yukon Basin is comprised of Cup'ik, Yup'ik, Koyukon and Gwich'in Athabascan Tribal Nations consisting of 62 Tribal communities, over 11% of all Tribes in the entire United States. The population of the entire watershed is approximately 119,000 people, with roughly 88% living in the Fairbanks area. The Fairbanks North Star Borough and the Fairbanks Census area is approximately 32,106 $mi^2$. The remaining 13,318 people live in the Yukon-Koyukuk and the Wade Hampton Census Areas. These areas combined cover 162,585 $mi^2$ , with roughly 83% of the population being Indigenous people (US Department of Commerce, 2010). A skeletal road system traverses the state and many of the Indigenous communities in the region are very remote with no access to the primary road system. They rely on travel via airplanes, riverboats, dog teams and snow-machines. The river and surrounding lands provide over 50% of the Indigenous peoples' food and nutrition in the form of fish, moose, caribou, berries, mountain sheep, rabbit, beaver, ducks, goose and other animals; making sustainable management and appropriately implemented adaptation strategies exponentially important.

**Figure 5. A moose navigates the river.**

## 3.0 Survey Summary

### 3.1 Survey Design

Our survey is part of EPA's 2008-2009 National Rivers and Streams Assessment and designed to evaluate stress on the aquatic condition, which can occur as people use the landscape. Their actions can produce effects through chemical, physical, or biological changes in the environment. The list of stressors selected for this survey is not intended to be all inclusive; budgets, logistics, or the lack of agreed upon methods for evaluating stressors limited our selection. In-situ and laboratory parameters were assessed as indicators of stress based on direct measures in the river or adjacent riparian areas. This report highlights only a select few; others are available in Appendices A through F. The majority of results indicate little to no change throughout the reach surveyed, and fall within expected natural conditions

This study was completed in a synoptic fashion. A synoptic study is a short-term investigation of water quality during selected seasonal periods or hydrologic conditions. Studies of this nature provide improved spatial resolution, compared with fixed-site data, for critical water-quality conditions during selected seasonal periods or hydrologic conditions. They also evaluate the spatial distribution of selected water-quality conditions in relation to causative factors, such as land uses and other contaminant sources.

In order to accomplish the survey three crews worked simultaneously. The survey occurred during the first two weeks of July 2009. YRITWC technicians sampled water quality and performed outreach along the entire reach. Two crews made up from ADEC, ENRI, BLM, NWR, and the YRITWC sampled physical habitat, biological specimens, and additional water quality parameters. One crew focused on the upper reach starting in Fort Yukon and worked downriver to Tanana. The second crew focused on the lower reach from Tanana to Kaltag.

### 3.2 Site Selection

Site selection was determined using a stratified systematic sample design. The sample points were confined to the main-stem Yukon River, 25 samples above and 25 below the Tanana confluence (Figure 6). Physical habitat transects composed of 11 shoreline sites centered about each water sampling site, approximately 1.0 to 1.5 river miles apart. Five-hundred and fifty physical habitat sites were sampled along the entire reach, 225 above the Tanana confluence, and 225 below. The first five sites of each transect were located on the right side of the river, upon crossing the river a grab sample of water was collected mid channel before the remaining six sites were sampled on the left side of the river.

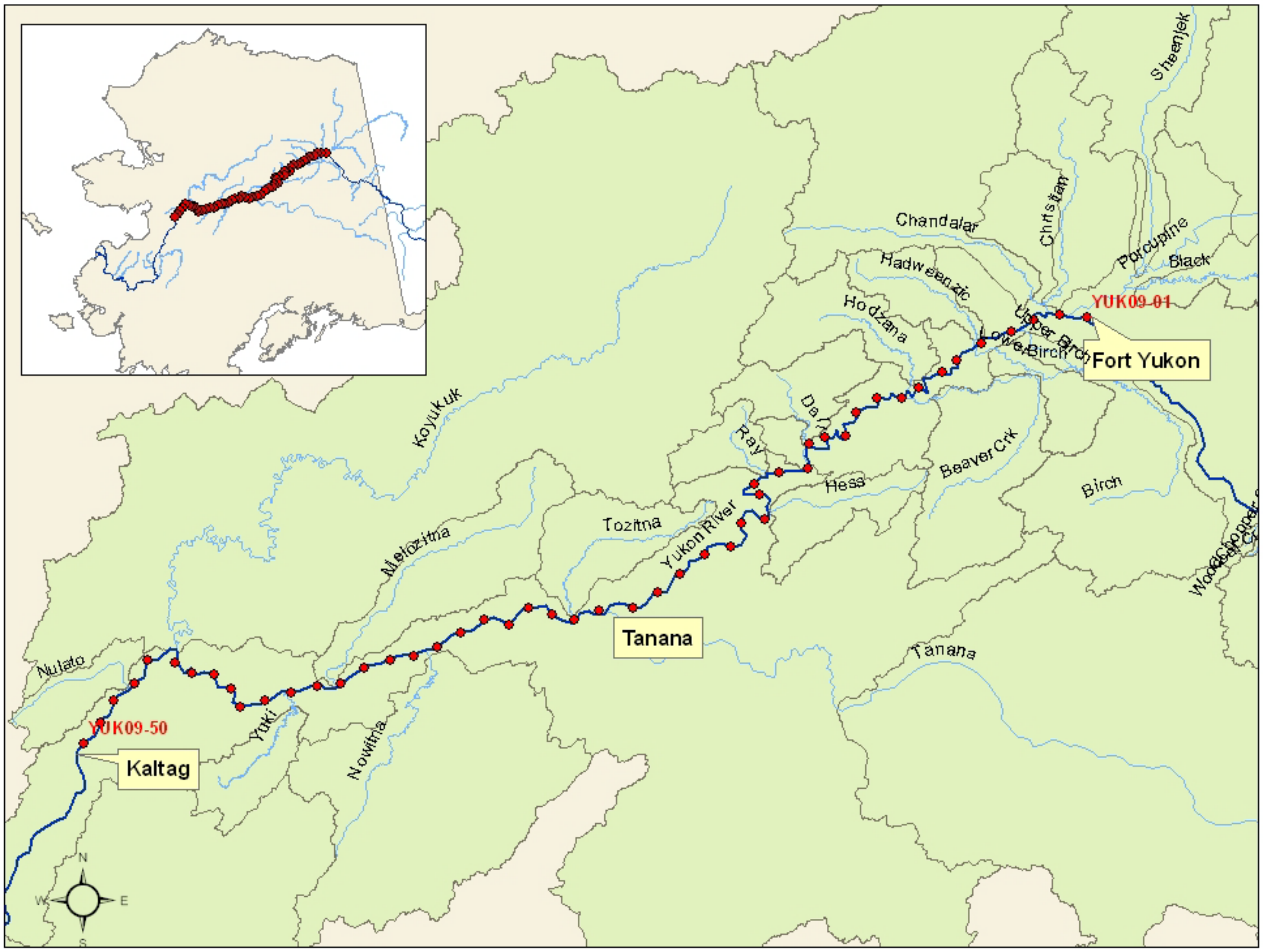


**Figure 6. During the 2009 Yukon River Survey 50 sites were surveyed from Fort Yukon to Kaltag, AK.**

### 3.3 Water Chemistry

In-situ and laboratory results were evaluated due to concerns about the extent to which they may be impacting the river biota. A few parameters are highlighted below; the majority of measurements were consistent with natural variability and expected conditions throughout the reach. Temperature increased in a downstream direction, while dissolved oxygen was unrelated to longitudinal position (Figure 7). Total suspended solids also increased in a downstream direction, with highest readings found after the confluence of the Tanana River (Figure 8). All water chemistry parameters are summarized below in Table 1.

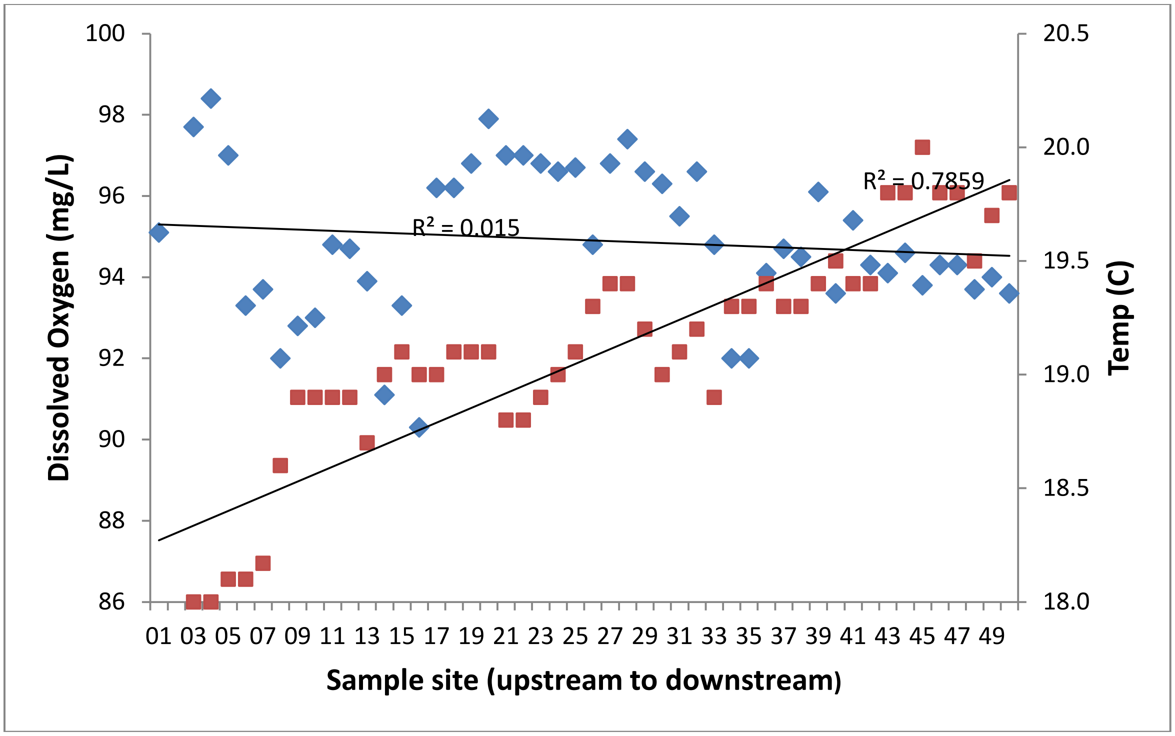


**Figure 7. Longitudinal pattern of dissolved oxygen and temperature in surface water column samples.**

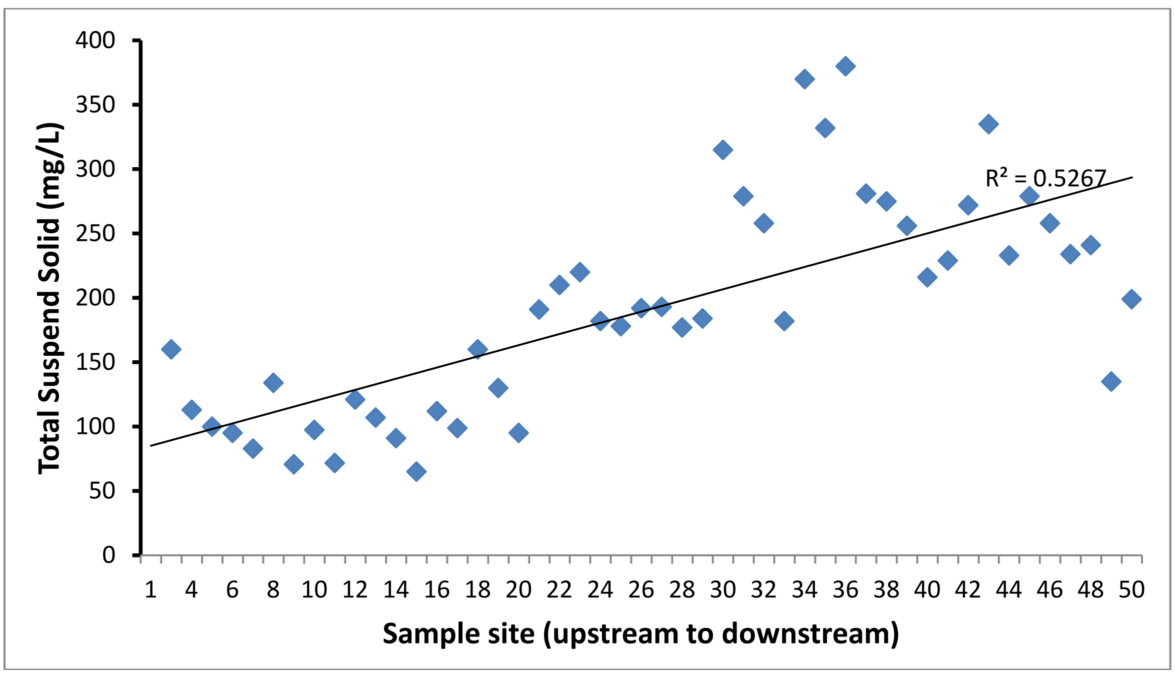


**Figure 8. Longitudinal pattern of total suspended solids in surface water column samples.**

**Table 1. Summary of water quality parameters throughout the reach surveyed. Samples were analyzed in-situ with a portable YSI 556 Multi-Probe Sensor or collected and field preserved for laboratory analysis.**

| | Minimum | 25th Percentile | 75th Percentile | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|---|
| pH | 7.24 | 7.93 | 8.13 | 8.85 | 8.05 | 0.302 |
| SpCond (uS/cm) | 191 | 223 | 232 | 238 | 226 | 7.63 |
| Cond (uS/cm) | 163 | 197 | 207 | 212 | 201 | 8.36 |
| ODO% | 90.3 | 93.7 | 96.6 | 98.4 | 94.9 | 1.85 |
| ODO Conc | 8.37 | 8.60 | 8.93 | 9.31 | 8.79 | 0.214 |
| TDS (g/L) | 0.124 | 0.145 | 0.151 | 0.154 | 0.147 | 0.005 |
| Turbidity+ (NTU) | 1.1 | 6.1 | 14.8 | 1619.6 | 199.6 | 493.8 |
| TSS (mg/L) | 65 | 113 | 252 | 380 | 191 | 84 |
| TOC (mg/L) | 4.2 | 4.7 | 5.2 | 6.9 | 5.0 | 0.49 |
| DOC (mg/L) | 4.6 | 5.1 | 5.3 | 6.0 | 5.2 | 0.24 |
| TP (mg/L) | 0.0529 | 0.0761 | 0.1245 | 0.2400 | 0.1089 | 0.0438 |
| NitrateN (mg/L) | 0.18 | 1.44 | 1.89 | 2.27 | 1.57 | 0.49 |
| NO3 (ueq/L) | 41.9 | 42.9 | 44.6 | 54.6 | 44.4 | 2.50 |
| NH4 (ueq/L) | 0.9 | 1.2 | 3.0 | 9.9 | 3.4 | 3.3 |
| SO4 (ueq/L) | 711.1 | 751.0 | 810.1 | 898.5 | 784.1 | 43.5 |
| Cl (ueq/L) | 14.5 | 16.3 | 25.8 | 37.4 | 22.3 | 6.27 |
| K (ueq/L) | 23.4 | 27.4 | 34.2 | 41.7 | 30.9 | 4.19 |
| Mg (ueq/L) | 695.4 | 726.8 | 741.4 | 856.4 | 735.3 | 22.93 |
| Na (ueq/L) | 94.0 | 104.2 | 118.9 | 138.6 | 112.1 | 9.54 |
| Ca (ueq/L) | 1479.1 | 1584.5 | 1621.5 | 1684.5 | 1597.3 | 36.492 |
| UV (@254) | 0.155 | 0.178 | 0.190 | 0.227 | 0.186 | 0.014 |
| SUVA | 3.0 | 3.4 | 3.7 | 4.4 | 3.6 | 0.28 |
| 2-H (per mil) | -170.1 | -168.6 | -166.8 | -162.9 | -167.6 | 1.447 |
| O-18 (per mil) | -21.4 | -21.1 | -20.6 | -20.2 | -20.8 | 0.321 |

3.4 Sediment enzymes

Benthic organisms are influenced by the physical and chemical properties of sediments they are in contact with. Current research suggests sediment enzymes can be used to assess water body eutrophic condition (Koster. M et al., 1997), asses the responses of microbial assemblages to environmental conditions (Foreman et al., 1998), and serve as a functional indicator of key ecosystem processes (NRSA Field Manual 2008). EPA included these indicators nationally as a research question and has since published a scientific article describing their findings. Analytical tests included dissolved inorganic nitrogen, total nitrogen, ammonia, dissolved inorganic carbon, total carbon and total phosphorus. Results from EPA's study indicate sediment enzymes may be used to assess regional impacts of climate change or anthropogenic disturbances on a large scale. (Hill et al., 2012).

3.5 Littoral Substrate

Our habitat measurements allowed an extensive suite of habitat metrics to be calculated (Angradi et al, 2006). For this report we present only the percent areal cover of fine substrate (i.e., particles <0.06 mm) and % sand and fine substrate (i.e., particles <2 mm) in the littoral zone as these metrics varied substantially across the survey reach and because substrate composition is an important feature of diatom, macroinvertebrate, and fish habitat. Longitudinal plots of these substrate metrics indicated different trends below and above the Tanana River, so we divided the data sets and analyzed data from above and below the Tanana separately. Above the Tanana, % fines was unrelated to longitudinal position and averaged 25% (±15%) (Figure 9). Below the Tanana, % fines increased in a downstream direction, from 27% at Site 26 to 44% at Site 50, based on linear regression point estimates (Figure 9). Percent sand and fines was unrelated to longitudinal position below the Tanana and averaged 75% (±13%) (Figure 10). Above the Tanana, % sand and fines decreased in a downstream direction, from 70% at Site 1 to 44% at Site 25 (Figure 10).

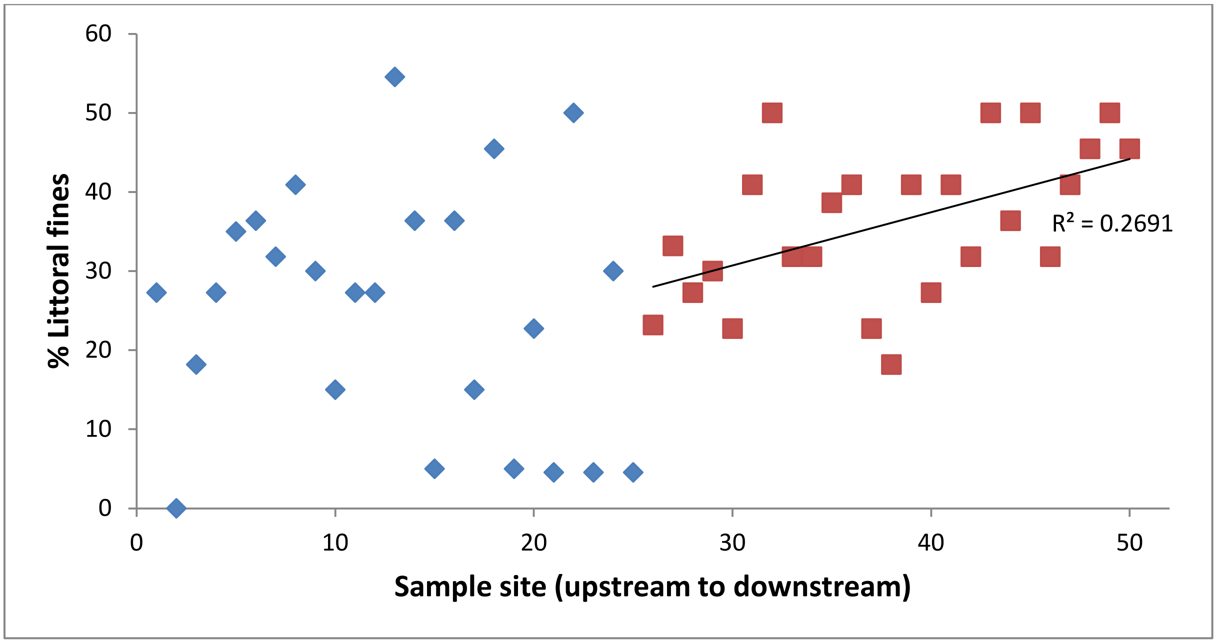


Figure 9. Longitudinal pattern in % fine substrate in the littoral zone.

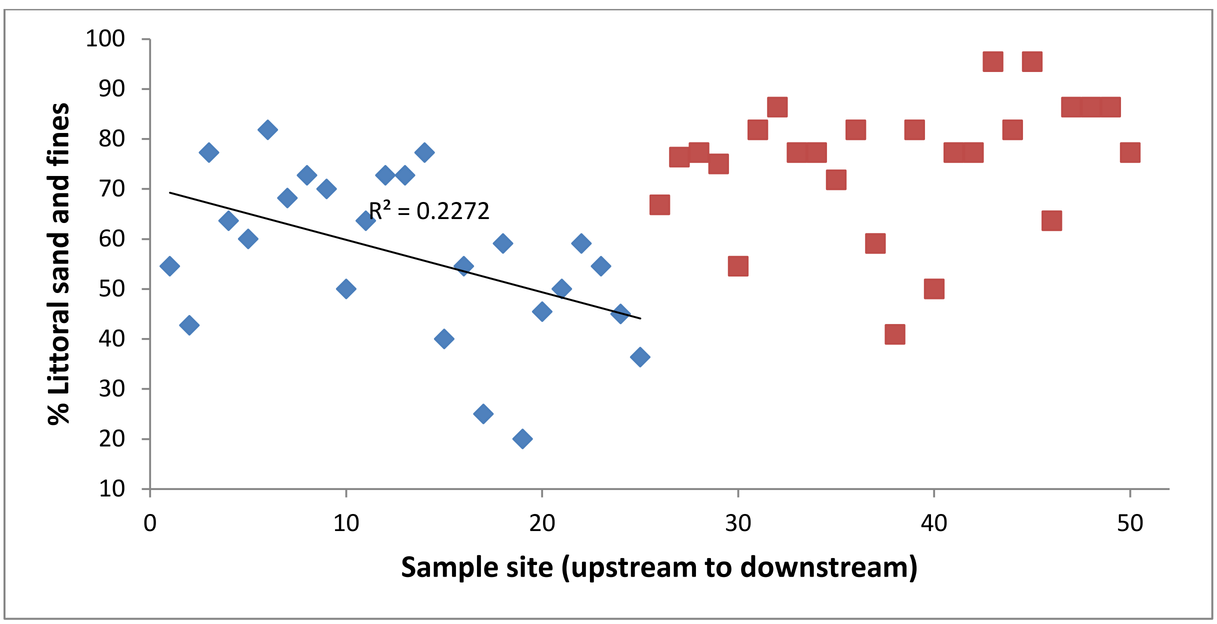


Figure 10. Longitudinal pattern in % sand and fine substrate in the littoral zone.

3.6 Macroinvertebrates

Benthic macroinvertebrates are an important component in riverine food webs, are relatively easy to collect, and are sensitive to a variety of environmental stressors (Barbour et al., 1999; Angradi et al., 2006). In this study we sampled macroinvertebrates using a D-frame net (500-µm mesh) from shoreline littoral habitat at each transect. Samples from the 11 transects comprising each sample reach were combined into a single composite sample. See Angradi et al. (2006) for more details on field sampling methodology. Laboratory protocols call for subsampling composite samples to a 500-organism fixed count (see USEPA 2008); however we identified all organisms found in the composite samples due to the relatively small number of organisms. We identified all macroinvertebrates to genus or lowest practical taxon using keys in Weiderholm (1983), Pennack (1989), Wiggins (1996), Thorpe and Covich (2001), Stewart and Oswood (2006), and Merritt et al. (2008).

**Figure 11. Dan Bogan, AKNHP, collects macroinvertebrates using a D net.**

The number of organisms identified from individual composite samples ranged from 4 to 413, for a total of 4862 in the 50 composite samples. We identified a total of 114 taxa; the vast majority of these were insects, although nematodes, annelids, arachnids, gastropods, and crustacean were also present (Appendix D). Over 90% of the organisms identified belonged to 3 taxonomic orders: Diptera (true flies), Tubificida (worms), and mayflies (Ephemeroptera).

Using the macroinvertebrate community data, we calculated a number of metrics intended to reflect the biological condition at each site (see Barbour et al., 1999). These were the number of individuals, number of taxa (richness), proportional abundance of the dominant taxon (% dominant taxon), and the proportional abundance of the 5 numerically dominant taxonomic orders: % Diptera, % Tubificida, % mayflies, % stoneflies (Plecoptera), and % caddisflies (Trichoptera). Mayflies, stoneflies, and caddisflies are considered to be relatively intolerant to pollution (Barbour et al. 1999), so rarity or absence of these taxa could indicate poor habitat conditions.

The number of individual macroinvertebrates collected at each site was relatively low and highly variable, with a mean (±standard deviation) of 97 (±88) (Appendix D). The low abundance is probably related to the inherently unstable substrates and naturally high suspended sediment load in this glacier-fed river. An equivalent amount of sampling effort in wadeable, clear water streams in Alaska would typically contain thousands of organisms (Rinella and Bogan, unpublished data). We identified an average of 17 (±8) taxa at each site.

Macroinvertebrate samples were most frequently dominated by the worm Naididae (23 sites) and the mayfly *Pseudocloeon dardanum* (13 sites), and the dominant taxon comprised 38% (±17%) of the total community. Mayflies were surprisingly abundant, comprising 31% (±22%) of the total community. Stoneflies and caddisflies comprised 6.2% (±6.8%) and 1.8% (±3.1), respectively. True flies and Tubificida were each major components of the macroinvertebrate community, comprising 30% (±21%) and 27% (±24%), respectively.

We used regression analysis to examine longitudinal changes in macroinvertebrate community structure over the survey reach. Of the above metrics, only % mayflies and % Tubificida correlated significantly ($\alpha = 0.05$) with longitudinal position. Mayflies comprised 43% of the macroinvertebrate community at the upstream end of the survey reach but only 20% at the downstream end, based on linear regression point estimates (Figure 12). Percent Tubificida, by contrast, increased in a downstream direction throughout the survey reach, comprising 14% of the macroinvertebrate community at the upstream end and 39% at the downstream end (Figure 13).

Samples from this survey yielded two mayfly taxa that have not previously been reported from Alaska. We collected *Pseudocloeon dardanum* at 42 of the 50 sampling sites, suggesting that this mayfly is widespread and abundant within the mainstem Yukon River. These records extend the known range of this mayfly to the northwest by about 1500 km. We also collected *Ametropus neavei* at three sites in the lower 200 km of the survey reach, extending its known range to the northwest by over 2000 km. A manuscript describing these and other new Alaskan aquatic insect records has been submitted for publication (Rinella et al. in review).

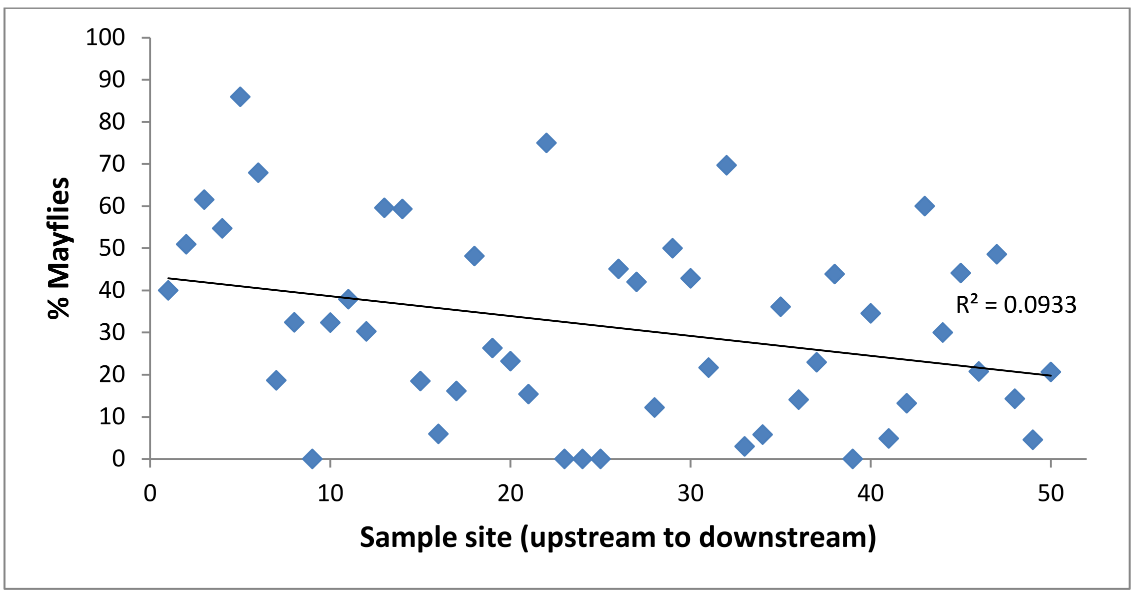


**Figure 12. Longitudinal pattern in % of the macroinvertebrate community composed of mayflies.**

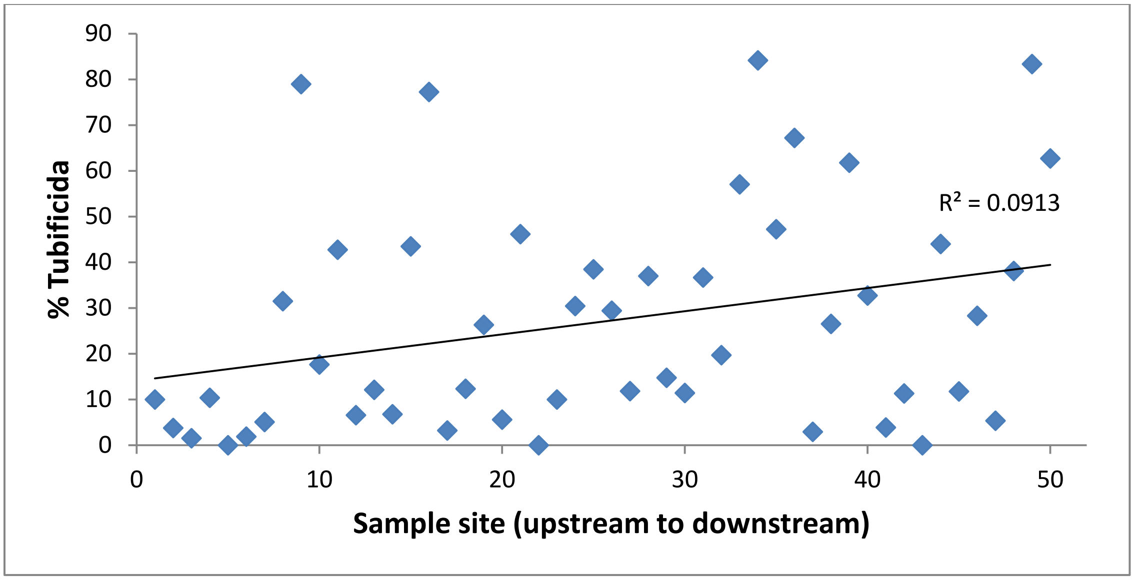


**Figure 13. Longitudinal pattern in % of the macroinvertebrate community composed of Tubificida worms.**

### 3.7 Diatoms

Benthic diatoms are a diverse group of single-celled algae encased in silica capsules. They are ubiquitous in aquatic habitats, where they serve as important primary producers. Diatom community composition is a valuable indicator of environmental conditions, including sedimentation, nutrient enrichment, metals, and other pollution sources (Van Dam et al,. 1994; Stevenson and Bahls, 1999).

We sampled diatoms by scrubbing 25 $cm^2$ of the biofilm layer from hard substrates (i.e., wood, rock) in the littoral habitat at each transect. As for macroinvertebrates, we combined samples from the 11 transects comprising each sample reach into a single composite sample. We did not collect diatoms at 5 sites (14, 15, 18, 43, 48) due to a lack of hard substrates needed for sampling. See Angradi (2006) for more details on field sampling methodology. In the lab, diatom samples were cleaned, concentrated, and mounted on microscope slides. We identified a fixed count of 600 diatom valves from each site (see USEPA 2007) to species or variety using keys in Patrick and Rimer (1975), Kramer and Lang-Bertalot (1986–1991), and Lang-Bertalot (1996).


**Figure 14. Dan Rinella, AKNHP, scrubs woody debris for diatom collection.**

We identified a total of 134 diatom taxa from the 50 sites. The three most numerous taxa – *Gomphonema productum*, *Achnanthidium minutissimum*, and *Diatoma tenuis* – together comprised half of all diatoms sampled (Appendix E). Over 80% of all diatoms belonged to the 10 most numerous taxa.

We calculated a number of metrics from each site's diatom community data. These included species richness and % dominant taxon as indicators of general biotic integrity. We used % motile individuals as a siltation index (Stevenson and Bahls, 1999). Motility, an adaptation possessed by a few genera, allows diatoms to crawl to the surface when buried by silt, and the proportion of motile diatoms can be high in steams with high silt loads (e.g., up to 83%; see Dickman 2005). Finally, we used Van Dam et al.'s (1994) ecological indicator values for pH, nitrogen uptake metabolism, oxygen requirements, and saprobity. Indicator values are assigned to each taxon based, respectively, on its preferred acidity/alkalinity, concentration of organically bound nitrogen, levels of dissolved oxygen saturation, and saprobic water quality class (see Van Dam et al., 1994). We expressed ecological indicator values as the community-wide weighted average for each sample.

Across the 50 sites we identified an average of 26 (±5) diatom taxa. The community was frequently dominated by *Gomphonema productum* (24 sites) or *Achnanthidium minutissimum* (12 sites), with the dominant taxon comprising 27% (±9%) of the total community. Motile diatoms comprised 3% (±4%) of the community, which is surprisingly low given the Yukon River's high silt load. The pH index averaged 3.9 (±0.24), indicating adaptation to neutral or alkaline conditions. The nitrogen uptake metabolism index averaged 2.0 (±0.17), suggesting that elevated nitrogen levels are not required to sustain the diatom community. Finally, diatoms were adapted to moderate to high water quality, as indicated by the oxygen (1.9 ±0.25) and saprobity (2.5 ±0.19) indices.

We used regression analysis to look for longitudinal changes in diatom community structure over the survey reach. Of the metrics considered, only nitrogen uptake metabolism and saprobity correlated significantly ($\alpha = 0.05$) with longitudinal position (Figures 15 and 16). Both increased in a downstream direction, suggesting that downstream diatom communities were adapted to slightly higher levels of organic nitrogen, lower levels of dissolved oxygen, and higher biological oxygen demand (Van Dam et al., 1994). Interestingly, scores for both indices were flat or trending downward over the upper half of the survey reach (i.e., above the Tanana River) and clearly trending upward over the lower half of the survey reach (Figures 15 and 16).

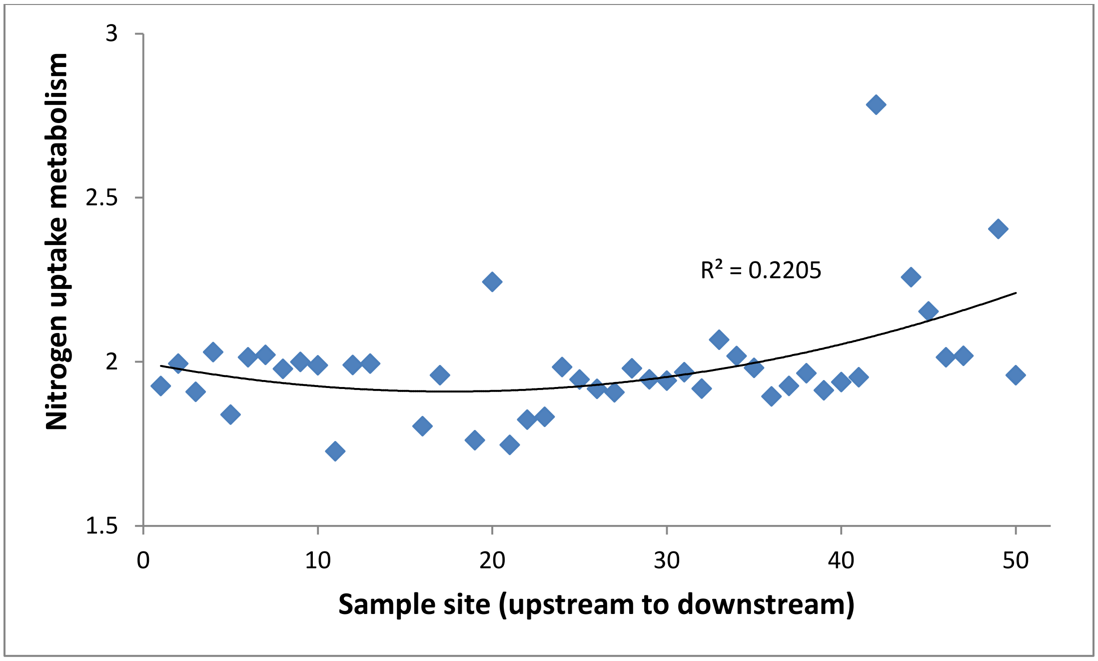


**Figure 15. Longitudinal pattern in nitrogen uptake metabolism index scores for the diatom community.**

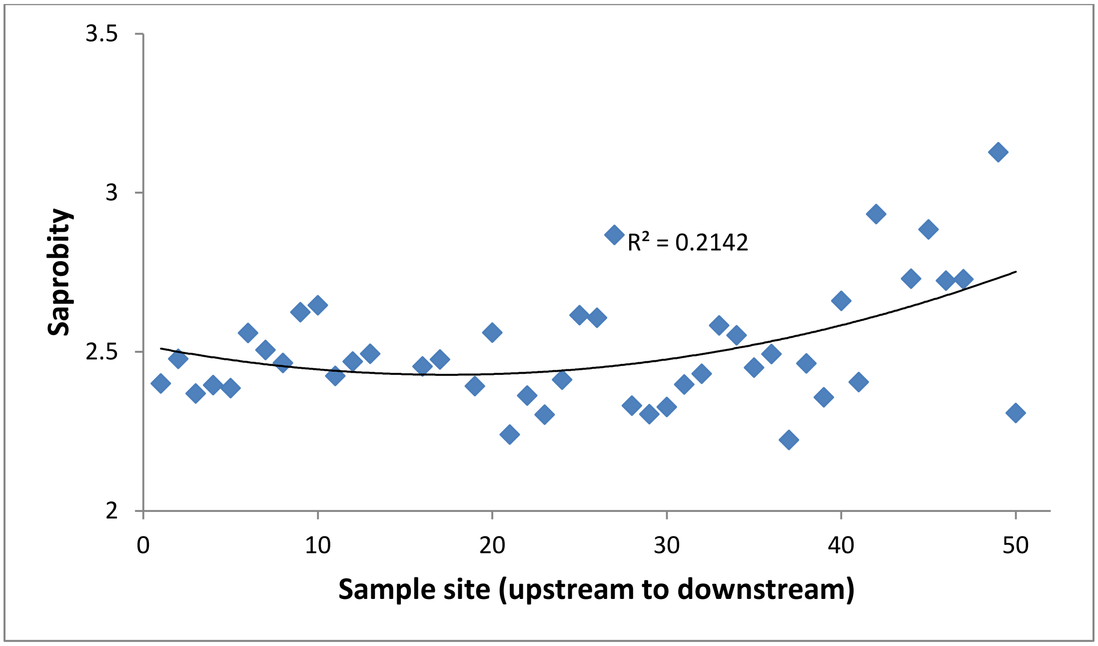


**Figure 16. Longitudinal pattern in saprobity index scores for the diatom community.**

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3.8 Fish

A number of larval lamprey were collected in the macroinvertebrate samples. The specimens were too young to identify with existing keys, and genetic analysis was impossible because DNA was degraded by the methanol in the sample preservative. Based on known geographic distributions (Mecklenburg et al. 2002), the specimens are likely Arctic lamprey (*Lampetra camtschatica*), although Alaskan brook lamprey (*Lampetra alaskense*) and Pacific lamprey (*Lampetra tridentate*) are also possibilities. Samples contained from 0 to 9 lamprey, with an average of 1.7 (±2) individuals (Appendix F). Lamprey abundance was not correlated with longitudinal position or substrate composition.

We intended to collect fish species for contaminant analysis during the survey, but poor or below average runs for Coho, Chum, and Chinook salmon prevented this (Yukon River Joint Technical Committee, 2010). The YRITWC instituted a fish for coffee exchange program and encouraged community members to participate. We were very pleased to received eight specimens in good condition during a year when subsistence fishing was extremely limited as well. Due to the low number of samples we did not perform any statistical analysis; instead, individual results are reported (Table 2).

**Table 2. A total of eight fish tissue samples were donated to the survey. Below are individual specimen results.**

| Site ID | Species | Sample Type | As | Cd | Cu | Pb | Se | THg |
|---|---|---|---|---|---|---|---|---|
| YUK09-01 | Northern Pike | skinless fillet | < 0.05 | <0.01 | <0.2 | <0.05 | 0.47 | 0.53 |
| YUK09-25 | Chinook Salmon | small chunk | 0.55 | <0.01 | 0.59 | <0.05 | 0.39 | 0.06 |
| YUK09-37 | Chum Salmon | small chunk | 0.52 | <0.01 | 0.51 | <0.05 | 0.38 | 0.019 |
| YUK09-37 | Chum Salmon | small chunk | 0.34 | <0.01 | 0.39 | <0.05 | 0.38 | 0.033 |
| YUK09-37 | Broad Whitefish | small chunk | < 0.05 | <0.01 | <0.2 | <0.05 | 0.29 | 0.016 |
| YUK09-42 | Burbot | skinless fillet | 0.96 | <0.01 | <0.2 | <0.05 | 0.37 | 0.44 |
| YUK09-45 | Burbot | skinless fillet | 0.22 | <0.01 | <0.2 | <0.05 | 0.4 | 0.52 |
| YUK09-45 | Silver Salmon | skinless fillet | 0.66 | <0.01 | 0.82 | <0.05 | 0.25 | 0.063 |

all concentrations in ppm (wet weight)

Fish tissue samples were analyzed for total mercury, THg. EPA's tissue-based water quality criteria is 0.300 ppm for methylmercury as concentration threshold that, if exceeded can potentially be harmful to human health. Using conservative guidelines and assuming all mercury is in the form of methylmercury, three samples have results that raise potential human health concerns.

3.9 Bacteria

Bacteria, *Enterococcus*, samples were collected at the last physical habitat transect for each site as an indicator of water quality health. The presence of *Enterococci bacteria* can indicate human or animal waste is entering the river. All samples results were reported as non-detects, meaning that no detectable level of bacteria forming colonies were found. This can result from sample degradation during storage, the inability to meet holding times or the lack of presence of *Enterococcus* species. All measures were taken to ensure the viability of the sample and meet holding times. The results are assumed to be accurate for our study period, but due to the variable nature of bacteria it should not be assumed as accurate for all locations or times along the Yukon River.

**Figure 17. Smoke haze from wildfires upstream lingered along the river corridor. Hot, dry conditions during the summer of 2009 led to record wildfires. More than 1,662,000 acres burned in the Yukon Basin.**

## 4.0 Discussion

The Yukon River or "Great River" is a large, dynamic river system that supports a relatively intact ecosystem. The river connects subsistence use communities throughout interior Alaska and Canada. Concerns with unregulated sewage, historic pollution, landfills containment issues, and climate change are a few of threats the river is experiencing.

In our survey, we sampled a total of 50 water quality and 550 physical habitat sites in an effort to characterize the condition of the Yukon River main stem. Our survey was designed to describe condition over a large geographic area and should not be used to characterize individual sites. Overall we found the results were consistent with natural variability and expected conditions throughout the reach. Results from water quality, sediment, and biological parameters sampled indicate naturally high water quality conditions, inherently unstable substrates, high suspended sediment loads, and sufficient nutrient levels to support biology.

The collaboration between partners in this survey was crucial to our success. Yukon River Inter-Tribal Watershed Council and the Council of Athabascan Governments knowledge of the river and surrounding communities were critical to this survey. Data gathered from this survey are available to governmental agencies, Native and Tribal organizations, general public, and other researchers. DEC utilizes data gathered on a large scale to help better understand the overall condition of Alaska's water quality. This allows DEC and other resource managers to: report on the overall condition of Alaskan waters, a responsibility of the Clean Water Act; and use the information to make good decisions about our laws and regulations that protect the Nation's most pristine water resources.

**Figure 18. Sun setting on the Yukon River.**

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# Appendix A

Sample Location Data

| Site ID | WQ Sample Date | Habitat Sample Date | Latitude | Longitude | Location Notes |
|---|---|---|---|---|---|
| YUK09-01 | 7/5/2009 | 7/5/2009 | 66.559226 | -145.286371 | at **Fort Yukon**, in Yukon Flats NWR |
| YUK09-02 | * | 7/6/2009 | 66.592962 | -145.655098 | Porcupine and Chandalar Rivers enter |
| YUK09-03 | 7/6/2009 | 7/6/2009 | 66.582820 | -146.024414 | |
| YUK09-04 | 7/6/2009 | 7/7/2009 | 66.530971 | -146.344269 | |
| YUK09-05 | 7/6/2009 | 7/7/2009 | 66.487956 | -146.762077 | |
| YUK09-06 | 7/7/2009 | 7/7/2009 | 66.407010 | -147.114360 | |
| YUK09-07 | 7/7/2009 | 7/8/2009 | 66.349053 | -147.336759 | above **Beaver, Beaver Creek enters** |
| YUK09-08 | 7/7/2009 | 7/8/2009 | 66.281292 | -147.671710 | Hodzana River enters |
| YUK09-09 | 7/7/2009 | 7/9/2009 | 66.228257 | -147.908202 | |
| YUK09-10 | 7/7/2009 | 7/9/2009 | 66.245444 | -148.245827 | |
| YUK09-11 | 7/7/2009 | 7/9/2009 | 66.171622 | -148.533504 | |
| YUK09-12 | 7/7/2009 | 7/10/2009 | 66.051425 | -148.711172 | |
| YUK09-13 | 7/8/2009 | 7/10/2009 | 66.050901 | -148.986491 | |
| YUK09-14 | 7/8/2009 | 7/11/2009 | 66.024525 | -149.205950 | below **Stevens Village** |
| YUK09-15 | 7/8/2009 | 7/11/2009 | 65.890014 | -149.237689 | Dall River enters |
| YUK09-16 | 7/8/2009 | 7/11/2009 | 65.876857 | -149.625981 | Dalton Hwy bridge crossing |
| YUK09-17 | 7/8/2009 | 7/12/2009 | 65.825150 | -149.963212 | Ray River enters |
| YUK09-18 | 7/9/2009 | 7/12/2009 | 65.765872 | -149.903083 | leave Yukon Flats NWR |
| YUK09-19 | 7/9/2009 | 7/12/2009 | 65.627651 | -149.857940 | |
| YUK09-20 | 7/9/2009 | 7/13/2009 | 65.615169 | -150.169981 | |
| YUK09-21 | 7/10/2009 | 7/13/2009 | 65.484577 | -150.319252 | below **Rampart** |
| YUK09-22 | 7/10/2009 | 7/13/2009 | 65.451115 | -150.674020 | |
| YUK09-23 | 7/10/2009 | 7/14/2009 | 65.351958 | -151.000508 | |
| YUK09-24 | 7/10/2009 | 7/14/2009 | 65.260496 | -151.307304 | |
| YUK09-25 | 7/10/2009 | 7/14/2009 | 65.181306 | -151.638604 | Tanana River enters |
| YUK09-26 | 7/10/2009 | 7/6/2009 | 65.166660 | -152.082071 | at **Tanana** |
| YUK09-27 | 7/10/2009 | 7/7/2009 | 65.126852 | -152.399102 | Tozitna River enters |
| YUK09-28 | 7/10/2009 | 7/7/2009 | 65.155715 | -152.685204 | |
| YUK09-29 | 7/10/2009 | 7/8/2009 | 65.191303 | -152.984282 | enter Nowitna NWR |
| YUK09-30 | 7/10/2009 | 7/8/2009 | 65.100325 | -153.235655 | |
| YUK09-31 | 7/11/2009 | 7/9/2009 | 65.127634 | -153.556231 | |
| YUK09-32 | 7/11/2009 | 7/9/2009 | 65.057620 | -153.868939 | |
| YUK09-33 | 7/11/2009 | 7/10/2009 | 64.983432 | -154.167590 | Nowitna River enters |
| YUK09-34 | 7/11/2009 | 7/10/2009 | 64.933441 | -154.473371 | |
| YUK09-35 | 7/11/2009 | 7/11/2009 | 64.911284 | -154.779447 | |
| YUK09-36 | 7/11/2009 | 7/11/2009 | 64.864023 | -155.107832 | leave Nowitna NWR |
| YUK09-37 | 7/11/2009 | 7/12/2009 | 64.779407 | -155.398869 | above **Ruby** |
| YUK09-38 | 7/11/2009 | 7/12/2009 | 64.760238 | -155.706283 | Melozitna River enters |
| YUK09-39 | 7/11/2009 | 7/13/2009 | 64.719787 | -156.035769 | |
| YUK09-40 | 7/12/2009 | 7/13/2009 | 64.674823 | -156.358109 | |

| Site ID | WQ Sample Date | Habitat Sample Date | Latitude | Longitude | Location Notes |
|---|---|---|---|---|---|
| YUK09-41 | 7/12/2009 | 7/14/2009 | 64.629663 | -156.681662 | |
| YUK09-42 | 7/12/2009 | 7/14/2009 | 64.729091 | -156.808248 | above **Galena** |
| YUK09-43 | 7/12/2009 | 7/15/2009 | 64.800999 | -157.022651 | enter Innoko NWR |
| YUK09-44 | 7/12/2009 | 7/15/2009 | 64.804200 | -157.310361 | |
| YUK09-45 | 7/12/2009 | 7/16/2009 | 64.856816 | -157.539672 | above **Koyukuk** |
| YUK09-46 | 7/12/2009 | 7/16/2009 | 64.859708 | -157.893725 | Koyukuk River enters |
| YUK09-47 | 7/12/2009 | 7/17/2009 | 64.728212 | -158.046383 | |
| YUK09-48 | 7/13/2009 | 7/17/2009 | 64.628962 | -158.288870 | below **Nulato** |
| YUK09-49 | 7/13/2009 | 7/18/2009 | 64.501833 | -158.443512 | |
| YUK09-50 | 7/13/2009 | 7/18/2009 | 64.384146 | -158.627632 | above **Kaltag** |

* did not sample WQ, river current too strong

Datum: Nad 83

# Appendix B

Water Chemistry Data

| Site ID | DO; mg/L | Temp; C | pH | Conductivity; us/cm | Turbidity; NTU | NO3-N; mg/L | TDS; g/L | Air Temp; C |
|---|---|---|---|---|---|---|---|---|
| YUK09-01 | 9.5 | 17.6 | 7.61 | 210 | | | | |
| YUK09-03 | 9.3 | 18.0 | 8.15 | 214 | 20.1 | | 1.390 | 26.8 |
| YUK09-04 | 9.3 | 18.0 | 8.13 | 214 | 15.2 | 1.490 | 1.390 | 24.7 |
| YUK09-05 | 9.2 | 18.1 | 8.25 | 236 | 8.3 | | 0.153 | |
| YUK09-06 | 8.8 | 18.1 | 8.89 | 220 | 12.5 | 1.670 | 0.143 | |
| YUK09-07 | 8.8 | 18.2 | 8.46 | 225 | 19.1 | 1.672 | 0.146 | 22.6 |
| YUK09-08 | 8.6 | 18.6 | 7.69 | 228 | 1609.6 | 0.242 | 0.147 | 27.4 |
| YUK09-09 | 8.6 | 18.9 | 7.60 | 229 | 1619.6 | 0.181 | | 28.2 |
| YUK09-10 | 8.6 | 18.9 | 7.81 | 226 | 1616.1 | 0.222 | | 25.5 |
| YUK09-11 | 8.8 | 18.9 | 7.66 | 224 | 1616.0 | 0.183 | | 25.0 |
| YUK09-12 | 8.8 | 18.9 | 8.35 | 224 | 1618.8 | 1.434 | | 24.7 |
| YUK09-13 | 8.8 | 18.7 | 8.55 | 225 | 250.3 | 1.581 | 0.146 | 18.7 |
| YUK09-14 | 8.4 | 19.0 | 8.93 | 227 | 650.9 | 1.665 | 0.147 | |
| YUK09-15 | 8.6 | 19.1 | 8.54 | 223 | 346.2 | 1.494 | 0.145 | 22.1 |
| YUK09-16 | 8.4 | 19.0 | 8.41 | 226 | 145.9 | 1.656 | 0.147 | 24.9 |
| YUK09-17 | 8.9 | 19.0 | 8.59 | 222 | 5.0 | 1.767 | 0.144 | 18.9 |
| YUK09-18 | 8.9 | 19.1 | 8.03 | 222 | 16.3 | 1.752 | 0.144 | |
| YUK09-19 | 9.0 | 19.1 | 8.02 | 222 | 10.7 | 1.862 | 0.145 | 23.0 |
| YUK09-20 | 9.1 | 19.1 | 7.93 | 222 | 6.1 | 1.816 | 0.145 | 17.1 |
| YUK09-21 | 9.0 | 18.8 | 7.46 | 223 | 12.8 | 1.948 | 0.145 | 16.0 |
| YUK09-22 | 9.0 | 18.8 | 8.00 | 223 | 1.8 | 2.094 | 0.145 | |
| YUK09-23 | 9.0 | 18.9 | 8.01 | 223 | 5.0 | 2.105 | 0.145 | 20.3 |
| YUK09-24 | 9.0 | 19.0 | 7.96 | 222 | 7.4 | 1.969 | 0.145 | 21.6 |
| YUK09-25 | 8.9 | 19.1 | 7.95 | 223 | 12.5 | 2.231 | 0.145 | 22.0 |
| YUK09-26 | 8.7 | 19.3 | 7.89 | 224 | 4.8 | 0.867 | 0.146 | 22.5 |
| YUK09-27 | 8.9 | 19.4 | 7.90 | 224 | 1.1 | 1.277 | 0.145 | 21.8 |
| YUK09-28 | 9.0 | 19.4 | 7.91 | 224 | 7.7 | 1.613 | 0.145 | 21.2 |
| YUK09-29 | 8.9 | 19.2 | 7.95 | 230 | 8.7 | 1.517 | 0.149 | 21.4 |
| YUK09-30 | 8.9 | 19.0 | 7.95 | 233 | 12.1 | 1.567 | 0.151 | 20.1 |
| YUK09-31 | 8.8 | 19.1 | 8.54 | 233 | 7.0 | 2.271 | 0.151 | 19.9 |
| YUK09-32 | 8.9 | 19.2 | 8.47 | 227 | 4.5 | 1.926 | 0.147 | 20.7 |
| YUK09-33 | 8.8 | 18.9 | 8.37 | 238 | 13.7 | 1.896 | 0.154 | 19.6 |
| YUK09-34 | 8.5 | 19.3 | 7.91 | 236 | 10.6 | 1.592 | 0.154 | 24.2 |
| YUK09-35 | 8.5 | 19.3 | 7.98 | 237 | 11.2 | 1.438 | 0.154 | 24.2 |
| YUK09-36 | 8.7 | 19.4 | 7.97 | 236 | 3.9 | 1.506 | 0.154 | 24.7 |
| YUK09-37 | 8.7 | 19.3 | 8.00 | 232 | 7.0 | 1.591 | 0.151 | 26.4 |
| YUK09-38 | 8.7 | 19.3 | 8.00 | 232 | 8.0 | 1.692 | 0.151 | 24.0 |
| YUK09-39 | 8.8 | 19.4 | 8.02 | 227 | 8.4 | 1.890 | 0.148 | 18.4 |

| Site ID | DO; mg/L | Temp; C | pH | Conductivity; us/cm | Turbidity; NTU | NO3-N; mg/L | TDS; g/L | Air Temp; C |
|---|---|---|---|---|---|---|---|---|
| YUK09-40 | 8.6 | 19.5 | 8.01 | 234 | 9.9 | 1.843 | 0.152 | 24.5 |
| YUK09-41 | 8.8 | 19.4 | 8.01 | 231 | 13.3 | 2.010 | 0.150 | 25.9 |
| YUK09-42 | 8.7 | 19.4 | 8.07 | 232 | 11.0 | 1.895 | 0.151 | 23.3 |
| YUK09-43 | 8.6 | 19.8 | 7.98 | 233 | 8.5 | 1.286 | 0.151 | 28.1 |
| YUK09-44 | 8.6 | 19.8 | 7.98 | 228 | 5.7 | 1.361 | 0.148 | 27.1 |
| YUK09-45 | 8.5 | 20.0 | 7.97 | 231 | 6.7 | 1.464 | 0.150 | 27.9 |
| YUK09-46 | 8.6 | 19.8 | 8.00 | 229 | 5.8 | 1.417 | 0.149 | 24.4 |
| YUK09-47 | 8.6 | 19.8 | 7.93 | 232 | 2.3 | 1.902 | 0.151 | 25.3 |
| YUK09-48 | 8.6 | 19.5 | 7.24 | 232 | 3.2 | 1.631 | 0.151 | 22.6 |
| YUK09-49 | 8.6 | 19.7 | 7.77 | 227 | 5.8 | 2.182 | 0.147 | 25.0 |
| YUK09-50 | 8.5 | 19.8 | 7.81 | 224 | 7.3 | 1.954 | 0.145 | 21.3 |

Data collected using a YSI 556 MPS by YRITWC

| WQ Indicator | YUK09-01 | YUK09-03 | YUK09-04 | YUK09-05 | YUK09-06 | YUK09-07 | YUK09-08 | YUK09-09 | YUK09-10 | YUK09-11 | YUK09-12 | YUK09-13 | YUK09-14 | YUK09-15 | YUK09-16 | YUK09-17 | YUK09-18 | YUK09-19 | YUK09-20 | YUK09-21 | YUK09-22 | YUK09-23 | YUK09-24 | YUK09-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 7.74 | 8.13 | 8.13 | 8.24 | 8.85 | 8.45 | 7.69 | 7.58 | 7.8 | 7.62 | 8.35 | 8.55 | 8.53 | 8.54 | 8.4 | 8.59 | 8.03 | 8.02 | 7.93 | 7.96 | 7.98 | 8.01 | 7.96 | 7.95 |
| pHmV (mV) | -79.5 | -102 | -101 | -108 | -135 | -114 | -74.5 | -68.4 | -80.3 | -70.4 | -109 | -120 | -119 | -119 | -112 | -133 | -104 | -104 | -99.4 | -101 | -102 | -104 | -101 | -100 |
| Salinity (ppt) | 0.09 | 0.1 | 0.1 | 0.11 | 0.1 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 |
| ORP (mV) | 93 | 157 | 191 | 119 | 68 | 66 | 62 | 94 | 75 | 146 | 69 | 64 | 83 | 22 | 74 | 71 | 65 | 72 | 73 | 85 | 80 | 77 | 75 | 49 |
| ODO% | 95.1 | 97.7 | 98.4 | 97 | 93.3 | 93.7 | 92 | 92.8 | 93 | 94.8 | 94.7 | 93.9 | 91.1 | 93.3 | 90.3 | 96.2 | 96.2 | 96.8 | 97.9 | 97 | 97 | 96.8 | 96.6 | 96.7 |
| ODO Conc (mg/L) | 9.09 | 9.24 | 9.31 | 9.16 | 8.81 | 8.83 | 8.59 | 8.6 | 8.63 | 8.81 | 8.8 | 8.75 | 8.44 | 8.64 | 8.37 | 8.92 | 8.9 | 8.96 | 9.06 | 9.04 | 9.03 | 9 | 8.96 | 8.95 |
| SpCond (uS/cm) | 191 | 212 | 214 | 236 | 220 | 224 | 228 | 229 | 226 | 224 | 224 | 225 | 227 | 223 | 226 | 222 | 222 | 222 | 222 | 223 | 223 | 223 | 222 | 223 |
| Cond (uS/cm) | 163 | 184 | 185 | 204 | 191 | 195 | 200 | 203 | 200 | 198 | 197 | 198 | 201 | 197 | 200 | 197 | 197 | 197 | 197 | 196 | 197 | 197 | 197 | 197 |
| TDS (g/L) | 0.124 | 0.138 | 0.139 | 0.153 | 0.143 | 0.146 | 0.148 | 0.149 | 0.147 | 0.146 | 0.145 | 0.146 | 0.147 | 0.145 | 0.147 | 0.144 | 0.144 | 0.145 | 0.145 | 0.145 | 0.145 | 0.145 | 0.145 | 0.145 |
| TSS (mg/L) | | 160 | 113 | 100 | 95.1 | 82.9 | 134 | 70.7 | 97.4 | 71.7 | 121 | 107 | 91 | 65 | 112 | 98.8 | 160 | 130 | 95.1 | 191 | 210 | 220 | 182 | 178 |
| Turbidity+ (NTU) | 20.1 | 22 | 15.2 | 8.3 | 12.5 | 19.1 | 1610 | 1620 | 1617 | 1617 | 1618 | 294.6 | 650.4 | 246.5 | 145.9 | 5 | 16.3 | 10.7 | 6.1 | 12.8 | 1.8 | 5 | 7.4 | 12.5 |
| DOC (mg/L) | 5.2 | 5.1 | 5.3 | 5 | 5.2 | 5.1 | 5 | 5.1 | 5.1 | 5.2 | 5.2 | 5.2 | 5.2 | 5.3 | 5.4 | 5.2 | 5.2 | 5.3 | 5.4 | 5.2 | 5.3 | 5.3 | 5.5 | 5.4 |
| NitrateN (mg/L) | 1.42 | 1.36 | 1.49 | 1.62 | 1.67 | 1.67 | 0.24 | 0.18 | 0.22 | 0.18 | 1.43 | 1.58 | 1.66 | 1.49 | 1.67 | 1.77 | 1.75 | 1.86 | 1.82 | 1.95 | 2.09 | 2.1 | 1.97 | 2.23 |
| NitratemV (mV) | 133.4 | 134.7 | 132.5 | 130.6 | 129.8 | 129.9 | 177.1 | 184.3 | 179.3 | 184 | 133.9 | 131.4 | 130.3 | 132.9 | 130.2 | 128.8 | 129.1 | 127.6 | 128.2 | 126.4 | 124.6 | 124.5 | 126.2 | 123.2 |
| NH4 (ueq/L) | 3.3 | <0.9 | 1 | <0.9 | <0.9 | 2.4E | <0.9 | <0.9 | | <0.9 | <0.9 | <0.9 | 2.2 | 5.3 | <0.9 | <0.9 | <0.9 | 9.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 |
| NO3 (ueq/L) | 43.7 | 43.8 | 42.4 | 42.3 | 42.9 | 42.6 | 43.7 | 42.1 | | 44.1 | 41.9 | 44.1 | 43.6 | 42.9 | 42.3 | 54.6 | 43 | 49.6 | 42.5 | 44.3 | 51.7 | 42.3 | 47 | 42.5 |
| SO4 (ueq/L) | 711.1 | 762.3 | 721.5 | 810.1 | 731.5 | 765.1 | 744.3 | 746.3 | | 754 | 741.6 | 760.1 | 754.4 | 774.1 | 743.1 | 789.1 | 744.4 | 769.4 | 751.7 | 750.2 | 793.4 | 739.2 | 740.8 | 761.9 |
| TP (mg/L) | | 0.066 | 0.204 | 0.089 | 0.105 | 0.095 | 0.053 | 0.073 | 0.076 | 0.076 | 0.067 | 0.156 | 0.084 | 0.062 | 0.072 | 0.067 | 0.074 | 0.094 | | 0.075 | 0.083 | 0.093 | 0.073 | 0.077 |
| TOC (mg/L) | | 4.2 | 4.4 | 4.5 | 4.4 | 4.4 | | 4.8 | 4.5 | 4.6 | | 4.6 | 4.9 | 4.6 | 4.9 | 5 | 4.7 | 5.8 | 4.8 | 6 | 4.9 | 4.9 | 5 | 5.1 |
| Cl (ueq/L) | 33 | 15.7 | 31.7 | 15.4 | 18 | 24.3 | 14.9 | 14.5 | | 15.7 | 15.7 | 17.1 | 17.9 | 29.6 | 18.9 | 34.6 | 14.9 | 33 | 21 | 16.1 | 32.6 | 15.1 | 17.4 | 16 |
| Na (ueq/L) | 113.8 | 105.5 | 112.6 | 94 | 100.9 | 106 | 100.4 | 99.2 | | 104 | 102 | 104.5 | 106.5 | 121.4 | 104.3 | 127.6 | 99.4 | 123.6 | 107.9 | 103.6 | 123.1 | 100.2 | 103.4 | 103.4 |
| K (ueq/L) | 28.7 | 28.2 | 28.6 | 23.4 | 27.5 | 26.8 | 26.5 | 25.3 | | 26.3 | 25.9 | 28 | 26.9 | 32.7 | 26.6 | 31.1 | 26.5 | 33.6 | 27.8 | 29.1 | 31.4 | 26.3 | 30.5 | 26.8 |
| Mg (ueq/L) | 736.6 | 732.6 | 727.8 | 740.4 | 730.9 | 741.4 | 741.1 | 733.3 | | 714.6 | 704.6 | 696.9 | 734.4 | 732.6 | 728.3 | 731.2 | 726.9 | 730.5 | 742.2 | 743 | 738.8 | 741.3 | 738.7 | 717.3 |
| Ca (ueq/L) | 1479 | 1508 | 1517 | 1685 | 1543 | 1589 | 1584 | 1582 | | 1577 | 1571 | 1582 | 1586 | 1591 | 1568 | 1601 | 1569 | 1594 | 1598 | 1599 | 1615 | 1585 | 1585 | 1589 |
| UV (@254) | 0.177 | 0.186 | 0.181 | 0.156 | 0.174 | 0.178 | 0.176 | 0.182 | 0.194 | 0.19 | 0.174 | 0.182 | 0.178 | 0.189 | 0.181 | 0.18 | 0.189 | 0.179 | 0.187 | 0.177 | 0.181 | 0.175 | 0.198 | 0.169 |
| SUVA | 3.4 | 3.6 | 3.4 | 3.1 | 3.3 | 3.5 | 3.5 | 3.6 | 3.8 | 3.7 | 3.3 | 3.5 | 3.4 | 3.6 | 3.4 | 3.5 | 3.6 | 3.4 | 3.4 | 3.4 | 3.4 | 3.3 | 3.6 | 3.1 |
| 2-H (per mil) | -167 | -167 | -167 | -170 | -167 | -168 | -168 | -170 | -169 | -168 | -169 | -169 | -169 | -170 | NA | -170 | -170 | -169 | -168 | -167 | -168 | -166 | -169 | -168 |
| std dev | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| O-18 (per mil) | -20.4 | -20.2 | -20.3 | -21 | -20.3 | -20.7 | -20.9 | -21 | -21.1 | -21.1 | -21.1 | -21.1 | -21.3 | -20.2 | NA | -21 | -21.1 | -21.1 | -21.1 | -21 | -20.9 | -21.4 | -20.8 | -21.4 |
| std dev | 0.2 | 0.2 | 0.15 | 0.15 | 0.15 | 0.2 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.2 | 0.15 |

| WQ Indicator | YUK09-26 | YUK09-27 | YUK09-28 | YUK09-29 | YUK09-30 | YUK09-31 | YUK09-32 | YUK09-33 | YUK09-34 | YUK09-35 | YUK09-36 | YUK09-37 | YUK09-38 | YUK09-39 | YUK09-40 | YUK09-41 | YUK09-42 | YUK09-43 | YUK09-44 | YUK09-45 | YUK09-46 | YUK09-47 | YUK09-48 | YUK09-49 | YUK09-50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 7.69 | 7.9 | 7.91 | 7.95 | 7.95 | 8.54 | 8.47 | 8.37 | 7.91 | 7.98 | 7.97 | 8 | 8 | 8.02 | 8.01 | 8.01 | 8.07 | 7.98 | 7.98 | 7.97 | 8 | 7.93 | 7.24 | 7.77 | 7.81 |
| pHmV (mV) | -86.8 | -97.9 | -98.3 | -100 | -100 | -128 | -125 | -119 | -93.4 | -97.1 | -96.5 | -98.1 | -98.5 | -99.4 | -99 | -99 | -102 | -97.3 | -97.5 | -96.9 | -98.4 | -94.6 | -57.7 | -87.2 | -89.4 |
| Salinity (ppt) | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 |
| ORP (mV) | 35 | 42 | 48 | 56 | 50 | 74 | 73 | 76 | 39 | 35 | 44 | 50 | 52 | 56 | 66 | 63 | 45 | 20 | 37 | 40 | 49 | 55 | 76 | 69 | 71 |
| ODO% | 94.8 | 96.8 | 97.4 | 96.6 | 96.3 | 95.5 | 96.6 | 94.8 | 92 | 92 | 94.1 | 94.7 | 94.5 | 96.1 | 93.6 | 95.4 | 94.3 | 94.1 | 94.6 | 93.8 | 94.3 | 94.3 | 93.7 | 94 | 93.6 |
| ODO Conc (mg/L) | 8.74 | 8.91 | 8.96 | 8.92 | 8.93 | 8.84 | 8.93 | 8.81 | 8.48 | 8.48 | 8.66 | 8.74 | 8.7 | 8.85 | 8.6 | 8.77 | 8.67 | 8.58 | 8.64 | 8.53 | 8.6 | 8.6 | 8.61 | 8.6 | 8.54 |
| SpCond (uS/cm) | 224 | 224 | 224 | 230 | 233 | 233 | 227 | 238 | 236 | 237 | 236 | 232 | 232 | 227 | 234 | 231 | 232 | 233 | 228 | 231 | 229 | 232 | 232 | 227 | 224 |
| Cond (uS/cm) | 200 | 199 | 200 | 204 | 206 | 206 | 201 | 210 | 211 | 212 | 211 | 207 | 207 | 203 | 209 | 206 | 208 | 210 | 206 | 209 | 207 | 209 | 208 | 204 | 201 |
| TDS (g/L) | 0.146 | 0.145 | 0.145 | 0.149 | 0.151 | 0.151 | 0.147 | 0.154 | 0.154 | 0.154 | 0.154 | 0.151 | 0.151 | 0.148 | 0.152 | 0.15 | 0.151 | 0.151 | 0.148 | 0.15 | 0.149 | 0.151 | 0.151 | 0.147 | 0.145 |
| TSS (mg/L) | 192 | 193 | 177 | 184 | 315 | 279 | 258 | 182 | 370 | 332 | 380 | 281 | 275 | 256 | 216 | 229 | 272 | 335 | 233 | 279 | 258 | 234 | 241 | 135 | 199 |
| Turbidity+ (NTU) | 4.8 | 1.1 | 7.7 | 8.7 | 12.1 | 7 | 4.5 | 13.7 | 10.6 | 11.2 | 3.9 | 7 | 8 | 8.4 | 9.9 | 13.3 | 11 | 8.5 | 5.7 | 6.7 | 5.8 | 2.3 | 3.2 | 5.8 | 7.3 |
| DOC (mg/L) | 5.2 | 5.3 | 5.3 | 4.8 | 4.7 | 5.1 | 4.6 | 5.1 | 4.9 | 4.9 | 5 | 5.3 | 5.2 | 5 | 5 | 5.1 |  | 5.3 | 5.3 | 5.3 | 5.3 | 5.4 | 6 | 5.8 | 5.5 |
| NitrateN (mg/L) | 0.87 | 1.28 | 1.61 | 1.52 | 1.57 | 2.27 | 1.93 | 1.9 | 1.59 | 1.44 | 1.51 | 1.59 | 1.69 | 1.89 | 1.84 | 2.02 | 1.89 | 1.29 | 1.36 | 1.46 | 1.42 | 1.9 | 1.63 | 2.18 | 1.95 |
| NitratemV (mV) | 146.3 | 136.9 | 131.2 | 132.7 | 131.8 | 122.8 | 126.8 | 127.1 | 131.5 | 134 | 132.9 | 131.5 | 130.1 | 127.3 | 128 | 125.8 | 127.3 | 137 | 135.5 | 133.9 | 134.6 | 127.4 | 131 | 124 | 126.7 |
| NH4 (ueq/L) | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | <0.9 | 1.3 | <0.9 | 0.9 | 1.2E | <0.9 | <0.9 | <0.9 |
| NO3 (ueq/L) | 45.6 | 42.4 | 42.1 | 43 | 43.3 | 43.1 | 42.8 | 45.2 | 47.6 | 44.6 | 43.5 | 45.2 | 44.8 | 43.4 | 48.9 | 44.1 | 43.9 | 46.2 | 44 | 44.4 | 44.4 | 44.1 | 44.7 | 44.2 | 44.1 |
| SO4 (ueq/L) | 744.3 | 751.3 | 754.9 | 793.8 | 819.9 | 791.7 | 753.8 | 817.1 | 794.5 | 819 | 840.1 | 798.4 | 821.4 | 888.5 | 825.1 | 793 | 824.4 | 872.8 | 833 | 778.8 | 785.5 | 807.7 | 898.5 | 863.8 | 805.4 |
| TP (mg/L) | 0.167 | 0.124 | 0.152 | 0.151 | 0.147 | 0.104 | 0.084 | 0.074 | 0.21 | 0.24 | 0.145 | 0.124 | 0.102 |  | 0.083 | 0.117 | 0.205 | 0.126 | 0.115 | 0.101 | 0.095 | 0.096 | 0.09 | 0.151 | 0.094 |
| TOC (mg/L) | 4.9 | 5.5 | 5.3 | 5.2 | 4.8 |  | 4.8 | 5.2 | 4.2 | 4.9 | 4.7 | 5.1 |  | 5.1 | 5.1 | 5.2 | 5 | 5.3 | 5.3 | 6.9 | 5.6 | 5.4 | 5.2 | 5.4 | 5.2 |
| Cl (ueq/L) | 16.2 | 16 | 16.3 | 22.1 | 24.1 | 20 | 17.6 | 37.4 | 26.2 | 27.9 | 23.6 | 21.3 | 24.5 | 21.3 | 25.5 | 23.1 | 23.6 | 23.5 | 28.5 | 26 | 29.5 | 29.3 | 17 | 22.4 | 25.8 |
| Na (ueq/L) | 105.1 | 103 | 109.8 | 114.4 | 118.4 | 118.5 | 104.7 | 138.6 | 127.2 | 123.1 | 118.3 | 114.4 | 121.7 | 113.6 | 126.8 | 117.7 | 118.9 | 119.5 | 120.5 | 116.9 | 120.1 | 113.6 | 111 | 107.7 | 110.7 |
| K (ueq/L) | 28.2 | 27.5 | 26.8 | 33.2 | 34.3 | 30.5 | 29.1 | 41.7 | 39.1 | 37.1 | 35.1 | 33.6 | 35.1 | 31.8 | 38 | 34.2 | 35 | 35.1 | 33.8 | 34.8 | 35.1 | 34.2 | 27.6 | 31.9 | 35.4 |
| Mg (ueq/L) | 712.3 | 695.4 | 736.9 | 745 | 743.2 | 737.6 | 729.6 | 752.3 | 756.6 | 755.1 | 750.3 | 743.4 | 726.3 | 705.3 | 749.3 | 741.4 | 740.5 | 737.5 | 727.3 | 725.1 | 723.1 | 715.6 | 856.4 | 758.8 | 724.3 |
| Ca (ueq/L) | 1594 | 1586 | 1585 | 1616 | 1622 | 1605 | 1579 | 1647 | 1651 | 1650 | 1635 | 1622 | 1634 | 1605 | 1644 | 1622 | 1623 | 1626 | 1607 | 1593 | 1585 | 1601 | 1634 | 1611 | 1600 |
| UV (@254) | 0.186 | 0.184 | 0.183 | 0.171 | 0.208 | 0.19 | 0.184 | 0.189 | 0.201 | 0.2 | 0.204 | 0.161 | 0.184 | 0.155 | 0.192 | 0.189 |  | 0.186 | 0.209 | 0.193 | 0.187 | 0.193 | 0.227 | 0.222 | 0.188 |
| SUVA | 3.6 | 3.5 | 3.5 | 3.6 | 4.4 | 3.7 | 4 | 3.7 | 4.1 | 4.1 | 4.1 | 3 | 3.5 | 3.1 | 3.8 | 3.7 |  | 3.5 | 3.9 | 3.6 | 3.5 | 3.5 | 3.8 | 3.8 | 3.4 |
| 2-H (per mil) | -168 | -168 | -168 | -169 | -169 | -168 | -168 | -167 | -165 | -167 | -167 | -168 | -167 | -168 | -165 | -168 | -167 | -167 | -167 | -166 | -166 | -167 | -163 | -165 | -165 |
| std dev | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| O-18 (per mil) | -21.1 | -21 | -20.7 | -21 | -21.1 | -21.2 | -21.1 | -20.8 | -20.6 | -20.7 | -20.8 | -20.9 | -20.6 | -20.7 | -21.1 | -20.9 | -20.4 | -20.3 | -20.5 | -20.6 | -20.6 | -20.7 | -20.3 | -20.5 | -20.6 |
| std dev | 0.2 | 0.15 | 0.15 | 0.15 | 0.2 | 0.15 | 0.15 | 0.15 | 0.2 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.2 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |

# Appendix C

Littoral Substrate Data

| Site ID | % Areal coverage of fine sediment (<0.06 mm) in the littoral zone | % Areal coverage of sand and fine sediment (<2 mm) in the littoral zone |
|---|---|---|
| YUK09-01 | 27 | 55 |
| YUK09-02 | 0 | 43 |
| YUK09-03 | 18 | 77 |
| YUK09-04 | 27 | 64 |
| YUK09-05 | 35 | 60 |
| YUK09-06 | 36 | 82 |
| YUK09-07 | 32 | 68 |
| YUK09-08 | 41 | 73 |
| YUK09-09 | 30 | 70 |
| YUK09-10 | 15 | 50 |
| YUK09-11 | 27 | 64 |
| YUK09-12 | 27 | 73 |
| YUK09-13 | 55 | 73 |
| YUK09-14 | 36 | 77 |
| YUK09-15 | 5 | 40 |
| YUK09-16 | 36 | 55 |
| YUK09-17 | 15 | 25 |
| YUK09-18 | 45 | 59 |
| YUK09-19 | 5 | 20 |
| YUK09-20 | 23 | 45 |
| YUK09-21 | 5 | 50 |
| YUK09-22 | 50 | 59 |
| YUK09-23 | 5 | 55 |
| YUK09-24 | 30 | 45 |
| YUK09-25 | 5 | 36 |
| YUK09-26 | 23 | 67 |
| YUK09-27 | 27 | 77 |
| YUK09-28 | 30 | 75 |
| YUK09-29 | 23 | 55 |
| YUK09-30 | 41 | 82 |
| YUK09-31 | 33 | 76 |
| YUK09-32 | 27 | 50 |
| YUK09-33 | 41 | 77 |
| YUK09-34 | 32 | 77 |
| YUK09-35 | 50 | 86 |
| YUK09-36 | 32 | 77 |
| YUK09-37 | 32 | 77 |
| YUK09-38 | 39 | 72 |
| YUK09-39 | 41 | 82 |
| YUK09-40 | 23 | 59 |
| YUK09-41 | 18 | 41 |
| YUK09-42 | 41 | 82 |
| YUK09-43 | 50 | 95 |
| YUK09-44 | 36 | 82 |
| YUK09-45 | 50 | 95 |
| YUK09-46 | 32 | 64 |
| YUK09-47 | 41 | 86 |
| YUK09-48 | 45 | 86 |
| YUK09-49 | 50 | 86 |
| YUK09-50 | 45 | 77 |

# Appendix D

Macroinvertebrate Data

| Site ID | Number of individuals | Number of taxa | % Dominant taxon | % Mayfly | % Stonefly | % Caddisfly | % Diptera | % Tubificida |
|---|---|---|---|---|---|---|---|---|
| YUK09-01 | 30 | 12 | 23 | 40 | 30 | 0 | 20 | 10 |
| YUK09-02 | 53 | 18 | 23 | 51 | 8 | 11 | 26 | 4 |
| YUK09-03 | 65 | 16 | 23 | 62 | 9 | 2 | 26 | 2 |
| YUK09-04 | 106 | 23 | 37 | 55 | 6 | 1 | 27 | 10 |
| YUK09-05 | 64 | 12 | 45 | 86 | 5 | 0 | 6 | 0 |
| YUK09-06 | 53 | 16 | 34 | 68 | 4 | 0 | 26 | 2 |
| YUK09-07 | 413 | 38 | 56 | 19 | 2 | 0 | 73 | 5 |
| YUK09-08 | 327 | 23 | 31 | 32 | 2 | 1 | 33 | 31 |
| YUK09-09 | 38 | 5 | 39 | 0 | 0 | 0 | 13 | 79 |
| YUK09-10 | 34 | 14 | 21 | 32 | 15 | 0 | 26 | 18 |
| YUK09-11 | 124 | 15 | 43 | 38 | 3 | 1 | 15 | 43 |
| YUK09-12 | 76 | 27 | 12 | 30 | 9 | 1 | 50 | 7 |
| YUK09-13 | 99 | 19 | 47 | 60 | 16 | 1 | 10 | 12 |
| YUK09-14 | 59 | 18 | 41 | 59 | 2 | 0 | 32 | 7 |
| YUK09-15 | 184 | 21 | 38 | 18 | 4 | 1 | 33 | 43 |
| YUK09-16 | 303 | 22 | 77 | 6 | 0 | 0 | 15 | 77 |
| YUK09-17 | 31 | 15 | 29 | 16 | 23 | 3 | 48 | 3 |
| YUK09-18 | 81 | 20 | 21 | 48 | 2 | 0 | 37 | 12 |
| YUK09-19 | 19 | 7 | 26 | 26 | 26 | 0 | 16 | 26 |
| YUK09-20 | 125 | 30 | 12 | 23 | 1 | 2 | 58 | 6 |
| YUK09-21 | 13 | 8 | 46 | 15 | 0 | 8 | 31 | 46 |
| YUK09-22 | 4 | 3 | 50 | 75 | 0 | 0 | 25 | 0 |
| YUK09-23 | 20 | 8 | 30 | 0 | 0 | 0 | 90 | 10 |
| YUK09-24 | 23 | 12 | 30 | 0 | 0 | 0 | 65 | 30 |
| YUK09-25 | 13 | 5 | 38 | 0 | 15 | 0 | 46 | 38 |
| YUK09-26 | 51 | 16 | 27 | 45 | 6 | 10 | 8 | 29 |
| YUK09-27 | 169 | 32 | 17 | 42 | 8 | 4 | 31 | 12 |
| YUK09-28 | 246 | 27 | 37 | 12 | 6 | 9 | 35 | 37 |
| YUK09-29 | 122 | 16 | 25 | 50 | 11 | 4 | 16 | 15 |
| YUK09-30 | 70 | 17 | 26 | 43 | 7 | 0 | 36 | 11 |
| YUK09-31 | 60 | 20 | 33 | 22 | 5 | 2 | 28 | 37 |
| YUK09-32 | 66 | 8 | 55 | 70 | 2 | 0 | 9 | 20 |
| YUK09-33 | 135 | 20 | 54 | 3 | 3 | 1 | 24 | 57 |
| YUK09-34 | 208 | 10 | 84 | 6 | 0 | 0 | 3 | 84 |
| YUK09-35 | 36 | 9 | 47 | 36 | 3 | 0 | 14 | 47 |
| YUK09-36 | 64 | 9 | 67 | 14 | 6 | 0 | 13 | 67 |
| YUK09-37 | 170 | 39 | 19 | 23 | 9 | 2 | 61 | 3 |
| YUK09-38 | 98 | 17 | 23 | 44 | 16 | 3 | 9 | 27 |
| YUK09-39 | 68 | 10 | 62 | 0 | 0 | 0 | 35 | 62 |
| YUK09-40 | 110 | 20 | 29 | 35 | 5 | 1 | 19 | 33 |
| YUK09-41 | 103 | 25 | 49 | 5 | 3 | 2 | 85 | 4 |
| YUK09-42 | 53 | 14 | 19 | 13 | 0 | 0 | 72 | 11 |
| YUK09-43 | 25 | 10 | 44 | 60 | 8 | 0 | 20 | 0 |
| YUK09-44 | 50 | 10 | 44 | 30 | 4 | 0 | 20 | 44 |
| YUK09-45 | 34 | 15 | 32 | 44 | 6 | 3 | 29 | 12 |
| YUK09-46 | 53 | 19 | 28 | 21 | 9 | 13 | 23 | 28 |
| YUK09-47 | 280 | 34 | 16 | 49 | 8 | 1 | 35 | 5 |
| YUK09-48 | 42 | 18 | 38 | 14 | 0 | 0 | 33 | 38 |
| YUK09-49 | 66 | 8 | 83 | 5 | 0 | 3 | 6 | 83 |
| YUK09-50 | 126 | 18 | 63 | 21 | 2 | 2 | 9 | 63 |

| Taxon | Phylum | Class | Order | Family | Total abundance |
|---|---|---|---|---|---|
| Naididae | Annelida | Oligochaeta | Tubificida | Naididae | 1351 |
| Pseudocloeon dardanum | Arthropoda | Insecta | Ephemeroptera | Baetidae | 568 |
| Procladius | Arthropoda | Insecta | Diptera | Chironomidae | 403 |
| Heptageniidae | Arthropoda | Insecta | Ephemeroptera | Heptageniidae | 279 |
| Metretopus | Arthropoda | Insecta | Ephemeroptera | Metretopodidae | 278 |
| Polypedilum | Arthropoda | Insecta | Diptera | Chironomidae | 275 |
| Monodiamesa | Arthropoda | Insecta | Diptera | Chironomidae | 181 |
| Ephemerellidae | Arthropoda | Insecta | Ephemeroptera | Ephemerellidae | 101 |
| Heptagenia | Arthropoda | Insecta | Ephemeroptera | Heptageniidae | 100 |
| Isoperla decolorata | Arthropoda | Insecta | Plecoptera | Perlodidae | 89 |
| Enchytraeidae | Annelida | Oligochaeta | Tubificida | Enchytraeidae | 82 |
| Isoperla | Arthropoda | Insecta | Plecoptera | Perlodidae | 79 |
| Nematoda | Nematoda | | | | 79 |
| Chironomidae | Arthropoda | Insecta | Diptera | Chironomidae | 76 |
| Micropsectra | Arthropoda | Insecta | Diptera | Chironomidae | 57 |
| Cyphomella | Arthropoda | Insecta | Diptera | Chironomidae | 57 |
| Brachycentrus | Arthropoda | Insecta | Trichoptera | Brachycentridae | 57 |
| Micropsectra/Tanytarsus | Arthropoda | Insecta | Diptera | Chironomidae | 53 |
| Paracladius | Arthropoda | Insecta | Diptera | Chironomidae | 53 |
| Perlodidae | Arthropoda | Insecta | Plecoptera | Perlodidae | 46 |
| Brillia | Arthropoda | Insecta | Diptera | Chironomidae | 33 |
| Stictochironomus | Arthropoda | Insecta | Diptera | Chironomidae | 33 |
| Hemerodromia | Arthropoda | Insecta | Diptera | Empididae | 32 |
| Chironominae | Arthropoda | Insecta | Diptera | Chironomidae | 29 |
| Thienemannimyia group | Arthropoda | Insecta | Diptera | Chironomidae | 27 |
| Paracladopelma | Arthropoda | Insecta | Diptera | Chironomidae | 27 |
| Culicoides | Arthropoda | Insecta | Diptera | Ceratopogonidae | 21 |
| Oligochaeta | Annelida | Oligochaeta | | | 19 |
| Orthocladinae | Arthropoda | Insecta | Diptera | Chironomidae | 18 |
| Ephemerella | Arthropoda | Insecta | Ephemeroptera | Ephemerellidae | 17 |
| Harnischia | Arthropoda | Insecta | Diptera | Chironomidae | 15 |
| Rhithrogena | Arthropoda | Insecta | Ephemeroptera | Heptageniidae | 15 |
| Metachela/Chelifera | Arthropoda | Insecta | Diptera | Empididae | 13 |
| Cladotanytarsus | Arthropoda | Insecta | Diptera | Chironomidae | 13 |
| Tanypodinae | Arthropoda | Insecta | Diptera | Chironomidae | 12 |
| Lebertia | Arthropoda | Arachnida | Hydrachnidia | Lebertiidae | 12 |
| Stempellinella | Arthropoda | Insecta | Diptera | Chironomidae | 12 |
| Arctopsyche | Arthropoda | Insecta | Trichoptera | Hydropsychidae | 11 |
| Trichoptera | Arthropoda | Insecta | Trichoptera | | 10 |
| Baetidae | Arthropoda | Insecta | Ephemeroptera | Baetidae | 10 |
| Cricotopus/Orthocladius | Arthropoda | Insecta | Diptera | Chironomidae | 9 |
| Baetis | Arthropoda | Insecta | Ephemeroptera | Baetidae | 9 |
| Isoperla pinta | Arthropoda | Insecta | Plecoptera | Perlodidae | 8 |

| Taxon | Phylum | Class | Order | Family | Total abundance |
|---|---|---|---|---|---|
| Cryptotendipes | Arthropoda | Insecta | Diptera | Chironomidae | 8 |
| Chironomini | Arthropoda | Insecta | Diptera | Chironomidae | 7 |
| Chironomus | Arthropoda | Insecta | Diptera | Chironomidae | 7 |
| Chaoborus | Arthropoda | Insecta | Diptera | Chaoboridae | 7 |
| Empididae | Arthropoda | Insecta | Diptera | Empididae | 7 |
| Phaenopsectra | Arthropoda | Insecta | Diptera | Chironomidae | 7 |
| Potthastia | Arthropoda | Insecta | Diptera | Chironomidae | 7 |
| Stilocladius | Arthropoda | Insecta | Diptera | Chironomidae | 7 |
| Stagnicola | Mollusca | Gastropoda | | Lymnaeidae | 6 |
| Ablabesmyia | Arthropoda | Insecta | Diptera | Chironomidae | 6 |
| Ametropus | Arthropoda | Insecta | Ephemeroptera | Ametropodidae | 5 |
| Krenosmittia | Arthropoda | Insecta | Diptera | Chironomidae | 5 |
| Lepidoptera | Arthropoda | Insecta | Lepidoptera | | 5 |
| Suwallia | Arthropoda | Insecta | Plecoptera | Chloroperlidae | 5 |
| Simulium | Arthropoda | Insecta | Diptera | Simuliidae | 5 |
| Hydropsychidae | Arthropoda | Insecta | Trichoptera | Hydropsychidae | 4 |
| Demicryptochironomus | Arthropoda | Insecta | Diptera | Chironomidae | 4 |
| Procloeon | Arthropoda | Insecta | Ephemeroptera | Baetidae | 4 |
| Ephemeroptera | Arthropoda | Insecta | Ephemeroptera | | 4 |
| Hydropsyche | Arthropoda | Insecta | Trichoptera | Hydropsychidae | 4 |
| Isoperla petersoni | Arthropoda | Insecta | Plecoptera | Perlodidae | 4 |
| Tanytarsus | Arthropoda | Insecta | Diptera | Chironomidae | 4 |
| Dolichopodidae | Arthropoda | Insecta | Diptera | Dolichopodidae | 3 |
| Isoperla longiseta | Arthropoda | Insecta | Plecoptera | Perlodidae | 3 |
| Pteronarcella | Arthropoda | Insecta | Plecoptera | Pteronarcyidae | 3 |
| Tvetenia | Arthropoda | Insecta | Diptera | Chironomidae | 3 |
| Paratrichocladius | Arthropoda | Insecta | Diptera | Chironomidae | 3 |
| Rhabdomastix | Arthropoda | Insecta | Diptera | Tipulidae | 3 |
| Ceratopogonidae | Arthropoda | Insecta | Diptera | Ceratopogonidae | 2 |
| Brachycercus | Arthropoda | Insecta | Ephemeroptera | Caenidae | 2 |
| Collembola | Arthropoda | Insecta | Collembola | | 2 |
| Diptera | Arthropoda | Insecta | Diptera | | 2 |
| Paraphaenocladius | Arthropoda | Insecta | Diptera | Chironomidae | 2 |
| Parametriocnemus | Arthropoda | Insecta | Diptera | Chironomidae | 2 |
| Nanocladius | Arthropoda | Insecta | Diptera | Chironomidae | 2 |
| Parakiefferiella | Arthropoda | Insecta | Diptera | Chironomidae | 2 |
| Hygrotus | Arthropoda | Insecta | Coleoptera | Dytiscidae | 2 |
| Heterotrissocladius | Arthropoda | Insecta | Diptera | Chironomidae | 2 |
| Hydrachnidia | Arthropoda | Arachnida | Hydrachnidia | | 1 |
| Pteronarcys dorsata | Arthropoda | Insecta | Plecoptera | Pteronarcyidae | 1 |
| Hydroporinae | Arthropoda | Insecta | Coleoptera | Dytiscidae | 1 |
| Sperchon | Arthropoda | Arachnida | Hydrachnidia | Sperchonidae | 1 |
| Lipiniella | Arthropoda | Insecta | Diptera | Chironomidae | 1 |

| Taxon | Phylum | Class | Order | Family | Total abundance |
|---|---|---|---|---|---|
| Chrysomelidae | Arthropoda | Insecta | Coleoptera | Chrysomelidae | 1 |
| Stilobezzia | Arthropoda | Insecta | Diptera | Ceratopogonidae | 1 |
| Hyalella | Crustacea | Malacostraca | Amphipoda | Hyalellidae | 1 |
| Limnophyes | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Isoperla katmaiensis | Arthropoda | Insecta | Plecoptera | Perlodidae | 1 |
| Limnephilidae | Arthropoda | Insecta | Trichoptera | Limnephilidae | 1 |
| Tipula | Arthropoda | Insecta | Diptera | Tipulidae | 1 |
| Triznaka | Arthropoda | Insecta | Plecoptera | Chloroperlidae | 1 |
| Arctoconopa | Arthropoda | Insecta | Diptera | Tipulidae | 1 |
| Valvata | Mollusca | Gastropoda | | Valvatidae | 1 |
| Ceraclea | Arthropoda | Insecta | Trichoptera | Leptoceridae | 1 |
| Physidae | Mollusca | Gastropoda | | Physidae | 1 |
| Euryhapsis | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Gyrinus | Arthropoda | Insecta | Coleoptera | Gyrinidae | 1 |
| Paralauterborniella | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Pentaneurini | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Larsia | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Ormosia | Arthropoda | Insecta | Diptera | Tipulidae | 1 |
| Psectrocladius | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Dicrotendipes | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Dytiscidae | Arthropoda | Insecta | Coleoptera | Dytiscidae | 1 |
| Plecoptera | Arthropoda | Insecta | Plecoptera | | 1 |
| Probezzia | Arthropoda | Insecta | Diptera | Ceratopogonidae | 1 |
| Cricotopus | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Corynoneura | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Eukiefferiella | Arthropoda | Insecta | Diptera | Chironomidae | 1 |
| Colepotera | Arthropoda | Insecta | Colepotera | | 1 |
| Isoperla sobria | Arthropoda | Insecta | Plecoptera | Perlodidae | 1 |

# Appendix E

Diatom Data

| Site ID | Number of taxa | % Dominant taxon | % motile | pH index | Oxygen index | Nitrogen uptake metabolism index | Saprobity index |
|---|---|---|---|---|---|---|---|
| YUK09-01 | 27 | 36 | 0.7 | 3.6 | 1.8 | 1.9 | 2.4 |
| YUK09-02 | 20 | 43 | 2.0 | 3.7 | 1.9 | 2.0 | 2.5 |
| YUK09-03 | 28 | 25 | 1.2 | 4.1 | 1.7 | 1.9 | 2.4 |
| YUK09-04 | 24 | 25 | 1.7 | 4.0 | 1.8 | 2.0 | 2.4 |
| YUK09-05 | 22 | 36 | 1.0 | 3.7 | 1.6 | 1.8 | 2.4 |
| YUK09-06 | 16 | 37 | 0.7 | 3.8 | 1.9 | 2.0 | 2.6 |
| YUK09-07 | 27 | 31 | 1.3 | 3.8 | 1.9 | 2.0 | 2.5 |
| YUK09-08 | 26 | 24 | 3.2 | 4.0 | 1.9 | 2.0 | 2.5 |
| YUK09-09 | 25 | 19 | 1.7 | 4.1 | 2.1 | 2.0 | 2.6 |
| YUK09-10 | 28 | 21 | 2.5 | 4.0 | 2.0 | 2.0 | 2.6 |
| YUK09-11 | 25 | 16 | 1.7 | 4.0 | 1.9 | 1.7 | 2.4 |
| YUK09-12 | 20 | 19 | 0.0 | 4.0 | 1.9 | 2.0 | 2.5 |
| YUK09-13 | 23 | 25 | 0.0 | 3.9 | 1.8 | 2.0 | 2.5 |
| YUK09-14* | | | | | | | |
| YUK09-15* | | | | | | | |
| YUK09-16 | 31 | 19 | 0.3 | 4.2 | 1.8 | 1.8 | 2.5 |
| YUK09-17 | 19 | 21 | 0.0 | 4.3 | 1.9 | 2.0 | 2.5 |
| YUK09-18* | | | | | | | |
| YUK09-19 | 34 | 16 | 1.7 | 4.2 | 1.8 | 1.8 | 2.4 |
| YUK09-20 | 31 | 14 | 13.7 | 3.9 | 2.2 | 2.2 | 2.6 |
| YUK09-21 | 22 | 17 | 1.8 | 3.9 | 1.7 | 1.7 | 2.2 |
| YUK09-22 | 35 | 18 | 6.8 | 4.1 | 1.8 | 1.8 | 2.4 |
| YUK09-23 | 27 | 28 | 1.3 | 4.3 | 1.6 | 1.8 | 2.3 |
| YUK09-24 | 24 | 26 | 0.7 | 4.0 | 1.7 | 2.0 | 2.4 |
| YUK09-25 | 26 | 21 | 0.7 | 4.0 | 1.9 | 1.9 | 2.6 |
| YUK09-26 | 15 | 31 | 0.0 | 3.7 | 2.1 | 1.9 | 2.6 |
| YUK09-27 | 27 | 33 | 4.3 | 4.1 | 2.3 | 1.9 | 2.9 |
| YUK09-28 | 18 | 44 | 1.0 | 3.9 | 1.6 | 2.0 | 2.3 |
| YUK09-29 | 22 | 41 | 2.0 | 3.7 | 1.6 | 1.9 | 2.3 |
| YUK09-30 | 27 | 39 | 1.5 | 3.6 | 1.6 | 1.9 | 2.3 |
| YUK09-31 | 34 | 26 | 2.3 | 3.9 | 1.9 | 2.0 | 2.4 |
| YUK09-32 | 39 | 23 | 3.8 | 4.0 | 1.7 | 1.9 | 2.4 |
| YUK09-33 | 25 | 19 | 1.0 | 4.0 | 2.0 | 2.1 | 2.6 |
| YUK09-34 | 27 | 22 | 5.5 | 3.8 | 1.9 | 2.0 | 2.6 |
| YUK09-35 | 25 | 27 | 0.5 | 3.8 | 1.8 | 2.0 | 2.5 |
| YUK09-36 | 24 | 23 | 2.7 | 3.8 | 1.7 | 1.9 | 2.5 |
| YUK09-37 | 23 | 54 | 0.8 | 4.8 | 1.5 | 1.9 | 2.2 |
| YUK09-38 | 19 | 31 | 1.3 | 4.0 | 1.8 | 2.0 | 2.5 |
| YUK09-39 | 32 | 24 | 1.3 | 4.2 | 1.8 | 1.9 | 2.4 |
| YUK09-40 | 30 | 19 | 2.5 | 4.0 | 2.0 | 1.9 | 2.7 |
| YUK09-41 | 25 | 40 | 1.0 | 3.6 | 1.8 | 2.0 | 2.4 |
| YUK09-42 | 24 | 25 | 25.5 | 3.9 | 2.8 | 2.8 | 2.9 |
| YUK09-43* | | | | | | | |
| YUK09-44 | 30 | 16 | 7.3 | 3.8 | 2.2 | 2.3 | 2.7 |
| YUK09-45 | 31 | 16 | 6.3 | 4.0 | 2.4 | 2.2 | 2.9 |
| YUK09-46 | 25 | 23 | 0.3 | 3.7 | 2.0 | 2.0 | 2.7 |
| YUK09-47 | 25 | 25 | 1.3 | 3.8 | 2.1 | 2.0 | 2.7 |
| YUK09-48* | | | | | | | |
| YUK09-49 | 25 | 29 | 2.0 | 3.8 | 2.4 | 2.4 | 3.1 |
| YUK09-50 | 32 | 43 | 5.0 | 4.6 | 1.6 | 2.0 | 2.3 |

*Diatoms were not collected at some sites due to a lack of hard substrates required for sampling.

| Diatom Taxon | Total abundance |
|---|---|
| Gomphonema productum (Grunow) Lange-Bertalot et Reichardt | 5443 |
| Achnanthidium minutissimum (Kützing) Czarnecki | 4360 |
| Diatoma tenuis Agardh | 3838 |
| Synedra ulna (Nitzsch) Ehrenberg | 2750 |
| Staurosirella pinnata (Ehrenberg) Williams et Round | 1382 |
| Navicula cryptocephala Kützing | 1356 |
| Fragilaria capucina Desmazières | 1041 |
| Staurosira construens Ehrenberg | 756 |
| Nitzschia palea (Kützing) Smith | 595 |
| Tabellaria flocculosa (Roth) Kützing | 569 |
| Hannaea arcus (Ehrenberg) Patrick | 407 |
| Encyonema silesiacum (Bleisch in Rabenhorst) Mann | 393 |
| Eucocconeis laevis (Østrup) Lange-Bertalot | 337 |
| Nitzschia acicularis (Kützing) Smith | 334 |
| Encyonema minutum (Hilse) Mann | 327 |
| Gomphonema micropus Kützing | 264 |
| Diatoma moniliformis Kützing | 244 |
| Meridion circulare (Greville) Agardh | 209 |
| Cocconeis placentula Ehrenberg | 200 |
| Reimeria sinuata (Gregory) Kociolek et Stoermer | 177 |
| Gomphonema olivaceum (Lyngbye) Kützing | 161 |
| Aulacoseira ambigua (Grunow) Simonsen | 153 |
| Luticola mutica (Kützing) Mann | 133 |
| Nitzschia dissipata (Kützing) Grunow | 113 |
| Diatoma mesodon (Ehrenberg) Kützing | 97 |
| Gomphonema parvulum (Kützing) Kützing | 86 |
| Craticula accomoda (Hustedt) Mann | 72 |
| Gomphonema sarcophagus Gregory | 63 |
| Surirella angusta Kützing | 41 |
| Eucocconeis flexella (Kützing) Cleve | 40 |
| Discostella pseudostelligera (Hustedt) Houk et Klee | 37 |
| Melosira varians Agardh | 35 |
| Brachysira neoexilis Lange-Bertalot | 33 |
| Eunotia praerupta Ehrenberg | 32 |
| Hantzschia amphioxys (Ehrenberg) Grunow | 31 |
| Cyclotella meneghiniana Kützing | 28 |
| Staurosirella leptostauron (Ehrenberg) Williams et Round | 26 |
| Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot | 26 |
| Sellaphora pupula (Kützing) Meresckowsky | 25 |
| Eunotia bilunaris (Ehrenberg) Mills | 25 |
| Rossithidium pusillum (Grunow) Round et Bukhtiyarova | 25 |
| Psammothidium bioretii (Germain) Bukhtiyarova et Round | 25 |
| Nitzschia linearis (Agardh) W. Smith | 23 |

| Diatom Taxon | Total abundance |
|---|---|
| Amphora copulata (Kützing) Schoeman et Archibald | 23 |
| Discostella stelligera (Hustedt) Houk et Klee | 23 |
| Planothidium lanceolatum (Brébisson ex Kützing) Lange-Bertalot | 23 |
| Cyclotella tripartita Håkansson | 22 |
| Surirella brebissonii Krammer et Lange-Bertalot | 20 |
| Eunotia incisa Smith ex Gregory | 19 |
| Aulacoseira subarctica (Müller) Haworth | 18 |
| Neidium bisulcatum (Lagerstedt) Cleve | 18 |
| Navicula cryptotenella Lange-Bertalot in Krammer et Lange-Bertalot | 17 |
| Amphora inariensis Krammer | 17 |
| Nitzschia levidensis (W. Smith) Grunow | 16 |
| Cymbella cistula (Ehrenberg) Kirchner | 16 |
| Caloneis silicula (Ehrenberg) Cleve | 16 |
| Asterionella formosa Hassal | 16 |
| Navicula gregaria Donkin | 15 |
| Nitzschia perminuta (Grunow) Peragallo | 14 |
| Amphora pediculus (Kützing) Grunow | 14 |
| Cymbella naviculiformis Auerswald ex Héribaud | 14 |
| Amphipleura pellucida (Kützing) Kützing | 14 |
| Navicula lanceolata (Agardh) Ehrenberg | 12 |
| Denticula kuetzingii Grunow | 11 |
| Neidium ampliatum (Ehrenberg) Krammer | 11 |
| Luticola goeppertiana (Bleisch) Mann | 10 |
| Didymosphenia geminata (Lyngb.) M. Schmidt | 10 |
| Nitzschia filiformis (Smith) Van Heurck | 10 |
| Pinnularia borealis Ehrenberg | 10 |
| Cymbella gracilis (Ehrenberg) Kützing | 9 |
| Cyclotella michiganiana Skvortzow | 9 |
| Cocconeis neodiminuta Krammer | 9 |
| Cymbella caespitosa Brun | 8 |
| Gomphonema olivaceoides Hustedt | 8 |
| Eunotia paludosa Grunow | 8 |
| Cyclotella ocellata Pantocsek | 8 |
| Rossithidium petersennii (Hustedt) Round et Bukhtiyarova | 8 |
| Planothidium peragalli Brun et Héribaud | 7 |
| Rhoicosphenia abbreviata (Agardh) Lange-Bertalot | 6 |
| Planothidium oestrupii (Cleve-Euler) Round et Bukhtiyarova | 6 |
| Pinnularia microstauron (Ehrenberg) Cleve | 6 |
| Nitzschia tubicola Grunow in Cleve et Grunow | 6 |
| Navicula spp. | 6 |
| Meridion circulare var. constrictum (Ralfs) Van Heurck | 6 |
| Cymbella mexicana (Ehrenberg) Cleve | 6 |
| Diploneis elliptica (Kützing) Cleve | 6 |

| Diatom Taxon | Total abundance |
|---|---|
| Encyonopsis cesatii (Rabenhorst) Krammer | 6 |
| Frustulia vulgaris (Thwaites) De Toni | 6 |
| Pseudostaurosira parasitica (Smith) Morales | 5 |
| Rhopalodia gibba (Ehrenberg) Müller | 4 |
| Cyclostephanos dubius (Fricke) Round | 4 |
| Psammothidium subatomoides (Hustedt) Bukhtiyarova et Round | 4 |
| Chamaepinnularia soehrensis (Krasske) Lange-Bertalot et Krammer | 4 |
| Karayevia clevei (Grunow) Bukhtiyarova | 4 |
| Nitzschia spp. | 4 |
| Cyclotella bodanica fo. lemanica (Muller in Schroter; Muller in Chodat) Bachmann | 4 |
| Hippodonta capitata (Ehrenberg) Lange-Bertalot, Metzeltin et Witkowski | 4 |
| Navicula radiosa Kützing | 4 |
| Stauroneis spp. | 4 |
| Pinnularia spp. | 4 |
| Planothidium haynaldii (Schaarschmidt) Lange-Bertalot | 4 |
| Pinnularia divergens Smith | 4 |
| Eucocconeis alpestris (Brun) Lange-Bertalot | 3 |
| Caloneis spp. | 2 |
| Craticula cuspidata (Kützing) Mann | 2 |
| Stauroneis anceps Ehrenberg | 2 |
| Surirella linearis Smith | 2 |
| Nitzschia amphibia Grunow | 2 |
| Caloneis bacillum (Grunow) Cleve | 2 |
| Planothidium joursacense (Héribaud) Lange-Bertalot | 2 |
| Pinnularia subcapitata Gregory | 2 |
| Frustulia rhomboides (Ehrenberg) De Toni | 2 |
| Aulacoseira crassipunctata Krammer | 2 |
| Fallacia pygmaea (Kützing) Stickle et Mann | 2 |
| Diatoma hyemalis (Roth) Heiberg | 2 |
| Discostella woltereckii (Hustedt) Houk et Klee | 2 |
| Gomphonema gracile Ehrenberg emend. Van Heurck | 2 |
| Achnanthes biasolettiana (Kützing) Grunow | 2 |
| Diploneis parma Cleve | 2 |
| Diploneis oblongella (Naegeli ex Kützing) Ross | 2 |
| Stauroneis prominula (Grunow) Hustedt | 2 |
| Tetracyclus glans (Ehrenberg) Mills | 2 |
| Navicula paramutica Bock | 2 |
| Gomphonema truncatum Ehrenberg | 2 |
| Navicula rhynchocephala Kützing | 2 |
| Encyonopsis descripta (Hustedt) Krammer | 2 |
| Cymbella mesiana Cholnoky | 2 |
| Gomphonema clavatum Ehrenberg | 2 |
| Eunotia bilunaris var. mucophila Lange-Bertalot et Nörpel | 2 |

| Diatom Taxon | Total abundance |
|---|---|
| Cyclotella spp. | 2 |
| Encyonema reichardtii (Krammer) Mann | 2 |
| Cyclotella rossii Håkansson | 2 |
| Cymatopleura solea (Brébisson) Smith | 2 |
| Gomphonema spp. | 2 |

# Appendix F

Lamprey Data

| Site ID | Number of larval lamprey | Site ID | Number of larval lamprey |
|---|---|---|---|
| YUK09-01 | 2 | YUK09-26 | 2 |
| YUK09-02 | 0 | YUK09-27 | 1 |
| YUK09-03 | 1 | YUK09-28 | 3 |
| YUK09-04 | 0 | YUK09-29 | 2 |
| YUK09-05 | 2 | YUK09-30 | 1 |
| YUK09-06 | 1 | YUK09-31 | 0 |
| YUK09-07 | 5 | YUK09-32 | 8 |
| YUK09-08 | 5 | YUK09-33 | 0 |
| YUK09-09 | 4 | YUK09-34 | 0 |
| YUK09-10 | 0 | YUK09-35 | 0 |
| YUK09-11 | 0 | YUK09-36 | 3 |
| YUK09-12 | 5 | YUK09-37 | 0 |
| YUK09-13 | 0 | YUK09-38 | 0 |
| YUK09-14 | 2 | YUK09-39 | 2 |
| YUK09-15 | 9 | YUK09-40 | 2 |
| YUK09-16 | 1 | YUK09-41 | 1 |
| YUK09-17 | 1 | YUK09-42 | 0 |
| YUK09-18 | 4 | YUK09-43 | 4 |
| YUK09-19 | 2 | YUK09-44 | 2 |
| YUK09-20 | 1 | YUK09-45 | 1 |
| YUK09-21 | 2 | YUK09-46 | 0 |
| YUK09-22 | 0 | YUK09-47 | 0 |
| YUK09-23 | 2 | YUK09-48 | 2 |
| YUK09-24 | 1 | YUK09-49 | 0 |
| YUK09-25 | 0 | YUK09-50 | 3 |