2020

WATER QUALITY REPORT

FORT YUKON

INDIGENOUS OBSERVATION NETWORK

ONE PEOPLE-ONE RIVER
Yukon River Inter-Tribal Watershed Council
www.yritwc.org

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INTRODUCTION

THE YRITWC

The Yukon River Inter-Tribal Watershed Council (YRITWC) is an Indigenous grassroots organization, consisting of 74 First Nations and Tribes, dedicated to the protection and preservation of the Yukon River Watershed. The YRITWC accomplishes this by providing Tribes in Alaska and First Nations in Canada in the Yukon Watershed with technical assistance. We facilitate the development and exchange of information, coordinate efforts between Tribes and First Nations, undertake research, and provide training, education and awareness programs to promote the health of the Watershed and its Indigenous peoples.

Our Mission

"We, the Indigenous Tribes/First Nations from the headwaters to the mouth of the Yukon River, having been placed here by our Creator, do hereby agree to initiate and continue the clean-up and preservation of the Yukon River for the protection of our own and future generations of our Tribes/First Nations and for the continuation of our traditional Native way of life."

THE INDIGENOUS OBSERVATION NETWORK

The Indigenous Observation Network (ION) is the largest international, Indigenous initiative combining Indigenous Knowledge and western science to research, sustain and protect the Yukon River Watershed, its resources and cultures. ION is a network of communities along the Yukon River and its tributaries who conduct research and monitoring that is applicable at the community, watershed, circumpolar and global scales; an amazing feat in the world of science.

The water quality project is the core project of ION and YOU are an essential part of it. Our projects connect communities like yours so that your observations and research on your environment have meaning and application at the community, watershed, state, federal and global scales. The YRITWC works to give you the tools and training necessary to operate and manage a large-scale environmental observational network and collect high quality data that can be verified by other communities or scientists. Thank you for making ION a success!

ACKNOWLEDGEMENTS

While ION would not exist without your community's interest or participation, ION also relies heavily on several key collaborators and various external sources of funding. The cooperation, expertise and financial resources of these partners contribute immensely to the success and sustainability of ION.

The United States Geological Survey (USGS) has played an essential role in the development and support of ION. From 2001-2006, the USGS conducted an intensive research program on the Yukon River. In 2007, the ION used this program as the foundation for its current day water quality program. The USGS has provided technical assistance and the majority of the laboratory analysis for this program since its inception. USGS also allows YRITWC staff and community members to assist with this analysis providing another opportunity for capacity building for your community.

Since 2019, the University of Alaska Fairbanks has supported the ION by providing water quality and active layer expertise and by conducting laboratory analysis of incoming water quality samples from the Yukon River Watershed. Thanks to the University's contributions, YRITWC has been able to enhance, localize and expedite its water quality analysis work.

The Environment Protection Agency's Indian General Assistance Program (IGAP) funds many of the Tribal Environmental Programs that participate in ION. IGAP has played an essential role in ensuring the sustainability and capacity of ION.

The National Science Foundation (NSF) has funded ION to become part of the Arctic Observation Network (AON) and Navigating the New Arctic (NNA) to continue its water and active layer monitoring and Indigenous knowledge program.

The Government of Yukon supported the initial development of the Yukon side of the water quality monitoring program for three years (2007-2010). They continue to provide regional and water quality expertise, support and outreach opportunities.

The Administration for Native Americans provided the initial funding for the development of ION and its water quality program (2006-2009).

With support from National Geographic, BSCS Science Learning, the Gordon and Betty Moore Foundation, and the National Science Foundation (listed above), ION and the YRITWC were granted access to the "FieldScope" platform. FieldScope is a mapping database that has social networking capabilities. Having access to this database is a tremendous resource that will allow for increased participation and access to your community's data with some capability for analysis by community members themselves.

YRITWC is fortunate to supplement its ION, community-collected data with data from the Government of Canada as well as the United States Geological Survey (USGS). The data gathered from various Government of Canada and USGS sites in Alaska, Yukon Territory, and British Columbia extend the period of time for which the YRITWC has water quality data and has thus allowed community-level water quality analysis to be more robust in recent years.

The YRITWC receives additional funding through competitive proposals from a wide variety of other sources for other projects that the organization and ION carries out. The agencies and ministries mentioned here have directly supported the data presented within these community reports. For additional acknowledgement information, please see the YRITWC website: www.yritwc.org.

BACKGROUND ON WATER QUALITY

WHAT IS "WATER QUALITY"?

Water quality is really just a measure of the suitability of water for a particular use. Some water is great for drinking and is referred to as being "potable." Some water is not potable (not suitable for drinking) but might make healthy fish habitat or be great for watering your garden.

We cannot tell if a water sample is safe for drinking, or suitable for any other use, just by looking at it. We need to measure certain characteristics of the water, which might be physical, chemical or biological. We can divide the characteristics we are measuring into a few groups (field parameters, major ions, nutrients, dissolved organic carbon and stable water isotopes), which are discussed below.

WATER QUALITY STANDARDS

In order to decide whether water is suitable for a particular use or unsuitable for that use, we need water quality standards. Basically, we need to designate the use of a water body and use water quality criteria to protect that use and prevent pollution. "Designating the use" of a water body means deciding if it is fit or safe for drinking, swimming, fishing, watering crops or some other function. "Water quality criteria" are just numbers and other requirements that our samples have to meet in order to prove that the water is suitable for its use. Currently, the Alaska Department of Environmental Conservation's *Water Quality Standards* (AK-DEC, 2020) and *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (AK-DEC, 2008) are used to evaluate water quality in the state of Alaska.

OUR WATER QUALITY STANDARDS

The YRITWC is developing a Yukon River Watershed Plan to protect and improve the water quality in the Yukon River from the headwaters to the mouth. Development of the plan was recommended at the 2011 YRITWC Biennial Summit, co-hosted by the Ruby Tribal Council in Ruby, AK and approved by all signatory Tribes and First Nations at the 2013 YRITWC Summit, co-hosted by the First Nation of Na-Cho Nyak Dun in Mayo, YT. Currently, the YRITWC is in the process of implementation and governance of the Yukon River Watershed Plan through Alaska Tribes and First Nations water quality legislation.

The Yukon River Watershed Governance Strategy describes the Tribes' and First Nations' long-term vision and objectives for the Yukon River watershed. The

centerpiece of the plan is a set of measurable water quality standards describing the quality of the river water necessary to achieve the plan's vision and objectives. The water quality standards are specifically aimed at improving and protecting the quality of the river's water to sustain the health of the people, animals and plants of the watershed. The water quality standards in the plan apply *across the entirety of the watershed* (i.e. in both Canada and the United States). The Tribes and First Nations intend these standards to be consistent with the legal and regulatory regimes of the other sovereign governments relevant to the different parts of the Yukon River Watershed: Alaska, Yukon, and British Columbia.

Anti-degradation: The other key component of the Water Governance strategy is the emphasis on the concept of "anti-degradation". Anti-degradation essentially states that any degradation (worsening) of water quality (even if it remains above the water quality standard) is unlawful unless there is significant social or economic justification. The data presented within this report allows us to establish baseline conditions, monitor for change, and ultimately determine whether water quality degradation is occurring.

FIELD PARAMETERS

Field parameters are the characteristics of water that you measure when you go out and take a water sample. Many of these parameters tell us multiple stories about the Yukon River. In its current state, our water quality program focuses on parameters that are important for fish habitat, climate change, and hydrology and, to a much lesser extent, drinking water. Currently, we have several pilot programs in select communities investigating more specific contaminants. Please contact the YRITWC if you would like to develop or be involved with these other projects.

pH: pH is a measure of how acidic or basic a water sample is. The range of pH values goes from zero to fourteen. Low values of pH indicate acidic waters whereas high values of pH indicate basic waters. The number seven is right in the middle so it is considered neutral. pH can affect the concentration of the anions, cations and nutrients (see "Laboratory Parameters", below) that are dissolved in the water so it is a very important indicator of water quality. The Alaska Department of Environmental Conservation water quality standards report a range of acceptable pH values from 6.5-8.5 (AK-DEC, 2020).

Dissolved oxygen: Even though you can't see it, the water you sample contains a dissolved gas: oxygen. Oxygen gets into the water from the surrounding air and from plants that are undergoing photosynthesis. The oxygen dissolved in the river is critical

for the aquatic life (fish and other organisms) living in it. We don't want dissolved oxygen to get too low or the aquatic life could feel stressed or even die. The Water Quality Standard of the Alaska Department of Environmental Conservation states the following for freshwater used for the growth and propagation of fish, shellfish, other aquatic life, and wildlife (AK DEC, 2020):

- **For waters used by anadromous* or resident fish, dissolved oxygen must be greater than 7 mg/L in waters used by anadromous* or resident fish.**
- **In no case may D.O. be greater than 17 mg/L.**

anadromous fish, such as salmon, migrate up rivers from the sea to breed in freshwater. Resident fish, such as rainbow trout, do not migrate out to the ocean, but remain in freshwater.

<u>Conductance</u>: Conductance is a measure of how well the water can conduct an electrical current. Water can conduct electrical currents because it contains dissolved charged particles called ions (the anions and cations discussed below). Conductance depends on the amount of solids dissolved in the water: pure water has a low conductance whereas seawater has a high conductance. When the conductance goes up or down, it is telling us something about the amount of dissolved solids in the water.

<u>Temperature</u>: Temperature tells us how hot or cold the water is. Temperature can affect the ability of water to conduct an electrical current, to hold oxygen and certain dissolved solids, and to undergo various reactions so it is very important to measure every time we take a sample. While temperatures can vary greatly (even within the day), consistently high water temperatures are detrimental to most salmonids (e.g., salmon, whitefish, sheefish, etc.).

LABORATORY PARAMETERS

The rest of the characteristics of water that we are interested in are measured in a laboratory using the samples that you collect in the field. We receive the samples in Anchorage, Fairbanks or Whitehorse, process them and send them to the University of Alaska Fairbanks Laboratory for analysis.

<u>Ions</u>: Ions are dissolved particles that have charge. *Anions* are negatively charged ions whereas *cations* are positively charged ions. All natural water samples, including the samples we take around the Yukon watershed, contain ions. Ions typically come from natural sources. The rocks and soil around the watershed naturally contain lots of anions and cations. Water (from rainfall, snowmelt or any other source) comes into contact with the rocks and soil and they react. During this process, some of the ions dissolve into the water. We measure these ions to understand how the water is

reacting with its environment, to assess the quality of the water and to monitor for possible sources of contamination.

<u>Anions</u>: Anions are dissolved particles with negative charge. We measure these using the water from the biggest plastic bottle with the white cap in your sample kit. There are three anions that we measure:

- **<u>Alkalinity</u>: Alkalinity is a measure of the capacity of water to neutralize acids. Alkalinity is important for fish and aquatic life because it can help prevent rapid pH changes. Remember that living organisms generally function best in a pH range of six to nine. Rapid pH changes could be caused by acid rain, mining contamination, or other potential sources of acid. Most of the alkalinity in the water we sample comes in the form of bicarbonate. (Baking soda is a type of bicarbonate!) Bicarbonate dissolves in the water when rain falls, infiltrates the ground, and reacts with rocks and soil. Bicarbonate is the most abundant anion in samples collected from the main stem of the Porcupine River and Yukon River. It is important that a minimum level of alkalinity be maintained because alkalinity affects pH, which has a direct effect on organisms as well as an indirect effect on the toxicity of some contaminants in the water. The Alaska Department of Environmental Conservation states that chronic alkalinity should not fall below 20 mg/L (as $CaCO_3$; except where natural alkalinity is lower) for the protection of aquatic life in freshwater (AK-DEC, 2008).**
- **<u>Sulfate</u>: Sulfate, like bicarbonate, dissolves in the water when rain falls, infiltrates the ground, and reacts with rocks and soil. Sulfate is a nutrient (see below). Usually the source of sulfate dissolved in water is natural, but sometimes it comes from fertilizers, mining operations, pulp and paper mills, tanneries or other sources. When sulfate concentrations are very high, the water usually tastes bad and could potentially cause diarrhea or dehydration. Sulfate is typically the second most abundant anion, after bicarbonate, in samples collected from the Yukon River and Porcupine River.**
- **<u>Chloride</u>: Some chloride dissolves in the water when it reacts with salts in the rocks and the soil. However, chloride dissolved in water often comes from other sources such as human or animal wastes, which are high in salt, or from salt used on roads for snow and ice control. In lower river communities, it is possible that chloride comes from seawater that the tides are pushing up into the river. When chloride concentrations are very high, the water usually tastes bad and could cause pipes to corrode. In samples collected from the Porcupine River and Yukon River and Porcupine River, there is typically much less chloride than there is bicarbonate and sulfate, but this is not always true for all bodies of water. The Alaska Department of Environmental Conservation states that**

chronic chloride concentrations should not exceed 230 mg/L for the protection of aquatic life in freshwater (AK-DEC, 2008).

Cations: Cations are dissolved particles with positive charge. We measure these using the water from the tall, thin plastic bottle with the white cap in your sample kit. There are four cations that we measure:

- **Calcium: Calcium dissolves in the water when rain falls, infiltrates the ground, and reacts with rocks and soil. It is the most abundant cation in samples collected from the main stem of the Porcupine River and Yukon River. There is currently no evidence of negative health effects caused by calcium in water for human consumption or aquatic life.**
- **Magnesium: Magnesium, like calcium, dissolves in the water when rain falls, infiltrates the ground, and reacts with rocks and soil. It is typically the second most abundant cation, after calcium, in samples collected from the Porcupine River and Yukon River. There is currently no evidence of negative health effects caused by magnesium in water for human consumption or aquatic life.**
    - **Hardness: When water does not contain much calcium and magnesium, we say that it is "soft water." When water contains a lot of calcium and magnesium, we say that it is "hard water." Hard water requires a lot of soap to produce a lather. It can also form white deposits called "scale" that can clog hot water pipes, boilers and other household appliances. Often people use water softeners to turn hard water into soft water; that is, to reduce the amount of calcium and magnesium in the water. It can be worthwhile to use a softener because soft water is more compatible with soap and extends the lifetime of plumbing.**
- **Sodium: Sodium, like calcium and magnesium, dissolves in the water when rain falls, infiltrates the ground and reacts with rocks and soil. Sometimes sodium dissolved in water, like chloride, comes from human or animal wastes, which are high in salt, or from salt used on roads for snow and ice control. In lower river communities, it is possible that sodium comes from seawater that the tides are pushing up into the river. When sodium concentrations are very high, the water usually tastes bad. In samples collected from the Yukon River, there is typically much less sodium than there is calcium and magnesium.**
- **Potassium: Potassium, like the other cations, dissolves in the water when rain falls, infiltrates the ground, and reacts with rocks and soil. Sometimes potassium dissolved in water comes from fertilizers. It is the least abundant cation in samples collected from the main stem of the Porcupine River and Yukon River.**

There is currently no evidence of negative health effects caused by potassium in water for human consumption or aquatic life.

Nutrients: Nutrients are measured using the water from the two identical small plastic bottles in your sample kit. A nutrient is a chemical that an organism needs to live and grow. Nutrients are essential for life but too many of them can degrade habitat for aquatic life and pollute drinking water. Too many nutrients in the water can cause algae to grow excessively and lower the dissolved oxygen in the water, which can impact fish and other aquatic life. This is called eutrophication. Natural sources of nutrients include soils and decaying plant materials (fallen leaves, grass, etc.). Sometimes nutrients dissolved in water come from human or animal wastes, fertilizers, or industrial wastewater. There are two nitrogen-bearing nutrients that we analyze directly from the two small bottles: nitrate and ammonium:

- **Nitrate: Small amounts of nitrate (NO_3) dissolve in the water when it reacts with decaying plant and animal material in the soil. Sometimes nitrate dissolved in water comes from human or animal wastes and fertilizers. We expect to find small amounts of nitrate in our samples, but we are concerned if these amounts ever get too high because nitrate can become toxic (especially to young infants) at elevated concentrations.**
- **Ammonium: As with nitrate, small amounts of ammonium (NH_4) dissolve in the water when it reacts with decaying plant and animal material in the soil. Sometimes ammonium dissolved in water comes from human or animal wastes and fertilizers. The water quality standards for ammonium are dependent on local site conditions (pH and temperature) and are difficult to display in a table or on a graph. There is very little risk from ammonium at the low levels normally encountered in our samples.**
- **Other Nutrients: Other nutrients that we analyze include sulfate (discussed above) and Dissolved Organic Carbon (or "DOC"; discussed below).**

Dissolved Organic Carbon: Dissolved Organic Carbon (DOC) is a measure of a whole bunch of organic molecules that are dissolved in water. It is measured using the water in the brown glass bottle in your sample kit. Because it is a nutrient, DOC is important and essential for life, especially for microorganisms: tiny life forms like algae, bacteria and fungi. These tiny life forms are the start of the food chain! Our health depends on the health of the fish, which depends on the health of these microorganisms. DOC is also important because it is highly reactive with other substances and can bind with pesticides or metals such as mercury and reduce their toxicity. Under certain conditions, this can allow living organisms to take in toxic materials. So, we measure

DOC because it can tell us something about toxic substances in the water and whether or not they are entering the food chain.

Stable Water Isotopes: Some molecules of water are lighter or heavier than others because of something called "isotopes." We can measure the isotopes in water to try to understand where the samples of water come from (ice? snow? rain? groundwater?) and how they are moving from one place to another. In this way, stable water isotopes can help us understand long-term trends in the watershed, including the effects of climate change. Different isotopes behave differently. Lighter water molecules (that is, water with more light isotopes) are more easily evaporated. Heavier water molecules (that is, water with more heavy isotopes) are more easily precipitated as rain or snow. We use the sample you take in the small, clear glass vial in your sample kit to measure the isotopes in the water. It is extremely important that the sample vial is totally full and has no air bubbles in it. An air bubble could cause the measurement of isotopes to change. We want the isotopes in the sample water to be just like they were when you collected them from the river! Stable water isotopes pose no risk to our health or the health of the river.

Greenhouse Gases: A greenhouse gas can absorb and release energy from the sun and ultimately cause the greenhouse effect that keeps our planet warm. Increasing amounts of greenhouse gases contribute to climate change. Greenhouse gases are in the air but they can also dissolve into the water, just like oxygen does. We measure two greenhouse gases in samples from specific locations: carbon dioxide and methane. Every time we breathe out, we are putting some carbon dioxide into the air. Carbon dioxide is also produced whenever we burn fossil fuels like gas, coal or diesel. Methane is the main ingredient in what we call "natural gas." It naturally occurs underground but can also come from manure, landfills, and other places. When the climate warms, the permafrost can melt and release carbon dioxide and methane. So, it's important to monitor how much carbon dioxide and methane are in our water samples because it helps us determine how much climate change is occurring and how climate change is affecting our watershed. Carbon dioxide and methane are typically found in small amounts in natural water samples, so they generally pose no risk to our health or the health of the river.

WATER QUALITY IN OUR COMMUNITY

Once we (a) understand what we are measuring in the water samples that we collect and (b) know what the relevant water quality standards are, then we can compare our results to the standards and assess our water quality!

The following pages illustrate and evaluate the water quality in <u>your</u> community, based on the data that <u>you</u> have gathered plus any supplemental data we acquired from exclusive USGS or Government of Canada sampling locations that can be accessed with the links below. Many YRITWC samples included in this report were analyzed at the USGS National Research Laboratory in Boulder, Colorado, but starting in 2019, YRITWC samples are analyzed at the University of Alaska Fairbanks.

The data are publicly available from two sources: 1) Schuster et al. 2010 is a USGS Open File Report containing data collected from all sampling locations during the years 2006 through 2008. This Open File Report is available online from the USGS and can be found at http://pubs.er.usgs.gov/publication/ofr20101241; and 2) Data collected from all sampling locations during the years 2009 through 2013 is available in downloadable Microsoft Excel spreadsheets at http://wwwbrr.cr.usgs.gov/projects/SWC_Yukon/YukonRiverBasin/. The data from 2014 to 2019 is reported here in preliminary form as it has not been through the full process of quality assurance (QA) and quality control (QC). When QA/QC procedures have been completed for this dataset it will be added to the Water-Quality Data from the Yukon River Basin in Alaska and Canada ScienceBase-Catalog website. This website also contains links to USGS Open File Reports containing the data collected by the USGS over the years 2001-2005.

Additional water quality data for the Yukon River Watershed can be located at:

- **The National Water Information System (NWIS) at https://waterdata.usgs.gov/nwis**
- **National Water Quality Monitoring Council at https://www.waterqualitydata.us/portal/#countrycode=US&statecode=US%3A02&siteType=Stream&siteid=USGS-15389000&mimeType=csv**
- **Yukon Government Water Data Catalogue at https://yukon.ca/en/water-quality-monitoring#find-water-quality-data & http://yukon.maps.arcgis.com/apps/webappviewer/index.html?id=2365a4c0b8744f34be7f1451a38493d2**
- **Canadian Freshwater Quality Data by the Government of Canada at http://aquatic.pyr.ec.gc.ca/webdataonlinenational/**

When searching for sites within the Yukon River Watershed, select "Pacific", then "Yukon River Baseflow Study", then "Long-term Monitoring Trends".

We use the Alaska Department of Environmental Conservation's *Water Quality Standards* (AK-DEC, 2020) and *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (AK-DEC, 2008) to evaluate the following parameters:

- **pH**
- **Dissolved Oxygen**
- **Alkalinity**
- **Chloride**

We also provide graphs for the following important parameters:

- **Conductance**
- **Anions and Cations**

Alaska Water Quality Standards

From Alaska Water Quality Standards (2020) and Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (2008) by the AK Department of Environmental Conservation (AK -DEC).

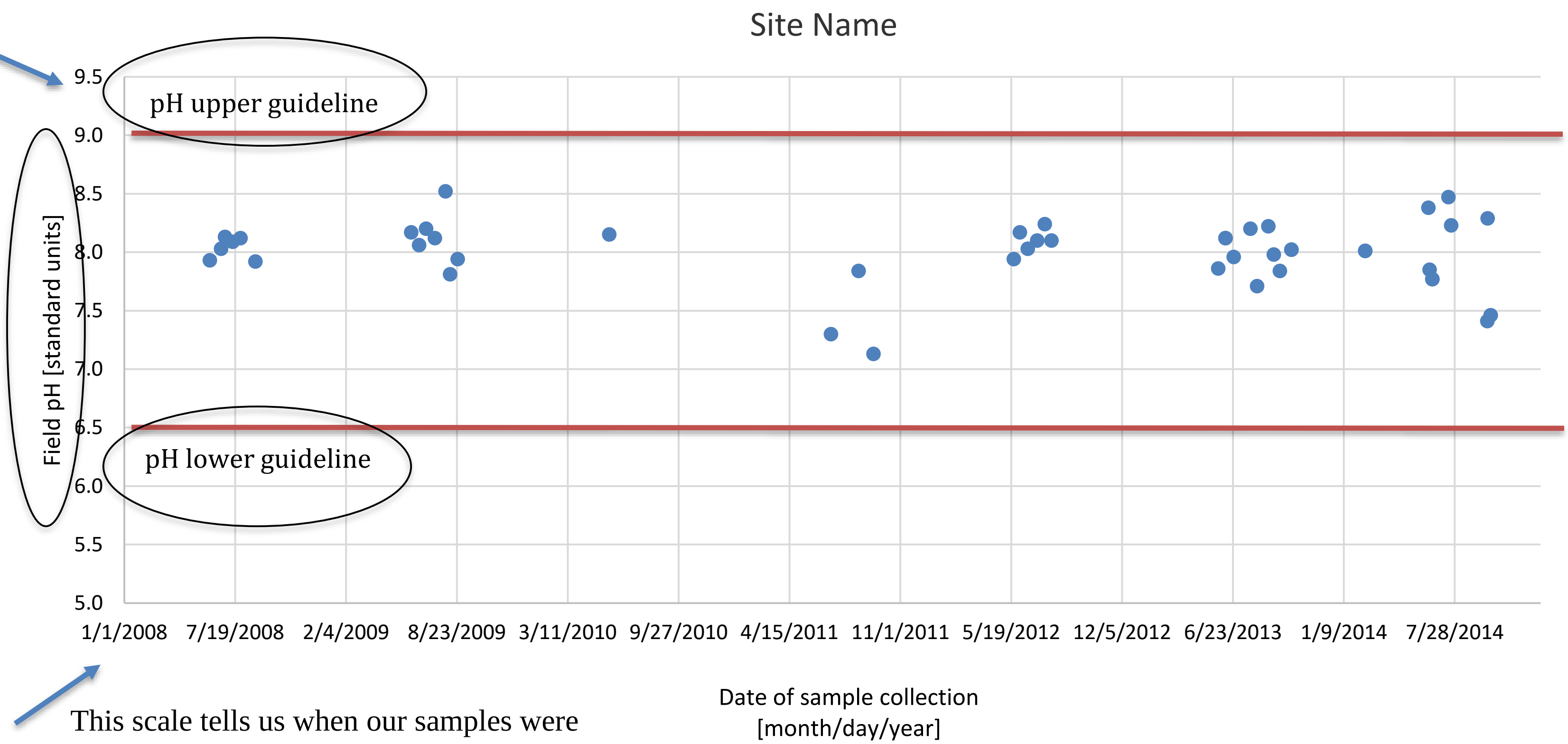
pH	Acceptable Range: 6.5 - 8.5 (AK-DEC, 2020)
Dissolved Oxygen	Lower limit: 7 mg/L for anadromous or resident fish. In no case may D.O. be greater than 17 mg/L (AK-DEC, 2020)
Conductance	No conductance guideline.
Alkalinity	Chronic alkalinity should not fall below 20 mg/L (as $CaCO_3$; except where natural alkalinity is lower) for the protection of aquatic life in fresh water (AK-DEC, 2008).
Chloride	Chlorides may not exceed 230 mg/L (AK-DEC, 2008)
Nitrate	No Nitrate guideline.

TIME SERIES DIAGRAMS

A time series diagram is a way of visualizing, or picturing, how our data looks over time. It is another way of representing a lot of data with a single image. Time series diagrams can help us find patterns in the data. Each point represents a measurement made as a result of one of our sampling trips. The red lines are guidelines. Healthy water is below the upper red line and, where applicable, above the lower red line. Keep in mind that not everything we measure has a guideline and therefore not every time series diagram will have these red lines.

This scale tells us the magnitude (size) of our measurement, usually milligrams per liter or mg/L

This label shows the parameter being measured and the units the measurement is in. In this case pH in standard units.

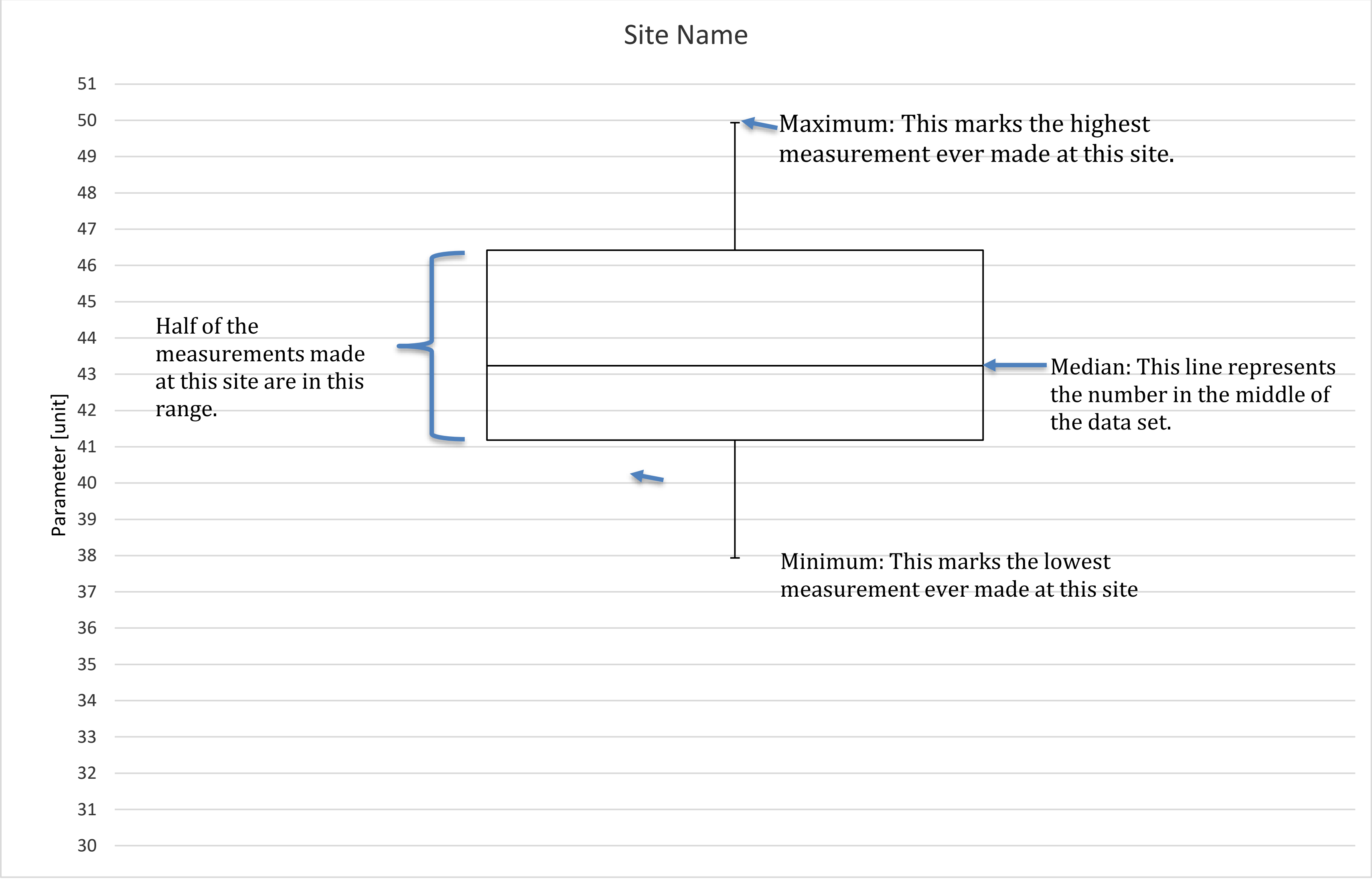


In the pages that follow, you can find time series diagrams for pH, dissolved oxygen, conductance, chloride and nitrate.

This scale tells us when our samples were collected.

BOX AND WHISKER DIAGRAMS

Below are some tips on how to interpret a box and whisker diagram. In the pages that follow, you can find a box and whisker diagrams for the ions (anions and cations) that we analyze in our samples.

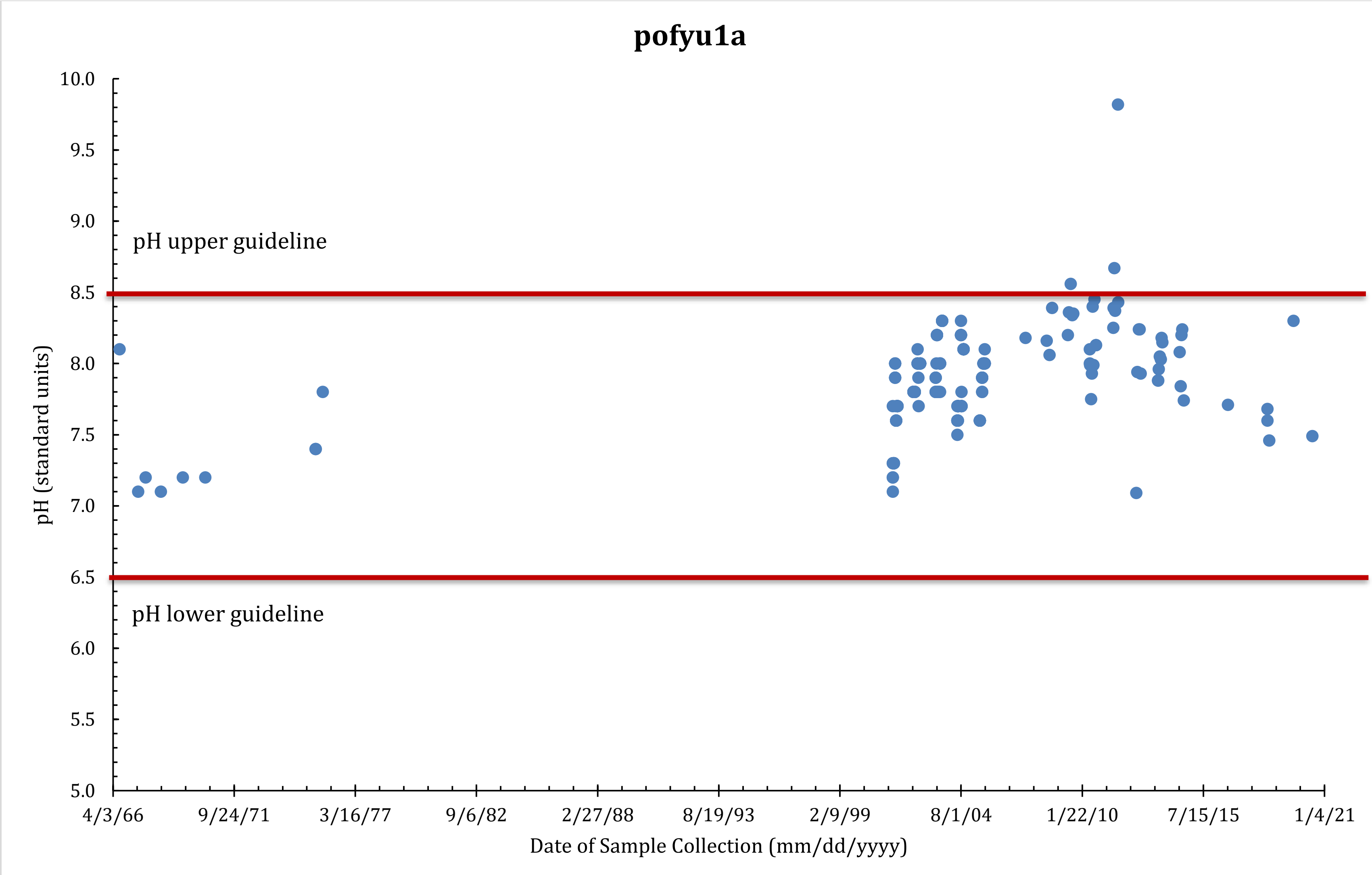


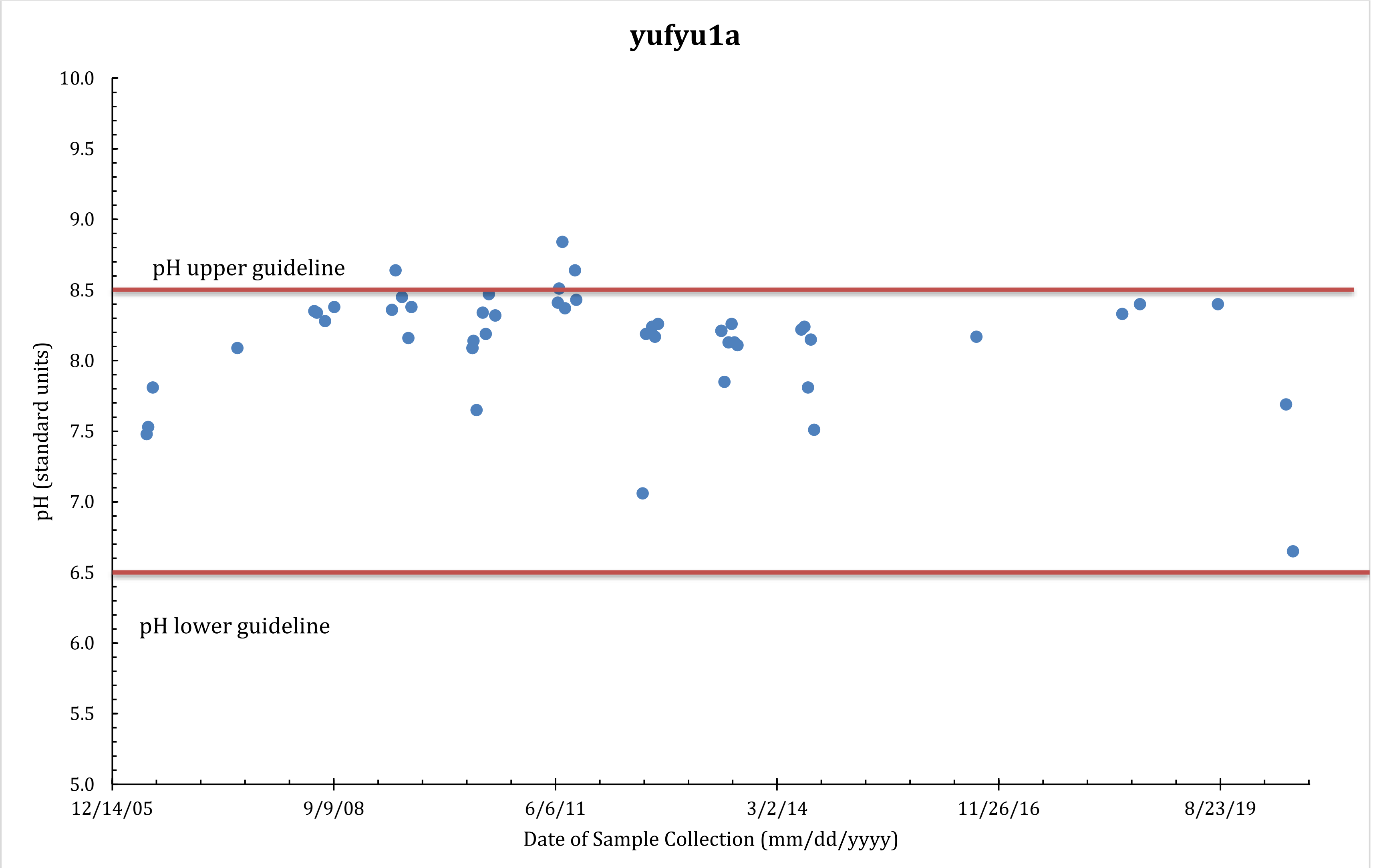
pH – pofyu1a & yufyu1a

The following page shows the field pH measurements recorded at your sampling sites, Porcupine River upstream of Fort Yukon (pofyu1a) and Yukon River upstream of Fort Yukon (yufyu1a). The Alaska Department of Environmental Conservation water quality standards report a range of acceptable pH values from 6.5-8.5 (AK-DEC, 2020).

The majority of the field measurements of pH at pofyu1a are between the guidelines except for three, taken in July 2009, July 2011, and September 2011, that exceed the upper guideline. The pH measurements taken at the pofyu1a sampling site have an average value of 7.90.

The majority of the field measurements of pH at the yufyu1a sampling site are between the guidelines except for four, which exceed the upper guideline and were taken in June 2009 and between June and September 2011 - the same time as those above the guideline at pofyu1a. The average value of pH at yufyu1a is 8.10.


pofyu1a
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
pH (standard units)
pH upper guideline
pH lower guideline
4/3/66
9/24/71
3/16/77
9/6/82
2/27/88
8/19/93
2/9/99
8/1/04
1/22/10
7/15/15
1/4/21
Date of Sample Collection (mm/dd/yyyy)


yufyu1a
pH upper guideline
pH lower guideline
pH (standard units)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
12/14/05
9/9/08
6/6/11
3/2/14
11/26/16
8/23/19
Date of Sample Collection (mm/dd/yyyy)

DISSOLVED OXYGEN –POFYU1A & YUFYU1A

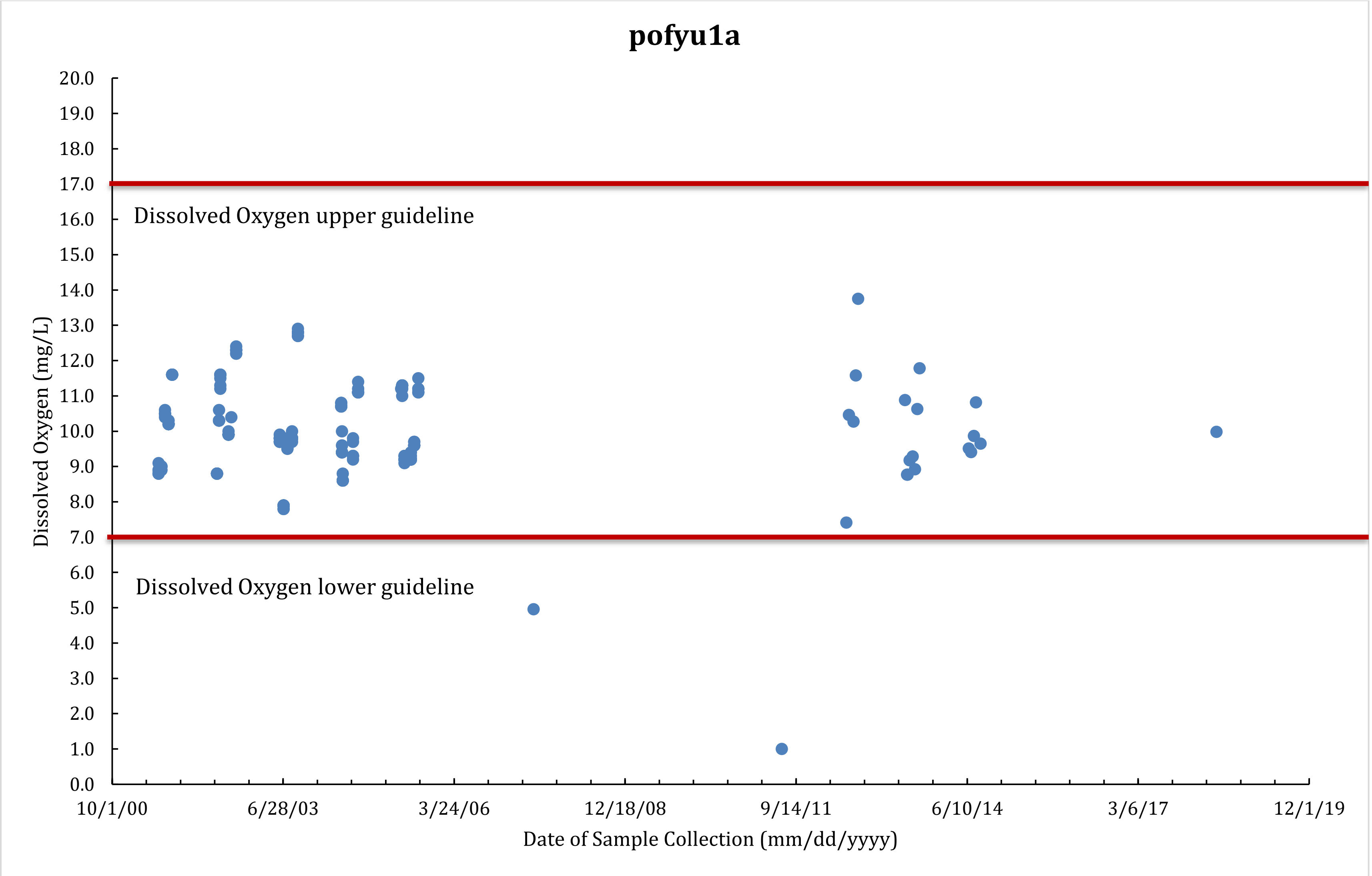
The following page shows the dissolved oxygen measurements recorded at your sampling sites, Porcupine River upstream of Fort Yukon (pofyu1a) and Yukon River upstream of Fort Yukon (yufyu1a). The Water Quality Standard of the Alaska Department of Environmental Conservation states the following for freshwater used for the growth and propagation of fish, shellfish, other aquatic life, and wildlife (AK DEC, 2020):

- **For waters used by anadromous* or resident fish, dissolved oxygen must be greater than 7 mg/L in waters used by anadromous* or resident fish.**
- **In no case may D.O. be greater than 17 mg/L.**

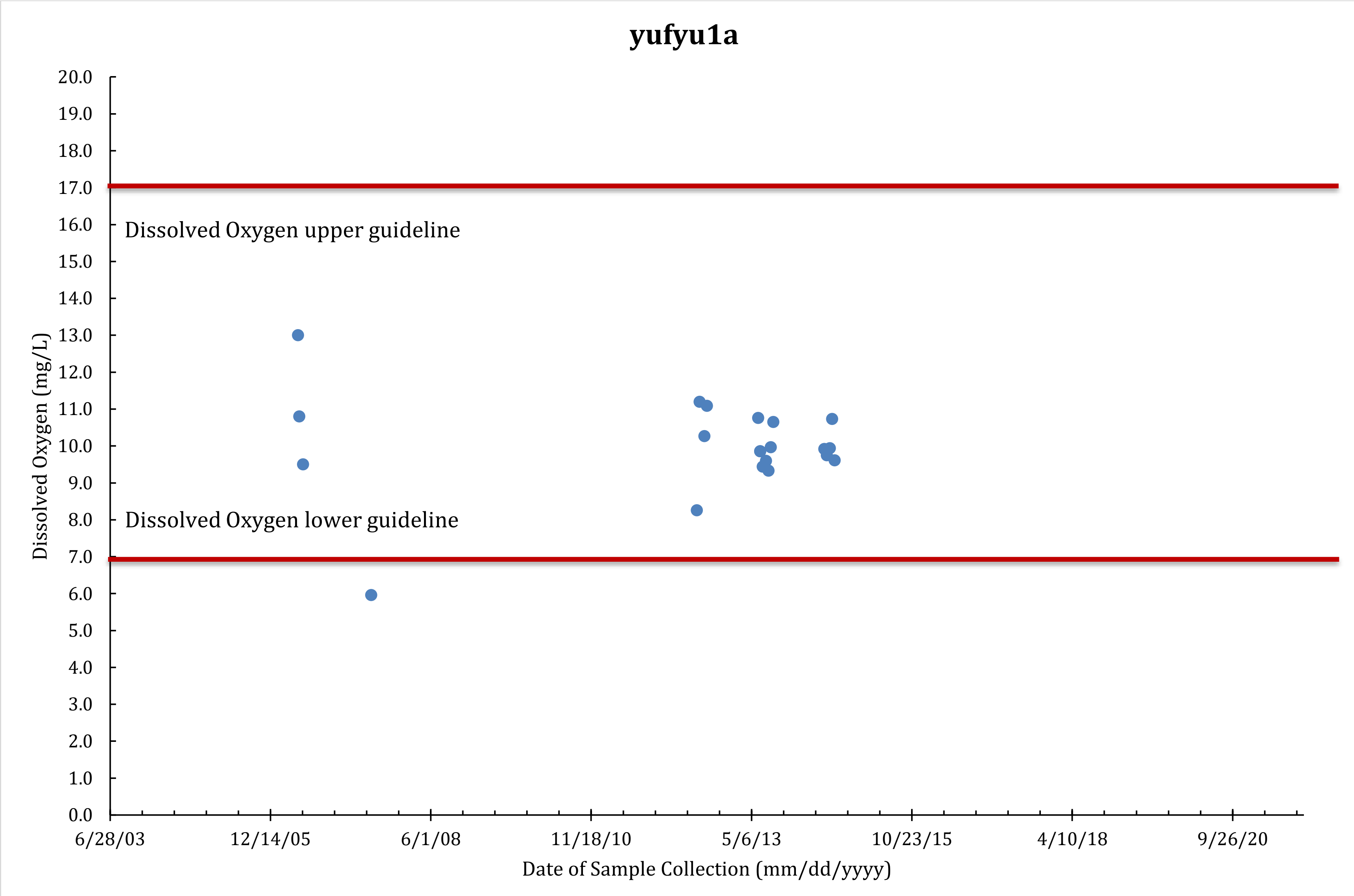
anadromous fish, such as salmon, migrate up rivers from the sea to breed in freshwater. Resident fish, such as rainbow trout, do not migrate out to the ocean, but remain in freshwater.

All of the measurements of dissolved oxygen at the pofyu1a sampling site are between the guidelines except for two, which fall below the lower guideline. These were collected in July 2007 and June 2011. We will carefully whether these outliners are true values or due to calibration error. We will continue to monitor dissolved oxygen concentrations at your sampling locations to ensure that they remain within these guidelines. Dissolved oxygen at pofyu1a has an average concentration of 10.00 mg/L.

The majority of the measurements of dissolved oxygen at the yufyu1a sampling site are between the guidelines except for one taken in July 2007 that was below the lower guideline. Dissolved oxygen was not monitored at yufyu1a from 2008-2010 and 2015-2019. Dissolved oxygen at yufyu1a sampling site has an average concentration of 10.00 mg/L.



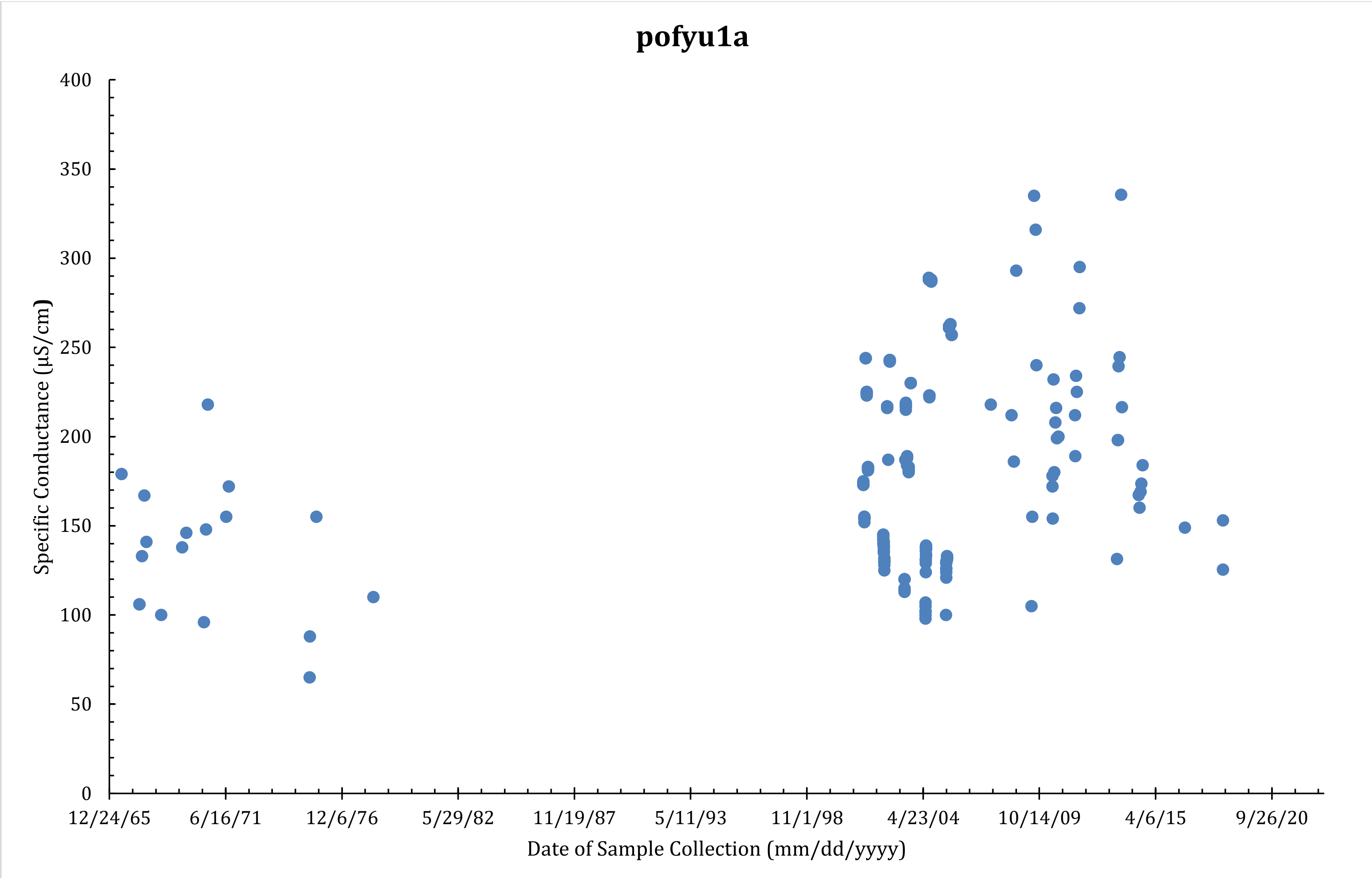
pofyu1a
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Dissolved Oxygen upper guideline
Dissolved Oxygen lower guideline
Dissolved Oxygen (mg/L)
10/1/00
6/28/03
3/24/06
12/18/08
9/14/11
6/10/14
3/6/17
12/1/19
Date of Sample Collection (mm/dd/yyyy)

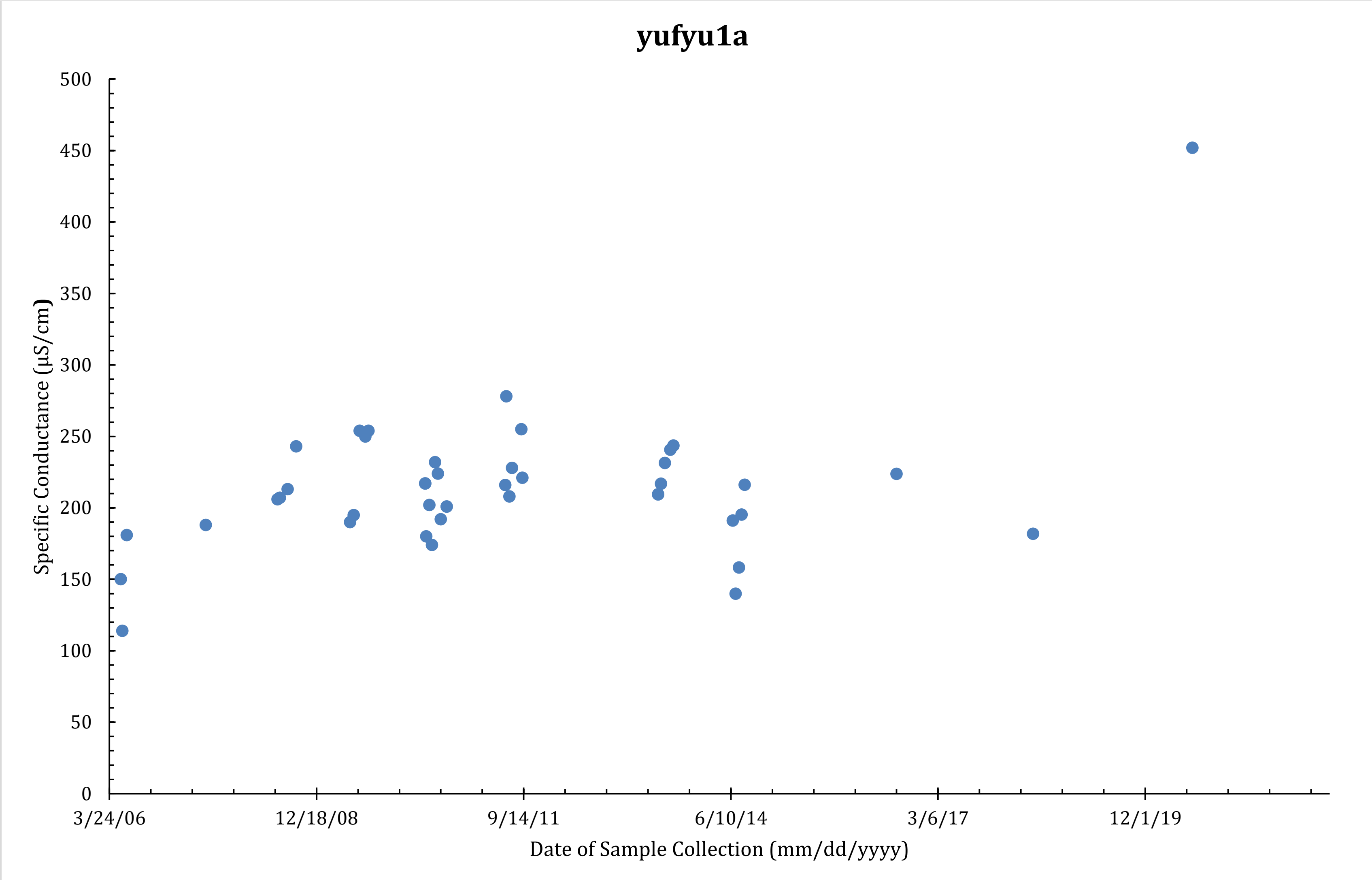

yufyu1a
Dissolved Oxygen upper guideline
Dissolved Oxygen lower guideline
Dissolved Oxygen (mg/L)
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
6/28/03
12/14/05
6/1/08
11/18/10
5/6/13
10/23/15
4/10/18
9/26/20
Date of Sample Collection (mm/dd/yyyy)

CONDUCTANCE–POFYU1A & YUFYU1A

The following page shows the conductance measurements recorded at your sampling sites, Porcupine River upstream of Fort Yukon (pofyu1a) and Yukon River upstream of Fort Yukon (yufyu1a). The Alaska Department of Environmental Conservation does not have a guideline for conductance. However, conductance is a very important parameter. Recall that when the conductance goes up or down, it is telling us something about the amount of dissolved solids in the water. The conductance at the pofyu1a sampling site has an average value of 189 µS/cm. The conductance at yufyu1a sampling site has an average value of 214 µS/cm.

The rivers of the Yukon River Watershed are typically covered with ice from mid-to-late October until mid-to-late May. During this period, there is less flow in the river because snow and ice are not melting, rain is not falling and flowing across the surface, etc. However, groundwater continues to seep into the river under the ice. The contribution of groundwater to the river is called "base flow." Groundwater is typically more concentrated than surface water, generally having a greater conductance and more total dissolved solids. So we expect winter samples, in general, to have a greater conductance and more total dissolved solids than summer samples.


pofyu1a
Specific Conductance (µS/cm)
400
350
300
250
200
150
100
50
0
12/24/65
6/16/71
12/6/76
5/29/82
11/19/87
5/11/93
11/1/98
4/23/04
10/14/09
4/6/15
9/26/20
Date of Sample Collection (mm/dd/yyyy)

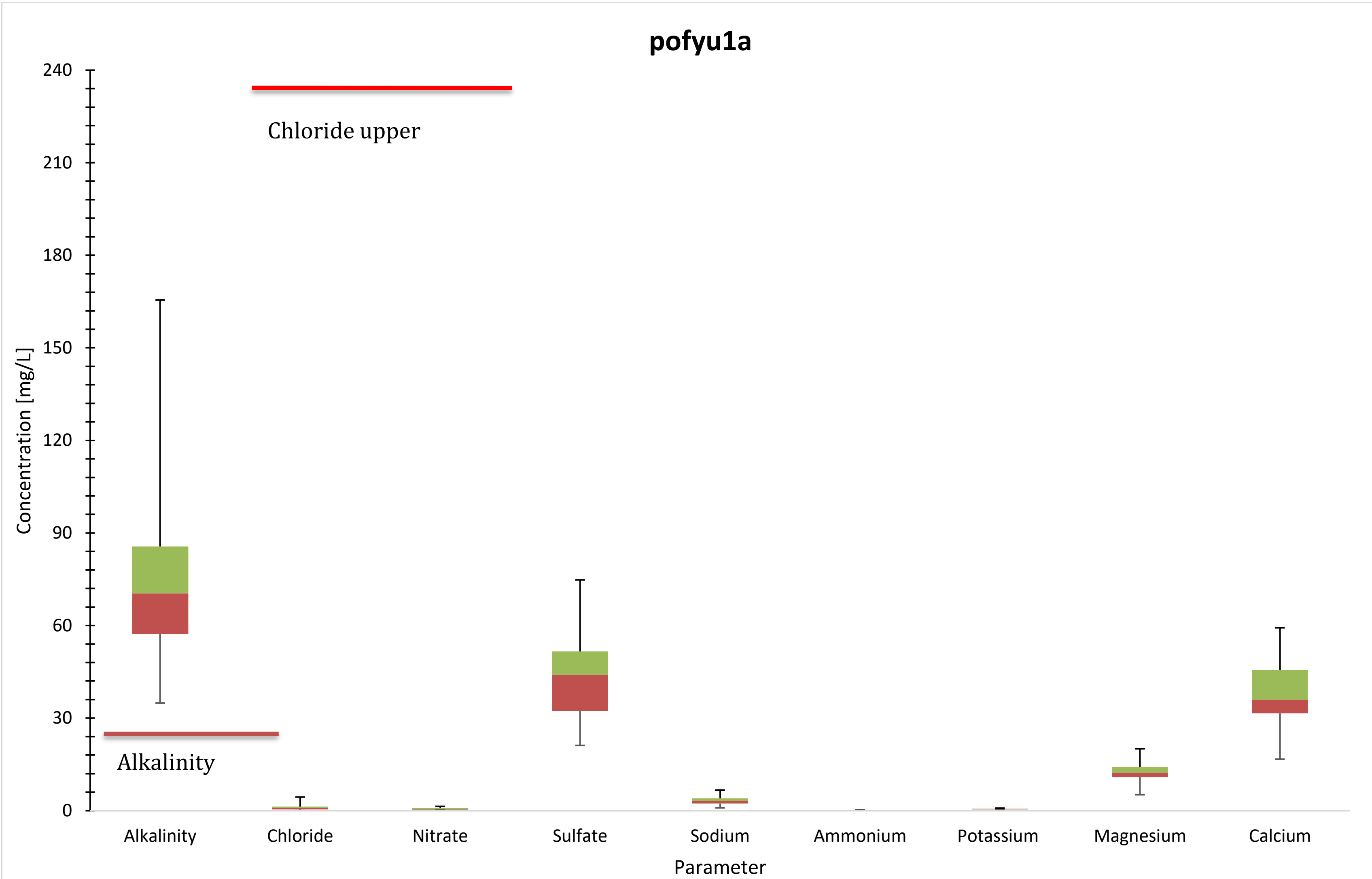

yufyu1a
Specific Conductance (µS/cm)
0
50
100
150
200
250
300
350
400
450
500
3/24/06
12/18/08
9/14/11
6/10/14
3/6/17
12/1/19
Date of Sample Collection (mm/dd/yyyy)

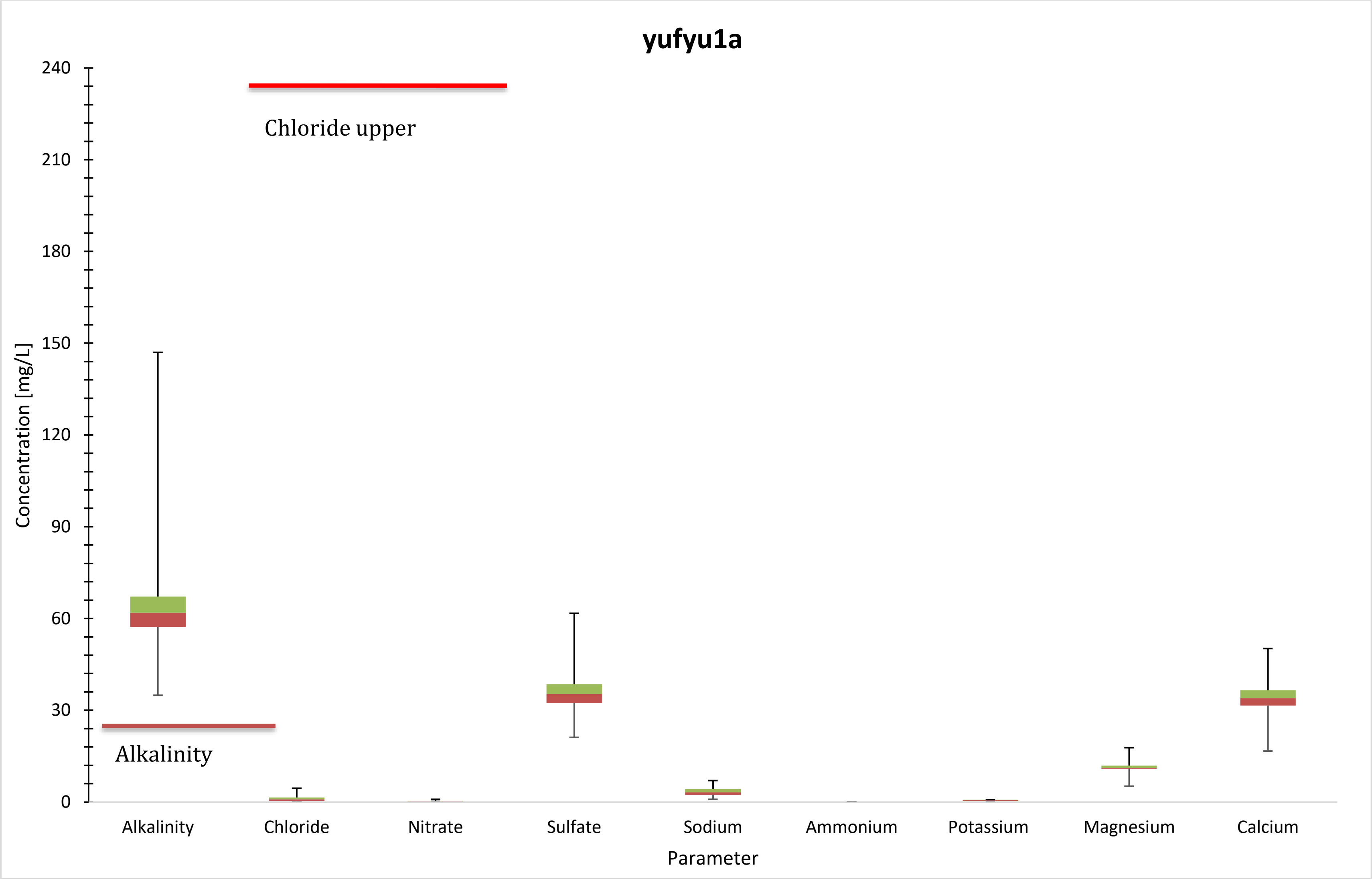
ANIONS AND CATIONS - POFYU1A & YUFYU1A

The following page shows a box and whisker diagram for all of the ions (anions and cations) analyzed in samples taken at your sampling sites. The diagram shows that alkalinity is abundant in your samples. There are also significant concentrations of calcium and sulphate in your samples. There are relatively small concentrations of magnesium and sodium in your samples and only "trace" (very small) concentrations of potassium, nitrate, and ammonium.

Since the most abundant anion is alkalinity (in the form of bicarbonate) and the most abundant cation is calcium, we can classify your water as "bicarbonate-calcium-type" water. Most water samples from healthy, natural river systems around the world are "bicarbonate-calcium-type" water.

You will notice that all of your samples are above the lower guideline for alkalinity and below the upper guideline for chloride. Based on these data, there are no indications of impacts to the habitat that our river provides to so many organisms. The following pages show us a more detailed view of the measurements of alkalinity and chloride concentrations made over time.

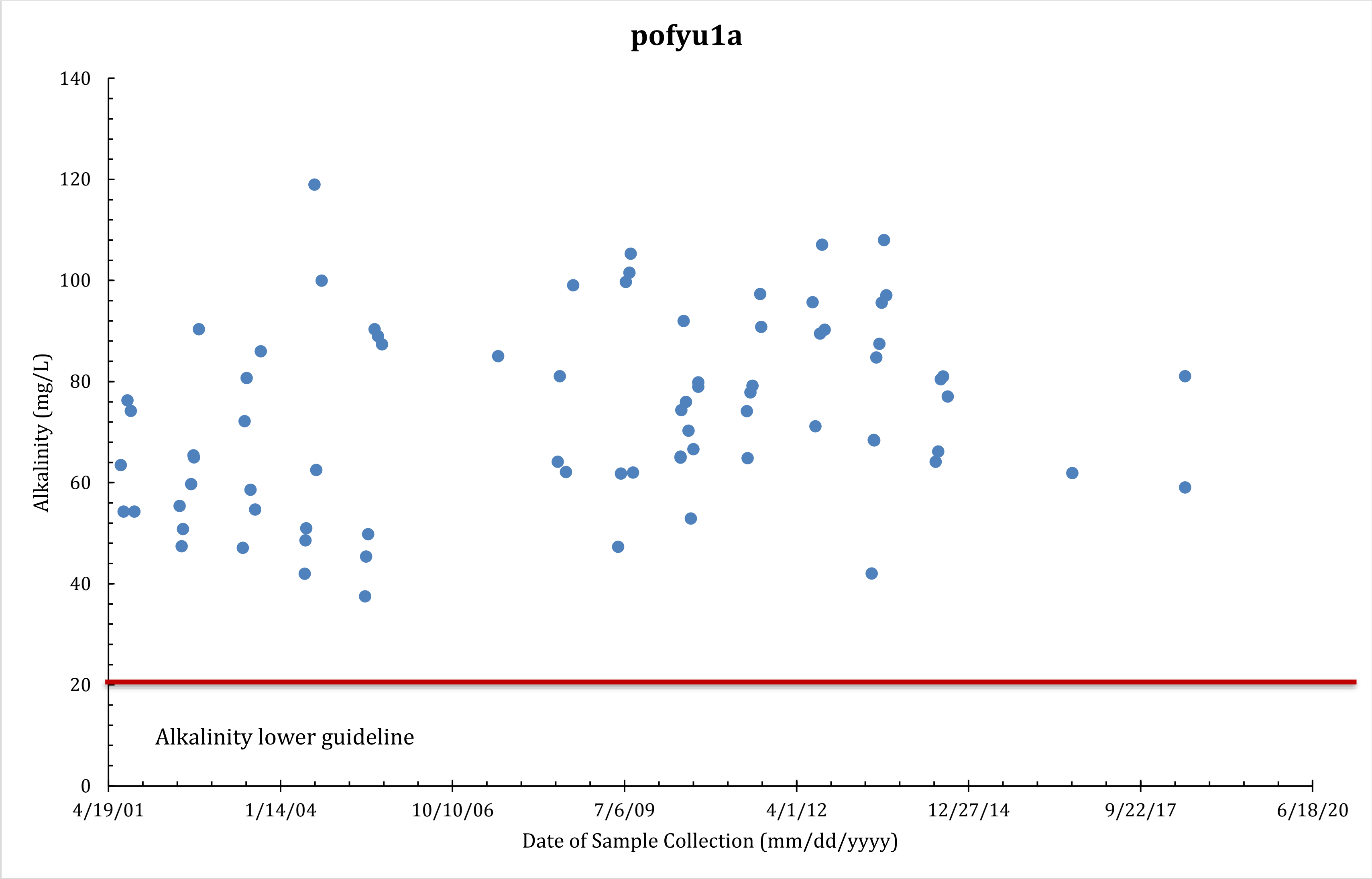

pofyu1a
Chloride upper
Alkalinity
Concentration [mg/L]
240
210
180
150
120
90
60
30
0
Alkalinity
Chloride
Nitrate
Sulfate
Sodium
Ammonium
Potassium
Magnesium
Calcium
Parameter

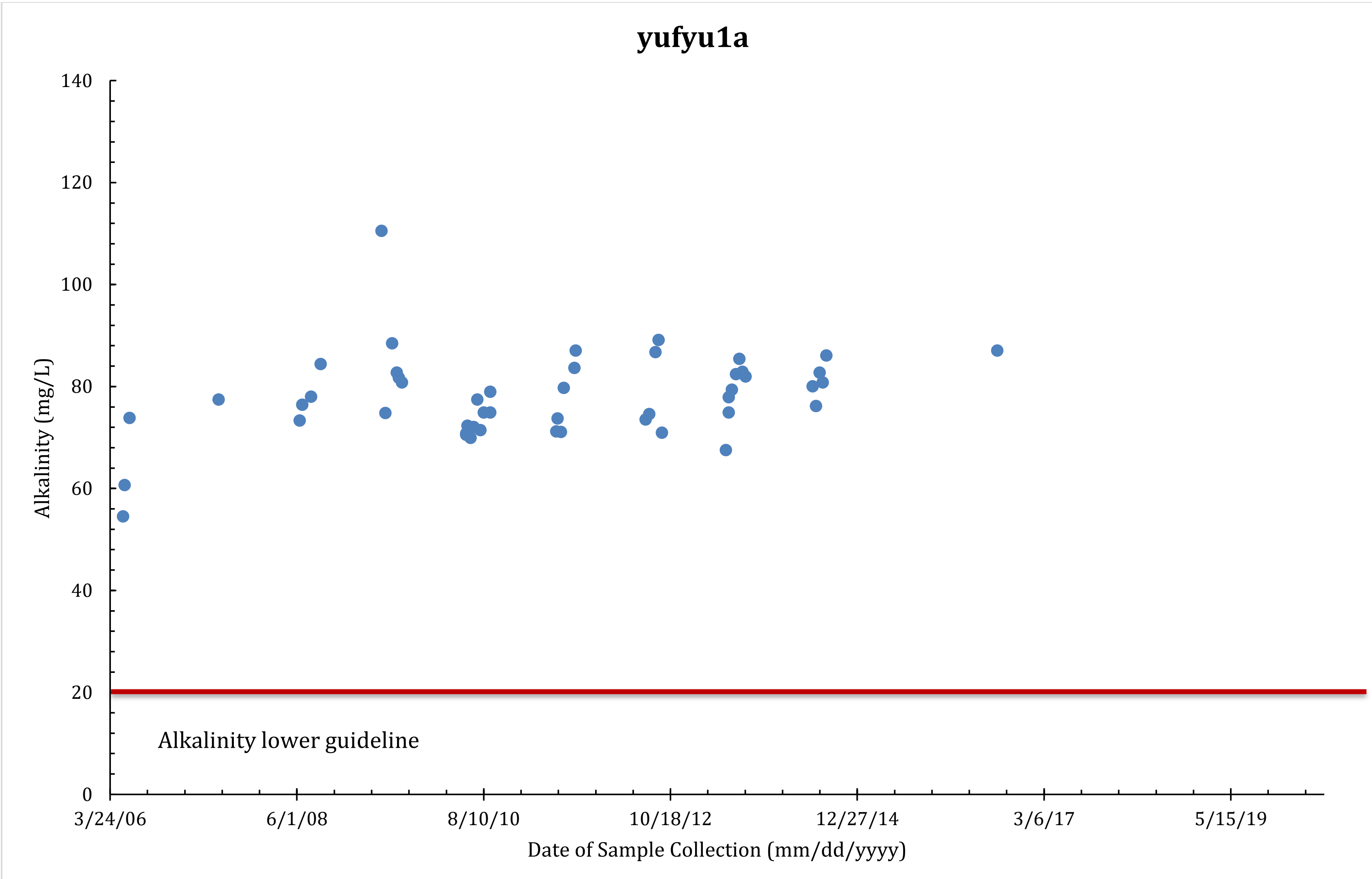


yufyu1a
Chloride upper
Alkalinity
Concentration [mg/L]
240
210
180
150
120
90
60
30
0
Alkalinity
Chloride
Nitrate
Sulfate
Sodium
Ammonium
Potassium
Magnesium
Calcium
Parameter

ALKALINITY- POFYU1A & YUFYU1A

The following page shows the alkalinity measurements recorded at your sampling sites, Porcupine River upstream of Fort Yukon (pofyu1a) and Yukon River upstream of Fort Yukon (yufyu1a). The Alaska Department of Environmental Conservation states that chronic alkalinity should not fall below 20 mg/L (as $CaCO_3$; except where natural alkalinity is lower) for the protection of aquatic life in fresh water (AK-DEC, 2008). All of your samples collected at pofyu1a are above this lower guideline; in fact, alkalinity in these samples has an average value of 73.45 mg/L. All of your samples collected at yufyu1a are above this lower guideline; in fact, alkalinity in these samples has an average value of 77.92 mg/L and is not trending upwards or downwards in a significant way.

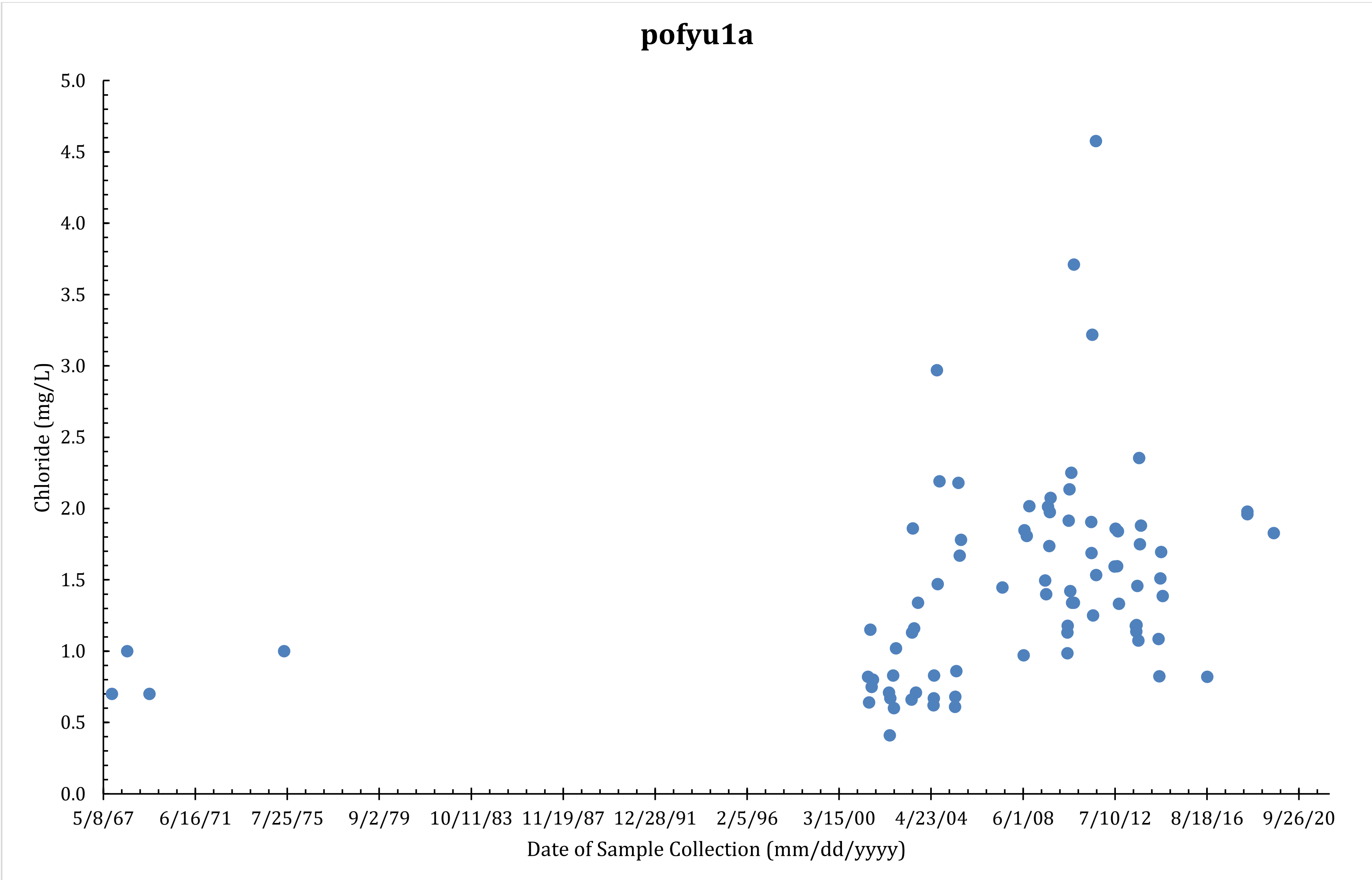

pofyu1a
140
120
100
80
60
40
20
0
Alkalinity (mg/L)
Alkalinity lower guideline
4/19/01
1/14/04
10/10/06
7/6/09
4/1/12
12/27/14
9/22/17
6/18/20
Date of Sample Collection (mm/dd/yyyy)


yufyu1a
140
120
100
80
60
40
20
0
Alkalinity (mg/L)
Alkalinity lower guideline
3/24/06
6/1/08
8/10/10
10/18/12
12/27/14
3/6/17
5/15/19
Date of Sample Collection (mm/dd/yyyy)

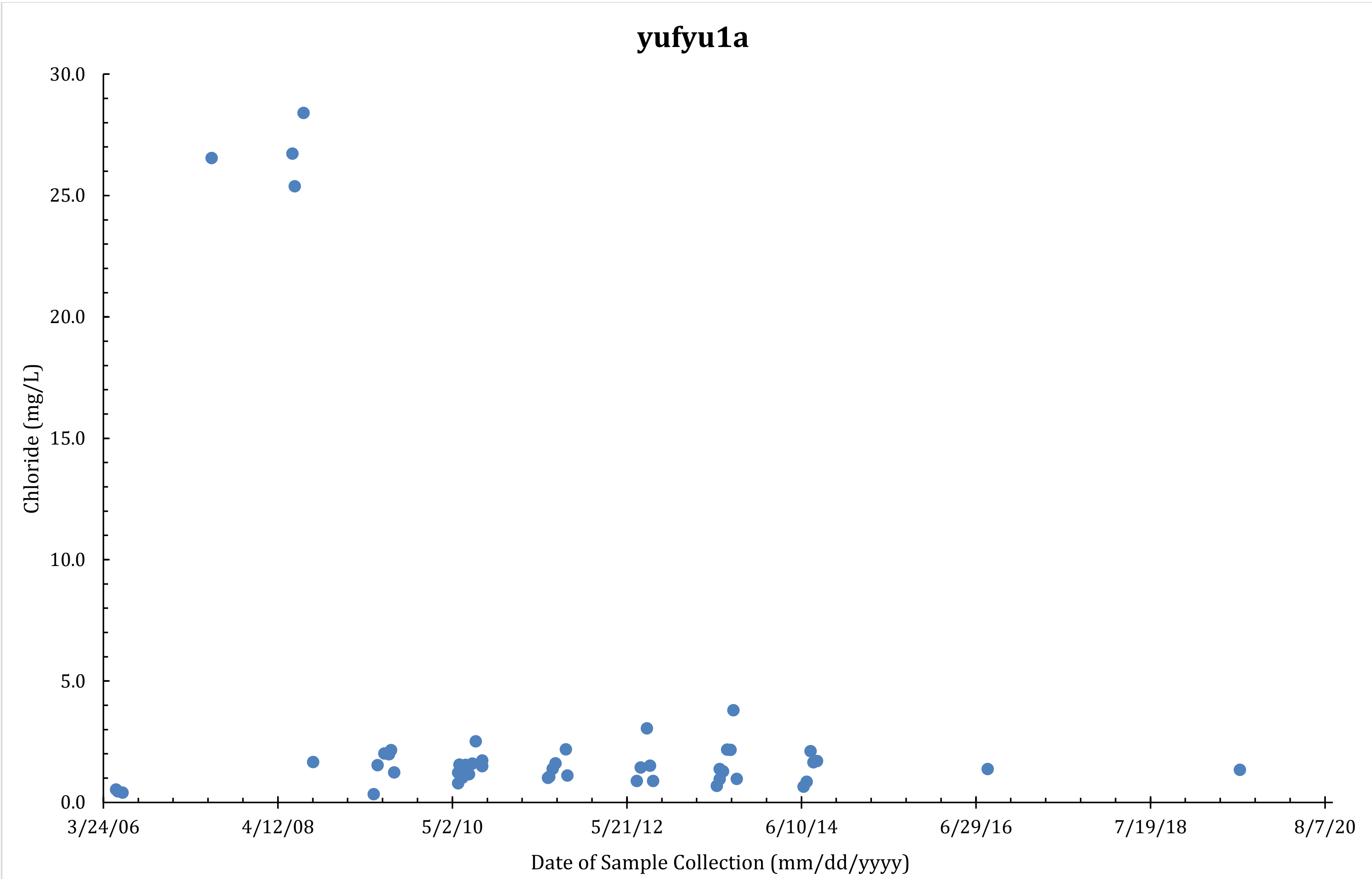
CHLORIDE- POFYU1A & YUFYU1A

The following page shows the chloride measurements recorded at your sampling sites, Porcupine River upstream of Fort Yukon (pofyu1a) and Yukon River upstream of Fort Yukon (yufyu1a). The Alaska Department of Environmental Conservation states that chronic chloride concentrations should not exceed 230 mg/L for the protection of aquatic life in freshwater (AK-DEC, 2008). All of your samples are far below this upper guideline; in fact, chloride concentrations in your samples from pofyu1a have an average value of 1.45 mg/L and those from yufyu1a have an average value of 3.46 mg/L.

There are a couple samples from yufyu1a, collected in 2008, that have higher concentrations than all of the other samples. Do you see them? It is still well below the upper guideline and therefore did not pose any risk for your community.



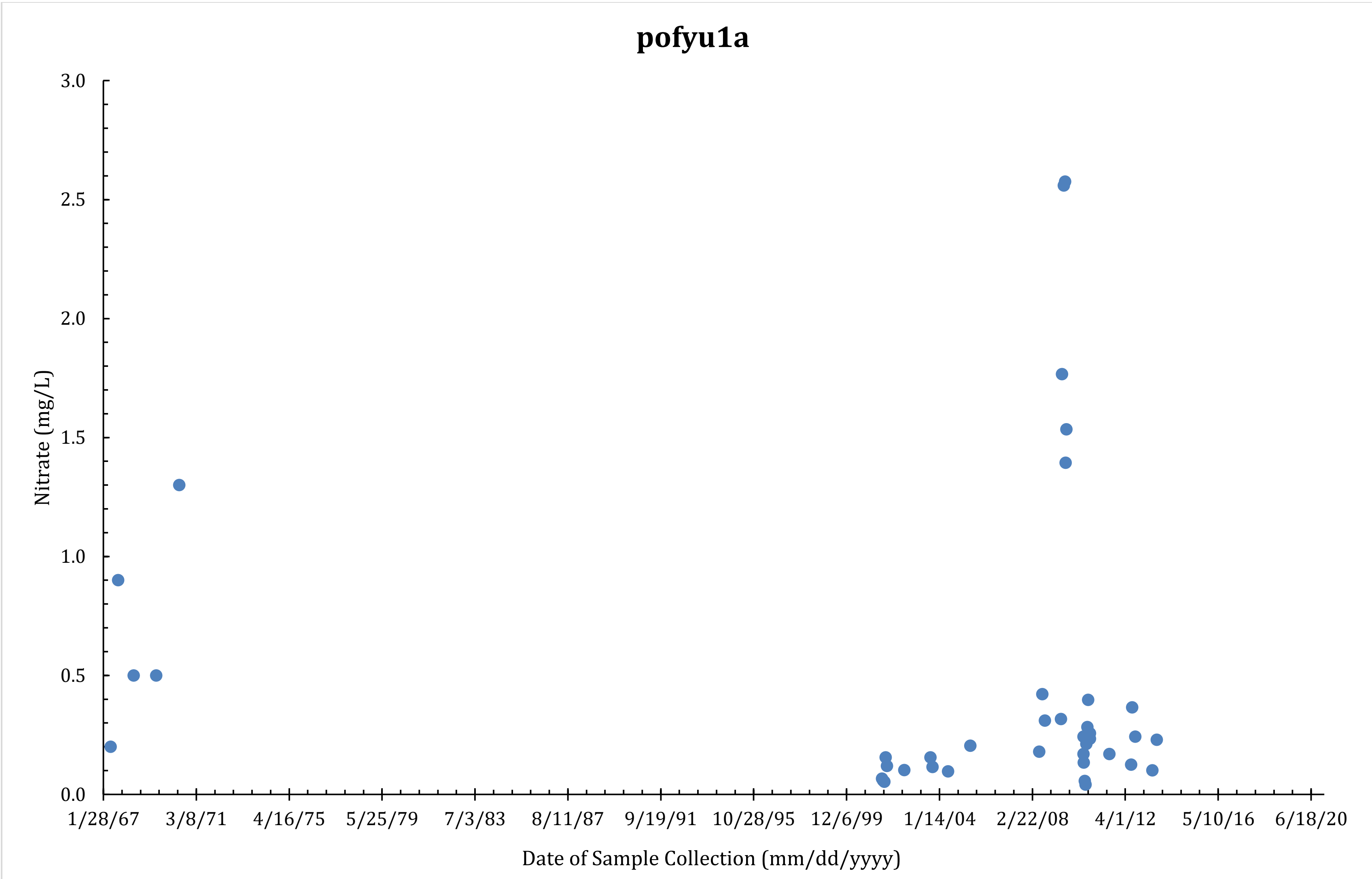
pofyu1a
Chloride (mg/L)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
5/8/67
6/16/71
7/25/75
9/2/79
10/11/83
11/19/87
12/28/91
2/5/96
3/15/00
4/23/04
6/1/08
7/10/12
8/18/16
9/26/20
Date of Sample Collection (mm/dd/yyyy)

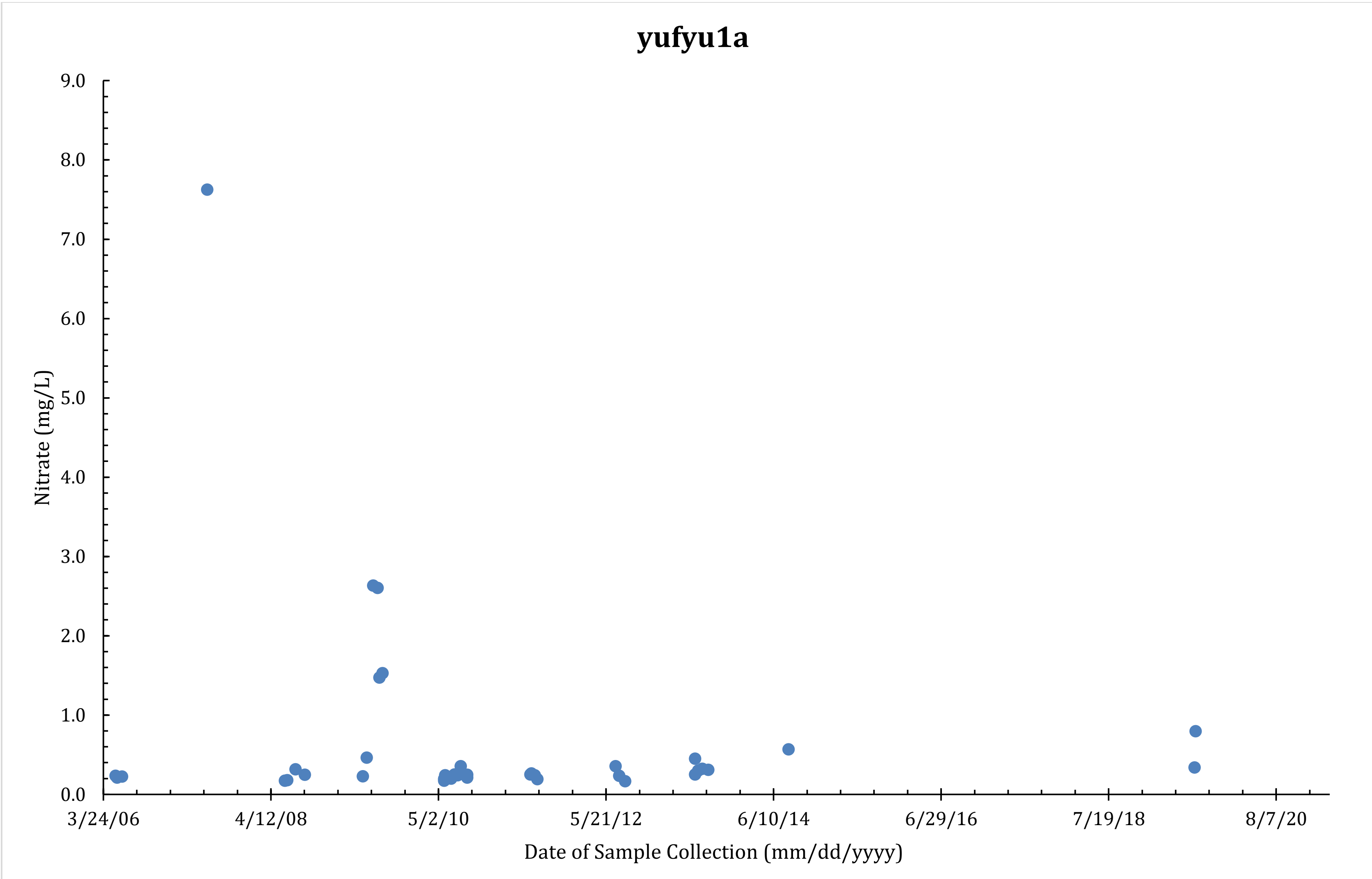

yufyu1a
Chloride (mg/L)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
3/24/06
4/12/08
5/2/10
5/21/12
6/10/14
6/29/16
7/19/18
8/7/20
Date of Sample Collection (mm/dd/yyyy)

NITRATE- POFYU1A & YUFYU1A

The following page shows the nitrate measurements recorded at your sampling sites, Porcupine River upstream of Fort Yukon (pofyu1a) and Yukon River upstream of Fort Yukon (yufyu1a). The Alaska Department of Environmental Conservation does not have a guideline for nitrate. Nitrate concentrations in your samples from pofyu1a a have an average value of 0.47 mg/L and those from yufyu1a have an average value of 0.65 mg/L.

Several of the samples collected in 2009 have slightly higher concentrations than the others. Do you see them? They are relatively low concentrations and therefore did not pose any risk for your community. There is also one sample from 2007 taken at yufyu1a that is higher than all others. We are in the process to interpreted nitrate concentrations levels across the watershed to determine, if the elevated concentrations are associated with major wildfire events or potentially outliners due to sampling or analysis error.


pofyu1a
Nitrate (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/28/67
3/8/71
4/16/75
5/25/79
7/3/83
8/11/87
9/19/91
10/28/95
12/6/99
1/14/04
2/22/08
4/1/12
5/10/16
6/18/20
Date of Sample Collection (mm/dd/yyyy)


yufyu1a
Nitrate (mg/L)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
3/24/06
4/12/08
5/2/10
5/21/12
6/10/14
6/29/16
7/19/18
8/7/20
Date of Sample Collection (mm/dd/yyyy)

OTHER PARAMETERS

There are several other parameters (including dissolved organic carbon, stable water isotopes, and greenhouse gases) that we have analyzed in your water samples. These parameters are best interpreted across the whole Yukon River Watershed instead of looking at them on a site-by-site basis. We are currently working on a watershed-wide report that will include graphs and interpretations of this data. Please contact us for further information!

FREQUENTLY ASKED QUESTIONS

HOW CAN WE USE THESE DATA?

"Baseline conditions" are terms used to refer to what water is like in its current state. The data you collect are baseline data, which help us determine the present conditions of the river.

Much like getting to know someone, it takes time to understand the natural fluctuations of a river. When you spend time with another person and become their friend, you can tell how they are feeling and see when they are sick or sad or angry. When you spend time getting to know the river, you can also tell when it's changing in a way that's not natural. This understanding of the river's cycle is critical for identifying changes that could be harmful or unhealthy.

Collecting baseline data is a long process because the river does have a way of changing naturally over time. (We all know that every year is a little different in terms of break-up and freeze-up dates, flooding, storms, etc.) It is critical that we continue to sample the river every year so that we can understand these natural variations and then determine if and how other processes such as climate change and industrial development might be affecting the water quality as well. It is this data, collected over a long time, which helps us to definitively identify water quality problems and decide how to fix them.

This information can be incredibly useful in a number of different ways:

- **To monitor the impacts of climate change. We can look to see if the water quality is changing in a way that is significant and linked to climate change.**
- **To ensure healthy habitat for fish and other organisms. We can review the water quality and compare the data to standards and guidelines for aquatic life.**
- **To protect our water quality from industrial or other forms of development. If any developments are planned upstream of a sampling location, we can use the baseline data to show what your water quality is like naturally. Then, we can assert our water rights to ensure that the natural water quality is not impacted. Baseline data are powerful!**

WHY DOES THE WATER QUALITY CHANGE OVER THE COURSE OF THE SUMMER?

Water quality is complicated and depends on many different factors. However, one of the most important factors is how much water is flowing in the river, which we call "discharge." We can't really understand water quality without understanding water quantity! The amount of water in the river can greatly affect the habitat of fish and aquatic life and can potentially dilute wastes and contaminants in the river. Discharge can change a lot over the course of the summer, depending on your sampling location.

All of the sampling sites in the Yukon River Watershed have periods of low flow in the winter when the rivers are locked under a layer of ice. However, the patterns of discharge in the summer can vary greatly depending on location. For example, a site located downstream of a melting glacier will behave differently than a site located downstream of a lake. These patterns of summer discharge will affect the water quality data that we record during the course of the summer field season.

WHY DO THE WINTER DATA LOOK DIFFERENT THAN THE SUMMER DATA?

Good eye! Summer (open-water) and winter (under-ice) water quality is often very different. Lots of people and communities have known this for years. Traditional knowledge about water quality has led many communities to a practice of drinking river water collected through holes in the ice in the winter but rarely drinking river water in the summer.

The rivers of the Yukon River Watershed are typically covered with ice from mid-to-late October until mid-to-late May. During this period, there is less flow in the river because snow and ice are not melting, rain is not falling and flowing across the surface, etc. However, groundwater continues to seep into the river under the ice. The contribution of groundwater to the river is called "base flow." Groundwater is typically more concentrated than surface water, generally having a greater conductance and more total dissolved solids. So we expect winter samples, in general, to have a greater conductance and more total dissolved solids than summer samples.

When the rivers are covered with ice the flowing water is no longer in contact with the air. It is more difficult for the water to dissolve oxygen from the air with a barrier of ice above it. So we expect winter samples, in general, to have lower readings of dissolved oxygen compared to summer samples.

IS OUR WATER CONTAMINATED?

The first thing that we should note is that the ION project is not monitoring drinking water. We are working to understand the background (natural) water quality of the Yukon River and its important tributaries. We are not testing all of the important parameters (such as Giardia—more commonly known as "beaver fever"—and E. coli) that a community needs to test in order to assess its drinking water supply. However, we are analyzing various parameters that are potential contaminants (such as nitrate) and indicators of contamination (such as chloride, sulfate, and sodium).

When <u>any</u> of the parameters we analyze exceeds a national regulation or guideline, *or* if <u>any</u> of the parameters we analyze suggests to us that some form of contamination has occurred, we will report this to you.

If you have other, specific concerns about contamination of the water in your community, please bring them to our attention! The YRIWTC would be happy to assist you in seeking funds to address your specific concerns.

IS CLIMATE CHANGE AFFECTING OUR WATER QUALITY?

This is a complicated question but a very important one! Based on the data collected so far, climate change may be affecting the water quality of the Yukon River Watershed but more research is needed. The climate is warming and warmer air temperatures can cause the permafrost to degrade. Permafrost is ground that is frozen for two or more years. The active layer is the top layer of soil above the permafrost thaws during summer and freezes during winter. The YRITWC monitors changes in the thickness of the active layer through our "Active Layer Network" (ALN), which has a site in <u>your</u> community! Changes in the thickness of the active layer can change the water quality, quantity and timing of water flowing in our rivers. Your work is helping us understand how climate change is affecting the water quality of the Yukon River Watershed.

WHAT ELSE CAN WE DO TO PROTECT OUR WATER QUALITY?

There are many things you can do to protect your water quality!

One of the most important actions a community can take is to consistently monitor their water. In order to protect our water quality, we need to know the "baseline conditions," which simply means what the water is like naturally. Since the natural water quality can vary over time, it is critical that we sample regularly over a long time period. <u>One</u> sample doesn't provide us with very much information. <u>Many</u> samples can allow us to

identify sudden or significant changes, which might be the result of climate change, contamination or other processes

Other actions you can take to protect your water quality range from daily individual actions such as not littering or long-term community projects like integrated watershed management planning. Here is a list of things that you and your community can do:

- **Make sure your sewage facility is up to current standards and isn't at risk of flooding.**
- **Keep your landfill contained. Several things you can do; make sure your landfill isn't so close to the river that run-off and flooding are risks; that it is lined and fenced; and that hazardous waste such as car/snow machine batteries are properly disposed of.**
- **Report any development and environmental change happening around you. Let us know if there is a site (a mine, for example) that concerns you and we will work with you to continue monitoring and protecting your water quality. We are also beginning a new project that focuses on recording local knowledge. We want to know what sort of environmental changes you and your community have been seeing over the years. We would love to hear what you have to say and would also like your involvement in shaping this project. Your participation will help us understand the dynamic nature of your water quality and how we can all work together to protect it.**
- **Support us with seeking funding and take your water quality testing to the next level! Additional funding could help us begin testing for more than just the basic water quality parameters. In the future we would love to help you test for specific contaminants, heavy metals, and drinking water quality in your communities.**
- **As development pressures continue to influence many of our communities, we should think about documenting sufficient water quantity for drinking, fish habitat, spiritual, or other important uses. Essentially, this would mean to measure 'baseline conditions" for water quantity within these important water sources for communities.**

Again, the YRITWC Science Department is happy to work with you and welcomes the opportunity to partner with your community on protecting our watershed!

References

Alaska Department of Environmental Conservation (AK-DEC), 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (Amended through December 12 2008). Accessed online: September 2020.

Alaska Department of Environmental Conservation (AK-DEC), 2020. Water Quality Standards (Amended as of March 2020) Accessed online: September 2020.

APPENDIX

DATA FOR POFYU1A- PORCUPINE RIVER NEAR FORT YUKON

POFYU1A - FIELD PARAMETERS AND LABORATORY PH

Sample ID	Date	Water Temperature (C)	Field pH	Specific Conductance (µS/cm)	DO (mg/L)	Lab pH
USGS	7/20/66		8.1	179		
USGS	5/24/67	2.0		106		
USGS	5/24/67	2.0	7.1	106		
USGS	7/7/67	13.0		133		
USGS	8/15/67	9.5		167		
USGS	9/23/67	1.0	7.2	141		
USGS	5/31/68	4.0	7.1	100		
USGS	4/28/69	0.0	8.2	363		
USGS	5/28/69	5.5	7.2	138		
USGS	8/8/69	8.0		146		
USGS	3/7/70	0.0		182		
USGS	6/6/70	7.5	7.2	96		
USGS	6/6/70	7.5				
USGS	7/14/70	13.0		148		
USGS	8/14/70	14.0		218		
USGS	9/19/70	3.0				
USGS	6/24/71	19.0		155		
USGS	8/11/71	8.5		172		
USGS	10/5/71	0.5		175		
USGS	4/12/72	0.0		390		
USGS	10/4/74	0.0	7.3	180		
USGS	4/23/75	0.0	7.4			
USGS	5/30/75	7.0	7.4	65		
USGS	6/3/75	7.0	7.4	88		
USGS	9/25/75	3.5	7.8	155		
USGS	4/5/78	0.0	7.2	400		
USGS	6/1/78	6.5		110		
USGS	3/29/01	0.0	7.6	376	5.2	
USGS	3/29/01	0.0	7.5	377	5.2	
USGS	3/29/01	0.0	7.5	377	5.3	

USGS	3/29/01	0.0	7.5	369	5.3	
USGS	3/29/01	0.0	7.5	376	5.3	
USGS	3/29/01	0.0	7.6	376	5.2	
USGS	6/30/01	16.5	7.7	173	8.9	
USGS	6/30/01	16.5	7.2	174	8.9	
USGS	6/30/01	16.5	7.1	175	9.1	
USGS	6/30/01	16.5	7.2	174	8.8	
USGS	6/30/01	16.5	7.3	173	8.8	
USGS	6/30/01	17.0	7.3	173	8.8	
USGS	7/16/01	16.0	7.3	154	9.0	
USGS	7/16/01	16.0	7.3	154	9.0	
USGS	7/16/01	16.0	7.3	152	8.9	
USGS	7/16/01	16.0	7.3	154	9.0	
USGS	7/16/01	16.0	7.3	155	9.0	
USGS	7/16/01	16.0	7.3	155	8.9	
USGS	8/7/01	13.1	7.9	244	10.5	
USGS	8/7/01	13.2	8.0	244	10.5	
USGS	8/7/01	13.1	7.9	244	10.5	
USGS	8/7/01	13.1	7.9	244	10.6	
USGS	8/7/01	13.1	8.0	244	10.5	
USGS	8/7/01	13.1	8.0	244	10.4	
USGS	8/27/01	11.2	7.6	224	10.2	
USGS	8/27/01	11.5	7.7	223	10.2	
USGS	8/27/01	11.5	7.6	224	10.2	
USGS	8/27/01	11.5	7.6	224	10.2	
USGS	8/27/01	11.5	7.6	225	10.2	
USGS	8/27/01	11.5	7.6	225	10.3	
USGS	9/17/01	7.2	7.7	182	11.6	
USGS	9/17/01	7.0	7.7	183	11.6	
USGS	9/17/01	7.0	7.7	182	11.6	
USGS	9/17/01	7.0	7.7	183	11.6	
USGS	9/17/01	7.0	7.7	182	11.6	
USGS	9/17/01	7.0	7.7	181	11.6	
USGS	3/11/02	0.0	7.2	405	6.0	
USGS	3/11/02	0.0	7.4	382	6.1	
USGS	3/11/02	0.0	7.4	377	6.2	
USGS	3/11/02	0.0	7.6	399	6.1	
USGS	6/6/02	13.5	7.8	143	8.8	
USGS	6/6/02	13.6	7.8	140	8.8	

USGS	6/6/02	13.4	7.8	142	8.8	
USGS	6/6/02	13.3	7.8	144	8.8	
USGS	6/6/02	13.5	7.8	145	8.8	
USGS	6/6/02	13.5	7.8	145	8.8	
USGS	6/18/02	11.7	7.8	138	10.3	
USGS	6/18/02	11.7	7.8	135	10.6	
USGS	6/18/02	11.6	7.8	136	10.3	
USGS	6/18/02	11.5	7.8	138	10.3	
USGS	6/18/02	11.6	7.8	139	10.3	
USGS	6/18/02	11.7	7.8	141	10.3	
USGS	6/26/02	11.9	7.8	130	11.6	
USGS	6/26/02	12.0	7.8	125	11.2	
USGS	6/26/02	11.9	7.8	128	11.5	
USGS	6/26/02	11.9	7.8	130	11.6	
USGS	6/26/02	12.0	7.8	131	11.3	
USGS	6/26/02	12.0	7.8	132	11.6	
USGS	8/13/02	11.7	8.0	217	9.9	
USGS	8/13/02	11.7	8.1	216	9.9	
USGS	8/13/02	11.6	8.0	216	9.9	
USGS	8/13/02	11.7	8.0	217	9.9	
USGS	8/13/02	11.7	8.0	217	9.9	
USGS	8/13/02	11.7	8.0	217	10.0	
USGS	8/26/02		7.9			
USGS	8/29/02	9.9	7.7	187	10.4	
USGS	9/27/02	5.3	8.0	243	12.3	
USGS	9/27/02	5.5	8.0	242	12.4	
USGS	9/27/02	5.3	8.0	242	12.2	
USGS	9/27/02	5.3	8.0	243	12.3	
USGS	9/27/02	5.3	8.0	243	12.2	
USGS	9/27/02	5.3	8.0	243	12.3	
USGS	4/4/03	0.0	7.4	385	5.2	
USGS	4/4/03	0.0	7.4	385	5.2	
USGS	4/4/03	0.0	7.4	385	4.9	
USGS	4/4/03	0.0	7.4	385	5.0	
USGS	4/4/03	0.0	7.4	380		
USGS	4/4/03	0.0	7.4	386	5.0	
USGS	6/9/03	12.2	7.8	120	9.8	
USGS	6/9/03	12.1	7.9	115	9.9	
USGS	6/9/03	12.1	7.8	114	9.8	

USGS	6/9/03	12.1	7.8	113	9.7	
USGS	6/9/03	12.2	7.9	120	9.7	
USGS	6/9/03	12.2	7.9	120	9.8	
USGS	6/19/03		8.0	187		
USGS	7/1/03	19.5	8.2	217	7.9	
USGS	7/1/03	19.7	8.2	217	7.9	
USGS	7/1/03	19.6	8.2	217	7.9	
USGS	7/1/03	19.7	8.2	215	7.9	
USGS	7/1/03	19.5	8.2	218	7.8	
USGS	7/1/03	19.5	8.2	219	7.8	
USGS	7/23/03	16.3	7.8	188	9.5	
USGS	7/23/03	16.3	7.8	189	9.5	
USGS	7/23/03	16.1	7.8	184	9.6	
USGS	7/23/03	16.1	7.8	184	9.6	
USGS	7/23/03	16.2	7.8	184	9.6	
USGS	7/23/03	16.4	7.8	184	9.8	
USGS	8/19/03	11.6	8.0	182	9.8	
USGS	8/19/03	11.7	8.0	183	10.0	
USGS	8/19/03	11.6	8.0	183	9.8	
USGS	8/19/03	11.6	8.0	183	9.8	
USGS	8/19/03	11.6	8.0	181	9.8	
USGS	8/19/03	11.7	7.8	180	9.7	
USGS	9/22/03	1.4	8.3	230	12.8	
USGS	9/22/03	1.4	8.3	230	12.9	
USGS	9/22/03	1.4	8.3	230	12.8	
USGS	9/22/03	1.4	8.3	230	12.8	
USGS	9/22/03	1.4	8.3	230	12.7	
USGS	9/22/03	1.4	8.3	230	12.7	
USGS	4/9/04	0.0	7.4	404	5.7	
USGS	4/9/04	0.0	7.4	404	5.6	
USGS	4/9/04	0.0	7.4	404	5.7	
USGS	4/9/04	0.0	7.4	400	5.7	
USGS	4/9/04	0.0	7.4	404	5.7	
USGS	4/9/04	0.0	7.4	404	5.7	
USGS	6/2/04	10.1	7.7	107	10.8	
USGS	6/2/04	10.0	7.6	105	10.7	
USGS	6/2/04	10.0	7.6	102	10.8	
USGS	6/2/04	9.9	7.6	100	10.7	
USGS	6/2/04	10.0	7.5	98	10.7	

USGS	6/2/04	10.0	7.6	102	10.7	
USGS	6/7/04	12.7	7.6	138	10.0	
USGS	6/7/04	12.6	7.6	136	9.6	
USGS	6/7/04	12.6	7.7	131	9.4	
USGS	6/7/04	12.7	7.7	129	9.4	
USGS	6/7/04	12.8	7.7	124	9.4	
USGS	6/7/04	12.7	7.7	131	9.4	
USGS	6/11/04	13.0	7.7	139	8.8	
USGS	6/11/04	13.0	7.7	138	8.6	
USGS	6/11/04	13.0	7.7	137	8.6	
USGS	6/11/04	13.0	7.7	134	8.6	
USGS	6/11/04	13.1	7.7	133	8.6	
USGS	6/11/04	13.0	7.7	137	8.6	
USGS	7/29/04	17.4	8.2	289		
USGS	7/29/04	17.3	8.2	288		
USGS	7/29/04	17.3	8.2	289		
USGS	7/29/04	17.4	8.2	288		
USGS	7/29/04	17.4	8.3	289		
USGS	7/29/04	17.4	8.2	289		
USGS	8/9/04	15.2	7.8	223	9.8	
USGS	8/9/04	15.1	7.7	223	9.7	
USGS	8/9/04	15.4	7.7	223	9.3	
USGS	8/9/04	15.0	7.7	223	9.3	
USGS	8/9/04	15.1	7.7	222	9.2	
USGS	8/9/04	15.1	7.7	223	9.3	
USGS	9/9/04	5.6	8.1	287	11.2	
USGS	9/9/04	5.7	8.1	287	11.1	
USGS	9/9/04	5.6	8.1	288	11.1	
USGS	9/9/04	5.7	8.1	287	11.1	
USGS	9/9/04	5.7	8.1	288	11.1	
USGS	9/9/04	5.4	8.1	288	11.4	
USGS	4/6/05	0.0	7.4	403	4.6	
USGS	4/6/05	0.0	7.4	403	4.6	
USGS	4/6/05	0.0	7.4	403	4.6	
USGS	4/6/05	0.0	7.4	403	4.6	
USGS	4/6/05	0.0	7.4	403	4.6	
USGS	4/6/05	0.0	7.4	403	4.6	
USGS	4/6/05	0.0	7.4	403	4.6	
USGS	4/6/05	0.0	7.4	403	4.8	

USGS	5/19/05	6.1	7.4	100	11.2	
USGS	5/25/05	7.5	7.7	126	11.3	
USGS	5/25/05	7.5	7.7	130	11.3	
USGS	5/25/05	7.5	7.7	129	11.3	
USGS	5/25/05	7.3	7.7	126	11.3	
USGS	5/25/05	7.3	7.7	124	11.2	
USGS	5/25/05	7.5	7.6	121	11.0	
USGS	6/7/05	11.9	7.6	132	9.2	
USGS	6/7/05	12.0	7.6	133	9.3	
USGS	6/7/05	12.0	7.6	133	9.3	
USGS	6/7/05	11.8	7.6	132	9.2	
USGS	6/7/05	11.8	7.6	131	9.1	
USGS	6/7/05	11.9	7.6	132	9.2	
USGS	7/14/05	15.3	7.9	261	9.2	
USGS	7/14/05	15.3	7.8	262	9.4	
USGS	7/14/05	15.3	7.8	262	9.3	
USGS	7/14/05	15.3	7.9	261	9.2	
USGS	7/14/05	15.2	7.9	261	9.2	
USGS	7/14/05	15.2	7.9	261	9.2	
USGS	8/3/05	12.8	8.0	263	9.6	
USGS	8/3/05	12.6	8.0	263	9.7	
USGS	8/3/05	12.7	8.0	263	9.7	
USGS	8/3/05	12.8	8.0	263	9.6	
USGS	8/3/05	12.8	8.0	263	9.6	
USGS	8/3/05	12.9	8.0	263	9.6	
USGS	8/26/05	11.5	8.0	257	11.2	
USGS	8/26/05					
USGS	8/26/05	11.4	8.1	257	11.5	
USGS	8/26/05	11.4	8.0	257	11.1	
USGS	8/26/05	11.5	8.0	257	11.1	
USGS	8/26/05	11.6	8.0	257	11.2	
9220	7/2/07	19.5	8.2	218	5.0	7.9
9402	4/17/08	8.2	8.5	426		8.5
9449	6/13/08		8.2			7.9
9464	6/24/08			212		8.2
9785	7/31/08	14.5	8.1	186		8.1
9959	9/11/08	11.5	8.4	293		8.2
10195	5/29/09	12.4	8.2	105		
10211	6/15/09	16.1	8.4	155		

10327	7/14/09	19.8	8.6	335		
10389	8/3/09					8.1
10423	8/11/09	13.6	8.3	316		
10438	8/25/09	11.5	8.4	240		
10853	5/27/10	19.0	8.1	178		7.8
10856	5/27/10	18.1	8.0	172		7.9
11131	6/1/10	16.0	8.0	154		7.8
11069	6/15/10	17.0	7.8	232		7.6
11132	6/28/10	19.6	7.9	180		7.8
11282	7/13/10	17.3	8.4	208		7.5
11275	7/27/10	13.0	8.0	216		7.8
11884	8/10/10	17.6	8.5	199		7.6
11996	9/7/10	12.6	8.1	200		7.8
12012	9/7/10	12.6	8.1	200		7.7
12286	6/17/11	16.9	8.3	212		
12303	6/22/11	16.4	8.4	189	1.0	
12700	7/7/11	19.5	8.7	234		
12741	7/19/11	17.5	8.4	225		
13009	9/2/11	15.0	9.8	272		
13013	9/8/11	12.0	8.4	295		
13240	7/3/12	20.0	7.1		7.4	
13315	7/19/12	14.6	7.9		10.5	
13591	8/15/12	15.9	8.2		10.3	
13693	8/28/12	12.0	8.2		11.6	
13887	9/11/12	7.5	7.9		13.8	
13937	6/12/13	10.3		131	10.9	8.3
13953	6/24/13	19.5	7.9	198	8.8	7.3
13954	6/27/13	19.5	7.9	198	8.8	7.8
14017	7/8/13	16.6	8.0	240	9.2	7.7
14047	7/26/13	17.1	8.1	245	9.3	8.0
14110	8/9/13	19.6	8.0		8.9	8.0
14145	8/22/13	13.2	8.2	336	10.6	7.9
14165	9/5/13	9.8	8.2	217	11.8	7.6
14382	6/19/14	15.1	8.1	167	9.5	7.7
14415	7/3/14	16.4	7.8	160	9.4	7.9
14447	7/19/14	14.9	8.2	169	9.9	8.1
14496	8/1/14	14.3	8.2	174	10.8	8.0
14532	8/27/14	15.4	7.7	184	9.7	7.5
15775	8/21/16	11.9	7.7	149		7.7

16226	6/7/18	13.0	7.7	153		7.8
16228	6/7/18	16.4	7.6	126	10.0	7.7
	7/7/18	15.7	7.5			
	7/18/18	18.0				
19039	8/8/19					
19044	8/12/19	14.2	8.3			
	6/15/20	16.5	7.5			
	7/23/20					
	10/6/20	5.6	6.3			

POFYU1A - MAJOR ANIONS, ALKALINITY, AND ISOTOPES

Sample ID	Date	CL- (mg/L)	SO_4^{2-} (mg/L)	NO3- (mg/L)	Alkalinity (mg/L)	Deuterium (dD)	Oxygen-18 (d180)
USGS	5/24/67		9.48	0.20			
USGS	9/23/67	0.70	13.54	0.90			
USGS	5/31/68	1.00	3.93	0.50			
USGS	4/28/69	5.70	28.44	0.60			
USGS	5/28/69	0.70	11.11	0.50			
USGS	6/6/70			1.30			
USGS	6/3/75	1.00	6.09				
USGS	3/29/01	4.15	47.54	0.90	170.98		
USGS	6/30/01	0.82	31.15	0.07	63.49		
USGS	7/16/01	0.64	31.02	0.06	54.29		
USGS	8/7/01	1.15	60.41	0.05	76.29		
USGS	8/27/01	0.75	52.82	0.16	74.19		
USGS	9/17/01	0.80	44.97	0.12	54.29		
USGS	3/11/02	3.53	46.32	0.97	178.97		
USGS	6/6/02	0.71	20.45		55.39		
USGS	6/18/02	0.41	28.31		47.39		
USGS	6/26/02	0.67	22.89	0.10	50.79		
USGS	8/13/02	0.83	64.74		59.69		
USGS	8/26/02	0.60	41.31		65.39		
USGS	8/29/02				65.00		
USGS	9/27/02	1.02	46.86		90.39		
USGS	4/4/03	4.03	43.21	0.92	175.98		
USGS	6/9/03	0.66	17.88		47.09		
USGS	6/19/03	1.13	27.09		72.19		
USGS	7/1/03	1.86	37.11		80.69		

USGS	7/23/03	1.16	39.41		58.59		
USGS	8/19/03	0.71	43.61	0.16	54.69		
USGS	9/22/03	1.34	43.75	0.12	85.99		
USGS	4/9/04	5.15	41.31	0.96	175.98		
USGS	6/2/04	0.62	12.81	0.10	41.99		
USGS	6/7/04	0.67	17.74		48.59		
USGS	6/11/04	0.83	22.62		50.99		
USGS	7/29/04	2.97	48.22		118.98		
USGS	8/9/04	1.47	67.58		62.49		
USGS	9/9/04	2.19	64.88		99.99		
USGS	4/6/05	5.07	46.59	0.91	174.98		
USGS	5/19/05	0.61	14.90		37.49		
USGS	5/25/05	0.68	17.34	0.20	45.39		
USGS	6/7/05	0.86	22.89		49.79		
USGS	7/14/05	2.18	55.39		90.39		
USGS	8/3/05	1.67	58.37		88.99		
USGS	8/26/05	1.78	58.78		87.39		
9220	7/2/07	1.45	29.77		85.02	-167.9	-10.4
9402	4/17/08	5.92	41.65	0.75	181.46	-169.0	-21.6
9449	6/13/08	0.97	26.68	0.18	64.16	-176.9	-22.6
9464	6/24/08	1.85	29.63		81.07	-169.4	-21.7
9785	7/31/08	1.81	46.52	0.42	62.10	-163.7	-21.1
9959	9/11/08	2.02	41.77	0.31	99.04	-165.3	-20.4
10195	5/29/09	1.50	13.98	0.32	47.31	-150.5	-18.8
10211	6/15/09	1.40	22.12	1.77	61.81	-148.3	-18.6
10327	7/14/09	2.01	35.21	2.56	99.70	-154.7	-19.2
10389	8/3/09	1.74	43.11	2.58	101.54	-170.8	-21.4
10423	8/11/09	1.98	44.39	1.39	105.32	-145.8	-18.3
10438	8/25/09	2.07	49.29	1.53	61.99	-168.7	-20.9
10853	5/27/10	1.13	23.14	0.24	64.97	-175.4	-22.2
10856	5/27/10	0.99	23.03	0.17	65.15	-176.9	-22.5
11131	6/1/10	1.18	24.83	0.13	74.34	-174.9	-22.2
11069	6/15/10	1.91	35.76	0.06	91.98	-169.4	-21.4
11132	6/28/10	2.13	41.39	0.04	75.98	-165.2	-21.2
11282	7/13/10	1.42	33.17	0.21	70.27	-164.8	-20.9
11275	7/27/10	2.25	39.08	0.28	52.91	-152.5	-17.5
11884	8/10/10	1.34	29.56	0.40	66.64	-159.3	-20.6
11996	9/7/10	1.34	41.72	0.23	78.97	-160.8	-20.4
12012	9/7/10	3.71	41.93	0.26	79.85	-160.3	-20.4

12286	6/17/11	1.91	29.36		74.14		
12303	6/22/11	1.69	30.21		64.84		
12700	7/7/11	3.22	30.80		77.88	-164.2	-20.8
12741	7/19/11	1.25	39.63	0.17	79.18	-161.4	-20.6
13009	9/2/11	4.58	47.55		97.35		
13013	9/8/11	1.53	47.19		90.83	-161.8	-20.5
13240	7/3/12	1.59	44.63	0.12	95.69	-173.8	-21.8
13315	7/19/12	1.86	51.13	0.37	71.15	-168.0	-21.3
13591	8/15/12	1.60	59.47		89.48	-164.9	-20.9
13693	8/28/12	1.84	60.58		107.11	-165.8	-20.8
13887	9/11/12	1.33	68.10	0.24	90.26	-163.5	-20.9
13937	6/12/13	1.18	17.77	0.10	42.02	-181.0	-23.0
13953	6/24/13	1.14	35.81		68.45	-176.6	-22.5
13954	6/27/13	1.18	35.99		68.37	-177.2	-22.6
14017	7/8/13	1.46	43.02		84.78		
14047	7/26/13	1.07	39.51		87.47	-130.8	-8.5
14110	8/9/13	2.35	62.95		95.61	-165.2	-20.9
14145	8/22/13	1.75	68.79	0.23	107.98	-165.6	-20.9
14165	9/5/13	1.88	64.29		97.09		
14382	6/19/14	1.08	35.07		64.14	-167.1	-21.2
14415	7/3/14	0.82	33.62		66.19	-165.2	-21.1
14447	7/19/14	1.51	34.32		80.43	-161.3	-20.6
14496	8/1/14	1.70	38.84		81.00	-160.5	-20.4
14532	8/27/14	1.39	42.00		77.03	-159.0	-20.2
15775	8/21/16	0.82	39.02		61.89		
16226	6/7/18	1.98	58.11		81.07	-166.4	-21.4
16228	6/7/18	1.96	13.59		59.05	-160.7	-20.1
19039	8/8/19		130.92			-156.9	-20.6
19044	8/12/19	1.83	87.44			-155.3	-19.6

POFYU1A - MAJOR CATIONS

Sample ID	Date	NH_4^+ (mg/L)	Ca (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)
USGS	5/24/67		16.00	1.50	2.80	1.00
USGS	9/23/67		21.00	0.30	4.00	1.50
USGS	5/31/68		15.00	0.80	3.30	0.80
USGS	4/28/69		60.00	0.30	12.00	4.80

USGS	5/28/69		21.00	1.20	3.70	1.30
USGS	6/6/70		15.00	0.80	2.60	0.90
USGS	6/3/75		15.00	0.70	1.90	0.90
USGS	3/29/01	0.01	58.90	0.57	12.10	4.49
USGS	6/30/01	0.00	26.10	0.54	5.15	2.19
USGS	7/16/01	0.01	22.80	0.48	5.00	2.05
USGS	8/7/01		33.70	0.52	7.72	2.91
USGS	8/27/01		31.80	0.42	7.13	2.27
USGS	9/17/01	0.01	26.10	0.44	5.97	2.33
USGS	3/11/02		58.80	0.54	12.30	4.24
USGS	6/6/02		21.40	0.70	3.92	1.38
USGS	6/18/02		19.80	0.45	4.57	1.83
USGS	6/26/02		21.80	0.38	4.07	1.30
USGS	8/13/02		28.90	0.52	7.99	2.45
USGS	8/26/02		28.80	0.35	6.44	1.96
USGS	9/27/02		37.30	0.42	7.63	2.54
USGS	4/4/03		60.50	0.53	12.70	5.07
USGS	6/9/03		18.20	0.58	3.52	1.24
USGS	6/19/03		28.20	0.57	5.37	1.94
USGS	7/1/03		31.80	0.63	6.35	3.07
USGS	7/23/03		25.20	0.46	6.03	2.25
USGS	8/19/03		26.60	0.39	6.62	1.93
USGS	9/22/03		34.50	0.36	6.92	2.35
USGS	4/9/04		61.90	0.59	13.50	5.38
USGS	6/2/04		17.10	0.71	2.69	2.11
USGS	6/7/04		19.30	0.63	3.34	1.21
USGS	6/11/04		21.40	0.61	3.95	1.71
USGS	7/29/04		50.80	0.63	8.38	3.75
USGS	8/9/04		30.10	0.65	7.77	3.29
USGS	9/9/04		41.20	0.53	8.77	4.07
USGS	4/6/05		62.40	0.67	14.10	5.69
USGS	5/19/05		15.50	0.97	2.80	1.20
USGS	5/25/05		18.70	1.02	3.45	1.32
USGS	6/7/05		20.40	0.71	4.45	1.81
USGS	7/14/05		39.80	0.70	8.35	4.23
USGS	8/3/05		38.60	0.67	8.42	3.55
USGS	8/26/05		22.80	0.36	5.32	2.70
9220	7/2/07		38.29	0.71	5.70	2.87
9402	4/17/08	0.18	69.15	1.42	14.90	5.89

9449	6/13/08		29.34	0.53	5.44	1.74
9464	6/24/08		35.03	0.54	6.67	2.55
9785	7/31/08		28.80	1.34	6.60	3.73
9959	9/11/08		43.04	0.48	9.20	4.22
10195	5/29/09		19.77	0.93	3.07	2.70
10211	6/15/09		28.19	0.85	4.73	2.76
10327	7/14/09		41.10	0.37	7.72	3.84
10389	8/3/09		43.15	0.65	8.77	3.41
10423	8/11/09		46.56	0.70	8.60	3.88
10438	8/25/09	0.17	29.74	0.43	8.18	5.01
10853	5/27/10	0.01	26.05	0.79	5.10	2.13
10856	5/27/10	0.45	26.04	0.70	5.01	2.08
11131	6/1/10	0.10	26.89	0.78	5.10	2.25
11069	6/15/10		35.57	0.38	7.43	3.62
11132	6/28/10		30.79	0.55	7.59	4.64
11282	7/13/10	0.04	30.18	0.35	6.22	3.32
11275	7/27/10	0.08	26.46	0.39	6.51	4.14
11884	8/10/10	0.31	28.08	0.33	5.97	2.96
11996	9/7/10	0.11	35.03	0.22	7.80	3.38
12012	9/7/10	0.03	35.14	2.02	7.87	4.32
12286	6/17/11		29.19	0.58	5.83	2.28
12303	6/22/11		25.60	0.41	5.47	2.59
12700	7/7/11		29.93	1.17	5.55	2.30
12741	7/19/11		33.62	0.35	5.98	2.61
13009	9/2/11		40.06	3.77	8.73	3.12
13013	9/8/11		37.06	0.49	8.47	2.61
13240	7/3/12		40.65	0.36	8.18	2.93
13315	7/19/12		32.77	0.30	8.52	4.51
13591	8/15/12		44.76	0.41	10.24	3.49
13693	8/28/12		45.15	0.39	11.20	3.42
13887	9/11/12	0.17	44.99	0.48	10.09	4.34
13937	6/12/13	0.10	19.36	0.86	4.60	2.89
13953	6/24/13		30.29	0.65	6.53	2.90
13954	6/27/13	0.04	30.86	0.75	6.58	2.51
14017	7/8/13	0.10	37.72	0.59	7.47	3.35
14047	7/26/13		40.49	0.61	7.82	2.67
14110	8/9/13		46.48	0.74	11.11	5.34
14145	8/22/13		47.44	0.55	10.21	3.07
14165	9/5/13		44.37	0.42	10.46	4.56

14382	6/19/14	0.25	27.65	0.36	6.33	4.03
14415	7/3/14	0.09	29.03	0.40	6.27	2.64
14447	7/19/14		38.66	0.29	8.36	4.16
14496	8/1/14		38.37	0.27	8.44	3.93
14532	8/27/14	0.09	39.38	0.50	9.41	3.38
15775	8/21/16	0.06	29.47	0.32	8.08	3.36
16226	6/7/18		26.00	0.30	6.60	3.60
16228	6/7/18	0.06	20.00	1.30	5.90	2.10

POFYU1A - GREENHOUSE GAS & DISSOLVED CARBON

Sample ID	Date	CO_2 (pCO2) ppmv	CH4 (pCH4) ppmv	DIC (µmoles/L)	UV Absorbance (254 nm)	DOC (mg/L C)	SUVA [L/(mg carbon * m)]
USGS	3/29/01				0.047	1.9	2.5
USGS	6/30/01				0.377	10.8	3.5
USGS	7/16/01					13.4	
USGS	8/7/01				0.185	6.0	3.1
USGS	8/27/01				0.237	6.8	3.5
USGS	9/17/01				0.451	12.2	3.7
USGS	9/17/01				0.451	12.2	3.7
USGS	9/17/01				0.451	12.2	3.7
USGS	3/11/02				0.046	2.0	2.3
USGS	6/6/02				0.302	8.2	3.7
USGS	6/18/02				0.478		
USGS	6/26/02				0.504		
USGS	8/13/02				0.222	7.7	2.9
USGS	8/26/02				0.366		
USGS	9/27/02				0.271	8.8	3.1
USGS	4/4/03				0.042	1.7	2.5
USGS	6/9/03				0.357	9.4	3.8
USGS	6/19/03				0.268	7.8	3.4
USGS	7/1/03					8.6	
USGS	7/23/03				0.403	12.0	3.4
USGS	8/19/03				0.305	8.7	3.5
USGS	9/22/03				0.278	9.1	3.1
USGS	4/9/04				0.040	1.8	2.3
USGS	6/2/04				0.551	16.3	3.4
USGS	6/7/04				0.363	10.9	3.3

USGS	6/11/04				0.366	13.1	2.8
USGS	7/29/04				0.079	3.1	2.5
USGS	8/9/04				0.209	5.8	3.6
USGS	9/9/04				0.126	4.4	2.9
USGS	4/6/05				0.040	1.3	3.1
USGS	5/19/05				0.653	17.5	3.7
USGS	5/25/05				0.544	15.2	3.6
USGS	6/7/05				0.534	14.3	3.7
USGS	7/14/05				0.187	6.2	3
USGS	8/3/05				0.173	5.8	3
USGS	8/26/05				0.238	7.6	3.1
9220	7/2/07	2744	4.2	2021	0.232	8.0	2.9
9402	4/17/08	2209	14.9	3647	0.076	3.8	2
9449	6/13/08	297	3.6	1849	0.327	9.5	3.4
9464	6/24/08	1184	5.6	2084	0.262	8.6	3.1
9785	7/31/08				0.511	15.7	3.3
9959	9/11/08	803	8.8	2516	0.210	7.1	3
10195	5/29/09				0.545	15.5	3.5
10211	6/15/09				0.264	8.6	3.1
10327	7/14/09				0.167	6.2	2.7
10389	8/3/09				0.174	6.3	2.8
10423	8/11/09				0.123	5.0	2.5
10438	8/25/09				0.266	8.2	3.3
10853	5/27/10				0.348	10.2	3.4
10856	5/27/10				0.334	11.0	3.0
11131	6/1/10				0.317	9.4	3.4
11069	6/15/10				0.162	6.9	2.3
11132	6/28/10				0.268	8.3	3.2
11282	7/13/10				0.363	11.0	3.3
11275	7/27/10				0.560E	16.0	3.5E
11884	8/10/10				0.528	16.8	3.2
11996	9/7/10				0.405	12.8	3.2
12012	9/7/10				0.420E	14.0	3.0E
12286	6/17/11				0.328	10.6	3.1
12303	6/22/11				0.402	12.2	3.3
12700	7/7/11				0.459	13.5	3.4
12741	7/19/11				0.346	11.7	3.0
13009	9/2/11				0.278	9.7	2.9
13013	9/8/11				0.307	9.7	3.2

13240	7/3/12				0.167	6.0	2.8
13315	7/19/12				0.395E	11.9	3.3E
13591	8/15/12				0.242	8.1	3.0
13693	8/28/12				0.154	6.0	2.5
13887	9/11/12				0.200E	3.1E	6.5E
13937	6/12/13				0.739	21.6	3.4
13953	6/24/13				0.339	10.6	3.2
13954	6/27/13				0.337	10.5	3.2
14017	7/8/13				0.254	9.0	2.8
14047	7/26/13				0.293	10.0	2.9
14110	8/9/13				0.196	8.8	2.2
14145	8/22/13				0.115	4.7	2.4
14165	9/5/13				0.190E	7.2	2.7E
14382	6/19/14				0.396	11.9	3.3
14415	7/3/14				0.468	13.2	3.5
14447	7/19/14				0.339	10.3	3.3
14496	8/1/14				0.277	8.6	3.2
14532	8/27/14				0.341	10.4	3.3
15775	8/21/16				0.589	15.5	3.799
16226	6/7/18				0.237	7.8	3
16228	6/7/18				0.158	4.5	3.5
19039	8/8/19					6.5	
19044	8/12/19					6.2	

POFYU1A - TRACE METALS

Sample ID	Date	Ba (µg/L)	Cu (µg/L)	Fe (µg/L)	Mn (µg/L)	SiO_2 (mg/L)	Sr (µg/L)	Zi (µg/L)
USGS	5/24/67					2.4		
USGS	9/23/67					4.4		
USGS	5/31/68					1.5		
USGS	4/28/69					3.0		
USGS	5/28/69					2.6		
USGS	6/6/70					2.3		
USGS	6/3/75			410.0	30.0			
USGS	3/29/01	91	0.7	12.1	10.9	4.1	155	2
USGS	6/30/01	54	2.4	194.0	2.7	3.2	77	1
USGS	7/16/01	58	2.8	219.0	2.7	3.6	74	2
USGS	8/7/01	67	1.9	67.3	2.4	3.2	127	2

USGS	8/27/01	58	1.6	91.6	2.5	3.6	104	2
USGS	9/17/01	52	2.9	347.0	4.9	4.6	82	3
USGS	3/11/02	91	0.8	11.3	15.7	4.3	160	4
USGS	6/6/02	40	1.7	135.0	2.1	2.4	58	< 1.0
USGS	6/18/02	39	2.8	204.0	2.8	3.1	62	2
USGS	6/26/02	40	2.6	178.0	3.2	3.2	63	1
USGS	8/13/02	50	1.6	65.8	2.4	3.2	107	3
USGS	8/26/02	49	1.9	173.0	3.8	4.0	93	3
USGS	9/27/02	58	1.9	123.0	3.9	3.8	103	3
USGS	4/4/03	86	0.6	11.4	13.7	4.5	154	2
USGS	6/9/03	37	2.0	172.0	2.5	2.4	54	2
USGS	6/19/03	46	1.8	115.0	2.0	3.1	80	E 0.7
USGS	7/1/03	56	1.7	59.3	1.5	2.7	104	4
USGS	7/23/03	45	2.3	137.0	2.6	3.5	81	1
USGS	8/19/03	40	2.3	116.0	3.4	3.8	99	2
USGS	9/22/03	47	1.4	121.0	6.0	3.8	109	2
USGS	4/9/04	94	0.7	8.8	11.1	4.7	161	2
USGS	6/2/04	38	2.5	310.0	6.6	2.2	44	1
USGS	6/7/04	37	4.3	148.0	4.2	2.6	55	E 0.6
USGS	6/11/04	44	2.0	171.0	4.5	2.8	64	1
USGS	7/29/04	68	1.4	E 4.0	0.6	2.5	134	1
USGS	8/9/04	55	2.2	72.0	4.6	3.3	130	2
USGS	9/9/04	67	1.7	25.2	4.4	2.7	144	2
USGS	4/6/05	102	0.9	6.8	16.0	4.7	187	1
USGS	5/19/05	33	3.7	302.0	17.3	2.2	44	7
USGS	5/25/05	42	3.3	220.0	6.8	2.5	43	1
USGS	6/7/05	43	2.5	224.0	4.1	3.1	66	1
USGS	7/14/05	68	1.4	28.8	1.3	2.8	135	1
USGS	8/3/05	58	1.5	15.5	2.2	2.9	135	E 0.5
USGS	8/26/05	44	8.4	19.5	4.2	1.6	81	16
12286	6/17/11	176		223.5	5.8	3.2	71	
12303	6/22/11	172		214.4	6.5	3.1	62	
12700	7/7/11	194		197.8	11.0	4.1	70	
12741	7/19/11	176		166.0	5.8	3.7	79	
13009	9/2/11	78		82.7	5.3	3.6	96	
13013	9/8/11	67		156.3	8.2	3.5	90	
13240	7/3/12	261	2.7	19.8	3.7	2.2	135	36
13315	7/19/12	421	2.7	127.2	3.4	2.9	131	47
13591	8/15/12	122	1.9	71.7	4.6	2.8	194	47

13693	8/28/12	77	1.3	24.3	10.0	2.2	180	19
13887	9/11/12	257		46.8	4.7	3.6	133	
13937	6/12/13	212		386.9	14.7	3.0	53	
13953	6/24/13	172		166.9	16.5	3.1	84	
13954	6/27/13	60		182.0	16.9	3.2	86	
14017	7/8/13	178		55.2	1.8	3.1	103	
14047	7/26/13	59		82.8	4.2	3.8	102	
14110	8/9/13	356		20.4	4.3	3.2	153	
14145	8/22/13	61		14.6	2.0	2.8	146	
14165	9/5/13	171		41.2	6.2	3.2	139	
14382	6/19/14	320		183.8	7.0	2.9	82	
14415	7/3/14	126		215.4	5.8	3.7	80	
14447	7/19/14	325		134.8	6.4	4.0	106	
14496	8/1/14	240		133.1	5.3	4.0	106	
14532	8/27/14	65		198.5	8.2	4.2	121	
15775	8/21/16	296		408.7	13.7	5.5	92	84
16226	6/7/18	395	4.8	225.0	5.8	3.0	82	97
16228	6/7/18	101	2.9	511.0	36.0	3.8	62	24

DATA FOR YUKON RIVER NEAR FORT YUKON

YUFYU1A - FIELD DATA & LABORATORY PH

Sample ID	Date	Water Temperature (C)	pH	Specific Conductance (µS/cm)	DO (mg/L)	Lab pH
9046	5/18/06	3.8	7.5	150	13.0	7.4
9058	5/25/06	10.9	7.5	114	10.8	7.5
9075	6/15/06	16.9	7.8	181	9.5	7.8
9134	10/4/06	6.9	7.9	162	11.4	8.0
9229	7/2/07	18.3	8.1	188	6.0	8.1
9399	4/17/08	4.1	8.4	309		8.1
9451	6/13/08	15.1	8.4	206		8.0
9461	6/24/08	8.2	8.3	207		8.1
9784	7/31/08	13.1	8.3	213		8.2
9960	9/11/08	11.5	8.4	243		8.1
10200	5/29/09	15.2	8.4	190		
10210	6/15/09	16.9	8.6	195		
10326	7/14/09	19.6	8.5	254		
10380	8/3/09					7.8
10422	8/11/09	14.0	8.2	250		
10439	8/25/09	13.8	8.4	254		
10855	5/27/10	19.8	8.1	217		7.9
10859	5/27/10	19.8	8.1	217		8.0
11120	6/1/10	16.5	8.1	180		7.8
11068	6/15/10	14.4	7.7	202		7.9
11125	6/28/10	16.1		174		7.9
11278	7/13/10	16.3	8.3	232		7.8
11260	7/27/10	14.3	8.2	224		7.8
11896	8/10/10	15.3	8.5	192		7.8
11999	9/7/10	11.1	8.3	201		8.1
12000	9/7/10	11.1	8.3	201		8.0
12285	6/17/11	16.7	8.4	216		
12299	6/22/11	14.9	8.5	278		
12698	7/7/11	14.7	8.8	208		
12739	7/19/11	14.9	8.4	228		
13007	9/2/11	13.7	8.6	255		
13019	9/8/11	11.6	8.4	221		

13256	7/3/12	16.5	7.1		8.3	
13317	7/19/12	14.3	8.2		11.2	
13604	8/15/12	15.9	8.2		10.3	
13688	8/28/12	13.1	8.2		11.1	
13886	9/11/12	8.7	8.3			8.3
13941	6/12/13	12.5			10.8	7.7
13950	6/24/13	17.2	8.2	210	9.9	7.6
13960	6/24/13	17.2	8.2	210	9.9	7.6
14018	7/8/13	16.1	7.9	217	9.4	7.7
14050	7/26/13	16.4	8.1	231	9.6	7.7
14109	8/9/13	18.0	8.3		9.3	7.9
14142	8/22/13	15.1	8.1	241	10.0	8.0
14159	9/5/13	12.2	8.1	244	10.7	7.8
14380	6/19/14	15.0	8.2	191	9.9	8.0
14414	7/3/14	16.7	8.2	140	9.8	8.2
14444	7/19/14	15.3	7.8	158	9.9	8.2
14497	8/1/14	14.7	8.2	195	10.7	8.0
14536	8/16/14	16.2	7.5	216	9.6	7.9
15776	8/18/16	15.2	8.2	224		8.0
16224	6/7/18	13.3	8.3	182		
	8/25/18	11.6	8.4			
19045	8/12/19	14.6	8.4			
	6/15/20	13.6	7.7			
	7/16/20	15.9	6.7	452		
	10/6/20	5.2	7.0	205		
	10/6/20	5.2	7.0	205		

YUFYU1A - MAJOR ANIONS, ALKALINITY, & ISOTOPES

Sample ID	Date	CL- (mg/L)	SO_4^{2-} (mg/L)	NO3- (mg/L)	Alkalinity (mg/L)	Deuterium (dD)	Oxygen-18 (d18O)
9046	5/18/06	0.54	20.43	0.24	54.55	-173.3	-22.2
9058	5/25/06	0.46	21.88	0.21	60.70	-171.8	-22.1
9075	6/15/06	0.40	33.08	0.22	73.86	-163.9	-21.2
9134	10/4/06	0.60	44.57	0.25	84.72	-159.9	-20.5
9229	7/2/07	26.54	1.36	7.63	77.47	-166.2	-21.3
9399	4/17/08	26.06	0.00	0.12	62.00	-162.8	-20.9
9451	6/13/08	26.73	0.00	0.17	73.31	-166.2	-21.2
9461	6/24/08	25.38	0.00	0.18	76.42	-166.9	-21.4
9784	7/31/08	28.40	0.00	0.32	78.02	-165.2	-20.9

9960	9/11/08	1.66	0.00	0.25	84.42	-165.2	-20.2
10200	5/29/09	0.34	20.50	0.23	110.53	-157.2	-20.1
10210	6/15/09	1.54	29.24	0.46	74.82	-174.8	-21.9
10326	7/14/09	2.02	34.95	2.63	88.48	-158.7	-19.7
10380	8/3/09	1.98	35.18	2.60	82.75	-153.8	-19.7
10422	8/11/09	2.15	37.79	1.47	81.74	-163.8	-19.7
10439	8/25/09	1.24	41.29	1.53	80.80	-154.9	-19.4
10855	5/27/10	0.79	35.28	0.19	70.52	-166.3	-21.2
10859	5/27/10	1.23	36.54	0.17	70.79		
11120	6/1/10	1.56	35.65	0.24	72.31	-168.3	-21.4
11068	6/15/10	1.02	41.29	0.20	69.91	-167.8	-21.3
11125	6/28/10	1.54	37.40	0.20	72.08	-166.2	-21.3
11278	7/13/10	1.16	40.51	0.25	77.46	-167.1	-21.2
11260	7/27/10	1.60	34.95	0.24	71.47	-167.1	-21.2
11896	8/10/10	2.52	37.50	0.35	74.90	-166.2	-21.2
11999	9/7/10	1.49	41.59	0.21	78.97	-164.0	-20.9
12000	9/7/10	1.73	39.48	0.25	74.89	-165.2	-20.5
12285	6/17/11	1.02	36.92	0.25	71.21		
12299	6/22/11	1.06	35.22	0.26	73.76		
12698	7/7/11	1.38	34.47	0.24	71.11	-166.5	-21.2
12739	7/19/11	1.61	40.76	0.19	79.74		
13007	9/2/11	2.19	42.54		83.65	-165.3	-21.0
13019	9/8/11	1.11	43.65		87.07	-164.9	-21.0
13256	7/3/12	0.88	39.71	0.35	73.52	-170.5	-21.8
13317	7/19/12	1.44	40.33	0.24	74.60	-168.3	-21.5
13604	8/15/12	3.05	40.91	0.16	86.73	-167.6	-21.4
13688	8/28/12	1.51	43.15		89.14	-167.3	-21.2
13886	9/11/12	0.89	42.61		70.93	-166.4	-21.1
13941	6/12/13	0.68	29.13		67.54	-174.7	-22.5
13950	6/24/13	0.96	36.20	0.45	74.93	-171.9	-21.9
13960	6/24/13	1.37	36.17	0.25	77.89	-172.9	-21.9
14018	7/8/13	1.27	37.56	0.30	79.37	-170.4	-21.9
14050	7/26/13	2.18	38.56	0.32	82.42	-172.2	-22.1
14109	8/9/13	2.16	39.63		85.42	-171.4	-21.9
14142	8/22/13	3.80	41.48	0.31	82.92	-171.5	-22.0
14159	9/5/13	0.97	48.00		81.98	-167.1	-21.3
14380	6/19/14	0.65	26.88		80.05	-169.1	-21.4
14414	7/3/14	0.85	40.12		76.20	-168.0	-21.5
14444	7/19/14	2.12	40.90		82.74	-168.8	-21.5

14497	8/1/14	1.66	38.44		80.82	-166.5	-21.3
14536	8/16/14	1.71	43.86	0.57	86.09	-167.2	-21.2
15776	8/18/16	1.37	50.71		87.07	-164.2	-20.9
19038	8/7/19	1.34	68.72	0.34		-165.0	-21.1
19045	8/12/19		6.74	0.80		-166.5	-20.7

YUFYU1A - MAJOR CATIONS

Sample ID	Date	NH_4^+ (mg/L)	Ca (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)
9046	5/18/06		23.23	1.09	5.90	1.84
9058	5/25/06		24.59	0.90	6.23	1.73
9075	6/15/06		29.28	0.74	8.89	1.98
9134	10/4/06		35.41	0.86	10.69	2.80
9229	7/2/07		30.20	1.11	7.52	2.83
9399	4/17/08	0.15	48.13	54.13	8.54	5.82
9451	6/13/08		29.82	0.83	9.14	2.22
9461	6/24/08		30.58	4.73	8.57	2.60
9784	7/31/08		31.18	0.74	9.05	4.59
9960	9/11/08		34.45	0.87	9.82	3.29
10200	5/29/09		22.39	1.02	5.45	2.23
10210	6/15/09		28.82	0.79	8.05	6.20
10326	7/14/09		30.39	1.03	8.92	6.20
10380	8/3/09		29.94	1.40	8.34	5.43
10422	8/11/09		31.84	1.27	8.49	5.64
10439	8/25/09	0.12	32.07	1.14	9.05	4.07
10855	5/27/10	0.23	26.27	1.07	8.46	2.52
10859	5/27/10	0.35	26.11	1.49	8.13	2.70
11120	6/1/10	0.12	26.60	1.73	8.41	3.29
11068	6/15/10		26.72	0.66	8.63	3.13
11125	6/28/10	0.20	26.95	1.17	8.76	4.17
11278	7/13/10	0.09	30.47	0.97	8.78	3.51
11260	7/27/10	0.14	27.09	0.83	8.17	4.04
11896	8/10/10	0.18	29.71	1.28	7.56	5.15
11999	9/7/10	0.18	30.50	0.63	9.61	4.40
12000	9/7/10	0.06	28.97	1.37	9.07	3.81
12285	6/17/11		27.98	0.79	8.57	2.89
12299	6/22/11		27.05	0.76	7.89	2.07
12698	7/7/11		26.31	0.85	7.34	2.34

12739	7/19/11		29.20	1.11	8.13	2.30
13007	9/2/11		31.23	1.44	9.19	2.41
13019	9/8/11		33.03	1.00	9.82	2.09
13256	7/3/12		28.87	0.55	9.41	2.81
13317	7/19/12		27.70	0.46	9.17	2.80
13604	8/15/12		33.51	0.56	10.45	6.71
13688	8/28/12		33.97	0.73	10.75	3.45
13886	9/11/12	0.17	33.67	1.04	9.77	3.88
13941	6/12/13	0.07	26.93	1.15	7.68	2.54
13950	6/24/13		29.02	1.07	8.49	3.52
13960	6/24/13	0.04	29.34	1.18	8.48	3.14
14018	7/8/13	0.06	29.49	1.48	8.37	3.88
14050	7/26/13		26.61	0.93	8.33	5.61
14109	8/9/13		32.42	0.81	9.39	5.43
14142	8/22/13		27.52	0.73	8.58	7.15
14159	9/5/13		34.44	0.82	10.56	3.83
14380	6/19/14	0.23	30.46	0.55	8.87	3.46
14414	7/3/14	0.06	28.88	0.79	8.50	2.52
14444	7/19/14		38.12	1.10	10.12	4.58
14497	8/1/14		34.45	0.83	9.54	5.12
14536	8/16/14	0.04	42.20	1.05	11.58	4.84
15776	8/18/16	0.12	35.06	0.87	10.79	4.34

YUFYU1A - GREENHOUSE GAS & DISSOLVED CARBON

Sample ID	Date	CO_2 (pCO2) (ppmv)	CH4 (pCH4) (ppmv)	DIC (µmoles/L)	UV Absorbance (254 nm)	DOC (mg/L C)	SUVA [L/(mg carbon * m)]
9046	5/18/06	1496	4.1	1254	0.650	19.0	3.4
9058	5/25/06	2633	3.0	1381	0.541	16.0	3.4
9075	6/15/06	5590	3.2	1779	0.113	4.3	2.7
9134	10/4/06	1013	3.2	2030	0.085	4.0	2.1
9229	7/2/07	1334	3.2	1759	0.117	4.0	3.0
9399	4/17/08	331	48.2	2794	0.038	2.4	1.6
9451	6/13/08	1032	3.7	1978	0.154	6.1	2.5
9461	6/24/08	1919	6.3	2072	0.148	4.4	3.4
9784	7/31/08				0.229	6.7	3.4
9960	9/11/08	1193	6.7	2200	0.152	4.6	3.3
10200	5/29/09	251	3.7	1621	0.318	8.5	3.8
10210	6/15/09				0.123	5.2	2.4

10326	7/14/09				0.090	3.2	2.9
10380	8/3/09					4.1E	
10422	8/11/09				0.053	3.6	1.5
10439	8/25/09				0.086	2.6	3.4
10855	5/27/10				0.241	7.1	3.4
10859	5/27/10				0.234	7.5	3.1
11120	6/1/10				0.222	6.4	3.5
11068	6/15/10				0.171	4.8	3.6
11125	6/28/10				0.160E	5.3	3.0E
11278	7/13/10				0.145	5.2	2.8
11260	7/27/10				0.250	12.9	1.9
11896	8/10/10				0.290E	7.9	3.7E
11999	9/7/10				0.219	6.5	3.4
12000	9/7/10				0.223	7.1	3.2
12285	6/17/11				0.187	6.1	3.1
12299	6/22/11				0.204	6.0	3.4
12698	7/7/11				0.294	8.0	3.7
12739	7/19/11				0.146	5.3	2.7
13007	9/2/11				0.153	4.9	3.2
13019	9/8/11				0.117	4.5	2.6
13256	7/3/12				0.156	4.7	3.3
13317	7/19/12				0.189	6.1	3.1
13604	8/15/12				0.091	4.2	2.1
13688	8/28/12				0.080	3.2	2.5
13886	9/11/12				0.090E	4.1E	2.2E
13941	6/12/13				0.219	7.0	3.1
13950	6/24/13				0.107	3.9	2.8
13960	6/24/13				0.116	4.7	2.5
14018	7/8/13				0.102	4.5	2.3
14050	7/26/13				0.114	4.4	2.6
14109	8/9/13				0.084	4.0	2.1
14142	8/22/13				0.100E	3.9	2.8E
14159	9/5/13				0.099	3.6	2.7
14380	6/19/14				0.094	3.2	3.0
14414	7/3/14				0.159	5.1	3.1
14444	7/19/14				0.118	3.7	3.2
14497	8/1/14				0.177	5.4	3.3
14536	8/16/14				0.097	3.5	2.7
15776	8/18/16				0.141	4.8	2.9

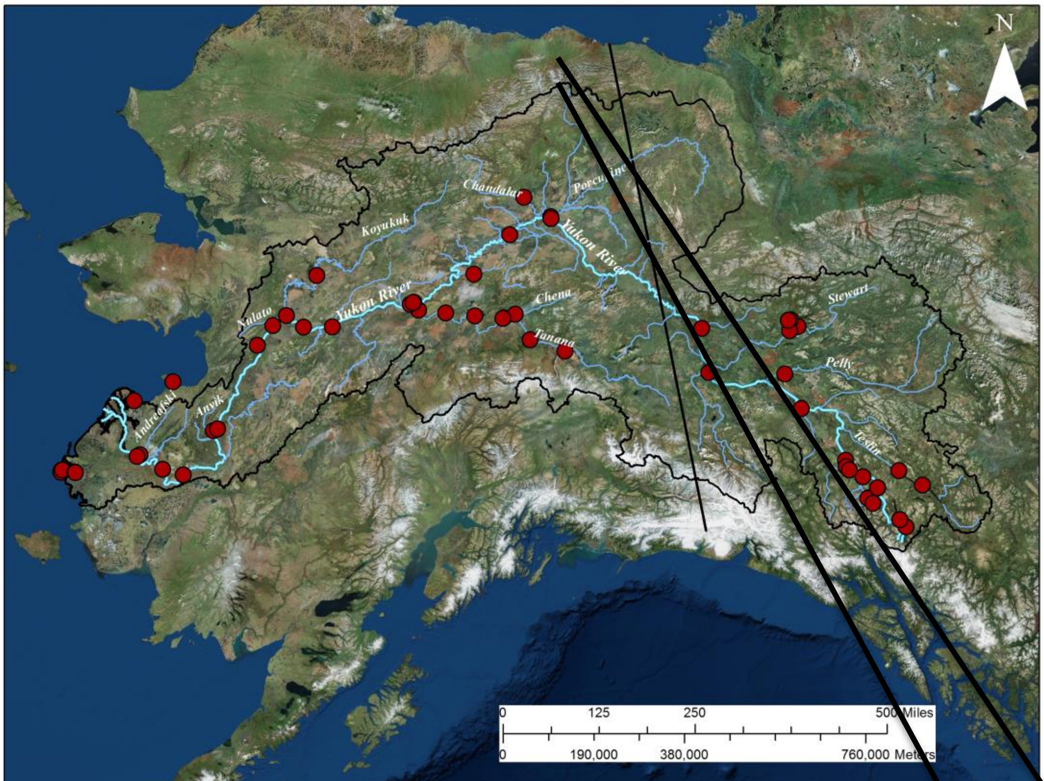
19038	8/7/19					5.2	
19045	8/12/19					5.0	

YUFYU1A - TRACE METALS

Sample ID	Date	Ba (µg/L)	Cu (µg/L)	Fe (µg/L)	Mn (µg/L)	Ni (µg/L)	SiO_2 (mg/L)	Sr (µg/L)	Zi (µg/L)
12285	6/17/11	210		143.8	6.0		6.4	136	
12299	6/22/11	196		56.5	8.3		6.3	103	
12698	7/7/11	158		83.3	6.4		6.7	97	
12739	7/19/11	88		45.7	2.8		6.4	108	
13007	9/2/11	135		31.9	5.2		6.7	118	
13019	9/8/11	64		36.0	10.5		6.8	130	
13256	7/3/12	195	3.2	45.4	4.5	<-0.17	4.9	153	47
13317	7/19/12	311	2.0	24.7	2.9	0.1	5.0	155	34
13604	8/15/12	905	1.3	10.5	1.0	<1.1	5.4	218	24
13688	8/28/12	270	0.7	7.5	5.0	<-0.17	5.0	200	32
13886	9/11/12	265		15.2	4.8		6.1	151	
13941	6/12/13	189		62.7	10.3		5.7	108	
13950	6/24/13	286		24.1	3.9		6.0	125	
13960	6/24/13	189		20.0	3.9		6.0	128	
14018	7/8/13	298		12.5	2.7		5.8	129	
14050	7/26/13	550		41.7	1.6		6.0	140	
14109	8/9/13	734		24.9	2.2		6.7	159	
14142	8/22/13	882		16.6	1.5		5.6	148	
14159	9/5/13	336		17.1	3.1		6.3	167	
14380	6/19/14	314		8.3	3.2		5.7	129	
14414	7/3/14	68		52.4	3.9		5.8	123	
14444	7/19/14	283		211.3	5.6		6.6	162	
14497	8/1/14	373		129.4	4.6		6.4	141	
14536	8/16/14	325		52.9	4.3		6.5	185	
15776	8/18/16	290		56.0	4.7	2.1	6.8	168	47

*LABORATORY DATA FROM SAMPLES COLLECTED SINCE 2014 ARE CONSIDERED PRELIMINARY AND ARE SUBJECT TO USGS QUALITY ASSURANCE AND QUALITY CONTROL APPROVAL.
<: Less than
E: ESTIMATED
NA OR BLANK: NOT MEASURED.

Location of Sampling Sites – yufyu1a & pofyu1a



Data acquired from pofyu1a is from 1967 - 2019 and includes supplemental USGS data.

Data acquired from yufyu1a is from 2006 - 2019.