Looking at the Water Quality in the Yukon River Watershed and its Effect on Subsistence Resources

Alaska State Science and Cultural Standards

Science Standards

A. Science as Inquiry and Process
SA Students develop an understanding of the processes and applications of scientific inquiry.

- **SA3** Students develop an understanding that culture, local knowledge, history, and interaction with the environment contribute to the development of scientific knowledge, and that local applications provide opportunity for understanding scientific concepts and global issues.

SF Students develop an understanding of the dynamic relationships among scientific, cultural, social, and personal perspectives.

- **SF1-3**

Cultural Standards

- **B Culturally-knowledgeable students are able to build on the knowledge and skill of the local cultural community as a foundation from which to achieve personal and academic success throughout life.**
  - **B4** Students are able to identify appropriate forms of technology and anticipate the consequences of their use for improving the quality of live in the community.
- **E Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interactions of all elements in the world around them.**
  - **E2** Students are able to understand the ecology and geography of the bioregion they inhabit.

Science Standards taken from Alaska Performance Standards, Department of Education and Early Development of the State of Alaska.

Cultural Standards taken from Alaska Standards for Culturally Responsive Schools, adopted by the Assembly of Alaska Native Educators; Anchorage, Alaska; February 3, 1998.

Looking at the Water Quality in the Yukon River Watershed and its Effect on Subsistence Resources

Grade Level: Grades 9-12

Objectives:

Students will be able to:

- To explain water quality monitoring and baseline data
- List the water quality parameters covered in the lesson such as:
  - Dissolved Oxygen
  - Temperature
  - pH
  - Conductivity
- To navigate www.fieldscope.org to explore existing water quality data on the Yukon River Watershed to see what the water quality parameters look like near their communities and how that might affect subsistence resources where they live

Resources and Materials:

- Table 1: Showing the Effects of Dissolved Oxygen on Salmon and Other Aquatic Life
- Table 2: Limiting Temperatures for Fish
- Table3: pH of Some Common Liquids
- Online resource: http://yukon.fieldscope.org/v3 or go to www.fieldscope.org – click on View Projects – scroll down and click on Yukon River Watershed

Teaching:

This curriculum is for the education of water quality monitoring, baseline data, and water quality parameters, in reference to the Yukon River Watershed. The following includes a two-part lesson, activities, and a worksheet. There are also extensions and suggestions provided to help meet the needs of varying learning environments.

Lesson:

This lesson is broken into two parts: 1) Overview of Water Quality Monitoring and Baseline Data and 2) Water Quality Parameters Tested in the Yukon River Watershed. In Part 1 students will learn about water quality monitoring, baseline data, and the monitoring that is occurring in the Yukon River Watershed. Part 1 ends with a group activity for the instructor to lead to demonstrate how baseline data works and why it is needed.

In Part 2 students will learn about the physical parameters that are being tested in the Yukon River Watershed which include Dissolved Oxygen, Temperature, pH, and Conductivity. There are additional parameters that can be taught if the instructor chooses to do so. Following the lesson, a worksheet is provided, perhaps have students take notes from the lesson to help them with answers on their worksheet. Additional activities are provided as well.

Part 1: Overview of Water Quality Monitoring & Baseline Data

Rivers are an excellent resource for taking "the pulse" or a reading of what is happening in a watershed. Measuring the chemistry of the water at any point in a river will give us the sum total of all natural processes and human activities that occur upstream. (Shuster, 2008
The first question we have to ask is, **"What is water quality monitoring?"**

According to the United States Environmental Protection Agency (EPA), water quality monitoring is the sampling and investigation of what is in the water and the conditions it is found in. These may include:

- Water quality characteristics found naturally in water, such as dissolved oxygen, bacteria, metals, and nutrients, that can be affected by human sources.
- Introduced pollutants, such as pesticides, heavy metals, hydrocarbons (petroleum and natural gas) or products of household cleaning, pharmaceutical and person hygiene.

How much these elements can affect the surrounding environment and impact subsistence resources also depends on the characteristics of the water quality, such as the pH (whether it is acidic or alkaline), the conductivity or electrical charge, and the temperature. The pH of the water can make some pollutants even more harmful or toxic. For example, the pH of the

water can cause heavy metal to be dissolved and then transported in the water. Similarly, charged elements such as polar organic compounds (household cleaning products) are soluble in the water and can become bioavailable for aquatic species. This demonstrates the importance of knowing the extent in which soluble compounds can be taken up by aquatic species and the importance of achieving to better understand their exposure to such pollutants. In addition, the characteristic of water temperature can affect how much dissolved oxygen can be contained in the water. (USEPA Volunteer Stream Monitoring Manual 1997: 125)

The next question we ask is, "**Why do we want to monitor the water?**"

The Indigenous People of the Yukon River Basin have been stewards the waters that they utilize for thousands of years. Today, the Yukon River Inter-Tribal Watershed Council (YRITWC) facilitates the integration of Indigenous knowledge and Western science to monitor water quality. Since 2006 the YRITWC and Yukon River Basin community members have partnered with the United States Geological Survey (USGS) to collect high quality data to achieve a better understanding about the water. The community members who live in the Yukon River Basin and collect water samples in the mentioned collaboration are part of the Indigenous Observation Network (ION). ION members undergo an intensive annual water quality training and then take samples from the Yukon River and its tributaries for chemical analysis. The community environmental samplers record data they retrieved about the water such as its pH, dissolved oxygen, temperature, etc. onto a data sheet and they send in the data sheet along with a sample of the water to the YRITWC main office in Anchorage, AK. The YRITWC preserves the water samples with a high concentrated acid to prevent any microbial digestion of the elements and then sends them to an USGS laboratory in Colorado. YRITWC staff document the information gathered from the data sheet onto www.fieldscope.org (a website that serves as a database is accessible to the public – students will be exploring this site later) and files the hard copy as backup. USGS completes the laboratory analysis to detect the concentration levels of the natural elements as well as anthropogenic (human caused) elements in the water. The findings are reported back to YRITWC, who then generates a water quality report with the information for each community. At last, the information of the water quality results are compared to the State of Alaska's water quality standards to evaluate if there is a concern to the waters since it is a

resource of drinking water, subsistence, recreation, and more. Knowing is available to the community members and they can make decisions if there is a concern to the waters since it is a resource of drinking water, subsistence, recreation, and much more. Knowing what is in the water and how if may affect environmental health or human livelihood is why we want to monitor the water. Wouldn't you want to know what is in the water source near your community?

To begin testing our waters for quality we need to establish baseline data for the river. So we need to answer the question, "**What is baseline data?**"
Baseline data for water quality monitoring is simply documenting the current status of the water and using that information for future monitoring efforts to be compared to. Then the trends or rate of change in the water system can be measured.

There are several things to check out and do before one tests the waters for establishing baseline data*. Ask the students what they think the steps would be for an organization or community to take before they started collecting water samples for baseline data. Feel free to write their ideas on the board. Then go over the following steps and see if the class was correct on any of their guesses:*

- **Find out what has already been done.** What information already exists about the quality of water that you would like to monitor? Does baseline data exist already?
- **Partner with existing program or start your own.** The partnership of the YRITWC, USGS, and the communities of the Yukon River Basin are an excellent example of working as a team.
- **Attend trainings.** Learn about sampling method protocols and how other water quality monitoring programs are set up.
- **Select sampling sites, the frequency of samples, and parameters to test.** The YRITWC, with partners, have over 50 established sites in the Yukon River Basin where water samples have been collected and over 30 different water quality parameters have been analyzed for data collection. Sampling sites should to selected to assure consistency in sampling frequency. For example, the USGS and YRITWC water monitoring program requires sampling to occur every 2 weeks during the open season (no ice on the river or stream) for all of their physical parameters (pH, temperature, conductivity, etc.). Parameters are discussed in more detail in Part 2.
- **Acquire supplies for sampling.** Collecting good water samples requires specialized equipment for measuring the physical parameter. To get an accurate reading, field equipment must be calibrated each time before use. Also, when

sampling for chemical parameters all equipment must be sterile and specific protocols must be followed to assure your data is accurate and of high quality.

- **Plan data storage/use.** Have a plan on what to do with the sample data information once it has been gathered from the laboratory. Laboratory results can be sent to communities for each sample site.

The final question we ask is, "**What are we testing for in the water and why?**"

Common parameters that are tested in water quality monitoring programs include pH, temperature, dissolved oxygen, conductivity, turbidity, nitrates, heavy metals, and many more. A community or organization chooses what water quality parameters to test as what may be of interest or of concern to them. The next section of this lesson will go into more details of some of these mentioned parameters.

When monitoring the water quality in the Yukon River Watershed, anyone of interest can observe if there are changes over time in the set parameters that could potentially negatively affect human health, subsistence resources, and drinking water. Having information about the water quality can help communities make city or tribal plans if they need to adjust any activities that happen in the communities such as harmful runoff from landfills, sewage lagoons, river pollution, etc. Information gathered about the river is also beneficial to scientists who study the water or the biological life that live near or in the watershed.

Group Activity

Demonstrating Baseline Monitoring

Have the class make a written record of the attendance of class from the past 10 days (of when school is in session – do not include weekends), either on the board or have one student be delegated as the recorder. Feel free to adjust the number of days as you see fit. If you are teaching in a non-traditional classroom setting, then have students record attendance for each minute of the program you are putting on. (If using minutes as a record of attendance then substitute the word *day* for the word *minute* in the following paragraph).

Have the students present their attendance data once it is complete. Then pose the students with this question, "If the next day's class attendance dropped to zero, what would you think after looking at the information shown in the attendance data?" I'm sure some

might make comments about awesome it would be about not being in school but their answers should be something along the lines of this: “Something happened for attendance to be zero.” Next, pose the students with this question, “How do you know something happened for the attendance to be zero?” The students’ responses should be something similar to: “Because normally the average attendance is higher and has never been zero.”

Now explain how the attendance record represents the baseline data and shows the class what the average or norm is. The students knew that zero attendance represented something that was not part of the norm because they had the data to prove it. Explain how this is how baseline data work with water quality monitoring. Baseline data for water quality monitoring is conducted by testing the water and keeping a record of the results of the parameters tested (pH, temperature, dissolved oxygen, etc.). If the results from a water sample come back and show a measure that is abnormal from what is usually a result, then those leading the water quality monitoring can examine what is causing the change. This is why baseline data is highly valuable, it gives us the norm to compare results to.

Part 2: Water Quality Parameters tested in the Yukon River Watershed

As mentioned in Part 1 of the lesson there are various water quality characteristics found naturally in water such as dissolved oxygen, bacteria, metals, and nutrients. Then there are other elements that may be found in water as introduced pollutants, such as pesticides, heavy metals, cleaning products, and oil. Just from these examples mentioned one can see that there potentially could be numerous characteristics to test water quality for. Some of these water quality characteristics can be measured using accessible tools such as a thermometer, pH reader, or an advanced water quality meter that can measure more than one of these elements. Other elements, however, can be harder to measure in water such as those mentioned introduced pollutants and water samples have to be sent to a laboratory to get results. Both pollutant elements (if found in high levels) and natural elements (if demonstrating unusual levels) can pose serious to harm to human health water is used for drinking and/or the water is utilized by the community’s subsistence resources.

Have the class brainstorm some subsistence resources in their community that would be affected if the elements in the local water source were negatively impacted. Discuss as a class.

The four elements that this lesson focuses on are: Dissolved Oxygen, Temperature, pH, and Conductivity. These are parameters that are tested by the Yukon River Watershed

communities, the YRITWC, and the USGS. There are additional parameters following the four that are mentioned in which the instructor can go over if they choose.

1. Dissolved Oxygen (YRITWC Water Quality Manual 2016:42 and EPA Volunteer Stream Monitoring Manual 1997: 139)

An analysis of dissolved oxygen (DO) tests the amount of oxygen that is in the water. A stream or river system creates and uses oxygen. Oxygen gets into the water from the surrounding air and from plants that are undergoing photosynthesis. Running water, because of its churning, dissolves more oxygen that still water, such as that in a pool or a lake behind a beaver dam. Fish and other aquatic animals, decomposition, and various chemical reactions use oxygen. Wastewater from sewage treatment plants often contains organic materials that are broken down by microorganisms, which use oxygen in the process. Other sources of oxygen-using waste include storm water runoff from the land, landfills, and failing septic systems. Oxygen is measured in its dissolved form as dissolved oxygen (DO). If more oxygen is used than is created, the dissolved oxygen (DO) levels decline and some sensitive animals may move away, weaken, or die.

DO levels change seasonally and over a 24-hour period. They vary with water temperature as well as altitude. Cold water holds more oxygen than warm water and water holds less oxygen at higher altitudes (nearer to the Alaska Range). Aquatic animals are more defenseless when DO levels are lower in the early morning on hot summer days when stream flows are low, water temperatures are high, and aquatic plants have not been producing oxygen since sunset.

On the other hand, if the concentration levels of total dissolved gas in water go over 110% it is harmful to aquatic life. Fish and aquatic invertebrates can— however rarely—experience “gas bubble disease” and die. Even though too much can be bad, some dissolved oxygen is entirely necessary for good water quality because life depends on oxygen. The amount of DO that an aquatic organism needs is dependent on the species of the animal, the water temperature, the animal’s physical state, and the pollutants present in the water. At higher temperatures fish use more oxygen because their metabolic rate increases. Research

suggests that 4 - 5 mg/L (milligrams per liter) is the minimum amount of DO that can support a large and diverse fish population. Good fish habitat generally averages around 9 mg/L of DO. Fish die when DO levels fall below 3 mg/L or climb above 17 mg/L.

The following chart displays different life functions that occur at different DO levels:

		Dissolved Oxygen
I.	**SALMONID* WATERS**	
	A. Embryo and larval stages	
	No production impairment	11
	Slight production impairment	9
	Moderate production impairment	8
	Severe production impairment	7
	Limit to avoid acute mortality	6
	B. Other life stages	
	No production impairment	8
	Slight production impairment	6
	Moderate production impairment	5
	Severe production impairment	4
	Limit to avoid acute mortality	3
II.	**NON-SALMONID** WATERS**	
	A. Early life stages	
	No production impairment	6.5
	Slight production impairment	5.5
	Moderate production impairment	5
	Severe production impairment	4.5
	Limit to avoid acute mortality	4
	B. Other life stages	
	No production impairment	6
	Slight production impairment	5
	Moderate production impairment	4
	Severe production impairment	3.5
	Limit to avoid acute mortality	3
III.	**INVERTEBRATES*** **	
	No production impairment	8
	Moderate production impairment	5
	Limit to avoid acute mortality	4

Table 1 Showing the Effects of Dissolved Oxygen on Salmon and Other Aquatic Life
(Water on the Web)

*_Salmonids_ are fish species of the Salmonidae family and include salmon, trout, chars, whitefish, sheefish, and graylings.
**_Non-Salmonids_ are fish species that are not in the Salmonidae family such as burbot, Alaska blackfish, sticklebacks, suckers, pike, and lamprey.
***_Invertebrates_ are animal species with no backbone and some found in the Yukon River include insects (common ones include midges, stoneflies, mayflies, and blackflies), worms, snails, and clams.

2. Temperature (YRITWC Water Quality Manual 2016:43 and EPA Volunteer Stream Monitoring Manual 1997: 147)

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. Temperature is measured in either degrees Fahrenheit (F) or degrees Celsius (C). The rate of change in all biological and chemical processes is affected by temperature. Organisms found in the water; from little tiny microbes to fish are dependent on certain temperature ranges for their best possible health. The best temperature for fish depends on the species: some survive best in colder water, while others like warmer water. Tiny macroinvertebrates that live at the bottom of lakes and rivers are also sensitive to temperature and will move around to find their favorite temperature range. If the temperatures stay to high or too low for a long period of time, they can stress and die.
There are two kinds of limiting temperatures for fish, the highest temperature for short exposures and also a weekly average temperature that is dependent on the time of year and the life cycle stage of the fish species. Reproductive stages (spawning and embryo development) are the most sensitive stages. Temperature affects the oxygen content of the water (oxygen levels become lower as temperature increases); the rate of photosynthesis by aquatic plants; the rates aquatic organisms grow, digest and reproduce; and the sensitivity of the organisms to toxic wastes, parasites, and diseases.

While temperatures can vary greatly (even within the day),
consistently high water temperatures are detrimental to most salmonids.

Species	Maximum weekly average temperature for growth (juveniles)	Maximum temperature for survival of short exposure (juveniles)	Maximum weekly average temperature spawning (a)	Maximum temperature for embryo spawning (b)
Atlantic salmon	20°C (68°F)	23°C (73°F)	5°C (41°F)	11°C (52°F)
Bluegill	32°C (90°F)	35°C (95°F	25°C (77°F)	34°C (93°F)
Brook trout	19°C (66°F)	24°C (75°F)	9°C (48°F)	13°C (55°F)
Common carp	---	---	21°C (70°F)	33°C (91°F)
Channel catfish	32°C (90°F)	35°C (95°F)	27°C (81°F)	29°C (84°F)
Largemouth bass	32°C (90°F)	34°C (93°F)	21°C (70°F)	27°C (81°F)
Rainbow trout	19°C (66°F)	24°C (75°F)	9°C (48°F)	13°C (55°F)
Smallmouth bass	29°C (84°F)	---	17°C (63°F)	23°C (73°F)
Sockeye salmon	18°C (64°F)	22°C (72°F)	10°C (50°F)	13°C (55°F)

a – Optimum or mean of range of spawning temperatures reported for the species
b – Upper temperatures for successful incubations and hatching reported for the species
c – Upper temperature for spawning

(Brungs and Jones 1977)

Table 2

Maximum average temperatures for growth and short-term maximum temperatures for selected fish (°C and °F)

Table 2 Limiting Temperatures for Fish
(EPA Volunteer Stream Monitoring Manual)

Causes of temperature change include weather, clearing land in and around the body of water, bodies of water confined by a barrier, such as a dam, colder water flowing into warmer water, and groundwater in flows to the stream.

Temperature Effects on Salmon (Washington Dept. of Ecology)

Salmonids need cool, well-oxygenated water to survive. The maximum temperature that salmonids can tolerate depends on the species, stage of life (e.g., fry, fingerling or adult), earlier responses to changes in the environment, oxygen availability, length of warmer temperature, and the presence of pollutants. Genetic abnormalities or the death of salmonid eggs can occur in temperatures above 11º C (52º F). Juvenile and adult salmon like water that is 13-18º C (55-64º F). They will live in warmer water only if excess food is available. Water temperatures of approximately 23-25º C (73-77º F) can be deadly to salmon.

Many laboratory studies have shown that higher water temperatures can have a number of negative effects on salmonids. While laboratories cannot duplicate the complex situations that salmonids encounter in nature, they do offer a picture of some of the harmful effects of warm water on salmonids, including the following:

a) Decreased supply levels of oxygen;

b) Disruption to metabolism;

c) Greater chance of being subject to toxins;

d) Greater chance of being subject to disease;

e) Greater chance of being caught by predators;

f) Food supply decreases.

3. pH (YRITWC Water Quality Manual 2016:42 and USEPA Volunteer Stream Monitoring Manual 1997: 151)

pH is a measure of how acidic or basic (also known as alkaline) a substance is. The range of pH values goes from 0 to 14.0. The number seven is right in the middle so it is considered neutral. Low values of pH (below pH 7) indicate acidity whereas high values of pH (above pH 7) indicate basicity. The range for natural water is pH 5.0 – 8.0 while the range for drinking water is 6.0 – 8.5. Name some of the common liquids found on the following illustration to see if students can guess their pH level:

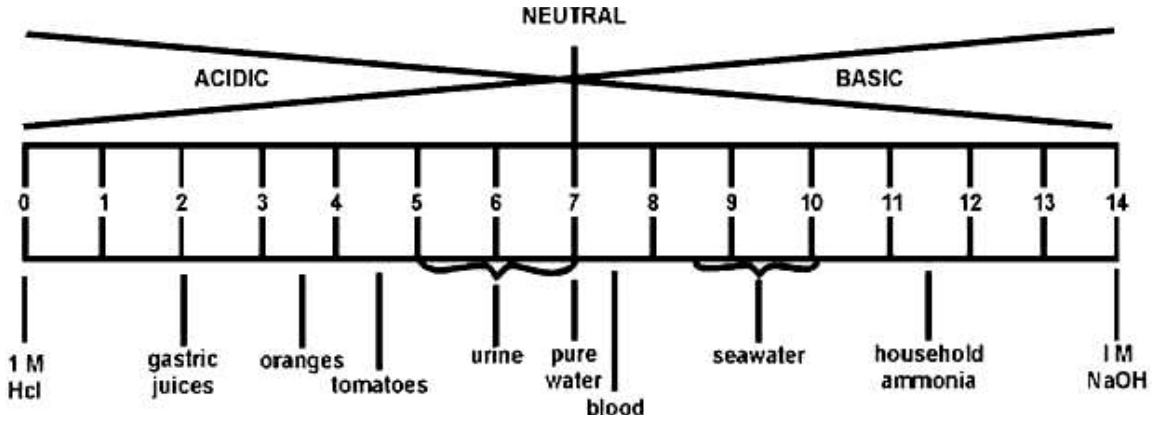


Table 3 pH of Some Common Liquids
(EPA Volunteer Stream Monitoring Manual)

pH affects many chemical and biological processes in the water. For example, different organisms flourish within different ranges of pH. Most aquatic animals prefer a range of 6.5-8.0. When the pH of the stream is outside this range there is a reduction of the variety of life found in the water because it stresses the way most organisms function and reduces reproduction. Low pH can also allow toxic elements and compounds to become mobile or available to aquatic plants and animals which can cause them be taken in or absorbed. This can produce conditions that are toxic to aquatic life, especially to sensitive species like rainbow trout. Changes in acidity can be caused by atmospheric deposition (acid rain), surrounding rock, and certain wastewater discharges.

The chemical explanation for the pH scale is as follows:
pH measures the logarithmic concentration of hydrogen (H+) and hydroxide (OH-) ions, which make up water (H+ + OH- = H2O). When both types of ions are in equal concentration, the pH is 7.0 or neutral. Below 7.0, the water is acidic (there are more hydrogen ions than hydroxide ions). When the pH is above 7.0, the water is alkaline, or basic (there are more hydroxide ions than hydrogen ions). Since the scale is logarithmic, a drop in the pH by 1.0 unit is equivalent to a 10-fold increase in acidity. So, a water sample with a pH of 5.0 is 10 times as acidic as one with a pH of 6.0, and pH 4.0 is 100 times as acidic as pH 6.0. (EPA Volunteer Stream Monitoring Manual 1997: 151)

4. Conductivity (USEPA Volunteer Stream Monitoring Manual 1997: 179)

Conductivity refers to the water's ability to carry an electrical charge or conduct electricity. It is affected by the presence of inorganic (non-living) dissolved solids like chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Ions are a group of atoms that has developed an electrical charge by losing or gaining one or more electrons. Organic (living) compounds like oil, phenol, alcohol, and sugar do not conduct electrical currents very well and therefore have a low conductivity when in water. Conductivity is also affected by temperature: the warmer the water, the higher the conductivity. Therefore, water is reported as conductivity at 25 degrees Celsius (25 C).

Conductivity in streams and rivers is affected by the geology of the area through which the water flows. Streams that run through areas with granite bedrock tend to have lower conductivity because granite is composed of nonmoving materials that do not ionize (dissolve into ionic components) when washed into the water. On the other hand, streams that run through areas with clay soils tend to have higher conductivity because of the presence of materials that ionize when washed into the water. Ground water inflows can have the same effects depending on the bedrock they flow through.

Discharges to streams can change the conductivity depending on their make-up. A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity.

Conductivity is useful as a general measure of stream water quality. Each stream tends to have a relatively constant range of conductivity that, once established, can be used as a baseline for comparison with regular conductivity measurements. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a stream.

Water Quality Parameters Lesson Extension

Following are two additional water quality parameters that the instructor can add to their lesson if they choose. They are valuable parameters however are not asked about in this lesson's worksheet.

5. Turbidity (USEPA Volunteer Stream Monitoring Manual 1997: 154)

Turbidity is a measure of how clear the water is, and how much the material floating in water reduces the ability of light to pass through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. These materials are typically in the size range of 0.004 mm (clay) to 1.0 mm (sand). Turbidity can affect the color of the water.

Higher turbidity increases water temperatures because the suspended particles soak up more heat. This reduces the amount of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light passing through the water, which reduces photosynthesis and the production of DO.

Suspended materials can clog fish gills, reducing the ability of the fish to fight disease, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and the tiny macro invertebrates that live on the bottom. Sources of turbidity include:

- Soil erosion
- Waste discharge
- Mining runoff
- Eroding stream banks
- Large numbers of bottom feeders which stir up bottom sediments
- Excessive algal growth

Turbidity can be useful as an indicator of the effects of runoff from mining, logging activity, and other sources. Turbidity often increases sharply during a rainfall. The flow of storm water runoff from solid surfaces rapidly increases stream velocity, which increases the erosion rates of stream banks and channels. Turbidity can also rise sharply during dry weather if earth-disturbing activities are occurring in or near a stream without erosion control practices in place. Older mining practices were very guilty of this.

Regularly monitoring turbidity will assist in noticing trends that might show increasing erosion in the watershed. However, turbidity is closely related to stream flow and speed and should be connected with these factors. Comparisons of the change in turbidity over time, therefore, should be made at the same location at the same flow.

6. Nitrates (USEPA Volunteer Stream Monitoring Manual 1997: 168)

Nitrates are a form of nitrogen, which is found in several different forms in land and water ecosystems. These forms of nitrogen include ammonia (NH3), nitrates (NO3), and nitrites (NO2). Nitrates are necessary for plant life, but too much causes major water quality problems. Nitrates in excess amounts can speed up the growth and decomposition of oxygen, causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in the stream. This, in turn, affects dissolved oxygen, temperature, and other indicators. Too many nitrates can cause hypoxia (low levels of dissolved oxygen) and can become toxic to warm-blooded animals at higher concentrations (10 mg/L or higher) under certain conditions. The natural level of ammonia or nitrate in surface water is usually low (less than 1 mg/L); in the out flow of wastewater treatment plants, it can range up to 30 mg/L.

Sources of nitrates include wastewater from treatment plants, runoff from fertilized lands, failing on-site septic systems, runoff from animal manure storage areas, and industrial discharges that contain corrosion inhibitors.

Nitrates from land sources end up in rivers and streams more quickly than other nutrients because they dissolve in water more readily, which attract soil particles. As a result, nitrates serve as a better indicator of the possibility of a source of sewage or manure pollution during dry weather.

Worksheet:

Instructions for the Teacher:
After learning about water quality parameters, students will look at those parameters in the Yukon River Watershed and examine how they may affect the subsistence resources in their community.
Individually or in small groups have students complete the attached worksheet (the following seven pages). Students will use information from the lesson and water quality data found at http://yukon.fieldscope.org/v3.

Students will need:

- Worksheet (including the Resource Tables [3 pages]
- A writing utensil
- Access to internet

Name:_____

Looking at the Water Quality in the Yukon River Watershed & its Effect on Subsistence Resources

In this activity you will answer the following questions about water quality, explore the current data available on water quality in the Yukon River Watershed, answer the corresponding questions, and utilize the available data on water near your community to examine whether subsistence resources near you may or may not be affected.

Part 1 - Questions:

What is the water quality monitoring?

Why is water quality monitoring important?

What is baseline data?

What are four parameters of water quality that were covered in the lesson?

1.

2.

3.

4.

Part 2 - Utilizing Available Water Quality Data:

For this next portion you will need to have internet access. Go to http://yukon.fieldscope.org/v3 to explore existing water quality data on the Yukon River Watershed. Click **MAP DATA** and then follow instructions below:

DISSOLVED OXYGEN (DO)
*Select the map labeled **Dissolved Oxygen** and use the information to answer the following questions:*

1. What is the lowest level of dissolved oxygen (mg/L) found on this map?

2. What is the highest level of dissolved oxygen (mg/L) found on this map?

3. Zoom in to find the dissolved oxygen level(s) found nearest your community and write your findings down:

4. Using Table 1 (found at the end of the worksheet) and the dissolved oxygen levels found near your community, answer the following:
    a. With your findings, does the dissolved oxygen level affect salmonid (salmon, trout, char, etc.) in their embryo/larval stages or in other life stages?

    b. If you answered yes, what salmonid stage of life is effected and to what level of impairment?

    c. With your findings, does the dissolved oxygen level affect non-salmonid (lamprey, pike, sticklebacks, etc.) in their early life stages or in other life stages?

    d. If you answered yes, what non-salmonid stage of life is effected and to what level of impairment?

    e. With your findings, does the dissolved oxygen level affect invertebrates (insects, worms, snails, clams, etc.)

f. If you answered yes, to what level of impairment would invertebrates be affected?

5. Good fish habitat generally averages around 9 mg/L of DO. Fish die when dissolved oxygen levels fall below 3 mg/L or climb above 17 mg/L. Would you say that the dissolved oxygen levels found near your community help give a good fish habitat? Support your answer.

WATER TEMPERATURE

*Click **Map Data** on top of the page. Select the map the is labeled **Water Temperature** and use the information to answer the following questions:*

6. What is the lowest water temperature (°F) found on this map?

7. What is the highest water temperature (°F) found on this map?

8. Zoom in to find the water temperature reading(s) found nearest your community and write your findings down:

9. Using Table 2 (found at the end of the worksheet) and the water temperature readings <u>found near your community</u>, answer the following:

    a. Does the water temperature reading(s) near your community exceed any of the maximum temperatures tolerable for any of the fish listed?

    b. If yes, which species of fish would be affected by the water temperature and in what stage(s) (juvenile, spawning, or embryo)?

    c. Are any of the fish listed in Table 2 a subsistence resource used in your community? List all that apply.

pH

*Click **Map Data** on top of the page. Select the map labeled **pH in the Yukon Watershed** and use the information to answer the following questions:*

10. What is the pH level found on this map?

11. What is the highest pH level found on this map?

12. Looking at Table 3 (found at the end of the worksheet), what do you think would be a good pH level for the Yukon River or one of its tributaries? Support your answer.

13. Zoom in to find the pH level(s) found nearest your community and write your findings down:

14. Most aquatic animals prefer a pH range of 6.5-8.0. Could the pH level(s) found near your community affect any of the river subsistence resources that are used?

RESOURCE TABLES FOR WORKSHEET

Table 1 Showing the Effects of Dissolved Oxygen on Salmon and Other Aquatic Life
(Water on the Web)

		Dissolved Oxygen
I.	**SALMONID* WATERS**	
	A. Embryo and larval stages	
	No production impairment	11
	Slight production impairment	9
	Moderate production impairment	8
	Severe production impairment	7
	Limit to avoid acute mortality	6
	B. Other life stages	
	No production impairment	8
	Slight production impairment	6
	Moderate production impairment	5
	Severe production impairment	4
	Limit to avoid acute mortality	3
II.	**NON-SALMONID** WATERS**	
	A. Early life stages	
	No production impairment	6.5
	Slight production impairment	5.5
	Moderate production impairment	5
	Severe production impairment	4.5
	Limit to avoid acute mortality	4
	B. Other life stages	
	No production impairment	6
	Slight production impairment	5
	Moderate production impairment	4
	Severe production impairment	3.5
	Limit to avoid acute mortality	3
III.	**INVERTEBRATES*****	
	No production impairment	8
	Moderate production impairment	5
	Limit to avoid acute mortality	4

**Salmonids* are fish species of the Salmonidae family and include salmon, trout, chars, whitefish, sheefish, and graylings.

***Non-Salmonids* are fish species that are not in the Salmonidae family such as burbot, Alaska blackfish, sticklebacks, suckers, pike, and lamprey.

****Invertebrates* are animal species with no backbone and some found in the Yukon River include insects (common ones include midges, stoneflies, mayflies, and blackflies), worms, snails, and clams.

Table 2 Limiting Temperatures for Fish
(EPA Volunteer Stream Monitoring Manual)

Species	Maximum weekly average temperature for growth (juveniles)	Maximum temperature for survival of short exposure (juveniles)	Maximum weekly average temperature spawning (a)	Maximum temperature for embryo spawning (b)
Atlantic salmon	20°C (68°F)	23°C (73°F)	5°C (41°F)	11°C (52°F)
Bluegill	32°C (90°F)	35°C (95°F	25°C (77°F)	34°C (93°F)
Brook trout	19°C (66°F)	24°C (75°F)	9°C (48°F)	13°C (55°F)
Common carp	---	---	21°C (70°F)	33°C (91°F)
Channel catfish	32°C (90°F)	35°C (95°F)	27°C (81°F)	29°C (84°F)
Largemouth bass	32°C (90°F)	34°C (93°F)	21°C (70°F)	27°C (81°F)
Rainbow trout	19°C (66°F)	24°C (75°F)	9°C (48°F)	13°C (55°F)
Smallmouth bass	29°C (84°F)	---	17°C (63°F)	23°C (73°F)
Sockeye salmon	18°C (64°F)	22°C (72°F)	10°C (50°F)	13°C (55°F)

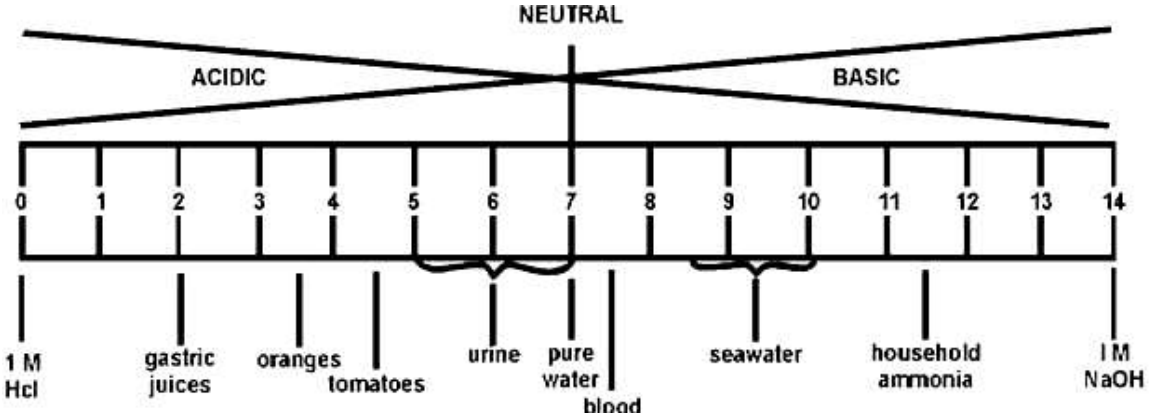
a – Optimum or mean of range of spawning temperatures reported for the species
b – Upper temperatures for successful incubations and hatching reported for the species
c – Upper temperature for spawning

(Brungs and Jones 1977)

Table 2

Maximum average temperatures for growth and short-term maximum temperatures for selected fish (°C and °F)

Table 3 pH of Some Common Liquids
(EPA Volunteer Stream Monitoring Manual)



Additional Activities/ Extensions

- Have the students watch a YouTube video on how water is collected and sampled on the Yukon River at: https://www.youtube.com/watch?v=Fg3XQGl9_xo&feature=youtu.be [Time: 3:05 min]

- Have the class investigate if there is someone that takes water samples in their community. They can do his by contacting their local tribal or city office. If there is someone, invite that person to come in to describe how they take water samples, why it is important, and have them show how they actually take samples on a class field trip.

- Take a class field trip to the river and have students take the water temperature. Once back in class have the students compare the temperature reading to Table 2 to see how it could affect subsistence resources. Report findings to the Yukon River Inter-Tribal Watershed Council [Thermometers needed]

- Help out local subsistence resources and have a litter pick up day! After learning about how different water elements can affect subsistence resources in the river, encourage students to help protect those resources and go to the river to pick up trash. Recycle what you can!

Sources for this curriculum:
This curriculum was adapted from the Environmental Preservation Lifeways Curriculum that was developed by the Telida Village Council and the Indian General Assistance Program (IGAP). Adaptation came from Water Quality and its Effect on Subsistence Resources lesson that is part of the Water Quality Science and Monitoring education. This curriculum and more can be found at: http://ukpreservation.com/environmental-curriculum/ .

This curriculum was adapted for the Yukon River Watershed region and by the Yukon River Inter-Tribal Watershed Council.

Additional Resources:
The Yukon River Inter-Tribal Watershed Council has a vast number of resources available online at www.yritwc.org. For more information, call (907) 258-3337.