Ta'an Kwäch'än Council

Water Temperature Data Collection Program

Contents

Cover photograph: Joe Creek entering Lake Laberge in late March, 2010.

Warm ground water enters the creek and keeps it from freezing. In the spring it melts a channel out to the lake.

Introduction

The Ta'an Kwäch'än Council has received funding from Indian and Northern Affairs Climate Change Impacts and Adaptation Program to carry out a Water Temperature Collection Program within our Traditional Territory. The Program will start in the summer of 2010. We wrote this report to inform our citizens of the projects that we will be conducting. We had two other reports prepared. The first is the "Guidebook for the use of Data Loggers to measure Water Temperatures in the Southwest Yukon". This will help our staff when they carry out the field work. The second is the "Ta'an Kwäch'än Council Water Temperature Data Collection Program: a geographical, administrative and temporal context." This explains our Program to others who share the land and waters of our Traditional Territory and others beyond them. The reports can be found on the TKC website at: www.taan.ca

The Program

People around the world now agree that Climate Change is occurring. As a people, we have been adapting to changing conditions as long as we have been stewards of our lands and waters. The change will continue, and we will continue to adapt. When we signed our Final Agreement, the governments of Canada and Yukon accepted us as a partner in the management of natural resources within our Traditional Territory. We don't have to let things happen to us anymore. We can make them happen.

We have Traditional Knowledge of the land and the water and of all living things in our Traditional Territory. Our elders will guide our youth as they develop into tomorrow's leaders. Then they will become elders themselves.

As they do so, the Yukon will change. More people will come here. They will want land to raise their families on. They will want water to farm with or for other purposes. The Yukon government will want to put more hydro projects on streams.

In preparation for this, youth are learning scientific and technical skills. They will need the skills to be able to develop scientific and technical knowledge of the Ta'an Kwäch'än Council Traditional Territory. The knowledge will allow them to communicate with staff from other First Nation, federal, territorial and even international governments. With guidance from the Elders, they will be able to work as equals with other governments to protect our important resources.

Fish are an important resource for us. Salmon, trout, whitefish, grayling, pike and ling cod have supported us since our ancestors came to this land. They took care of the fish and the waters that the fish used. Now it is our turn. We do it for ourselves, for our children, and for all our future citizens, forever.

Temperatures are important to fish. Fish are cold-blooded. Almost all the food that they eat is also cold-blooded. The rate that both fish and their food grow at is influenced by temperature. Temperatures determine when migrations occur, when spawning starts, and how long the eggs take to hatch. Temperatures determine what types of fish do well and which do not.

Most fish have a range of temperatures where they do best. Here are some examples. Lake trout can enter warmer water to feed in the summer, but if they stay in the warm water they may die. They need to return to cold water. Pike can enter colder water in the summer to feed. They digest their food best in clear warm water, that's why you see them in sloughs and shallows. Most juvenile fish grow faster in warmer water. However, if the water gets too warm and if the fish can't find some cooler water to escape to they will die. Parasites are also a bigger problem in warmer water.

Most information on Climate Change is from air temperature monitoring. Measuring air temperature is easy. Most of it is done at airports. It's all done the same way, using the same instruments. Measuring water temperature in streams has been hard and expensive and there isn't much information for the Yukon. Measurements are easier now because there are new instruments. These are called data loggers. They measure temperatures and then save the information in a computer memory. They can be left in the stream or river for months or even years.

We will use data loggers in our Water Temperature Collection Program, which will start in the summer of 2010. We know that water temperatures have already gone up due to Climate Change. We don't know how much. We think that the water temperatures will keep rising. Our program will first let us know what the temperature is now. Later, we will be able to measure how much it has changed. Our children will be also be able to use the information in the future to measure how much change has occurred since we gathered the information for them.

Knowledge of the change in water temperatures will guide and support decisions on what can be done to sustain the fish that are important to us. The decisions may be for land or water use or for fish or wildlife management. In some cases decisions may be made to enhance habitats for important fish species through construction activities. First Nations and other governments to the south have developed methods to do this.

We have three projects in the program. They are listed below and are described later in the report:

To determine the -

- effect of Lake Laberge on the downstream thermal regime of the Yukon River
- thermal regimes of tributaries within the TKC Traditional Territory
- thermal regimes of groundwater discharge zones

Thermal regime is a term to describe the pattern of heat gains and losses in a stream or other water body over a certain period of time. We will be measuring water temperatures over the entire year.

We don't have a project for Lake Laberge itself because the water flows in the lake are too complicated. The Yukon River is warmer than the lake water and flows on top of the lake. Winds push it around. Figure 1 shows the south end of Lake Laberge when there is a north wind. Figure 2 shows the lake from Big Island (Richthofen Island) looking toward the north when there is a south wind. The different colours of water have different temperatures. Sometimes the wind blows differently at different parts of the lake. It's just too complicated and expensive for us right now, so we are staying with projects we can do.

We'll first describe how the temperatures will be measured. Then we'll describe each of the projects and why we are doing it.

Figure 1 - above. Lake Laberge in August, 1977 during a north wind. The muddy water of the Yukon River is held back in the south end of the lake. Figure 2 - below. Lake Laberge in the late 1990s, with a south wind. The slightly muddy water of the Yukon River flows up the east shore.

How We Will Measure Temperatures

We are using Onset Tidbit v2 data loggers. Figure 3 shows a logger.

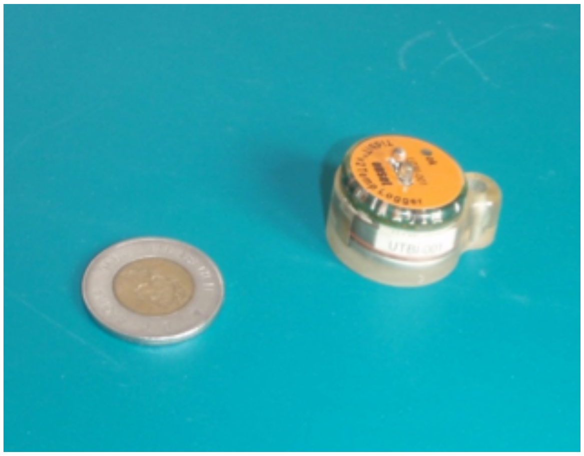

Figure 3. Tidbit v2 data logger, with toony for scale.

The data loggers are waterproof to 300 meters. They are very accurate and measure within 0.2°C. They can be adjusted to read at different intervals (lengths of time). We will have them measure the temperature every hour, on the hour. They can make about 42,000 measurements on the battery that is sealed inside them. This is over 4 years of measuring on every hour. It works out to 8.5 cents a day for each logger. We won't leave the loggers in the full four years. We'll replace them more often. Once they are out the temperature measurements are transferred to a computer. When the information is transferred we turn the data logger off and clean it up so that it is ready to be used again.

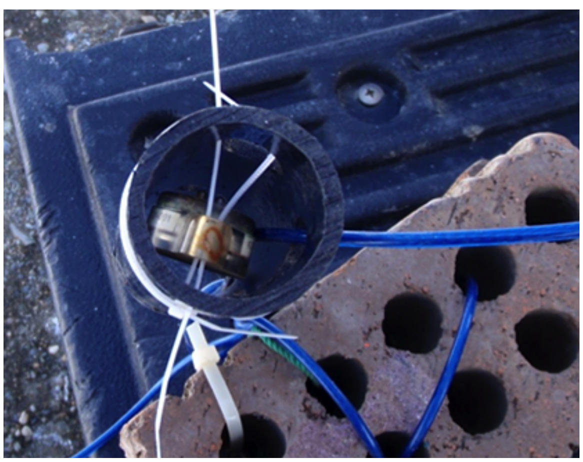

Figure 4. One data logger is double strapped through the holes in the top of the housing.

Figure 5. The logger is now ready to be put in the water. The clothes line is tied to the weight, the line is strapped to the top of the housing, and all loose ends have been cut off or tucked away.

When we set them in surface water such as rivers and streams, we have to make sure that they will stay in place and will not be damaged. Figures 4 and 5 show how we do it. First 1.5 inch PVC pipe is cut into 12 – 15 cm lengths, and then drilled at 90 degree angles top and bottom. These become the housings which protect the loggers from sticks, rocks or rubbing. We take them into the field, and then strap two loggers into each housing. We set two loggers for insurance purposes because sometimes a logger doesn't work properly or the battery dies.

Clothes line is strung through one of the top holes and one of the bottom holes, and then tied to a weight. The housing is slid down the clothes line until it touches the weight. The clothes line is strapped to the top so the housing doesn't slide back up.

We find a pool or protected area where the current isn't too fast. It has to be deep enough so the logger stays under water at all times. It also has to be far enough from the mouths of tributaries so that the water is totally mixed.

The measurements also have to be far enough from any springs or other ground water discharges so that they don't affect the measurements. For rivers it has to be far enough downstream from the outlets of lakes that the water from the top and the bottom of the lake can mix completely.

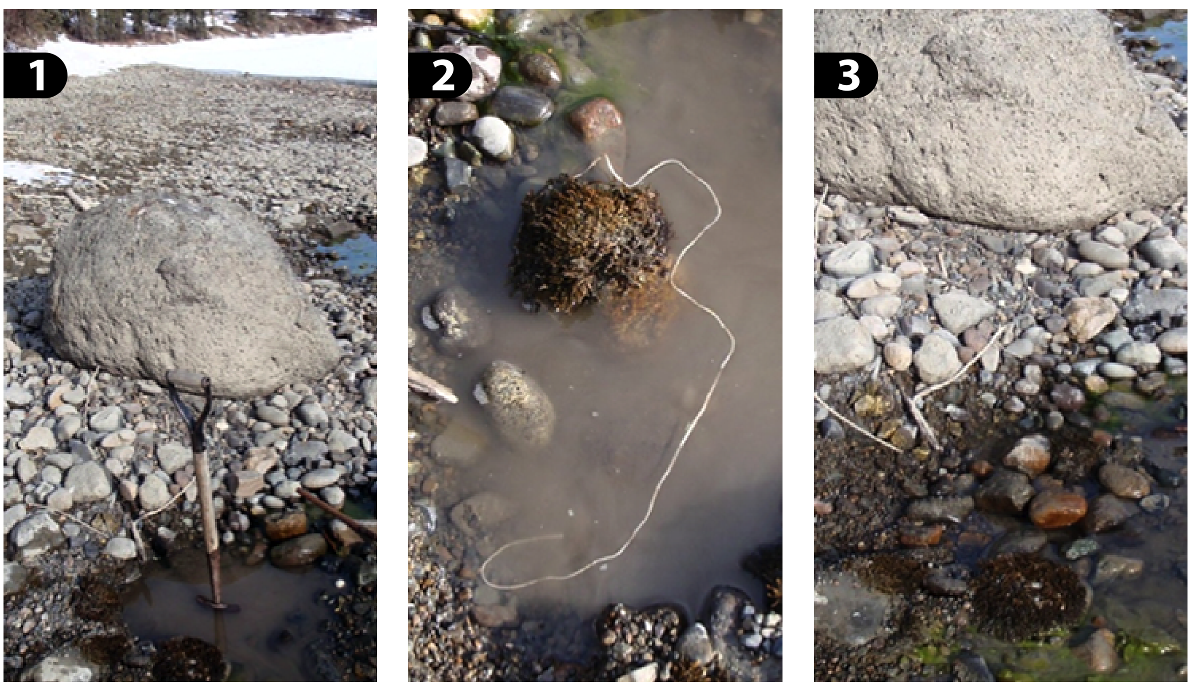

Figure 6. Sequence. Cobbles and shallow gravels have been cleared in front of a permanent feature in a ground water discharge area. The hole filled up with water. A track shovel was used to loosen the gravel to a depth of 35 cm (length of blade). In the second photograph the housing with the loggers has been pushed into the gravel and the braided cord looped above the ground surface. In the last photo the hole has been filled in and the cobbles replaced.

The weight is then lowered into the water. The idea is that the weight is on the stream or river bottom and the housing and loggers are just above it. The water can flow through the ends of the logger and the holes drilled into it. The measurements will then be accurate.

The clothes line is tied around the bottom of a tree, right above the ground. That way there is less chance that it will be disturbed. For rivers the clothes line is buried until it enters the bush so that people can't see it and won't disturb it. For streams the clothesline is brought up close to the bank and hidden until it is in the bush for the same reason.

For ground water we bury the housing and the data loggers right in the area where the water is discharging. Figure 6 shows how we do it. The loggers are buried 20 – 30 centimeters or 8 – 12 inches deep.

We use the same type of shovel that is used for cleaning equipment tracks, with a long, narrow blade. Once shovelling starts the hole fills up with water and the gravel slides into it. Rather than dig a large hole, the shovel is used to loosen the gravel. When the gravel is loose, the shovel is pushed in until the top of the blade is at water level. The shovel is shoved forward and the housing with the loggers is pushed down the back of the blade. A cord is attached to the housing and then looped at the surface. Woven cord is used because it is stronger than twisted cord. The loop is left so that when the logger is dug up it will be easier to find. The cord is buried and the site is smoothed off so that people don't notice and disturb it.

We will be setting (or deploying) the loggers in early summer 2010 and intend to retrieve and replace them in late fall. This way we won't lose the measurements that were made over the summer in case the loggers get carried away in the spring. We'll see how it goes this year. Depending on what we learn, the procedures may change in the future.

The Guidebook for Use of Data Loggers to Measure Water Temperatures in the Southwest Yukon was prepared to help our staff to decide where exactly to put the data loggers and how to put them in the streams so that we would get good information. It has more detail than here. If you want to look at it, go to www.taan.ca

That's how we will measure the temperatures. Now for the projects.

Project 1

Determine the effect of Lake Laberge on the downstream thermal regime of the Yukon River.

To do this we will measure the temperatures of the Yukon River upstream of Lake Laberge and also downstream of the lake outlet. We want to know what the difference is now and have a base to measure future differences from.

The outlet of the lake stays open all winter, but the river flowing into the lake freezes solid and stays that way. Figure 7 shows the open water area. If the weather is very cold, the open water area at the outlet gets smaller but the new ice melts as soon as the weather warms up. This is because the water at the outlet is a mixture of cold water from just under the ice and warmer water from deep in the lake. Figure 8 (next page) is a drawing of how this works. If the water gets warmer due to Climate Change, the open area will get larger. This probably wouldn't hurt the fish. It would be more difficult for people and animals that use the ice to travel on.

Figure 7. The Yukon River just below Lower Laberge and looking upstream in early March. The open water extended well into the lake. Ducks spent the winter in the open water.

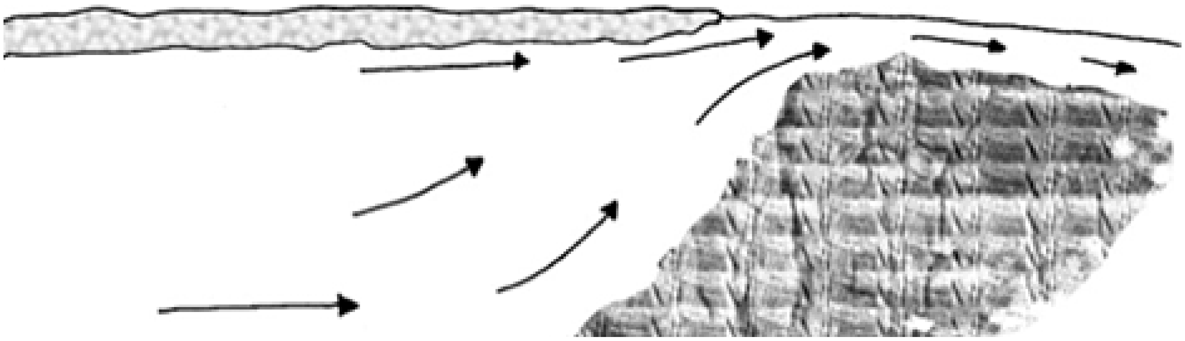

Figure 8. Profile drawing of a lake outlet in winter. The lake to the left is ice covered. The arrows show the water flow. The water from right under the ice is near freezing, but the water from deep in the lake is probably about 4°C. The warmer water keeps the lake outlet to the right of the drawing from freezing.

We think that the same thing happens in the summer. The flow at the lake outlet is made up of water from the surface and from deeper in the lake. If so, the water leaving the lake will be cooler than the water entering the lake. Then the river downstream would be cooler. This makes it easier for the King, or Chinook salmon coming back upstream to spawn.

The Chinook salmon come through Alaska in June. When the weather is hot and the river flows are low in western Alaska the water temperature near the mouth of the Yukon River can be 20°C. This is hard on the salmon. Some probably die in the river from heat stress. If the water becomes cooler their stress level goes down and they can recover their energy. The energy is needed to migrate and then to spawn. If they don't have enough energy they may not spawn completely. The dead females will still have many eggs left in their bodies. Figure 9 shows some females that did not complete their spawn.

Figure 9. Female chinook salmon carcasses found in the Yukon River near Marwell on August 28, 2005. Only 2 of the salmon had completed their spawn. These salmon were late in the run. They may have been weak when they entered the river.

Water temperatures will increase in the Yukon River. The value of the reach of river downstream of Lake Laberge may become increasingly important to Chinook salmon. The Chinook salmon are utilized all along the Yukon River in subsistence, commercial, domestic and Aboriginal fisheries. The TKC Traditional Territory contribution to the sustainability of these fisheries may rise. The data we collect will be able to support this by showing the value of our lake to the Yukon River Chinook salmon.

We might also be able to use the information from this project to understand what is happening with other fish. Burbot, pike, grayling, cisco (herring), suckers and other whitefish leave the lake in the summer and use the river.

Project 2

Determine the thermal regimes of tributaries within the TKC Traditional Territory.

Figure 10. Example of a tributary with warm, muddy water entering a colder river. Mixing does not occur until well downstream.

We will measure water temperatures with data loggers in eight streams and in the Takhini River. Laurier, Joe and Grizzly Creek (Laberge Creek) are on the east side of Lake Laberge. There isn't much development on them. We don't think that there will be for a while. Croucher Creek is on the east side of the Yukon River. It has some development, mainly roads and power lines. The City of Whitehorse wants to develop residential land near it. Horse Creek, Flat Creek, Deep Creek and Fox Creek have development, or have development planned. There is residential development, farming, irrigation and roads.

We think that the streams have different temperatures now. Our project will establish this. We can use the information as soon as we get it to determine if any stream temperatures are already too warm. As time passes and more development occurs, we will be able to track the changes.

For now, we think that streams that drain high ground and flow directly into Lake Laberge or the bigger rivers will probably be cool. These streams include Joe Creek and Flat Creek. The streams that don't drain high ground will probably be warm. These streams include Horse Creek, Deep Creek and Laberge Creek. The others will be in the middle.

We will put a Monitoring Station on each creek and on the Takhini River. The Stations will be in locations that are easy to reach by boat or vehicle. This will save time and money. We will not set the Stations immediately downstream of the mouth of a tributary. Waters of different temperatures have different densities and do not like to mix. Warm water is less dense than cold water and floats on top of it.

We will avoid any ground water discharges as they will be a different temperature from the stream. If we put the data loggers downstream of the discharges the measurements they make will not be accurate.

The streams we are measuring temperatures on are important to us because they are used by grayling and by juvenile Chinook salmon. Sometimes other fish either migrate up the streams to summer habitats or stay in the lowest section. The young salmon enter the creeks in June when they are between 45 and 50 mm or 1.5 to 1.9 inches long. The creeks usually have plentiful food and clear water. There are few predator fish or birds. The young salmon can spend their time feeding instead of hiding. Most swim at least a kilometre up the creeks by the end of the summer if there are no obstructions. By September they are usually 60 to 80 mm or 2.3 to 3.2 inches long. They stay in the creeks for the winter. Usually they spend the winter downstream of ground water discharges. In the spring they grow quickly. Some are more than 100 mm or 4 inches long when they leave the creeks and migrate to the ocean.

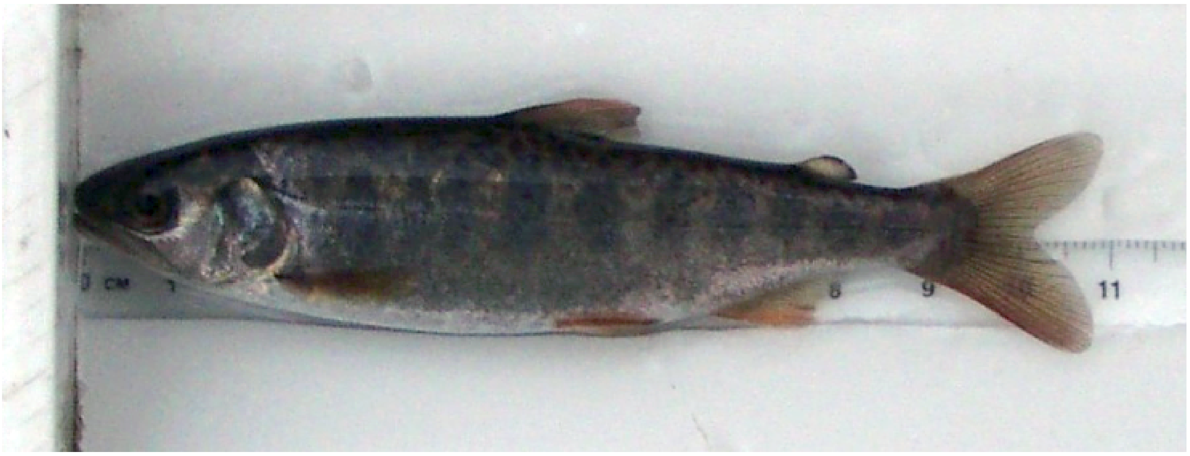

Figure 11. This juvenile Chinook was captured in mid September. It had excellent growing conditions: as much food as it could eat, very few other fish to compete with, and cool ground water to rest in.

Figure 12. This juvenile Chinook was captured further downstream in the same creek. The bump behind it's head is an encysted parasite. Several other juvenile chinook from the same area also had similar parasites.

If conditions are right in the first summer they can grow faster. This is when food is plentiful and there is little competition. Areas rich in food usually have warm water. The young salmon need areas of cool water where they can move to if the stream gets too warm. These are usually areas where cool ground water discharges into the streams. In food rich areas the young salmon can grow to over 100 mm or 4 inches long in the first summer. Figure 11 shows a juvenile Chinook salmon that had excellent habitat and grew quickly. Warm water and rapid growth isn't always a good thing. Parasites are more active in warmer water. Many live part of their life cycle in the insects and other organisms that fish, such as salmon, eat. If the conditions are right, they can infest the fish. Figure 12 shows a juvenile Chinook salmon with a parasite.

Young salmon have to be able to escape from predators such as otters and mink during the winter. Large juvenile salmon don't have as many places to hide.

Figure 13. Juvenile Chinook salmon in an area that they use for overwintering. Ground water discharges from between the boulders. Mink hunt in the channel during the winter. Larger juvenile salmon are more vulnerable to being caught by mink and otter than smaller Chinook. They have fewer places to hide, and can't swim as far into the boulders.

Figure 14. TKC staff and Elders releasing juvenile Chinook salmon to Fox Creek with DFO assistance. This was the first year of our Stock Restoration Plan.

Fox Creek is a very important creek for us. We are restoring the Chinook salmon spawning stock. In the summer of 2009 we released about 53,000 juvenile Chinook salmon to the stream. Figure 14 shows the release. The salmon eggs had been collected with the assistance of the Whitehorse Rapids Fish Hatchery and Fishway staff. The eggs were incubated in the Yukon College Northern Research Institute's McIntyre Creek Salmon Incubation Facility. The Department of Fisheries and Oceans helped us deliver the salmon to the creek.

Some grayling stay in the lower section of the streams that are used by the juvenile Chinook. Most grayling migrate further upstream than the juvenile Chinook and do so earlier in the year. Grayling spawn in late spring or early in the summer. The juveniles seem to do best in still or slowly moving water. They grow very swiftly if the habitat is good. In the fall almost all grayling move to overwintering habitats in lakes or larger rivers.

Those are the fish... Now let's look at what changes temperatures.

Temperatures in small streams can be changed by forest fires. There are usually landslides right after a forest fire. Flows in the creek go up because the plants aren't using water. The high water erodes the slides and carries sediment downstream. Figures 15 and 16 are photographs taken before and after a forest fire. There were no big rains between the photographs. They show how much water the plants use. The stream becomes wider and is open to the sky. In the second year the flows fall and the temperature rises.

Figure 15. This is Mickey Creek near Dawson in 2004 just before a forest fire. The creek is low and clear.

Figure 16. This is the same creek just after the fire. There hasn't been any big rains. The flows are now high and muddy.

Figure 17. The 1950s forest fire on Fox Creek created good habitat for beaver. The near side of the creek burned and came back into aspen. The beaver built a dam in the lower left hand corner of the photograph. It broke. Then they built the dam shown in this photo. Then it broke, and they have built a new dam further upstream.

Forest fires can also result in long term changes. Usually aspen and willow will come back first after a forest fire. The spruce trees grow through them and eventually it's back to a spruce forest. If the fire burns to the stream side, beaver move in. Each dam may only last for a few years, but the spruce always gets flooded out. The beavers just keep coming back.

Scientists don't agree on whether beaver are good or bad. It probably depends on where you are and what you think is important. No one in the Yukon has looked at what happens here. With the data loggers we can see whether the water going into the dams is warmer or cooler than the water going out. We can then use the information to decide what we want to do and where we want to do it. For example, if we find that beaver ponds in a creek are causing the stream temperatures to rise to levels that could hurt fish, we could decide to remove the beaver.

Melting permafrost can cause landslides even when there are no forest fires. The landslides aren't common in the populated area of the Traditional Territory right now, but there are some east of the Teslin River. If a landslide reaches a stream, it will fill up the stream channel and then the channel will change. If this happens it almost always results in the vegetation beside the stream being killed, leaving the stream open to the sun.   The stream then heats up.

Figure 18. The Ten Mile Creek Slide near Carmacks. The start of the slide is shown on the left.   It is in the headwaters of a small valley which used to be forested. As the slide travelled down the valley it swept the forest away. The stream is now open to the sky and may warm quickly.

There are limits as to what we can do to stop forest fires and landslides. We can limit the long term effects on certain streams by managing beaver if we decide to.

Human activities can be controlled. Our Final Agreement gives us a say on what happens within our Traditional Territory, and this includes the use of water, land and resources. Collecting information about the temperatures of the waters in Ta'an Traditional Territory helps us to understand how development may affect our land. We can use this information when responding to development applications in our Traditional Territory. The Government of Yukon must consider if a project will substantially alter the quantity, quality and rate of flow of water before granting approval for it to go ahead.

The best way to protect vulnerable streams is to avoid any activities that will increase water temperatures. An easy way to do this is to not clear the vegetation from the stream banks. The vegetation shades the stream. It has other benefits, too. Insects live on the vegetation and fall or fly into the water. Leaves fall into the stream and are eaten by aquatic insects. The roots keep the stream bank from eroding. This helps the stream stay clear so that the fish can see their food. Another easy way is to keep livestock from the stream banks.

We can also fix, or restore, areas where streams are warming up. Logging and agricultural development in BC and the northwestern United States wasn't done very well. They damaged their lands and their streams. They gave people rights to water without thinking of what the fish needed. About twenty five years ago they started to restore their lands and waters. Some of the things they tried didn't work very well. We can modify their successful methods to meet our needs.

An example is digging long, ground water fed channels. The salmon species they wanted to restore was usually coho salmon. The coho would move into the ground water channels in the summer when the stream temperatures were high. The ground water channels would be much cooler. The coho would also spend the winter in the channels when the main rivers were cold and high. In the Yukon juvenile Chinook will also move into the groundwater channels in the fall and spend the winter there. One lesson they learned in the southern interior of British Columbia was not to build the channels too long, as the beaver would move in and block it off. Some coho might get through to the channels but many would not be able to. Now they design their channels to reduce the risk of beaver dams.

Project 3

Determine the thermal regimes of groundwater discharge zones.

We will be measuring water temperatures at six known ground water discharge sites in the Whitehorse area. Four will be sites where we believe the water has been underground for a long time. We call this type of ground water "Regional". The other two sites will be where we believe the water has only been underground for a short period. We call this type of ground water "Local".

Ground water is something that we don't think of very often today. We'll probably be thinking more about it in the future. Parts of our Traditional Territory are rich in good quality ground water. The ground water is stored in "aquifers". These are the underground reservoirs where ground water is stored. Most of ours are in sands, gravels and larger rocks left by the glaciers. Some are in broken bedrock.

There are different ways to look at ground water discharges. For a fish, the ground water has to be free of substances that would harm it. In the Yukon these substances are usually dissolved metals. Almost all are from natural sources. As a rule the iron in these discharges leaves rusty stains as soon as it reaches the surface. Figure 19 is an example of iron staining. The water might smell like sulphur, and is often milky looking. There are no insects living in the rocks and very few plants.

Figure 19. Mineralized ground water discharge near Whitehorse. Note the iron staining and lack of seep mosses.

Figure 20. Seep mosses show where ground water discharges on river banks and even on river beds. The mosses grow best where there are rocks to anchor themselves to and where the water is fairly clear all year. On March 17 this digital thermometer measured the discharging ground water at 4°C.

Figure 21. Winter and summer views of a ground water discharge site near McIntyre Creek. At top left, the seep mosses are already green in February. At bottom left, Yellow monkey flower is the best indicator. At right, Yellow monkey flower in bloom.

Ground water is very important to fish. In small streams it provides most of the flows that keep the overwintering juvenile Chinook salmon alive. In Dezadeash Lake when the lake warms up in the summer the lake trout move into shallow water where cold water springs discharge into the lake. If something disturbed the springs it could kill off all the lake trout in the lake.

In the south of Canada and the western United States ground water is a valued resource. If there were no ground water discharges to create cool water refuges for young salmon many streams would have no salmon. It's a matter of life or death. We are probably a fair way from that happening here, but it's best to be prepared. The data that we collect on ground water temperatures today will be invaluable to those who follow us.

Conclusion

We hope that we have given you a good idea of what we intend to do and how we intend to do it. If you have any questions, please contact the TKC Lands, Resources and Heritage Department.

More information about the project can be downloaded from the TKC website: www.taan.ca