Community Observations on Climate Change

Arctic Village, Fort Yukon and Venetie, Alaska

ALASKA NATIVE
TRIBAL HEALTH
CONSORTIUM

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Note: All photos by Mike Brubaker unless otherwise indicated.

Above: Climate change was the topic at a community meeting in Venetie. Right: Sunset over the Yukon.

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USGS science for a changing world

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

“We have lived here all our lives. We know the changes that are occurring.”
Jerry Frank, First Chief, Venetie

Field Survey Participants
Brian Berube – Alaska Native Tribal Health Consortium
Mike Brubaker – Alaska Native Tribal Health Consortium
Brandon Garnett – Arctic Village Traditional Council
Albert Gilbert Jr. - Arctic Village Traditional Council
Rocky James – Gwichyaa Zhee Gwich’in Tribal Council
James Kelly – Council of Athabascan Tribal Governments
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Antonio Sisto - Venetie Village Council
Danielle Stickman – Yukon River Inter-Tribal Watershed Council
Ryan Toohey – United State Geologic Survey
Lance Whitewell – Venetie Tribal Council

We appreciate the participation and support of all of our local and regional tribal partners!

Introduction

For the Upper Yukon area, climate change has become a daily fact of life, causing a wide range of impacts to the environment, and in some cases to community health.

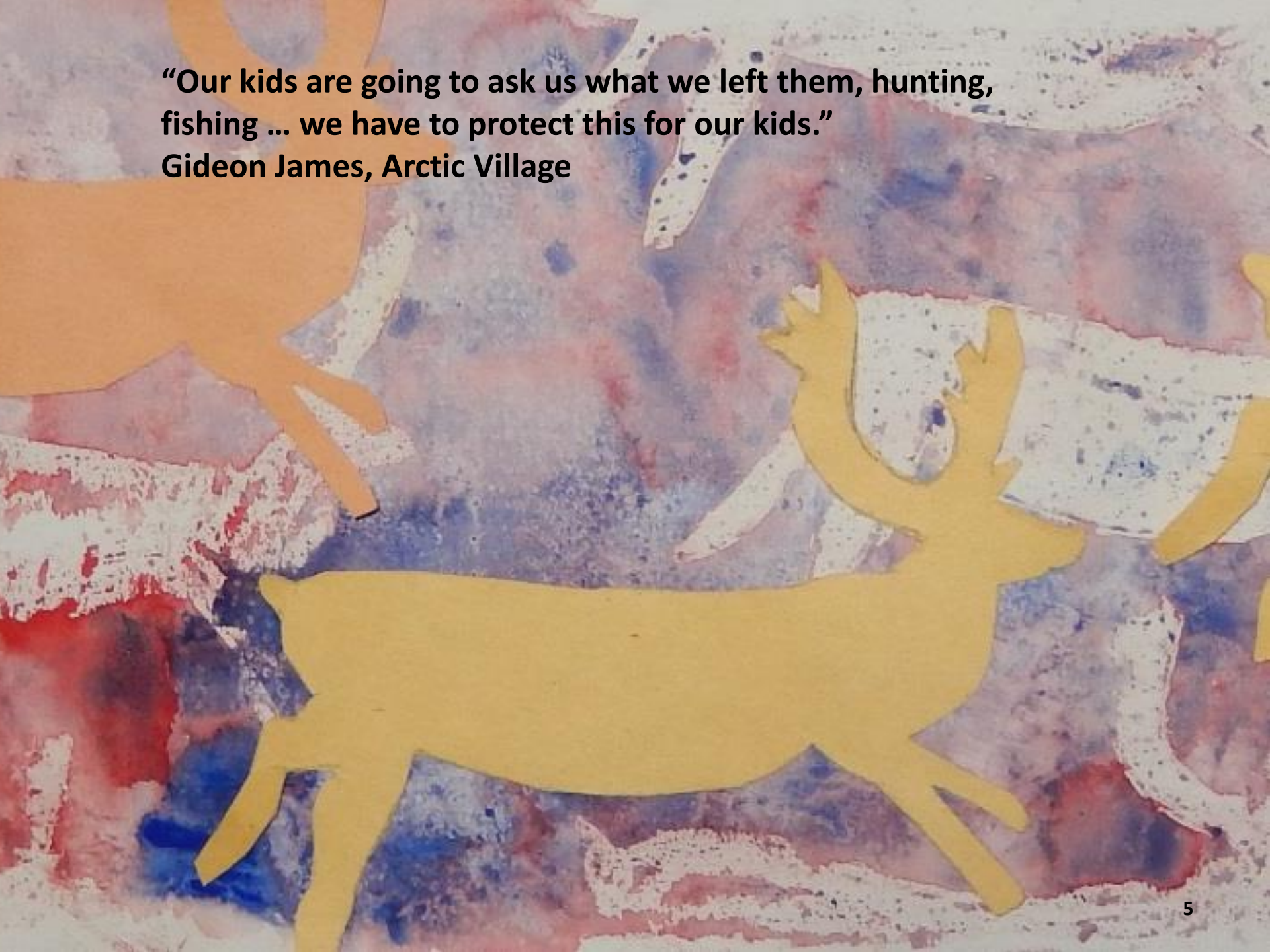
In 2015 the Alaska Native Tribal Health Consortium (ANTHC) and the U.S. Geological Survey (USGS) organized a climate change impacts assessment in Arctic Village, Fort Yukon, and Venetie.

Funding was provided by the USGS and in-kind support was provided by local tribal partners including Arctic Village Traditional Council, Gwichyaa Zhee Gwich'in Tribal Council, and the Venetie Village Council.

The assessment was also performed in partnership with three regional tribal organizations: the Council of Athabascan Tribal Governments, (CATG) the Tanana Chiefs Conference (TCC), and the Yukon River Inter-Tribal Watershed Council (YRITWC).

"I haul wood for a living. The low snow years are tough on snow machines. People sometimes hit tree stumps. I did that once and ripped a whole ski off." Jerrald John, Arctic Village

Above: The primary source for heating is wood. Dry conditions can result in a surplus of dead trees, good for firewood. However, low snow conditions in recent years have impacted travel conditions and access to firewood.


“Our kids are going to ask us what we left them, hunting, fishing … we have to protect this for our kids.”
Gideon James, Arctic Village

The information from community surveys also include findings from a 2012 Fort Yukon survey performed by ANTHC and funded by the U.S. Environmental Protection Agency.

Fort Yukon site visits were performed August 10-12, 2012 and July 15–16, 2015 Arctic Village visits were January 4–5, 2016 and August 8-9, 2016. Venetie site visits were January 6-8, 2016 and August 8-12, 2016. A project presentation was made in Fort Yukon at the CATG 30th Anniversary meeting on August 20, 2015.

Each assessment included at least one community tour, interviews with key environmental and health staff, health clinic, water plant and solid waste site tours, school and classroom visits, river survey, meeting with tribal staff and leadership, public meeting. Local Environmental Observer (LEO) Network training for tribal environmental staff, and the installation of time lapse cameras to help monitor environmental change.

Above: Staying cool. Fort Yukon has the state high temperature record. With increasing summer heat, residents are early adopters of cooling technology like air conditioning, a rarity in Alaska. An air conditioning window insert can be seen in the back wall of the tribal council office in Fort Yukon.

Right: These solar panels at the tribal council office in Fort Yukon generate enough energy in summer to power the interior air conditioning units.

As climate change is reducing the cost of heating, it is also increasing the need for cooling. Air conditioning systems were, until recently, virtually unheard of in the Arctic. Fort Yukon is one of the first rural communities in Alaska to implement air conditioning in homes and public buildings.


“We had 86 degrees fahrenheit on the 26th of June 2015.
When have we ever seen temperatures like that!”
Charlie Swaney, Arctic Village

Background

Along the upper Yukon, and the Chandalar River, residents describe change in the timing of seasons, frequency of unusual weather events, decrease in ice and snow, increasing temperatures, wildfire, lake and creek drying, river change, erosion, and vegetation growth.

Climate change is also associated with plants, fish, insects and animals emerging at times and in places where and when they were not seen before, raising questions about the implications for salmon, caribou, waterfowl, wild berries and other subsistence resources.

The tribal health system recognizes the importance of understanding the connections between climate change, environmental impacts and health effects. Including the potential for disease, injury, food and water insecurity and the impacts on critical health infrastructure.

The purpose of this assessment is to begin to document effects both positive and negative on community health.

Above: Rocky James and Albert Thomas catch dinner from the Yukon River during a 2012 survey.

Right: A fish wheel on the shore in Fort Yukon, out of commission because of a fishing closure.


“If the temperature continues to rise on the Yukon, we may never see any fish again.”
Jerry Frank, Venetie

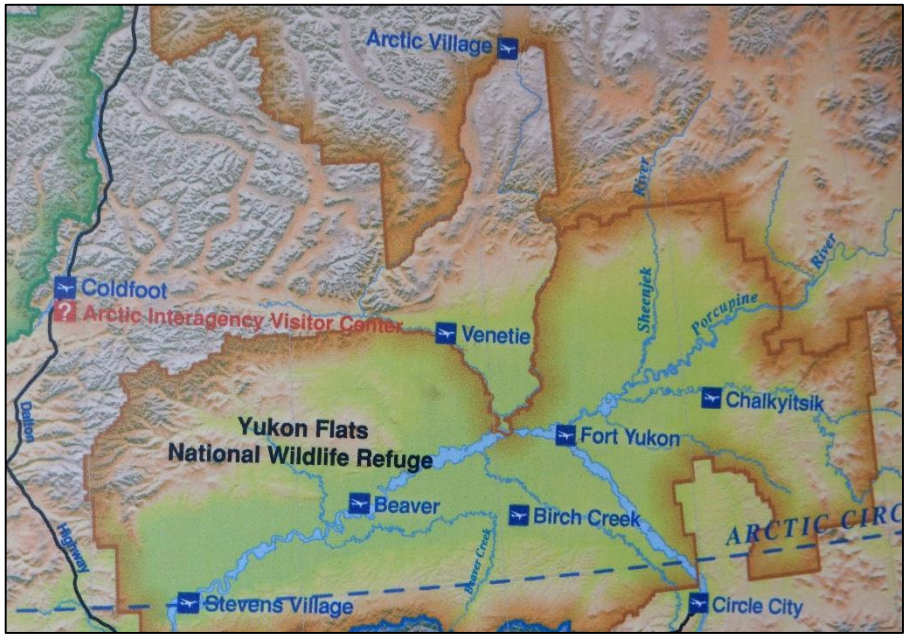
The Region

The communities are located within the Yukon River watershed which starts at the Llewellyn Glacier headwaters in British Columbia, and extends all the way to the Bering Sea. The watershed covers an area of 321,500 square miles. The word *Yukon*, is derived from the Gwich'in language and refers to the color of the river, rich with glacial silt.

Fort Yukon is located on the river and only two other communities (Eagle, Circle) lie between it and the Canadian border. Arctic Village and Venetie are located to the north, on the Chandalar, a tributary of the Yukon River.

Much of the area is encompassed within the Yukon Flats National Wildlife Refuge, which covers over 10 million acres. The Yukon Flats area is in itself a vast region with diverse landscapes, mountains, tundra, and lake-dotted wetlands, mixed forests of conifers and deciduous trees, and the many tributaries that feed the Yukon.

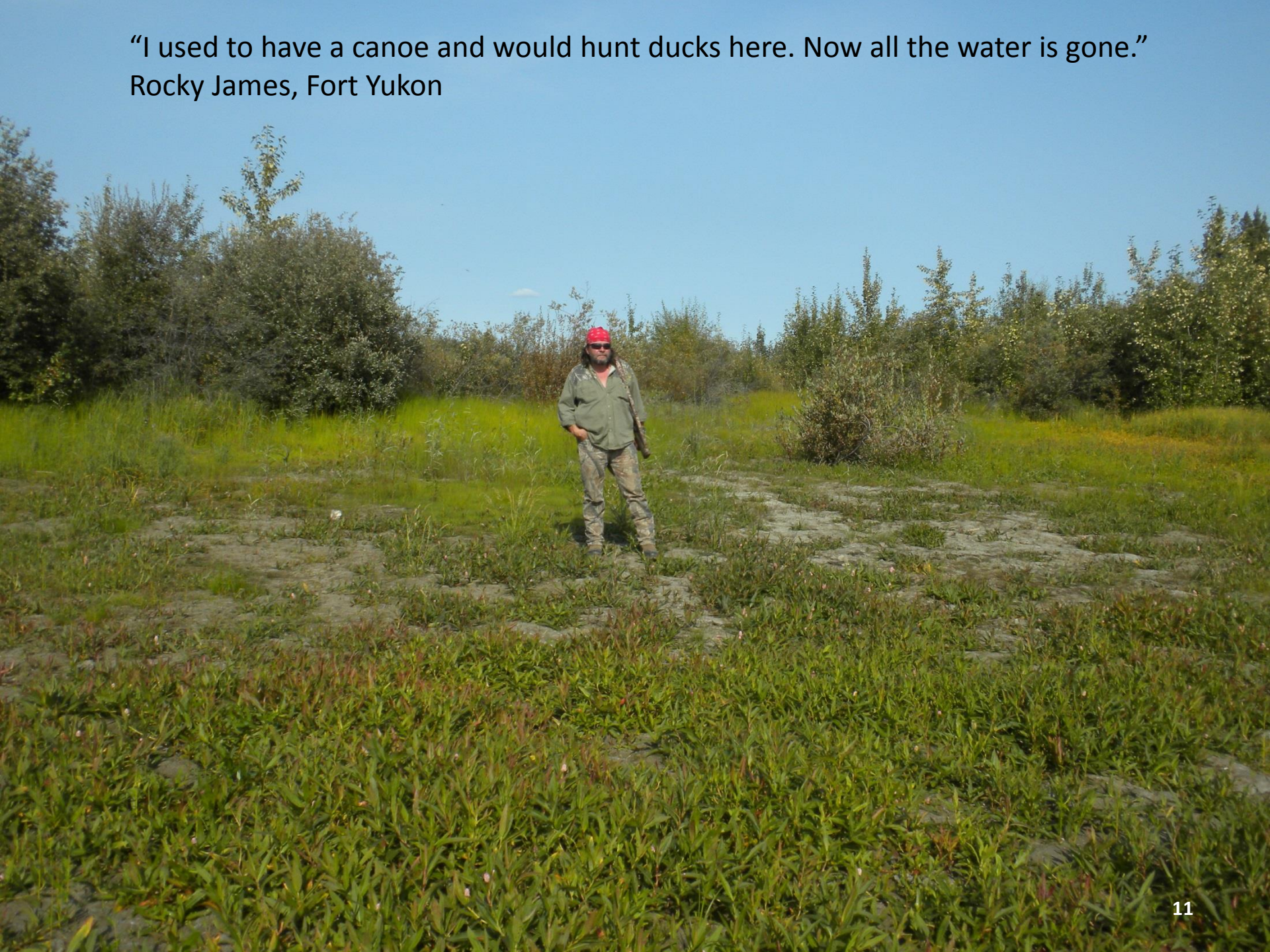
"For some reason, last September was raining all the time. There was water running all over the place." Eddie Frank, Venetie



Above: Map of the Upper Yukon Region. Source: Yukon Flats National Wildlife Refuge.

This is critical habitat for birds, fish, mammals, and people. It provides the Gwich'in Athabascan with clean air and water, and a range of subsistence resources that support healthy traditional lifestyles. Today the region is rapidly changing as a result of climate change.

“I used to have a canoe and would hunt ducks here. Now all the water is gone.”
Rocky James, Fort Yukon

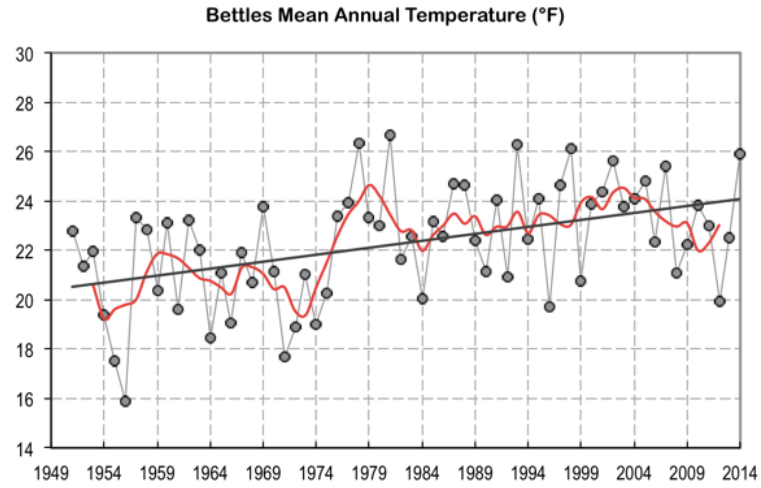


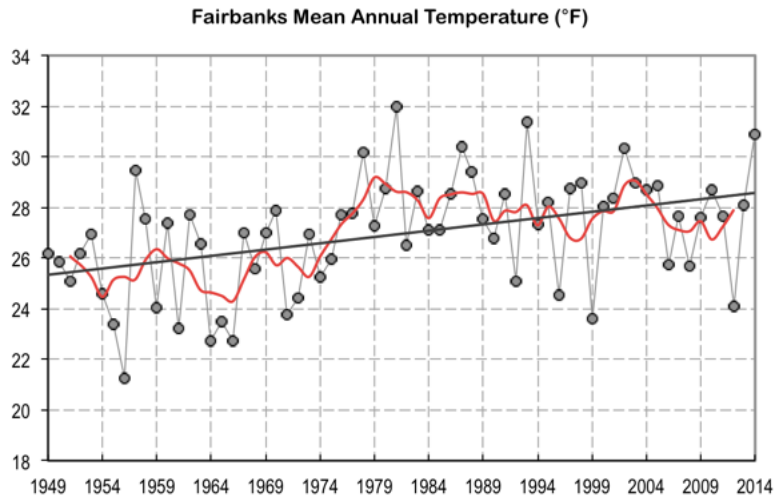
The New Climate

"Climate" describes a long term condition, as opposed to day to day "weather". With rapid change occurring, defining 'the new climate' is challenging. Scientists use historic data to develop projections for future conditions. But there are only a few long term weather stations in Alaska. The closest to the these communities is Bettles located about 140 miles west of Venetie or Fairbanks which is about the same distance from Fort Yukon.

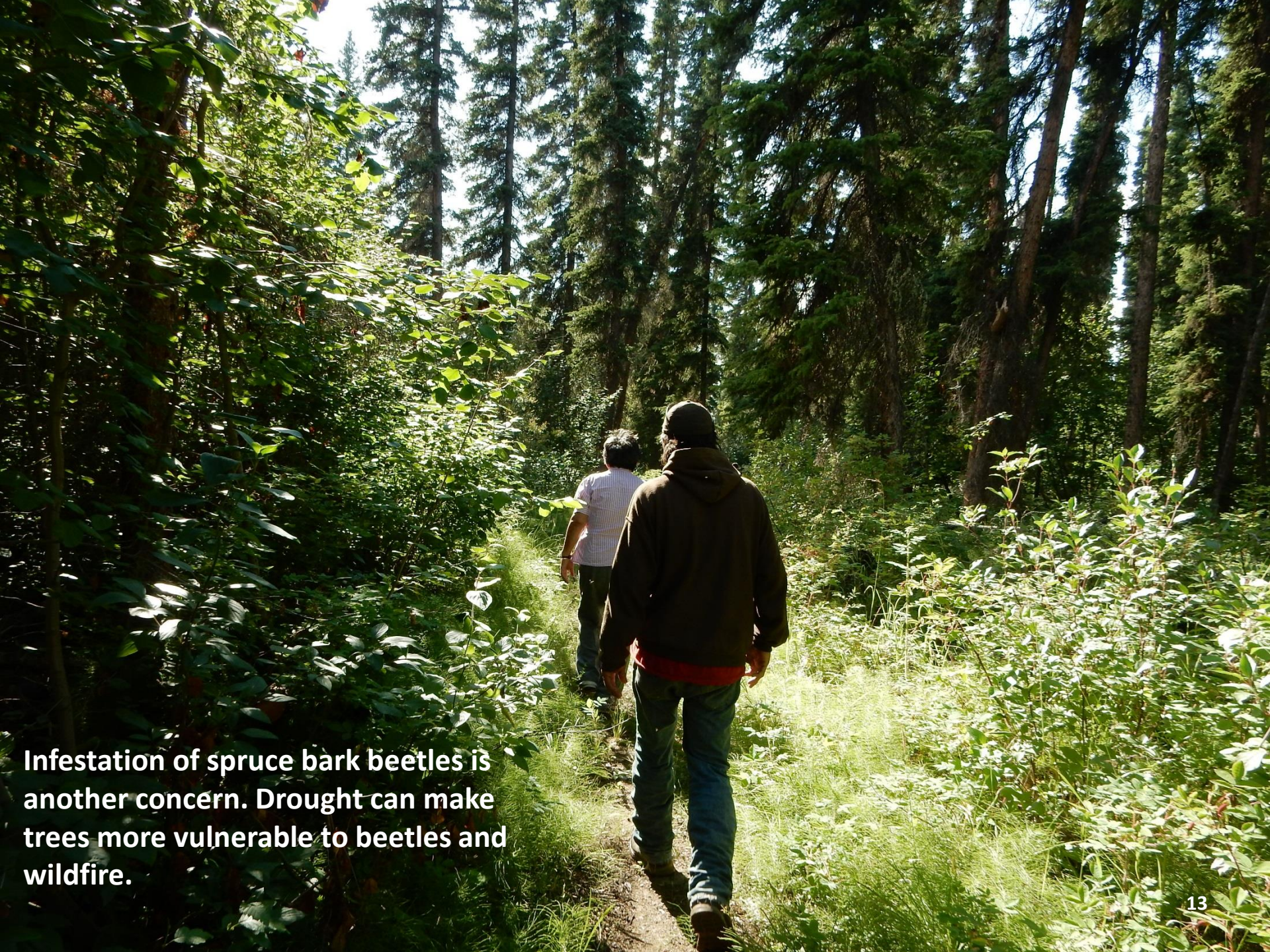
Mean annual temperature trend data is available from the Alaska Climate Science Center. The record shows a lot of year to year variation, but a definite gradual temperature increase (about 3 degrees) between 1949 and 2014. Both stations have seasonal differences, with the biggest change (about 7 degrees F) occurring in winter, and the least (1-2 degrees F) occurring in autumn. Climate models have been developed by the Scenario Network for Alaska and Arctic Planning (SNAP), for temperature and precipitation through 2099. These are included in the community section of this report.

"When I was a boy, everything was so nice, the cycles of the year were perfect. Life was healthy, but humans have caused all of this to tilt." Gideon James, Arctic Village



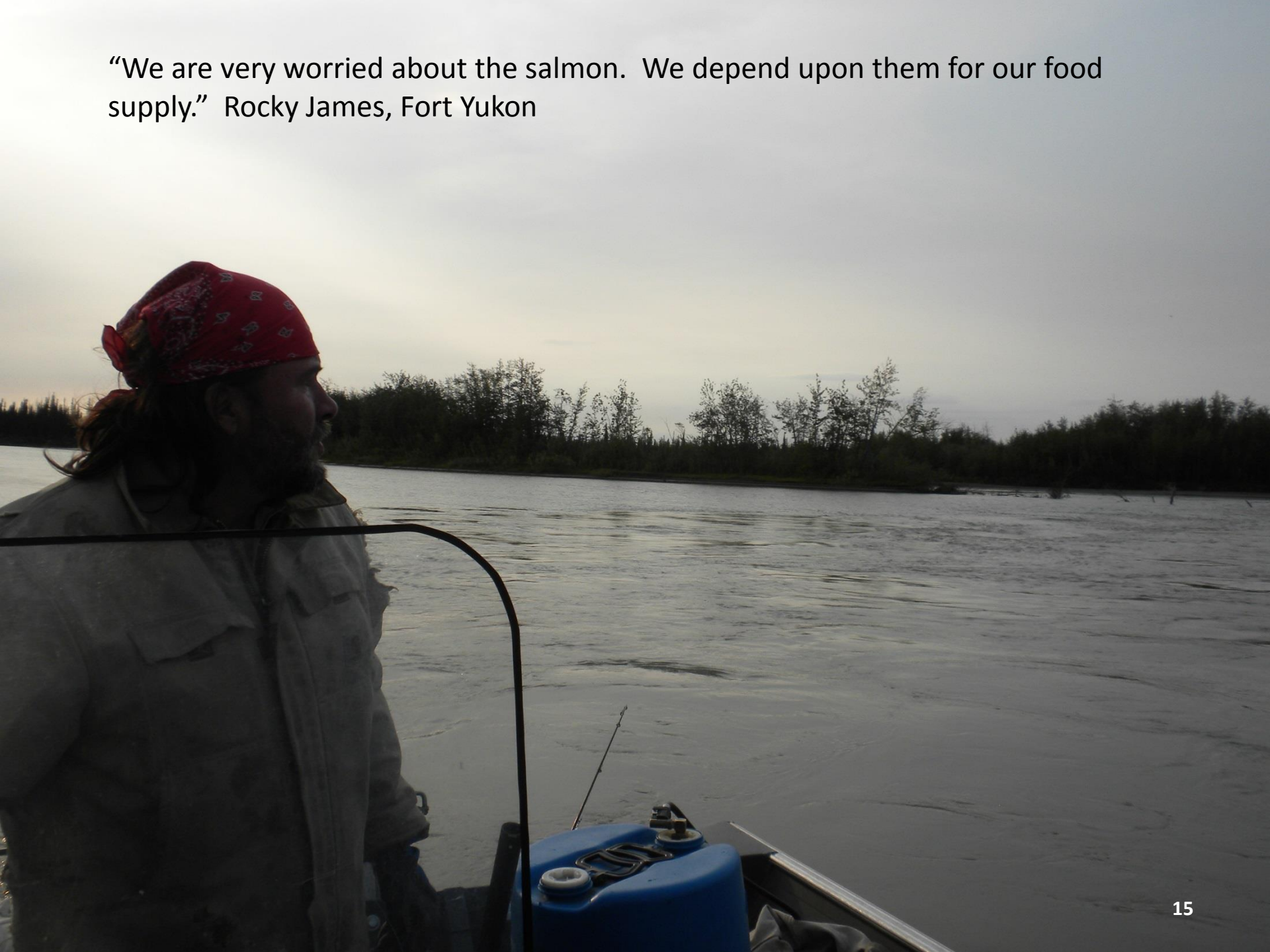


Source: Alaska Climate Science Center



Infestation of spruce bark beetles is another concern. Drought can make trees more vulnerable to beetles and wildfire.


A longer growing season can result in abundance, or conditions that are too hot and dry for Arctic plants.



"We are very worried about the salmon. We depend upon them for our food supply." Rocky James, Fort Yukon

Communities

This section provides an overview of each of the three communities included in the assessment. The location on the river, landscape, community population, local services and climate change related concerns are all included in the discussion.

During the assessments key observations were shared by community members, both about recent change, and changes that have occurred over decades or a lifetime.

Although each community is different, there were common impacts reported and shared concerns about extreme weather, drought, changes in the river channel, bank erosion, lake drying, vegetation change, and about the health of people and subsistence resources.

In the following pages, selected key observations and photos are provided to help characterize the conditions in the communities, as well as throughout the region.

"We see birds around here we have never seen before. We are shooting different kinds of ducks and eider species."
Gerald James, Venetie

Above: Main street Arctic Village. January 2016.

Right: A view of the church in Venetie, located at the old village site. The village was moved up on to the bluff in the 1960s, because of flood risk.


“I think we are a really lucky community that we are now up on the bluff and away from the river.” Jerry Frank, Venetie Alaska

Fort Yukon

Fort Yukon is one of Alaska's oldest communities. It is located above the Arctic Circle on the north bank of the Yukon River. Established in 1847 as a Hudson Bay Trading Post it has survived through booms and busts, epidemics, wars and floods. Today with a population of over 600, it is the largest Athabascan community in Alaska. At its heart, Fort Yukon is a subsistence community. People travel by snow in winter and by water in summer harvesting salmon , caribou, moose, geese, wild plants and berries.

The climate is one of the most extreme in Alaska, hot in summer and bitter cold in winter. The state record temperature of 100 degrees was set in Fort Yukon June 27, 1915. Streets lined with log homes are unique to the Interior. Heating is largely by wood stove. Air conditioners cool community buildings. Barges bring goods during the summer, and there are daily flights year round. There are stores, a post office, school, church, community center, radio station and a regional health clinic. The water supply is groundwater and there is piped water and sewer.

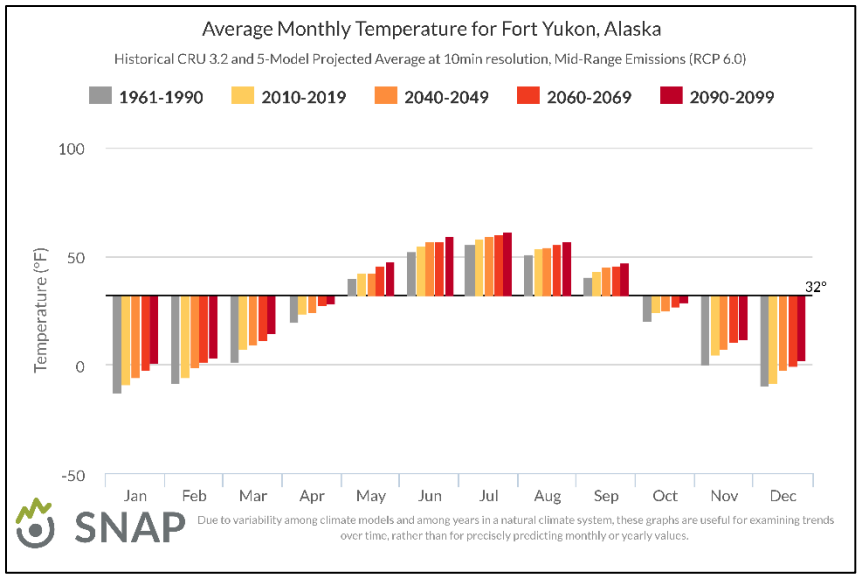
Climate Change Issues

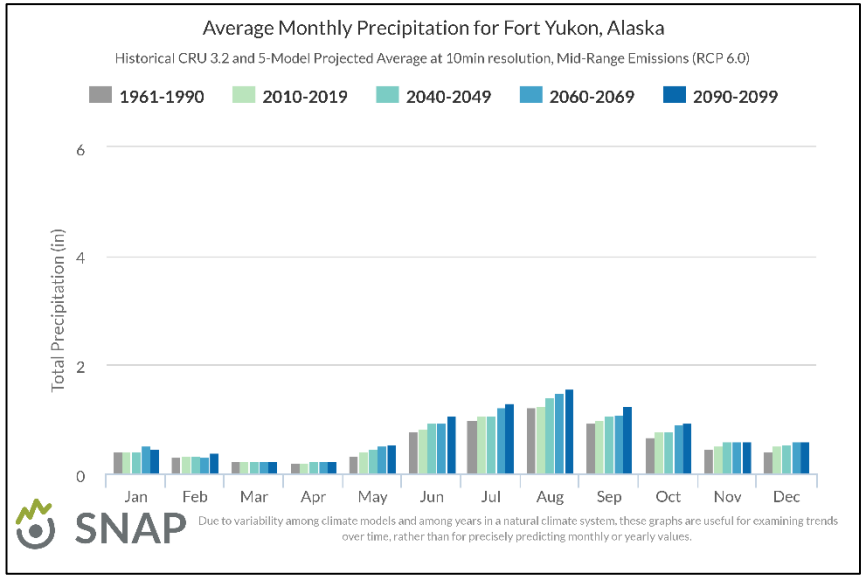
- River change
- Erosion
- Drought
- Extreme weather
- Salmon health and abundance
- Caribou and moose decline
- Wildfire and related smoke
- Snow and ice decline

Above: The landing at Fort Yukon.
Right: Example of shallow and braided channel of the Yukon River.


“The river is becoming more braided, difficult to travel.”
Albert Thomas, Fort Yukon

Fort Yukon Climate Models





Above: Temperature and precipitation model graphs.
Right: Bank erosion at a fish camp on the Yukon River.

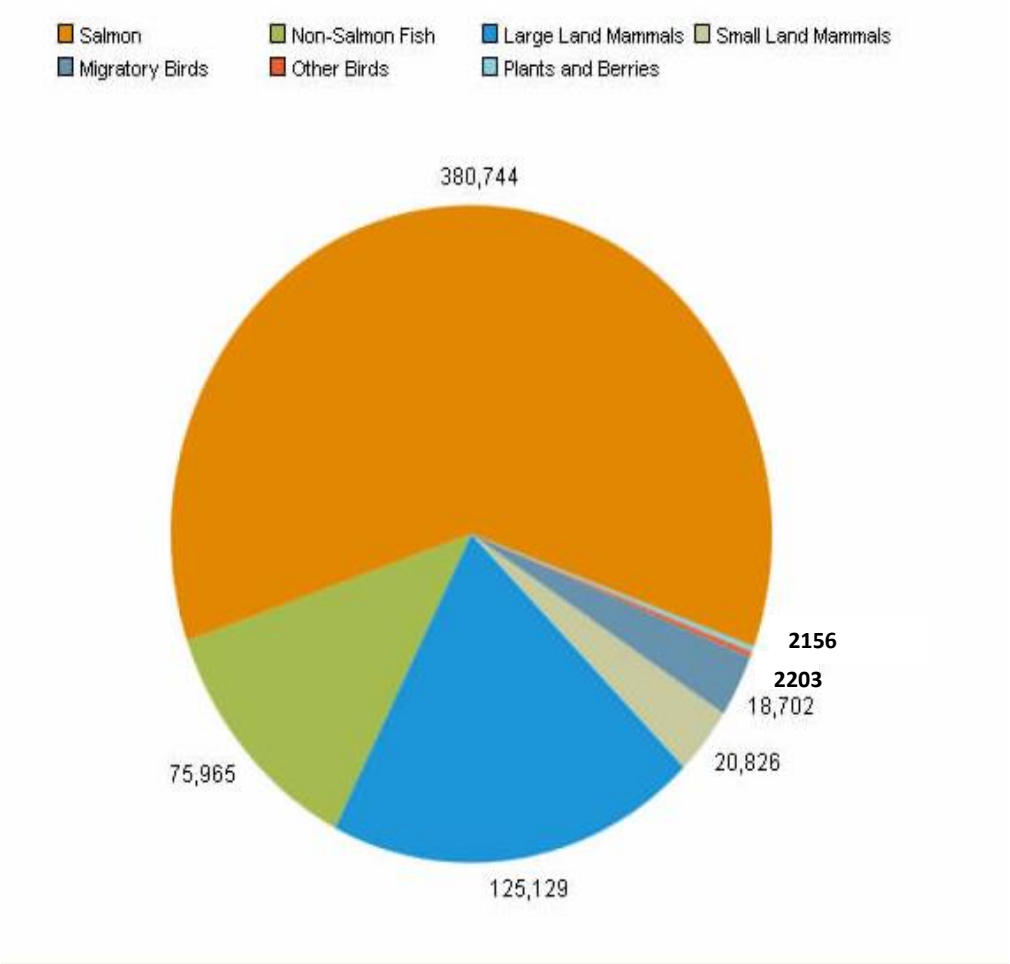
Temperature is projected to increase in every month, with the largest increases occurring in the winter. Precipitation is projected to have significant increases in the summer. See SNAP community charts. Based on these records, the new climate is warmer and at least in the summer, wetter.


“Some camps have fallen into the river.”
Albert Thomas, Fort Yukon

November 1, 2012. Source: LEO Network.

“This salmon that I am holding was caught by an elder in Fort Yukon, Nat Englishoe. It’s probably a silver salmon. Through the ice in the Yukon River. Salmon!! First time many of us have seen this, though a few in town say they have seen this before. The water is still open and although it has been -40 F. Crazy huh? The conditions are weird, and we do not usually see salmon so late. We got very little salmon this summer because of the king salmon crisis.”

Rocky James, Fort Yukon



Above: ADFG Harvest Profile – Fort Yukon Alaska 1987.

The chart shows the annual pounds of wild foods including salmon (orange wedge) the largest percentage of harvest at over 380,000 pounds. Today, for a variety of reasons, residents are experiencing regular harvest failures both for salmon and large land mammals such as caribou – the number one and number two largest categories. An update of the overall harvest level is recommended to understand current harvest and food security.

Arctic Village

Arctic Village is located on the east fork of the Chandalar River about 200 miles up stream from Venetie. Historically the river has been ice free from the end of May through mid September. At an elevation of about 2000 feet, the village is located in a broad river plain dotted by lakes, adjacent to the Brooks Mountain and Gates of the Arctic National Wildlife Refuge.

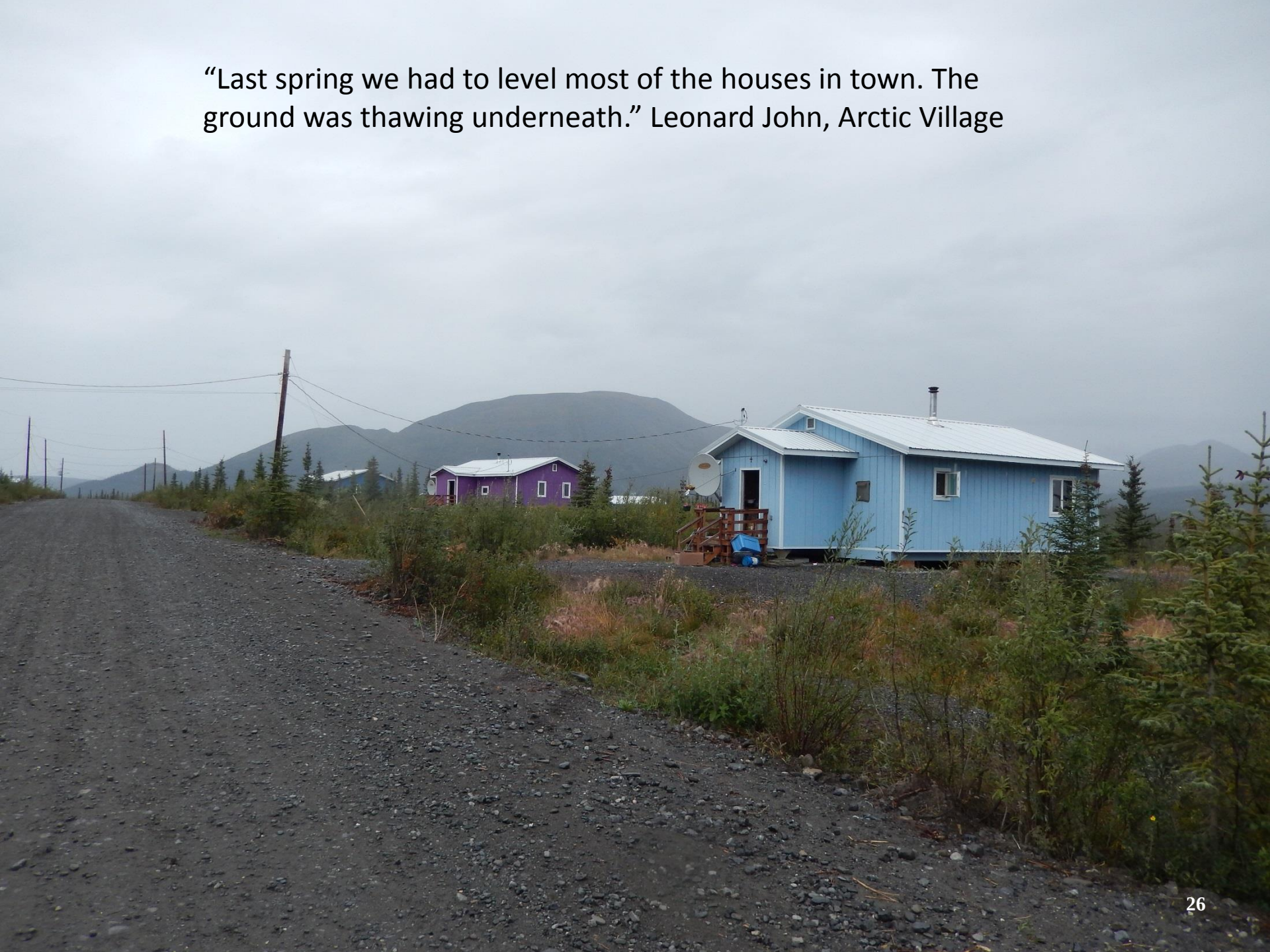
The site has been used seasonally by the Gwich'in People for thousands of years. It became a year round settlement in 1900 and today has a population of around 150 residents. Subsistence is important for the economy and culture with residents harvesting salmon and white fish, caribou, moose, plants and berries.

Wood is another important resource. The homes are largely of log construction. Heating is by wood stove. Access is exclusively by air, due to the shallow waters. There are daily flights year round, a store, a post office, school, church, community center, and a health clinic. The water supply is from the river and there is a washeteria for laundry. Most homes have out houses.

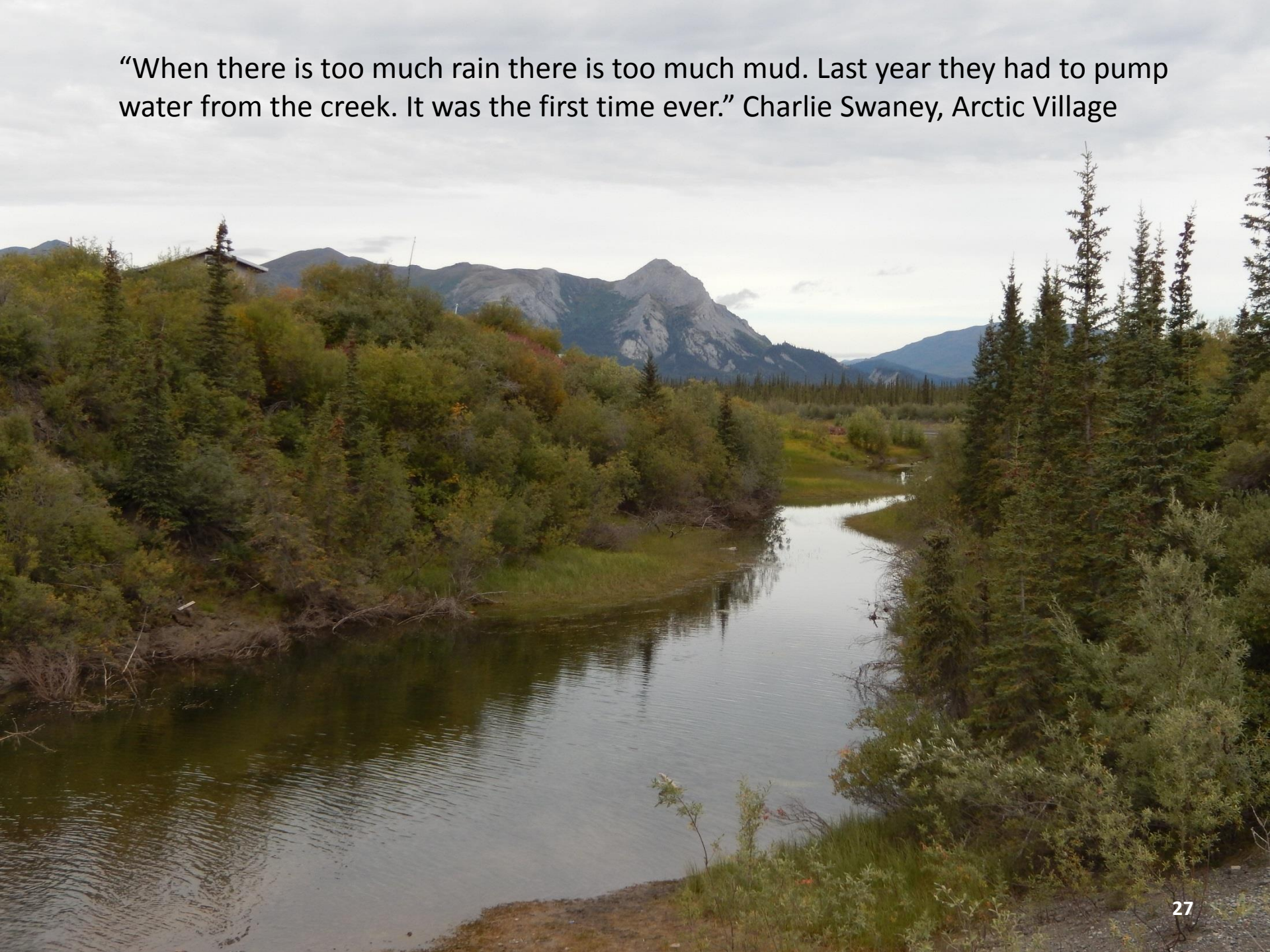
Climate Change Issues

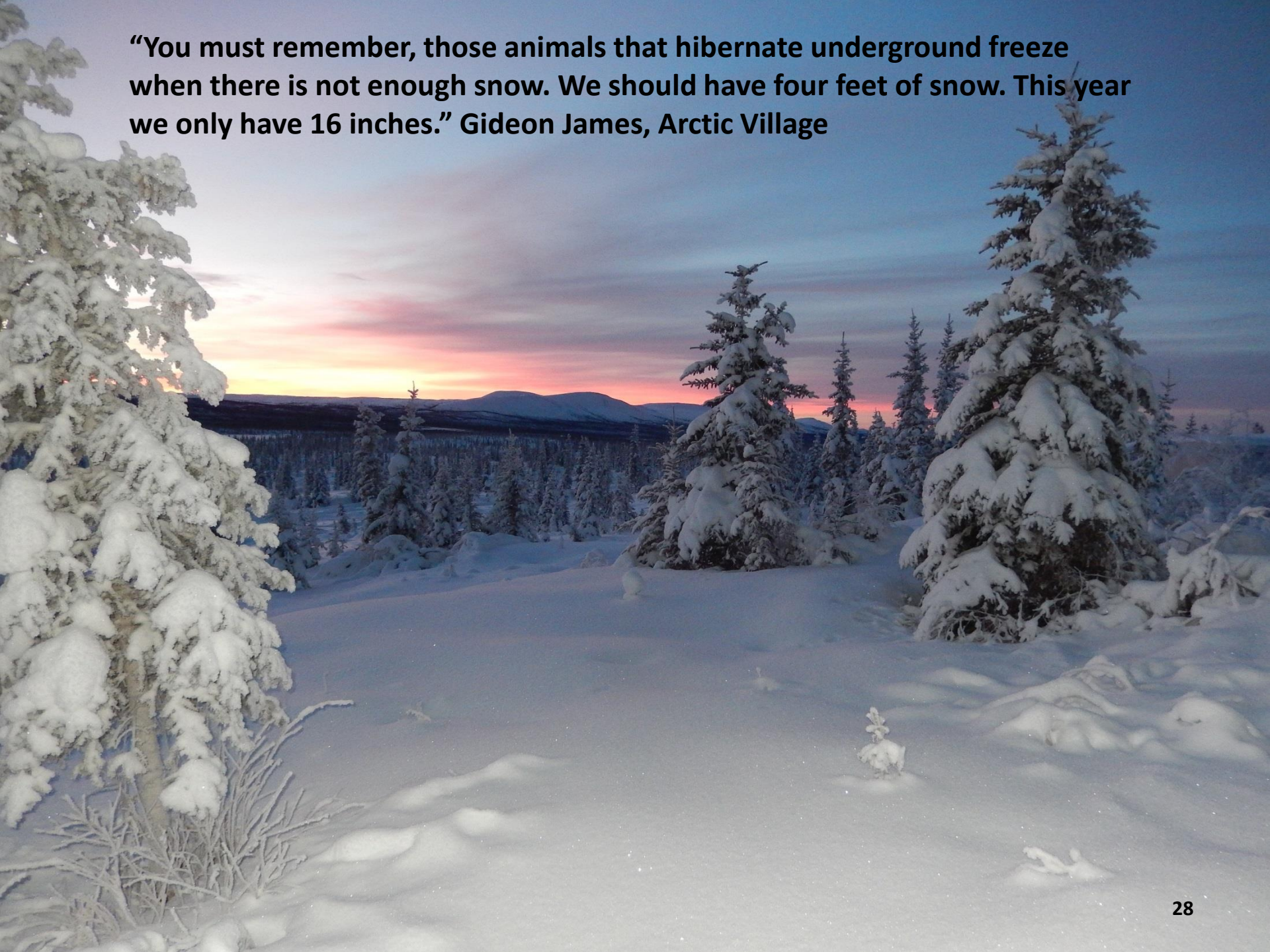
- River level and water quality
- Fish species / population shift
- Caribou and moose decline
- Wildfire and related smoke
- Snow and ice decline
- Erosion
- Warm winters

Above: View of central Arctic Village from Church Hill.
Right: Aerial view of Arctic Village.


“Last spring we had to level most of the houses in town. The ground was thawing underneath.” Leonard John, Arctic Village

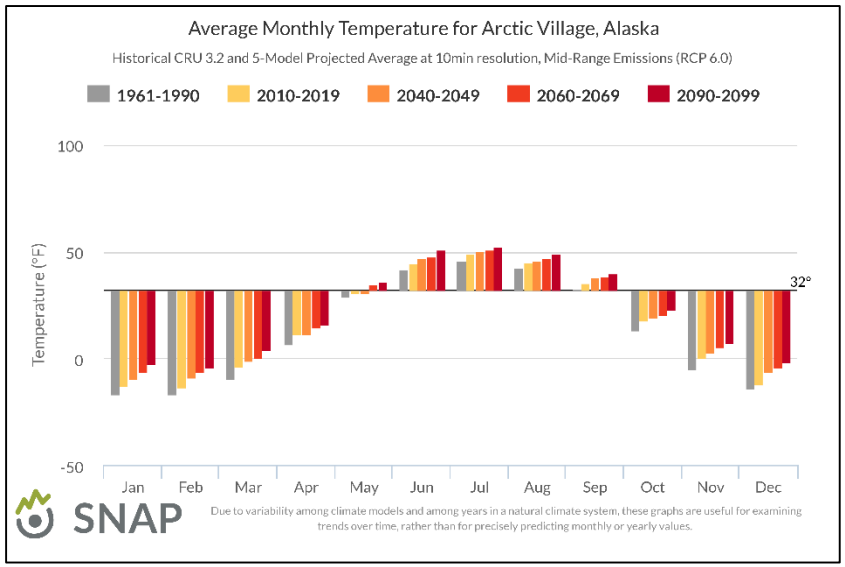
“When there is too much rain there is too much mud. Last year they had to pump water from the creek. It was the first time ever.” Charlie Swaney, Arctic Village

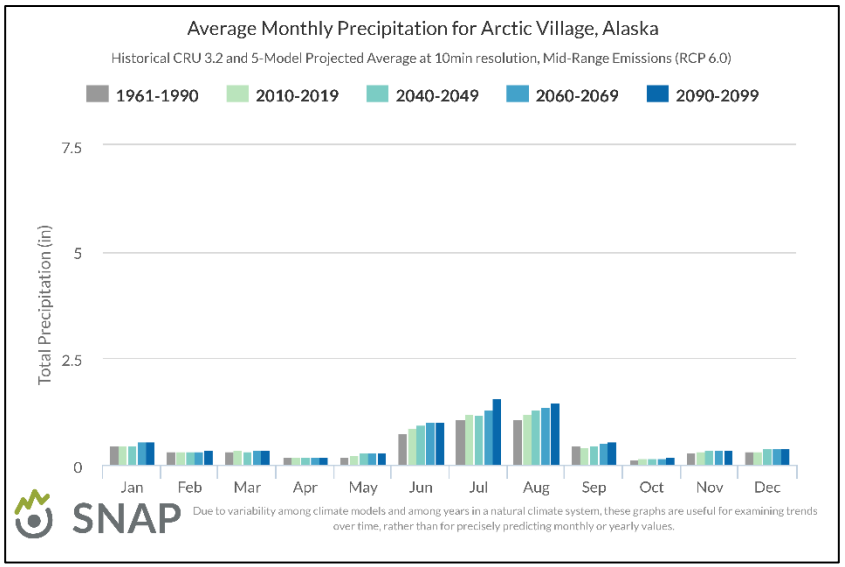




“You must remember, those animals that hibernate underground freeze when there is not enough snow. We should have four feet of snow. This year we only have 16 inches.” Gideon James, Arctic Village

Arctic Village Climate Models

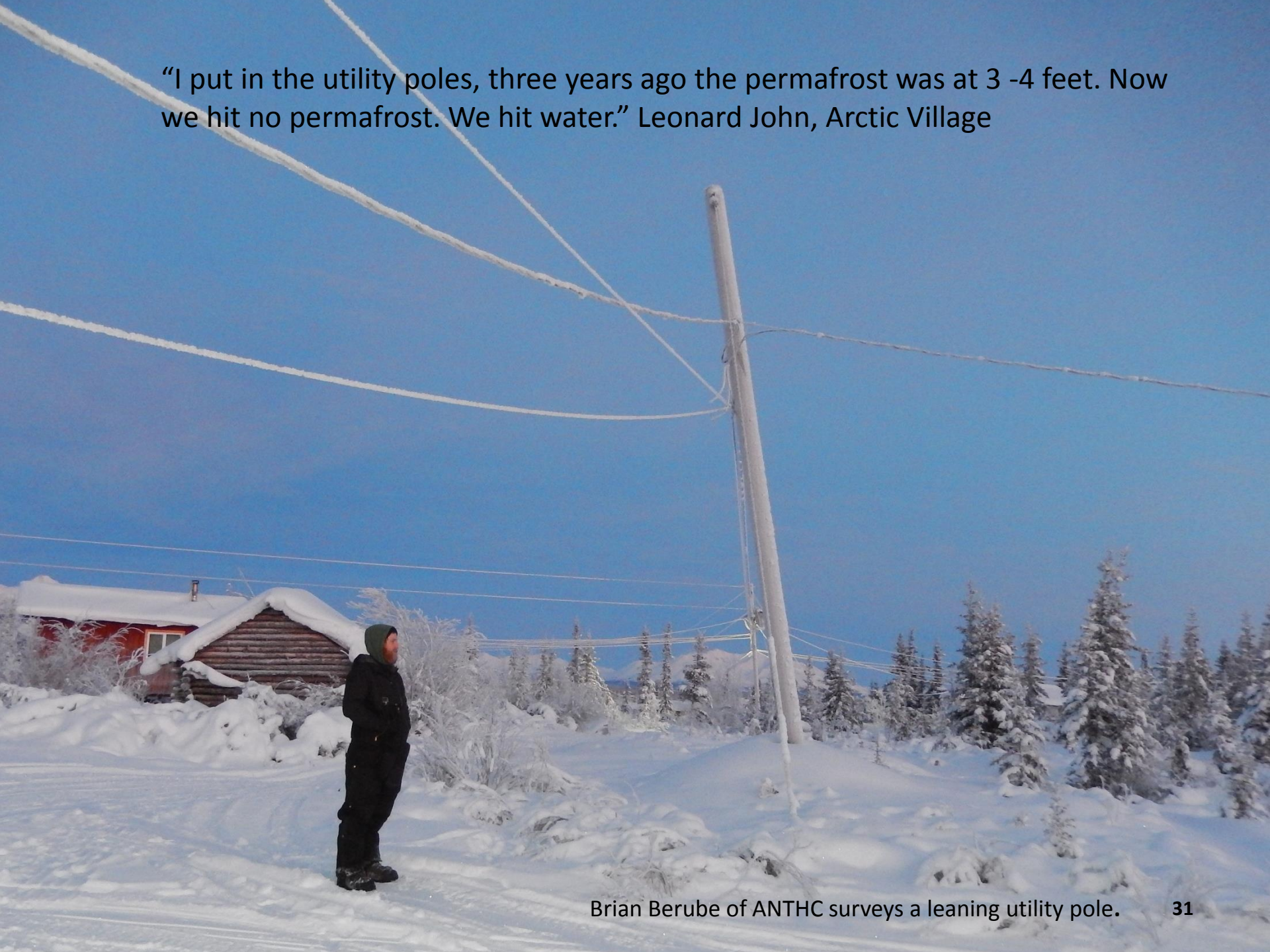




Above: Temperature and precipitation model graphs.

Temperature is projected to increase in every month, with the largest increases occurring in the winter. Precipitation is projected to have significant increases in the summer. See SNAP community charts. Based on these records, the new climate is warmer and at least in summer, wetter.

“The overflow on the river is already bad - in January. We usually do not see it like this until March! All of the creeks on the side of the hills are gushing water.”
Charlie Swaney, Arctic Village



"I put in the utility poles, three years ago the permafrost was at 3 -4 feet. Now we hit no permafrost. We hit water." Leonard John, Arctic Village

Brian Berube of ANTHC surveys a leaning utility pole.

“The river is really low, only a foot deep now. We had low water in the lake one winter. The lake froze to the ground.” Charley Swaney, Arctic Village

“Two years ago the water level was so low the river froze to the bottom. The operator could not pump water.” Racheal Lee, Tanana Chiefs Conference

Adaption Case Study
Keeping Health Clinics Cool and Clean

Keeping cool is a growing challenge in Interior Alaska. This is the warmest part of the state and climate change is resulting in summer temperatures that are even higher. Health clinic staff in Arctic Village, Venetie and many communities have reported problems with keeping clinics cool.

In Alaska most health clinics rely on open windows, outside air, and a breeze for cooling. But the outside air is not always cooler, or healthier. Dust, pollen and smoke are common problems. Closing windows is often necessary to limit these air pollutants. That means buildings can get very hot. Keeping the temperature in clinics at the right temperatures is important for patient comfort and for storage of medicine and supplies.

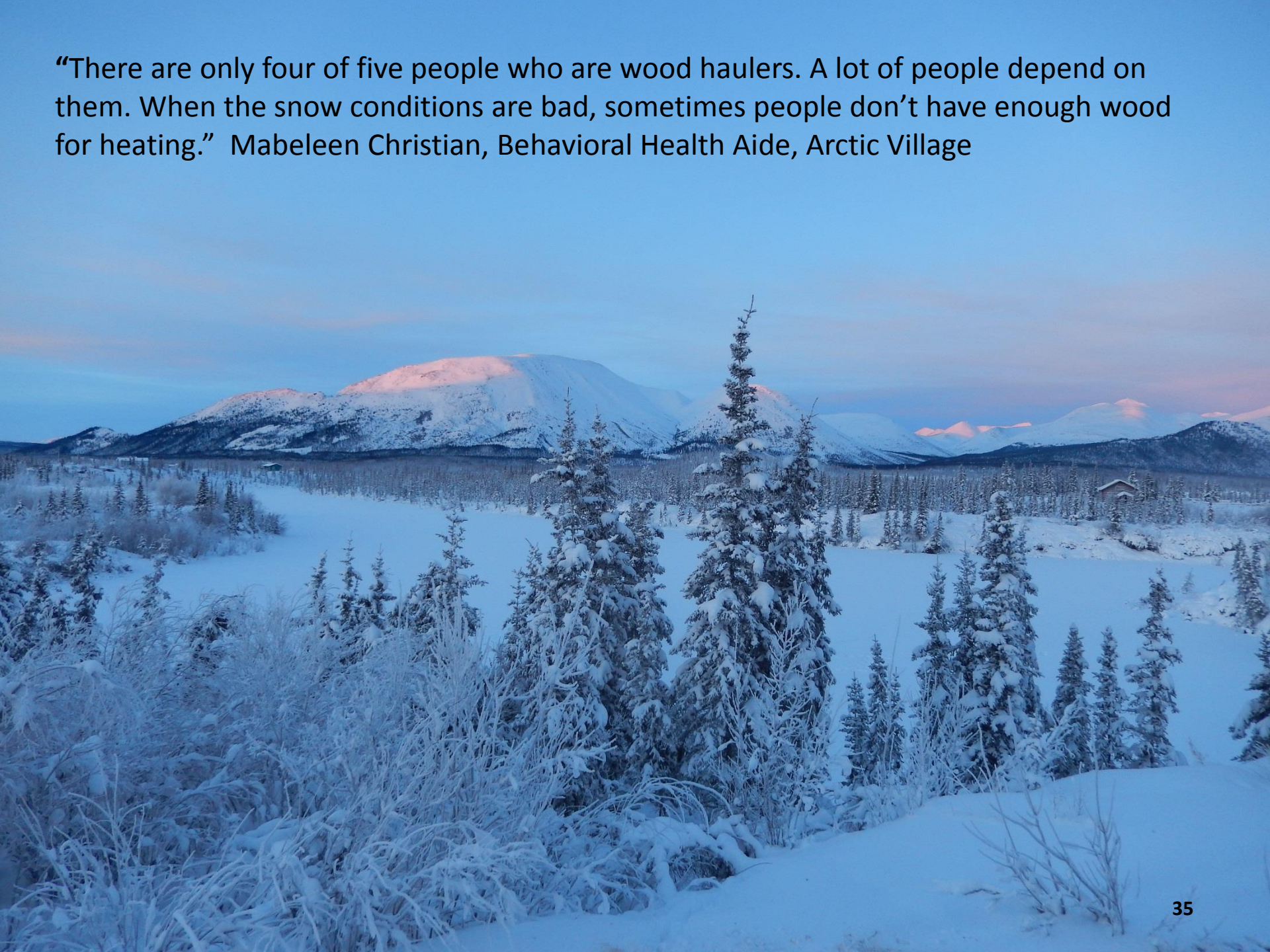
Fort Yukon has an innovative clinic cooling system and there is a growing use of small air conditioning units in public buildings and even homes. Integrating cooling and air filtration systems into clinics and other buildings is recognized as a priority for many communities. Patient comfort is a priority, but so is finding affordable, energy efficient systems.

Cooling Challenges

- Rising temperatures
- A longer warm season
- Arctic construction standards
- More wildfire smoke
- More allergy-causing pollens
- Dust, wood smoke, exhaust
- Problem heating systems
- Cost of cooling systems
- Access to cooling / filtration systems

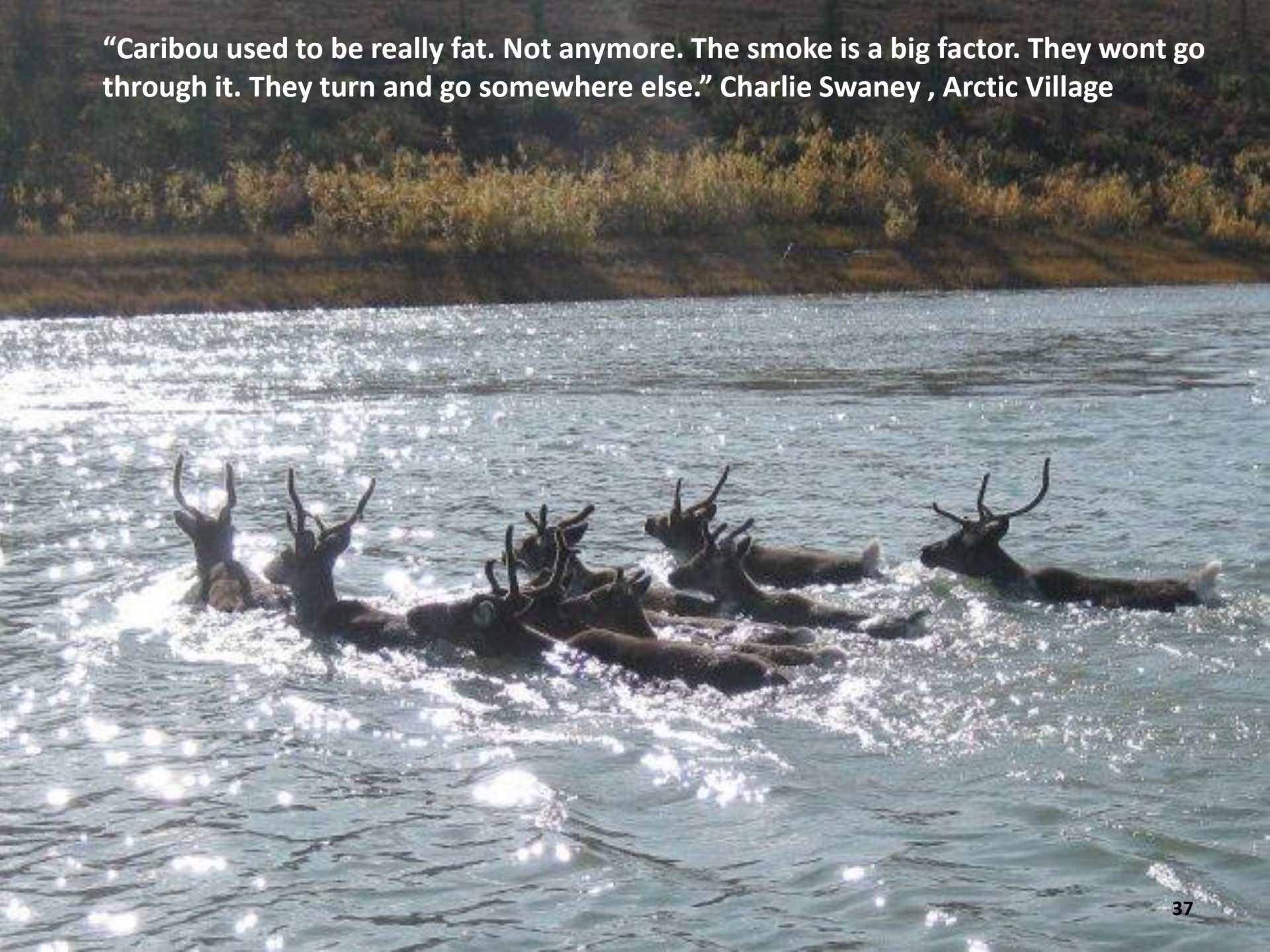
Above: The clinic in Fort Yukon is one of the few in Alaska equipped with an air cooling system, providing summer refuge in one of the hottest communities in Alaska.

"There have been times when we had both doors open and the fan running just trying to keep the clinic cool. And we are seeing allergies in people who have never had allergies before."
Sheena Tanner, Community Health Aide, Arctic Village

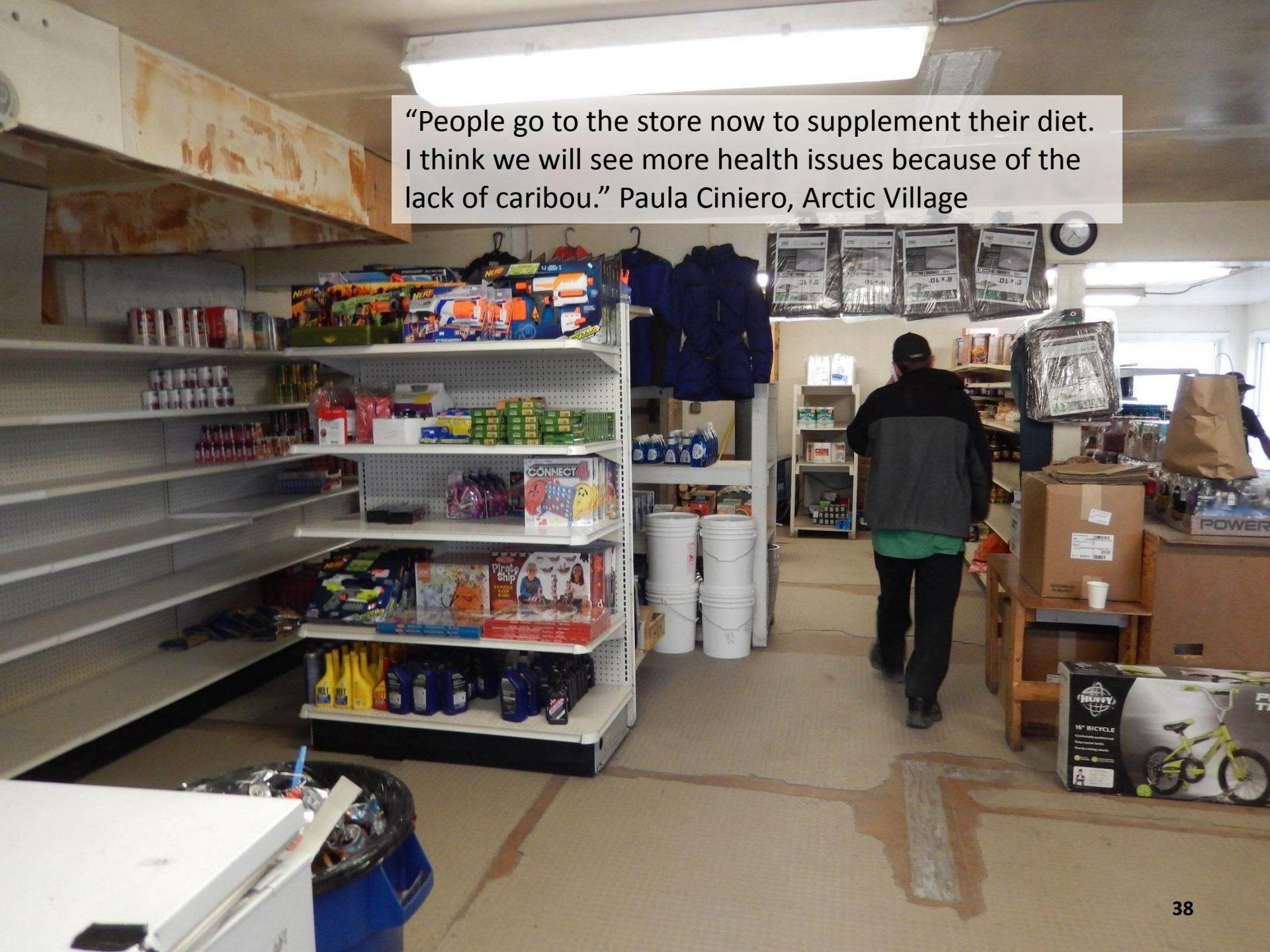


“There are only four of five people who are wood haulers. A lot of people depend on them. When the snow conditions are bad, sometimes people don’t have enough wood for heating.” Mabeleen Christian, Behavioral Health Aide, Arctic Village


“There are more willows now and more moose.” Audrey Tritt, Arctic Village



“Caribou used to be really fat. Not anymore. The smoke is a big factor. They wont go through it. They turn and go somewhere else.” Charlie Swaney , Arctic Village


"People go to the store now to supplement their diet. I think we will see more health issues because of the lack of caribou." Paula Ciniero, Arctic Village
NERF
CONNECT 4
Pirate Ship
HUFFY
16" BICYCLE


“In September 2013, my out board broke down 30 miles away. I walked along the mountain hillside. Every 100 feet I saw a slide. There were big sink holes (20') with trees in them.” Charley Swaney, Arctic Village

Venetie

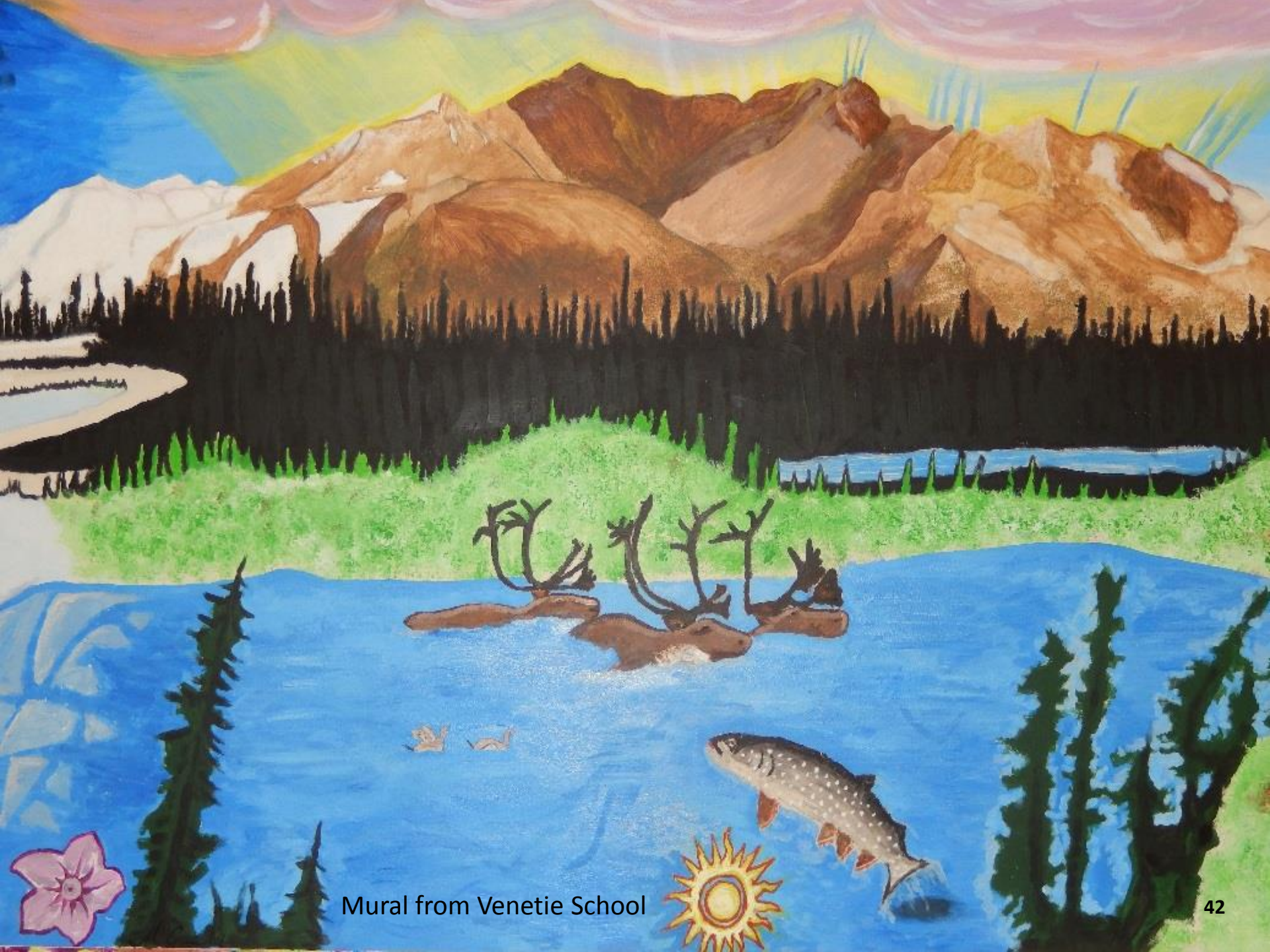
Venetie is located on the east fork of the Chandalar River about 45 miles up stream from Fort Yukon. Historically the river has been ice free from the end of May through mid September. At an elevation of about 500 feet, the village is located in a broad river plain dotted by lakes, adjacent to the Brooks Mountain and Gates of the Arctic National Wildlife Refuge.

A settlement was established in 1895. In 1943 it became a reservation in part to help protect the resources of the area. Today with a population of about 150 resident, residents continue to harvest salmon and white fish, caribou, moose, plants and berries among others.

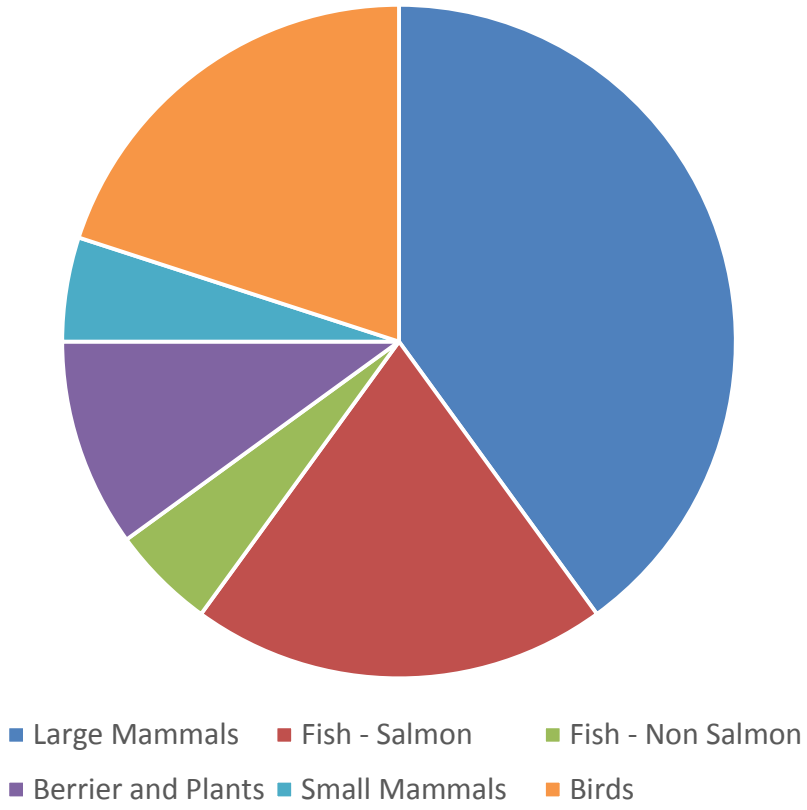
As with the other communities, wood is an important resource. The homes are largely of log construction. Heating is by wood stove. Access is exclusively by air, due to the shallow waters. There is a store, a post office, school, church, community center, and a health clinic. The water supply is from the river and there is a washateria. Some homes are served by piped water and sewer. Some use outhouses.

Above: Church at old village site, Venetie. Right: aerial view of Venetie.

In 1971 as part of the ANCSA settlement, Venetie and Arctic Village formed the Native Village of Venetie Tribal Government which manages 1.8 million acres of the former reservation lands.



Mural from Venetie School



Average annual harvest in Venetie 2016 (percentage) as estimated by James Martin.

Lake and River Change

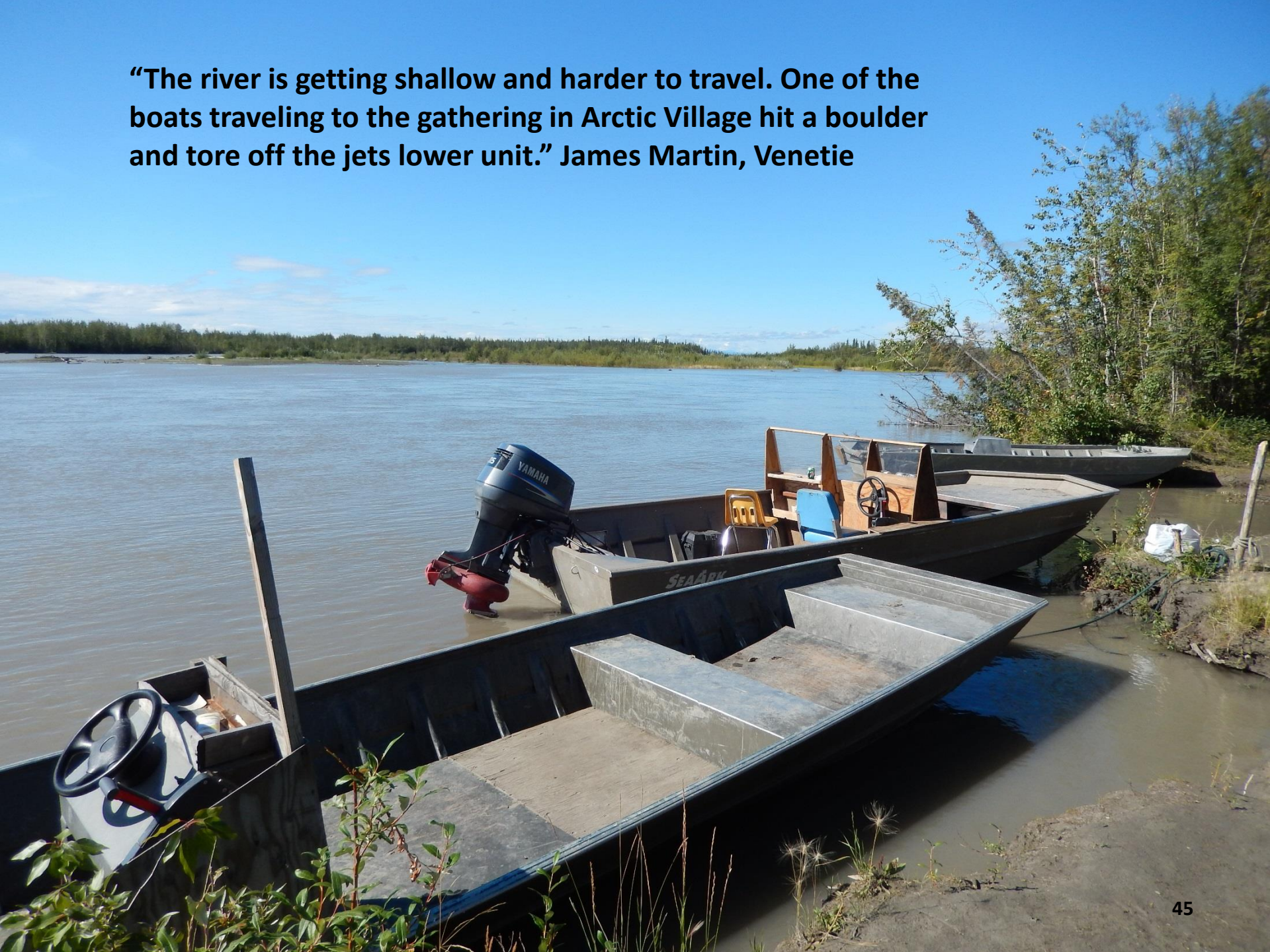
In Arctic Village, Fort Yukon and Venetie, changes to the rivers and lakes was a common theme. In Fort Yukon, Rocky James surveyed a dry lake bed where he had once paddled a canoe, now thick with willows.

In Venetie, James Martin pointed out aerial photographs where lakes have dried and transformed to meadow. Some possible contributing factors include the decline in snowfall, a longer warm season, and loss of the permafrost, that normally preserve lakes by perching water on top of frozen ground.

On both the Yukon and Chandalar Rivers, residents described rapid shore erosion, thaw features, declines in water level, warming waters and shallow conditions that make navigation more difficult. Relocation of camps back from the river bank is a common problem. Loss of camps to bank erosion is another.

The survey team traveled by skiff and kayak 20 miles down the Yukon and 160 miles of the Chandalar River. Bank erosion was visible everywhere, and in many areas extreme; such as the three large thaw features (thermokarst) on the East Fork of the Chandalar. Shore erosion and flooding continues to be a concern for Venetie and Fort Yukon.

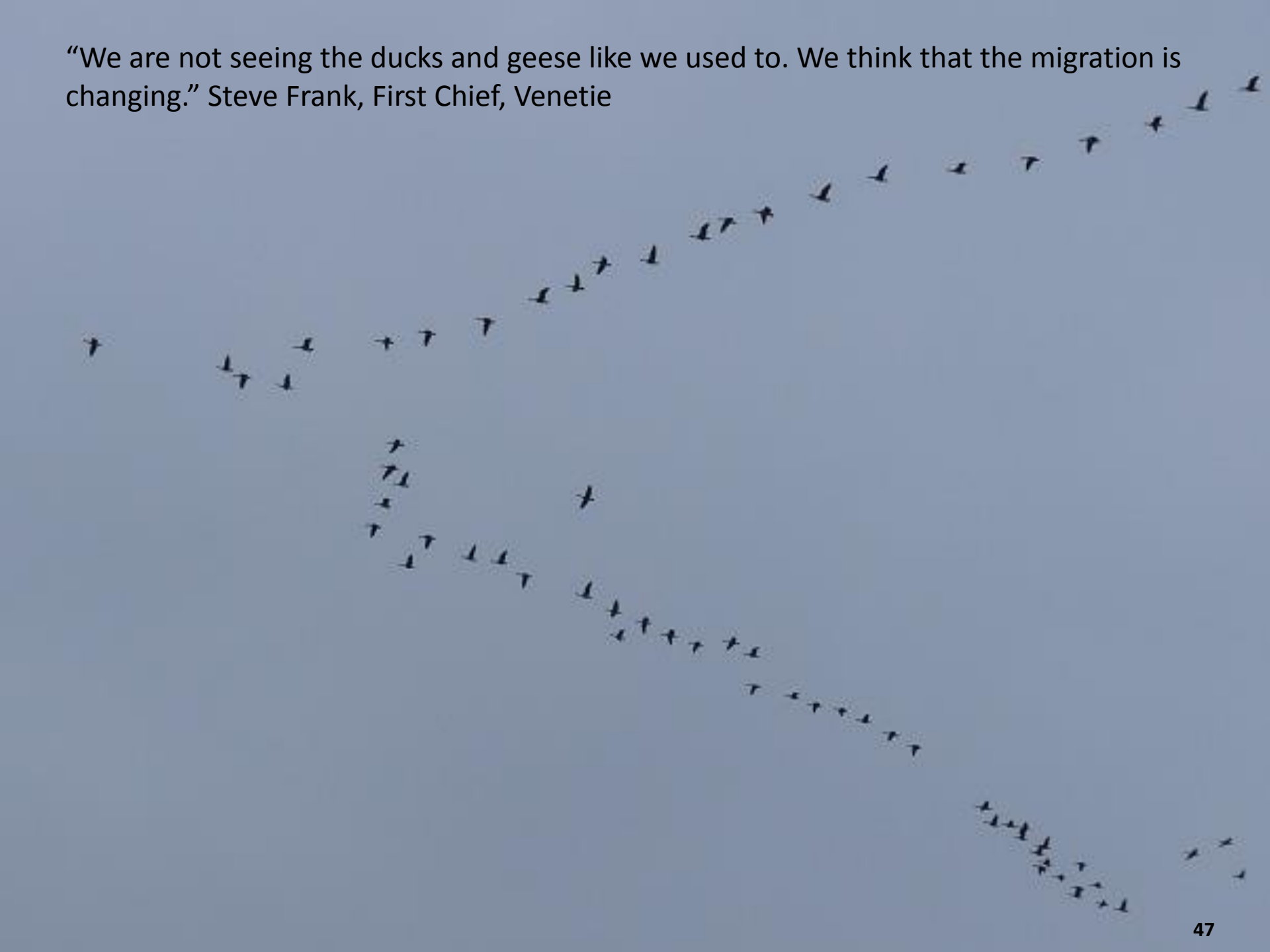
Above: James Martin describes changes to rivers and lakes.
Below: Aerial view of Little Lake in Venetie.



“The river is getting shallow and harder to travel. One of the boats traveling to the gathering in Arctic Village hit a boulder and tore off the jets lower unit.” James Martin, Venetie


“I remember when we used to hunt ducks in Little Lake”
James Martin, Venetie

“We are not seeing the ducks and geese like we used to. We think that the migration is changing.” Steve Frank, First Chief, Venetie

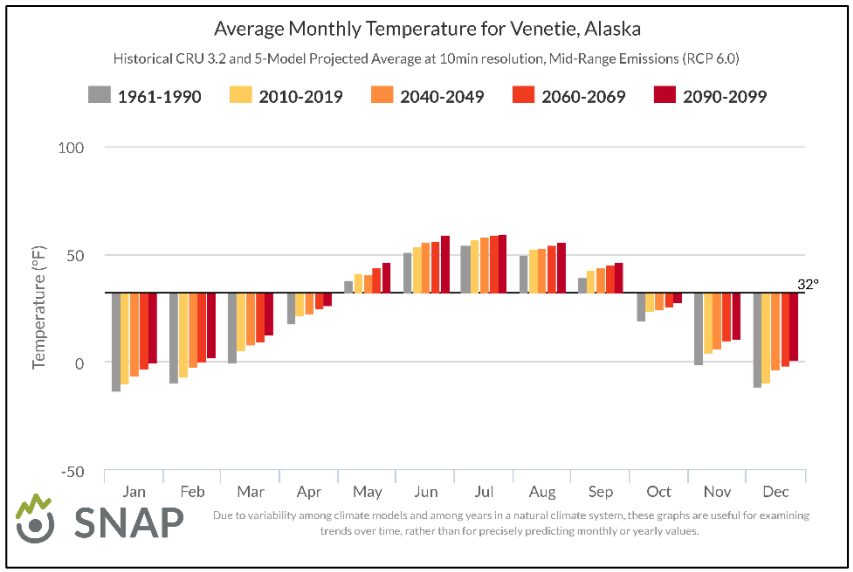


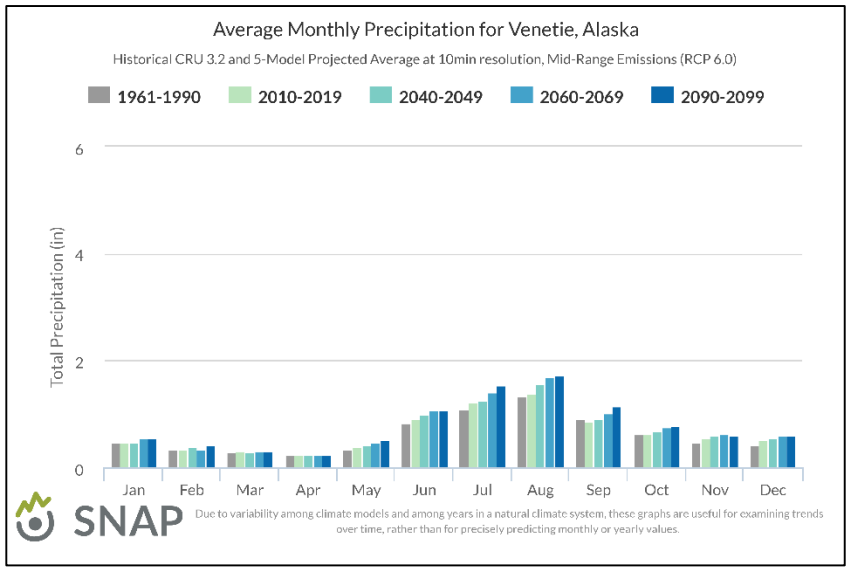
“Beaver are our enemy now. They are everywhere, moving into the tributaries, damming up the rivers, changing the landscape.”
Steve Frank, First Chief, Venetie

“I saw a Mountain Lion on the way to Fort Yukon. We had never heard of those being here before.” Lance Whitwell, Venetie

Some animals are increasing their range. Mule Deer have been sighted in Interior Alaska Others species are seeing their range decline. Photo Credit – National Park Service

Venetie Climate Models



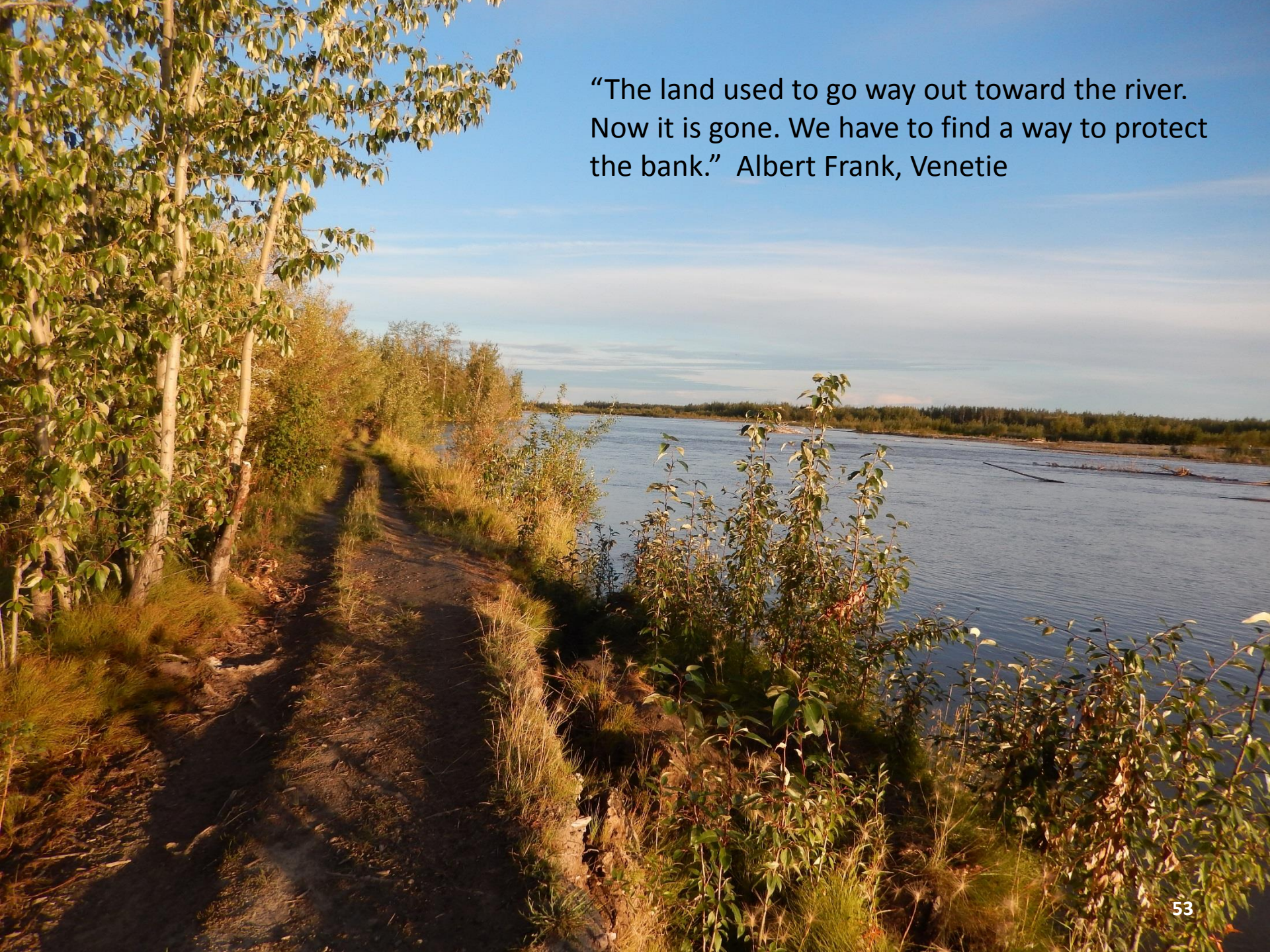


Above: Temperature and precipitation model graphs.

Temperature is projected to increase in every month, with the largest increases occurring in the winter. Precipitation is projected to have significant increases in the summer. See SNAP community charts. Based on these records, the new climate is warmer and at least in the summer, wetter.

"I remember when I first got here. It was cold and all our weather come from the north. Now it comes from the south." Lance Whitwell, Venetie


With a longer growing season, the opportunity for increasing food security with locally grown produce, is increasing with each year.


“The land used to go way out toward the river. Now it is gone. We have to find a way to protect the bank.” Albert Frank, Venetie

Adaptation Case Study
Recording Environmental Change

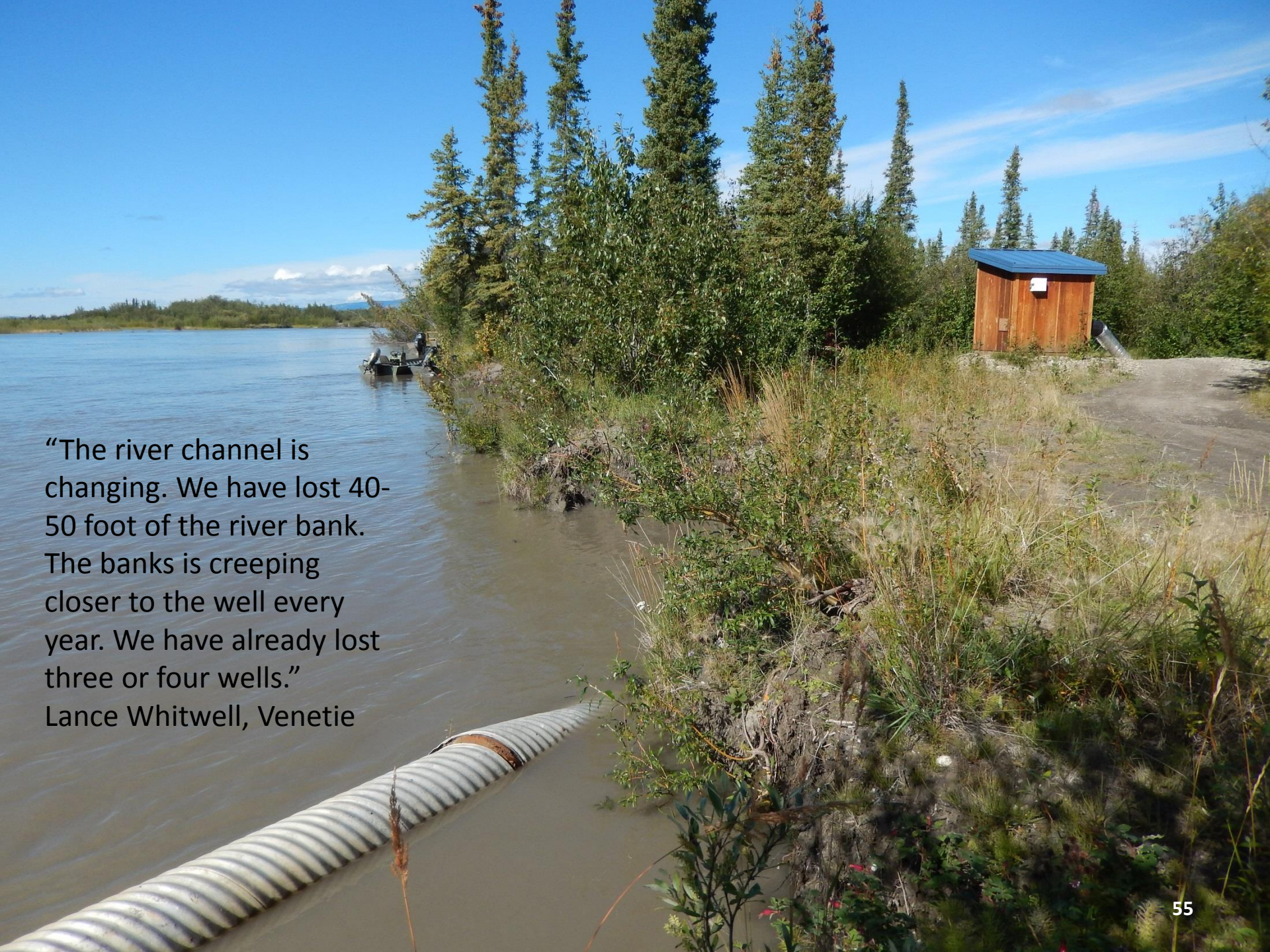
In addition to collecting observation from the three communities, the survey team trained tribal environmental staff and enrolled new members for the LEO Network. Observations were posted to the network in Venetie and Fort Yukon.

Tribal environmental staff were trained on the installation and use of time lapse cameras. Cameras were installed in Arctic Village and Venetie and shared with tribal staff in Fort Yukon.

The time lapse camera in Arctic Village was set up in the center of town near the old church. The purpose was to record daily conditions as well as seasonal change. First snow, snow depth and green up dates were all discussed as measures.

In Venetie, the river erosion has resulted in the relocation of the community water well. The environmental change topic of interest is rate of erosion. The camera, which takes one image per day, was set up to help measure rate of change at the location of the current community well.

Above: Lance Whitwell surveys the dump site. Below: Ryan Toohey of USGS assists with the installation of a time lapse camera. Right: Camera view of erosion area near community water well in Venetie.


“The river channel is changing. We have lost 40-50 foot of the river bank. The banks is creeping closer to the well every year. We have already lost three or four wells.”
Lance Whitwell, Venetie

Suspected Climate Change Impacts (described *)

	Issue	Arctic Village	Venetie	Fort Yukon
1	Rising temperatures (air, water, soil)	*	*	*
2	Shorter snow and ice season	*	*	*
3	Decrease in snow and ice	*	*	*
4	Extreme weather	*	*	*
5	Increase in wildfires		*	*
6	Lake drying	*	*	*
7	Algae growth / blooms			*
8	Permafrost thaw	*		
9	Erosion	*	*	*
10	River channel change	*	*	*
11	Tree disease		*	*
12	Salmon decline		*	*
13	Caribou or moose decline	*	*	*
14	Increase in berry harvest variability	*	*	*
15	Invasive species		*	*

Potential Health Impacts or Vulnerabilities

	Issue	Arctic Village	Venetie	Fort Yukon
1	Heat Illness (hot buildings)	*	*	*
2	Respiratory Illness (smoke/pollen)	*	*	*
3	Ice and snow related injuries	*	*	*
4	Insect stings (wasp / yellow jacket)		*	*
5	Water interruption (low river)	*		
6	Water interruption (loss of well)		*	
7	Mental stress (weather, disasters)	*	*	*
8	Mental stress (harvest failures)			
9	Infrastructure damage (thaw, erosion)	*	*	*
10	Poor nutrition (lack of wild foods)	*	*	*
11	Good nutrition (increase in gardening)	*	*	*
12	Food Insecurity (harvest failures)	*	*	*
13	Infectious disease (mosquitoes, ticks)			

Findings and Recommendations:

The following section provide a summary of key findings from the assessment, as well as recommendations which can be considered for local or regional action.

Findings – Understanding Climate Change Impacts

1. Warming is resulting in less winter snow and more rain, lack of river ice, changes in the seasons, and hazardous conditions for travel. Harvest for fishing, hunting and gathering have been delayed or disrupted due to changes in seasonal conditions. Subsistence seasons and approaches may need to be changed.

2. The forests are at times dry and under stress from insects. Change to Wild fires are more frequent and extreme leading to air quality problems. Introduction and range expansion of pollen producing plants may result in increasing cases of respiratory illness. Establishing clean-air refuges where residents can go, is encouraged.

3. Changing river conditions is a concern for all communities including bank erosion and land slides from extreme weather (such as rain events), drought, and related low stream levels, and increased difficulty related to barge navigation and travel by large skiffs.

4. Changing river conditions is also a concern for salmon health and habitat. Residents report change in salmon runs with declines in some species (sockeye) and increases in others (pinks, silvers, chums). There is less spawning habitat due to beaver dams, decreased snow pack and low water levels. Residents are concerned about temperature stress. Arctic Village reports more King salmon spawning in the head waters.

5. Changing river conditions such as water depth, water quality, temperature, presence of algae, invasive species and other factors can stress fish and other wildlife including subsistence food resources. Community members are concerned about food safety related to parasites and illness in fish. Protection of cool water refuges may one day be important for salmon spawning success.

6. All three communities are well sited with generally good elevation above the river. Fort Yukon has flooded during ice jams and is vulnerable to bank erosion. Venetie was moved out of the flood plain years ago, but also has erosion concerns. Spring flooding and ice scouring of river banks may decline as there have been fewer hard break ups in recent years.

Findings Continued.

7. Residents in all three communities report declines in caribou harvest. Variability in harvest of other resources seems to be increasing. Food security is threatened by declines in salmon, caribou, moose and berry harvest. A longer growing season improves gardening and with adequate precipitation, berry harvest. Emergence of new species present harvest opportunities.

8. Invasive species include new birds, insects and plants. Climate conditions including mild winters may contribute to an increase in wasps and related increases in insect stings. Mule deer are moving into the region from Canada. A new potential food resource, mule deer are known to carry winter tick which could infest moose and caribou. Vigilance for appearance of ticks in game is recommended.

9. Educating health and medical providers on emerging health issues related to climate change is recommended. Clinic staff may expect to see increases in allergy related respiratory visits, insect stings, heat illness, and during periods of harvest failures, nutrition related illnesses.

10. Vulnerabilities include food security related to changing harvest conditions of wild foods, economic and social impacts from changing river and ocean conditions, and forest change related to drought.

11. Sources of regional resilience to climate change include food production due to a longer growing season, decrease in floods (generally) because of good planning and siting of infrastructure at elevations high above river, energy related to firewood harvest, and ample summer sunlight, and ample sources of drinking water.

12. Examples of positive effects of climate change include a longer growing season, growth of some trees which create habitat and reduce dust in the communities, lower heating fuel consumption due to warmer temperatures.

Recommendations – Increasing Resilience to Climate Change

Food Security: Continue to adapt harvest strategies to accommodate changes in seasons, weather, environmental conditions, travel and access challenges. Explore options for harvest of new species like deer and range changes such as salmon in the upper Chandalar River. Relocate subsistence camps from erosion vulnerable areas. Exercise caution with food preservation when conditions are unusually warm or wet. Remain vigilante for parasites and illness in subsistence species, and coordinate with health and wildlife managers about concerns.

Water Security: River and ground water conditions are changing. Community water sources may require closer monitoring than in the past. Flooding, drought, erosion, water temperature, and river level are all factors that can impact supply and quality. Coordinate with regional environmental health officials on water resource concerns. Surface water quality monitoring is encouraged.

Air Quality: Dust is an established problem in all communities as is poor indoor air related to ventilation, wood fire smoke, chemicals and mold. Extreme precipitation (wetness or drought) can influence mold and dust. Changes in range, species and rate of vegetation growth can also impact air quality, specifically related to pollen types and levels. Warming, longer snow-free periods and increased lightening are causing more wildfires, and instances of extended smoke. Developing local air refuges (clinics or community centers) where people can find relief from poor air and heat is recommended. Air conditioning may be needed for some homes and buildings.

Infrastructure: Permafrost thaw in Arctic Village, erosion in Venetie and flooding in Fort Yukon are all climate change influenced impacts on infrastructure. Thoughtful planning for any new infrastructure is encouraged to select locations and designs that increase community resilience and sustainability.

Planning: Integration of climate change awareness into all aspects of community planning is encouraged, from construction to emergency preparedness. Increasing energy, food and water self sufficiency is a good goal. Tribal capacity exists within environmental programs. Increase coordination with upstream and down stream communities for better surveillance of emerging problems and opportunities for collaborations. Hold gathering focused on climate change. Identify a regional climate change advisory group.

"We need to organize ourselves so that we can create an awareness about climate change. We need to bring this to gatherings so that we can get people engaged and take action now."
Gideon James, Arctic Village

Conclusion

The most comprehensive measure of climate change is the observations of people who live here, travel the trails, watch the weather and harvest food from the land and river.

By listening we are learning about these changes, insights on causes, specific implications, and adaptations that are being developed and used every day.

This report provides a snapshot of conditions and concerns of residents. It includes complex observations and insights based on decades of experience and generations of local and traditional knowledge.

It is hoped that this report will help the Upper Yukon Region communities in understanding some of the impacts and to plan healthy and productive ways to adapt to changing climate.

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