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Chris Burn	Workshop Steering Committee and Resource Person Professor, Carleton University
Shannon Cooper	Workshop Steering Committee Councilor, Village of Mayo
Mark O'Donoghue	Workshop Steering Committee and Resource Person Regional Biologist, Government of Yukon
John Pattimore	Workshop Steering Committee Director of Lands and Resources, Nacho Nyak Dun First Nation
Vicky McCoy	Workshop Steering Committee and Resource Person Graduate Student, Carleton University
Don Trudeau	Workshop Facilitator
Nicole Carmichael	Logistics Coordinator
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Ron Cruikshank	Resource Person Director, Yukon Land Use Planning Council
Jill Johnstone	Resource Person Graduate Student, University of Alaska Fairbanks
Kevin Wallinger	Resource Person Planning/Training Co-ordinator, YTG Emergency Measures Organization
Jimmy Johnny	Video Recording
Ian Gray	Sound

Special thanks also to Mayor Michael McGinnis for encouraging the process that led to this workshop. Thanks also to Principle Bruce McGregor for bringing students from JV Clark School to the workshop. And most importantly, thank you to our workshop participants, especially the elders, for sharing stories, wisdom and experiences.

Thank you to workshop sponsors the Village of Mayo, Nacho Nyak Dun First Nation, Government of Yukon Environmental Awareness Fund, Government of Yukon Community Development Fund, and Northern Climate ExChange.

EXECUTIVE SUMMARY

On February 19-20, 2001, the Northern Climate ExChange, Village of Mayo and the First Nation of Nacho Nyak Dun hosted a workshop to discuss climate change and its impacts on the Central Yukon.

The workshop reviewed historical records compiled by Vicky McCoy and Chris Burn of Carleton University. The purpose of this work was to investigate changes in the environment of central Yukon. Economic, social and environmental data from historical records were compiled and analyzed for the region. This work provided a baseline understanding of climate change in central Yukon, by determining how conditions in the 1990s differed from the rest of the century. Detailed information on this work is available in the report *Climate Change in the Central Yukon* (McCoy and Burn, 2001). Some of the trends include:

- The climate in Mayo is becoming warmer, with the most pronounced increase occurring in the spring.
- More precipitation is occurring over time, most of this increase is in the form of snowfall.
- Climate changes are affecting some of the biophysical characteristics of the central Yukon, which may in turn, affect how people live.

The workshop also discussed ways in which long-range planning can be undertaken to prepare for the possible impacts of climate change on infrastructure and the environment within and surrounding the community. Experts on land-use planning, municipal planning, emergency response planning and ecosystem management discussed how to consider changing climate and environmental conditions when planning and managing infrastructure, renewable resources, communities, land use, and emergency response.

INTRODUCTION

On February 19-20, 2001, the Northern Climate Exchange, Village of Mayo and the First Nation of Nacho Nyak Dun hosted a workshop to discuss climate change and its impacts on the Central Yukon. The workshop reviewed historical records compiled by graduate student Vicky McCoy of Carleton University, and discussed ways in which long-range planning can be undertaken to prepare for the possible impacts of climate change on infrastructure and the environment within and surrounding the community. This workshop received national coverage on CBC radio.

On the first day of the workshop (What do we know?), the results of the inventory work carried out by Vicky McCoy and Chris Burn from Carleton University were explored. The purpose of this work was investigate changes in the environment of central Yukon. Economic, social and environmental data from historical records were compiled and analyzed for the region. This work provided a baseline understanding of climate change in central Yukon, by determining how conditions in the 1990s differed from the rest of the century. Detailed information on this work is available in the report *Climate Change in the Central Yukon* (McCoy and Burn, 2001).

Building upon inventory information, participants discussed ways in which long-range planning can be undertaken to prepare for the possible impacts of climate change on the second day of the workshop (where do we go from here?). Experts on land-use planning, municipal planning, emergency response planning and ecosystem management discussed how to consider changing climate and environmental conditions when planning and managing infrastructure, renewable resources, communities, land use, and emergency response.

What follows in this report is a summary of discussions and presentations that took place over the course of the workshop.

MONDAY FEBRUARY 19, 2001

WHAT DO WE KNOW?

Opening Comments

Don Trudeau, Workshop Facilitator

Workshop Facilitator Don Trudeau opened the workshop by introducing the meeting goals and objectives, and reviewing the agenda.

“Everyone has observed something about climate change, and everyone will be affected in some way”, Don said. He explained that our everyday lives are affected by weather in many ways. “Trappers are affected by fur quality, which is related to temperature; construction is affected by permafrost; highway maintenance is closely tied to climate events”.

Don noted that many decisions will need to be made regarding climate change. He is hopeful that this workshop will promote a better understanding of what climate change will mean to the central Yukon in the future.

By reviewing historical information of changes in the environment of central Yukon, gathering of local knowledge from participants, and with guidance from local experts, he hopes workshop participants will emerge from the workshop with a broader, common understanding of climate change.

Don concluded by encouraging active participation from everyone present to ensure that we can share as much knowledge in this workshop as possible.

Aynslie Ogden, Northern Climate ExChange

Aynslie Ogden discussed the events that took place over the previous year leading up to the workshop.

In January 2000, one month prior to the opening of the NCE, the Village of Mayo sent a letter to the NCE expressing Council’s interest in obtaining more

information about climate change and in finding out how it could affect their community. The letter stated “Council feels that climate change could adversely affect our community in the future, and therefore, we would be interested in having some climate change studies take place in the Mayo area to find out what impacts climate change may have on the future lives of the citizens of Mayo.”

In April 2000, a conference call was held with NCE Staff, Councilor Shannon Cooper, Chris Burn – Professor at Carleton University, and Mark O’Donoghue - Regional Biologist, to discuss opportunities to work together over the coming year. Mayor Michael McGinnis followed up on the conference call by inviting the NCE to visit Mayo in the summer and to hold a workshop.

In July 2000, the NCE followed up on the Mayor’s invitation and visited the community to see topographic effects on climate in central Yukon, witness long-term monitoring at the Mayo Scientific Reserve, participate in a planning meeting for the proposed workshop, and observe local participation in building expertise on climate change. During the visit, the NCE hosted a Public Information Session to obtain an overview of community concerns in regards to climate change, and met and informed and aware community. A detailed report on the session is available in the report *ExChanging Ideas on Climate Chang in the Yukon* (Ogden, 2001).

A Steering Committee was struck to commence workshop planning. Shannon Cooper, Mark O’Donoghue, Chris Burn, John Pattimore - Director of Lands and Resources for the Nacho Nyak Dun First Nation, Vicky McCoy - Graduate Student at Carleton University, and Aynslie Ogden worked together over the months leading up to the workshop to develop the agenda. Local resident Nicole Carmichael was hired to assist with logistical arrangements.

Aynslie thanked the organizations that sponsored the workshop, namely the Village of Mayo, Nacho Nyak Dun First Nation, Environmental Awareness Fund, Community Development Fund, and Northern Climate ExChange.

Roundtable Introductions

Workshop participants introduced themselves, and explained what their expectations were for the workshop, and what they were hoping to learn or contribute. Some of these comments are listed below:

- I believe we must do something about this issue
- I want to learn more about forest response to climate change

- I want to understand the effects of climate change on fish and fish habitat
- I am interested in knowing what changes we need to prepare for
- I have noticed a lot of changes, and would like to share what I have seen
- I am interested in knowing what aspects of climate change may affect how the municipal budget is allocated
- I have seen dramatic changes and would like to share my observations with others
- I am here as a representative of the Village Council who is responsible for policy and direction
- I am here to prepare a national report on the workshop for CBC Radio
- I am a local resident of Mayo, and interested in learning more about climate change
- I would like to share what happens in this workshop with other communities that have concerns about climate change and are looking for ways to begin to address some of the changes that are taking place

Local and Regional Observations and Concerns on Climate Change

Councilor Shannon Cooper, Village of Mayo

Shannon Cooper, Councilor for the Village of Mayo and Vice-President of the Association of Yukon Communities, extended a welcome to workshop participants on behalf on Mayor and Council, and special greetings to participating elders.

The community of Mayo, the hottest and coldest spot in the Yukon, was established in 1903. Mayo experienced its greatest level of growth after World War 2 with opening of the United Keno Hill Mines. With the opening of the mine followed the construction of infrastructure including the airport, bridges, hydro dam, roads, and nursing station. The 4 km² municipality was incorporated in 1984. Over the history of this community, residents have witnessed a number of economic boom and bust cycles.

Shannon explained the role of Municipal Government as being responsible for the operation and maintenance of water and sewer systems, fire department, recycling, landfill, tourist reception centre, recreation facilities, etc. The dyke, owned by the Yukon Government, is operated and maintained with input from the municipality. With a limited budget - 780k in capital funding and 140k in

taxation – the Village must plan carefully for future by looking for contingencies that may affect the allocation of resources within the finite budget.

Shannon read the 1999 Municipal Leaders Resolution on Climate Change, which calls for municipal governments, who are responsible for the well-being of communities, to make commitments to protect earth's climate system a priority. The resolution acknowledges that 1990-1999 was the warmest decade on record, and that local reductions of greenhouse gases are necessary to reduce impacts to human life from climate change. The resolution also highlights how climate change has the potential to become a strain on municipal budgets (examples include the ice storm in Montreal/Ottawa and Red River flood in Winnipeg). The Village of Mayo is a signatory to this resolution.

Shannon explained that different situations came together at an uncanny time to raise awareness of climate change issue, making timing right for the Village of Mayo to take action. In 1999, the Climate Change Action Fund funded the NCE and caribou research in the Yukon. Eric Fairclough remarked on the importance of this work to communities such as Mayo in an October 1999 riding report. In early 2000, the Association of Yukon Communities was requested to participate on the NCE Steering and local Mark O'Donoghue took the position. The Village of Mayo also contacted the NCE in early 2000, who were interested and open to working with Village.

The Village sent a research funding application to the Community Development Fund to see if local conditions reflect climate change. Shannon explained the support in the community for the work done by Chris Burn since 1982 "Chris supports this community in taking care of its own affairs and the community supports Chris coming back year to year to do research". The proposal to CDF was accepted and in August 2000, Chris and Vicky got to work.

Shannon reflected on why this issue is important to residents of the central Yukon. "In August 2000 it rained every day. Rainfall was 70.4 cm in August 2000 compared to 45.7 cm the same time during the previous year. Will we see another increase in 2001?". She remarked on other observations that may be consistent with a warming trend. For example, at the time of the workshop in February 2001 the Yukon River's Five Finger rapids were open, and the Stewart River near town hadn't frozen in some areas and was too rough for a skidoo in others. Also for the first time, Dawson was unable to open the ice bridge due to thin ice conditions on the Yukon River.

"Impacts vary from region to region, and adaptations may be required to minimize negative impacts", she explained. "We are here today in support of this exercise, and are eager to interact and hear experiences and observations".

Johnson Peter - Elder

Johnson Peter provided an Elder's perspective on climate change, and provided some of his observations and concerns about changes in the region.

"The ice is melting, and creeks have dried up", Johnson explained. "Last year had less snow than this year, and it seems to change every year".

He explained that foxes are now coming to town at night, and rabbits are now rarely seen. With the thin ice on the river, skidoos can not be used. He remarked that this is something he has not seen within his lifetime.

"It was common to have winter temperatures of 50-60 below, but not anymore. Last year we saw very few salmon in the river, and numbers are less and less each year".

Johnson Peter closed by saying he has observed many changes in the environment of the central Yukon, and expressed concern that there will be no jobs and no food in the future.

"Many stories foretell the future", he concluded.

Jimmy Johnny, Young Elder

Jimmy Johnny provided a young Elder's perspective on climate change and began by welcoming students from JV Clark school. He explained that it is important that elders acknowledge youth, and noted that many of the students have worked for Chris Burn.

Jimmy talked about permafrost changes in the region, referencing Chris Burn's study plots where slope movement is splitting trees apart, and eroding banks on the river. "Is permafrost melt responsible for changes seen in creeks...creeks that once flowed and are now dry and muddy?"

Jimmy also provided examples of lakes that are drying up -- Wind River, Bonnet Plume Lake, and he noted that Moshan lake on Dawson Road has dried up completely. "Grasses grow further out on lake shores" he said.

He described how there was lots of rain in the summer of 2000, and river levels were high all summer. "Rivers, where the water was clear before, are now muddy, and rust coloured". At the time of the workshop, "there is open water on the Yukon River at Dawson, the Five Finger Rapids, and the Carmacks bridge", also something Jimmy has never seen before in mid-winter.

Jimmy, a former guide, explained how he used to see moose and caribou everyday, which he doesn't see anymore. "Eagles and other birds are seen nesting where they have never been seen before. Leaves are coming early and leaving early."

"Considering the unusual mild winters now experienced, we need to be prepared for what's to come" he concluded.

Jimmy Lucas - Elder

Jimmy Lucas, an Elder who has lived in the region for 72 years, said "bad things have happened over past two years that have never happened before". He explained how he was born and raised here, and knows a lot about local animals.

"There are fewer animals all the time...and different animals", Jimmy said. "Rabbits are at a low turn in cycle and foxes are starving" he said, explaining the cycle of boom and bust in snowshoe hare populations. "There are lots of lynx because they know how to survive". He explained that a decrease in smaller mammals will affect larger animals that feed upon them. "All animals are part of same cycle and all will be affected".

Jimmy also explained that something is making animals sick. "Caribou are bad in stomach and liver, and moose bad in liver to eat". Jimmy said he suspects pollutants from outside the country are affecting this region, causing sickness in animals because their food source is affected. "Water is turning bad, polluted" he said.

He shared his observations of unusually mild winter temperatures, and says cold snaps in January of minus 70 degrees are now unheard of. "In some areas the ground not frozen yet, and the ground is thawing".

Jimmy concluded by saying he doesn't think we can do anything about the changes, or stop the changes from taking place. "Only the creator can bring back the way things were". He explained that he learned from his elders and from

the land. “My great grandfathers told stories about future. That is where I learned - not from going to school”.

Climate Change Science and Northern Canada

Chris Burn, Carleton University

Chris led a discussion on climate and climate change in northern Canada. He discussed the climate record from the past, what drives the local climate, and what the future climate may be in the central Yukon.

He began by noting that many of the recent reports on climate change relate to changes at the global scale. Scientists are confident in the amount of warming that may occur at the global level, and are less confident in the changes at local and regional scales, such as the central Yukon. However, “we need to understand global changes to understand local changes”, he explained.

Chris showed a diagram of temperatures in the northern hemisphere from 1400 to present, which showed how temperatures in Arctic regions have changed over the past 600 years. The information is based on tree growth, and direct temperature measurements. “While there is variation up and down, an upward trend began 100 years ago and temperatures have risen 1.5 degrees”, Chris explained. “This temperature increase began at the time when industry developed, and factories and vehicles that burn fossil fuels increased the amount of greenhouse gases in the atmosphere. We now know that changes in the composition of the atmosphere leads to variation in the temperature of the Earth”.

The amount of carbon dioxide in atmosphere is increasing, and is expected to double. Sources of greenhouse gases are expected to increase with expanding population and industrialization. At the same time, natural “sinks” for these gases, such as forests and wetlands, are expected to diminish. Chris explained that emissions of greenhouse gases in Canada, with a population of 30 million people, equal India, where the population is 1 billion. Canada, he explained, “has very high per capita emissions”.

Two types of energy influence global temperatures, short-wave radiation from the sun (solar energy) and long-wave radiation from the earth (heat or thermal energy). The atmosphere shields us from energy coming in from the sun. Only

70% of the short-wave radiation that arrives at the upper atmosphere reaches earth because of reflection from atmosphere. Once short-wave radiation from the sun reaches the ground, it is either reflected or absorbed. Snow has a high albedo (reflectivity) and reflects more energy than trees. Absorbed energy warms the ground, therefore, how much snow on ground affects how warm it gets during the day.

Long-wave radiation from the earth radiates into back into space. Chris compared this to the same heat or thermal energy radiated by the 50-60 people in the room. Long-wave radiation is trapped in atmosphere by greenhouse gases, including water vapour, carbon dioxide, and methane. Without these gases in the atmosphere, the average temperature of earth would be -13 degrees, compared to the now average 15 degrees. "Life on earth would not be same as it is today without this natural greenhouse effect".

Chris continued by explaining how energy is redistributed around the globe by the general circulation of the atmosphere from regions of energy surplus to those with a deficit. He explained that heat rises at the tropics and moves to the poles, and said there is now more heat coming to the poles from the tropics. With an increase in global temperature, this circulation is more vigorous. This air circulation cannot be stopped, and "we have to be ready for this additional energy coming up north." Chris provided an example of snow machines that fell through the ice this winter in the Mackenzie Delta where drilling is taking place.

Chris noted that understanding the climate system isn't always a simple task. There are many feedback mechanisms that can amplify or reduce the expected warming associated with climate change, and these mechanisms aren't well understood. Positive feedback mechanisms can contribute to a runaway greenhouse effect. For example, ice and snow are highly reflective of energy, and absorb little solar radiation. With warmer temperatures, the area covered by snow and ice will decrease, the ground surface becomes less reflective, resulting in greater absorption of energy, warmer temperatures, and more snowmelt than expected. Chris explained that with a warmer climate, spring will come earlier, summer is warmer, and snow disappears earlier. However, climate models tell us to expect more snow in winter. More snow in the winter means snow will last longer into the spring, contributing to cooler local air temperatures because snow has a higher albedo than snow-free ground -- a negative feedback mechanism that can result in less warming than expected.

Chris explained that the Yukon has two kinds of weather - local and imported. Climate is controlled to a great extent by mountains and valleys, and latitude. Mayo, located at 63 degrees N latitude, does not receive as much energy from the sun as at the equator where the sun is directly overhead. During the day,

temperatures are warm due to energy coming in from the sun. Temperatures are cool in evening when heat is radiated back into space from atmosphere. Chris also explained a regional phenomenon called a temperature inversion that occurs on clear days in the winter when cool air sinks to valley floor and temperatures are warmer at higher elevations. Temperature sensors placed at different elevations on Mount Haldane observed this phenomenon. He noted that in the Yukon, more than half of topography is high ground. High ground is warmer in winters than lower ground, whereas in the summer, high ground cooler than lower ground.

Chris also explained that the Coast and St. Elias mountains block many low-pressure, warm and wet, air masses from entering into the territory from the Pacific Ocean. He speculates that with more energy in the atmosphere, these systems are now travelling faster and are making their way over the mountains to the central Yukon. He also explained that more energy in the atmosphere means more clouds in winter, more air movement, less calm air, and more mixing of air. Temperature inversions and ponding of cold air in valley bottoms will occur less frequently in the Yukon with climate change.

Chris concluded by saying that the Yukon's climate may change even more than predicted if atmospheric circulation becomes sufficiently vigorous to overcome the blocking effect of the mountains on Pacific air masses, and calm conditions occur less in the winter so that the cold air does not settle in the valleys.

An audience member posed the question - why are northerly regions expected to warm more than southerly latitudes? Chris explained that around the north pole, there is an amoeba-shaped mass of relatively cold and dry air called the arctic air mass. Air in the upper atmosphere around the poles circulates from west to east, pushing cold fronts around the pole. Cold fronts collide, and the warm air between the fronts warms up the air mass. There used to be 5 cold fronts around the pole, and now 8 or 9 are expected because of climate change. Therefore, more tropical air will be absorbed because there are more fronts than in past.

Chris concluded by explaining that mean monthly temperatures in central Yukon are historically more variable in winter than in summer.

Session I - Climate Trends

Presentation: Vicky McCoy, Carleton University

Vicky McCoy, a graduate student from Carleton University, presented a summary of historical temperature and precipitation data for the central Yukon. Highlights from this presentation are summarized below, additional information is provided in the report *Climate Change in the Central Yukon* (McCoy and Burn, 2001).

Vicky explained that weather has been recorded at the Mayo airport since 1925, the second longest record in the territory (the longest being Dawson where records date back to 1898). Records show Mayo temperatures have been increasing, especially during the last two decades. In both Mayo and Dawson, temperatures have increased at a rate of 0.14 degrees/decade. Most of the warming has occurred in spring (0.32 degrees/decade) and summer (0.20 degrees/decade).

Vicky also found that the 1980's and 1990's were the warmest decades on record, although the 1940's were also warm. Of the 10 warmest years on record, 7 were in the 1980's and 1990's. Winter temperatures are highly variable from year to year, which may explain why she did not detect a statistically significant trend in winter temperatures.

The temperature in Mayo is directly related to temperature in Dawson. The same trends in temperature changes were detected, except temperatures in Dawson are 2 degrees cooler than in Mayo. Vicky explained that this relationship allows you to estimate temperatures in Mayo between 1898 and 1925 from the data collected in Dawson.

Precipitation records show that on average, Mayo receives 210 mm rainfall and 144 mm of snowfall each year. Four of the ten wettest years on record occurred in the 1980s and 1990s. Most snow falls in November and December, and August is the rainiest month. Total annual precipitation has increased from 1925 to 2000 by 12.7mm/decade, most of this increase has been in the form of snow. Snowfall has increased over the past century by approximately 10cm/decade, most of this occurring in the spring, resulting in a deeper snowpack at the end of winter.

Discussion

Following Vicky's presentation, there was time for questions and discussion.

One audience member asked if winter temperatures in 2000 were record high temperatures. Vicky explained but that there is no statistically significant trend of an increase in winter temperatures over the past century. She explained that because there is so much variation from year to year, very big differences are required to show a significant trend. She also explained that this can vary depending on how many years you look at in the historical record to detect a trend. For example, if you look at just past decade, a significant trend would be detected would because there is less variability from year to year making the increase visible. She also noted that five of the 10 warmest winters on record have occurred in the past decade.

Another audience member asked if the water content of snow has changed, and whether or not this is an important factor in detecting trends in snowfall. Vicky said that the central Yukon is now getting wetter snow and the data in her report uses snow water equivalent. She explained the importance of this trend by noting that more snow could mean more flooding in spring.

A question arose whether the data in the report is consistent with the climate change scenarios produced by climate models. Vicky explained that the data does match model predictions relatively well, and the predictions that climate models are making are similar to the trends to being detected in Mayo. The only exception is that models predict warmer winter temps and historical records don't show a statistically significant relationship yet.

Other observations from audience also arose during the discussion. One participant noted that they have seen more air masses from coast, more wind, more frequent storms, and noted that the high water did not recede last summer. Another participant noted that the weather is less predictable. A comment was also made that it can be difficult to know whether a change is related to natural variability or to climate change.

Workshop facilitator Don Trudeau concluded the session by remarking that both elders and scientists have gathered information and shared this today regarding changes in snow depth, precipitation and temperature.

Session II Physical Trends

Presentation: Chris Burn, Carleton University

Chris Burn presented a summary of the investigation of changes in the physical environment in the central Yukon. Highlights from this presentation are summarized below, additional information is provided in the report *Climate Change in the Central Yukon* (McCoy and Burn, 2001).

The presentation began with a discussion on permafrost. Chris, a local expert, has been studying the response of permafrost to climate change in the Mayo Scientific Research Reserve since 1982. Chris described about half of the ground in the area surrounding Mayo as being underlain by permafrost. Where permafrost occurs, it is about 30 m thick. Permafrost tends to occur in valley bottoms because of frigid winter conditions, and at the tops of hills because of mild summers and deep snow packs that may not melt until mid-summer. He explained that gravelly and sandy areas are most often permafrost-free because, as a general rule of thumb, permafrost develops only beneath soil with a minimum of 10 cm layer of insulating organic soil or moss. Ground surface temperatures fluctuate according to air temperatures and depth of snow accumulation. The active layer is the uppermost layer that thaws every year.

Chris also discussed how temperatures in permafrost have responded to warmer air temperatures. Warmer temperatures may lead to melting and disappearance of permafrost. Chris showed examples of subsidence and thaw-flow landslides related to permafrost thaw, and noted that greater subsidence can be expected in wetter soils because they can hold more water. In the McQuesten valley, many thermokarst lakes (lakes underlain by permafrost) are getting larger because the permafrost is melting. Chris explained that the relationship between climate change and permafrost conditions isn't always straightforward, and he gave an example of how, in the early 1990's, surface permafrost temperatures were colder despite warmer air temperatures. This trend was related to less snow accumulation.

Chris also discussed patterns in thickness of lake ice and related this to snow depths. Students at JV Clark school took measurements at 3 local lakes in 1999 and 2000. Their data have showed that ice thickness in 2000 was than in 1999, due to greater snow depths. This trend of greater snowdepths and thinner lake ice is expected continue into the future.

Trends in hydrology of the Stewart River were also discussed. Historical data do not show a good relationship between air temperatures and spring flood levels, however, snow depth is closely correlated with river flow. Chris explained that because snowfall is projected to increase in the future, spring flood levels will increase. Corresponding with this increase in river flow, bank erosion is expected to increase. Chris noted an example of this near town where 45 m of riverbank has eroded since 1990 during spring floods.

Chris discussed trends in forest fire around Mayo. Forest fire information has been collected since 1960. Since 1960, both the number of forest fires and area burned has increased. In the 1990's, 195 forest fires burned 414,000 ha, more than double the area burned in any other decade on record. Chris explained that the increase in forest fires is believed to be more related to an increase in lightning strikes than to warmer temperatures. He noted that only 15 years of lightning data is available, which is not a long enough data record to discern a trend.

Discussion

Following Chris's presentation, Workshop Facilitator Don Trudeau led a discussion and asked for observations from workshop participants.

One participant noted that ice on the Yukon River this year is very jumbled. Chris explained that when freeze up takes a long time, such as this year, bits of ice form and float down river, creating ice jams in constricted areas and shallow areas. He also explained that regular episodes of break up and freeze cycles can create jumble ice, as can fluctuating water levels.

Another participant described a related event that occurred in Dawson City during a low water year. When water levels in the Yukon River are low during break up, the ice is not easily flushed out of the system. One year, an ice dam developed, water backed up behind the dam, and the river almost flooded over the dyke.

Another observation related snow depth to forest fires. With greater snowfall, the snow loading on trees will increase and greater breakage. Increased fuel loading resulting from more dead wood can increase forest fire fuels and lead to larger and more intense forest fires.

The dangers of increased snowfall were also discussed. Increased snow depths insulates lake and river ice, reducing ice thickness. Dangerously thin ice conditions can occur with increasing snow depths.

Session III - Socio-Economic Trends

Presentation: Vicky McCoy, Carleton University

Vicky McCoy presented a summary of historical social and economic data for the central Yukon. Highlights from this presentation are summarized below, additional information is provided in the report *Climate Change in the Central Yukon* (McCoy and Burn, 2001).

Vicky explained how she explored the relationship between climate change and trapping in the central Yukon. According to historical data from 34 trap lines surrounding Mayo, Beaver, Lynx, Marten and Squirrel are most successfully trapped. The number of animals trapped over time has declined by about 40 individual animals per year. She explained that the decline in trapping activity is more closely associated with declining fur prices than with climate variables.

Vicky also reviewed historical data on energy consumption in Mayo. She explained that energy consumption over time can reflect changes in population size, better insulation and other technology improvements, household energy use patterns, and climate (specifically temperature). Energy consumption was examined for a single building (the Yukon Energy Building) in Mayo with continuous records. Since 1983, annual energy consumption has decreased significantly. The largest drop occurred in November and December, while patterns of consumption in the summer have remained relatively constant. Vicky explained that it is unclear if climate is the dominant factor resulting in this decrease.

Patterns in liquor consumption were also reviewed to explore if colder winter weather affects how much people drink. Per capita, Mayo ranks below average compared to other communities in the amount of liquor consumed, and liquor sales have dropped considerably after closure of Keno Hill Mine in 1989. Records on liquor sales are available starting in 1986 and indicate that liquor sales increase as temperatures decrease, especially in winter months.

Vicky concluded her presentation by indicating areas requiring further work. She explained that she intends to investigate maintenance schedules, mining and exploration, tourism, community health, and local gardening in the central Yukon to see if there is any relationship between these activities and climate change.

Discussion

Following Vicky's presentation, a number of questions were raised. One participant asked if any of the trends presented were related to population size. Vicky explained that population in the Mayo area has remained relatively constant other than population loss attributable to the mine closure, and therefore population changes do not appear to explain some of the trends observed.

Wrap-Up Session

Don Trudeau, Workshop Facilitator

Don Trudeau concluded the day by reviewing what was discussed, and outlining some of the challenges that lie ahead. A roundtable discussion took place to discuss which of the observations that were presented are of importance to workshop participants, and participants were asked how describe how these changes will influence how they interact with land and nature.

- Ian said he is concerned about more dangerous ice conditions, and intends to plan for this when doing activities near ice in the winter months.
- Mark explained that increased winter snowfall plus warmer winter temperatures will be significant to wildlife populations and to his work as a biologist.
- Alicia and Lizzy appreciated the opportunity to listen and learn.
- Kathy said she enjoyed the presentations and observations by the elders. She believes humans are adaptable and will learn to adapt to weather changes.
- Jill said she is interested in how changes in weather can affect vegetation, and wonder if moisture conditions will drive more changes than temperature.
- Jimmy expressed concern about dangerous ice conditions on river edges.
- Brad said he was very interested in Chris's explanation of the climate system, and relationship between climate and fish
- Crystal said many of her questions about climate change were answered, and she appreciated hearing both scientific and local observations
- Margarit said she was pleased with the report prepared by Chris and Vicky, and will use this to assist her with planning for emergency measures
- John explained his work is to manage lands and resources and to integrate local and scientific knowledge. Knowing what changes are to come will allow him to make adjustments in management plans.

- Jim explained that he likes workshops that answer the questions he came with, and results in him leaving with more questions for which he will be looking for answers.
- Shannon said she was pleased to see students in same room as elders, and is saddened to hear stories of how wildlife is being affected by climate change.
- Helen explained that she hadn't realized extent of the changes that are taking place.
- Vicky was pleased with the sharing of scientific and traditional knowledge.
- Chris appreciated the opportunity to listen to observations from locals who have been lived in the region for many decades.
- Patrick said he is interested in the social trends and land use planning. For example, warmer weather will bring more people out in winter months resulting in more impacts on wildlife. He thinks that in the future more planning on human use of recreational areas will need to take place.

TUESDAY FEBRUARY 20, 2001 WHERE DO WE GO FROM HERE?

Review of Day 1

Don Trudeau, Workshop Facilitator

Don Trudeau reviewed what we know about climate change in the central Yukon, and explained that evidence suggests that the climate and local environment are changing.

He outlined the agenda for the day, which was to discuss ways in which long-range planning can be undertaken to prepare for the possible impacts of climate change on infrastructure and the environment within and surrounding the community. He said experts on land-use planning, municipal planning, emergency response planning and ecosystem management will discuss how to consider changing climate and environmental conditions when planning and managing infrastructure, renewable resources, communities, land use, and emergency response.

Session 1: Climate Change and Local Infrastructure

Presentation: Jim Kincaid, City Manager, Dawson City

Jim Kincaid, Dawson City Manager, began his presentation by explaining that he is more familiar with topic of change than climate change. However, he said that similar principles apply when preparing for change, regardless of the source. Jim said he would focus his talk on some of the elemental steps that need to be worked through to plan for change.

Jim believes that Mayo is a leader in Yukon and many parts of Canada in taking steps to address the climate change issue. He said that cooperation is very important, and ongoing partnerships between the Village, Nacho Nyak Dun, Government of Yukon, Carleton University, and the Northern Climate ExChange will be essential to successful planning for climate change.

He said he is not sure which scientific camp is right about the causes of climate change and what will happen in the future. However, he does agree that climate change is happening and is inevitable, and believes there may be positive aspects to climate change as well as negative.

Jim explained that there are two barriers to dealing with climate change at the community level. The first surrounds uncertainty, and the human tendency to fear the unknown. The second barrier is our ability to separate fact from fiction, or knowledge from speculation. He explained that once these barriers are overcome, the real issues can be dealt with and noted that the information gathering completed by Chris and Vicky for the central Yukon is a great step towards overcoming these challenges.

Community Issues

To understand what impacts climate change will have on a community, Jim said that the following questions need to be asked:

- Which way is the climate changing?
- What is climate change doing to our natural environment?
- How fast is climate change happening?
- Are the impacts of climate change positive or negative?
- What opportunities arise from the positive changes?
 - Will there be positive changes to food supply?
 - What economic opportunities will arise from climate change?
 - If the climate is warming, what cost savings will occur?
- What can we do about negative changes?
 - What measures must we take if the food supply is harmed?
 - How do we protect our community from environmental change?
 - What lifestyle changes can we make to minimize climate change?

Community Response to Climate Change

Jim described some of the factors that affect the ability of a community to respond to climate change:

1. *The availability of site specific research and knowledge.* Jim explained that Mayo is ahead of other communities and is lucky to have the research that Chris and Vicky have done. Partnerships and community support have facilitated this work and have contributed to its success, along with the local knowledge that

is being brought into the process through this workshop. Jim explained that other communities may have difficulties with accomplishing this.

2. *The resources a community has to address climate change.* Resources that will assist communities with developing responses include people, partnerships, and ideas.
3. *The limitations that interfere with the community's ability to respond to climate change.* Limitations include human resources, funds, and the environment (for example, the presence of permafrost).
4. *Availability of assistance from outside the community.* Jim explained that the climate change issue is of such a large scope that communities will need to reach beyond their boundaries for some of the answers and for assistance in formulating a response. He also said that communities must be willing to accept, and may need to actively seek, outside assistance. He noted that neighboring communities will be facing similar issues, and share similar values and concerns, and are a good place to look for assistance with developing a response.

Jim continued by explaining that the types of questions that are asked, and the quality of answers that are obtained, will shape community responses. The ability of a community to cooperate will also influence whether or not responses will be successfully implemented. Involvement of different interest groups within a community will also assist in determining appropriate responses for a community. He emphasized that if a community is well prepared in terms of what they want to happen and what assistance is needed, they will be in a better position to ask for and receive assistance with developing responses to climate change.

Infrastructure Issues

Jim reviewed the types of community infrastructure that may be impacted by changing climate conditions. He noted that infrastructure does not just include buildings and service lines, but also bylaws, plans and policies that affect how a community will grow and develop:

1. *Above ground physical facilities.* For example, government offices, service buildings, schools, recreational facilities, privately owned facilities, utility plants
2. *Below ground structures.* For example, sewer collection lines, water distribution lines, cemeteries, sewage outfall lines, underground pumping utility stations, pipelines, and other underground utilities.
3. *Other "structures".* For example, organizational structures, emergency preparedness plans, long range community plans and policies.

Local Government Response to Infrastructure Issues

Jim outlined a sequence of seven steps that communities can follow to develop local responses to climate change on infrastructure issues.

1. *Collect and review community data on climate change.* This step involves determining what is happening in your area that relates to your infrastructure, and determining what impact climate change might reasonably have on your infrastructure.
2. *Create an Infrastructure Inventory.* The next step is to determine what infrastructure you have, what condition it is in, and what action needs to be taken to “climate proof” it in the short, medium and long term
3. *Prioritize the Inventory that Needs Recording or Replacement.* Jim recommended using a matrix evaluation that rates urgency of action with the cost or other factors that are considered important.
4. *Develop an “ideal action plan” based on the priorities identified.* This step involves identifying all of the actions that need to be taken, and then listing the actions in order of priority.
5. *“Cost” the action plan.* The next step is to identify the dollar costs associated with each action, and other resources that are needed to carry out the action plan (i.e. technical experts). A long-range financial plan can then be developed that incorporates climate change activities with routine operations in operating and capital budgets. This plan should identify shortfalls in finances and other resources.
6. *Develop a plan for dealing with the shortfalls.* Once shortfalls are identified, local governments will need to consider what can be achieved by restructuring available resources, determine whether or not additional sources of funding will need to be accessed, and develop a plan to attract outside resources. Jim recommends that communities work together to develop recommendations for senior governments regarding changes to funding regimes and to suggest new programs or other forms of assistance.
7. *Begin implementing the plan.* The final step is to incorporate the infrastructure action plan with the plan to attract outside resources.

Jim concluded his presentation with a few recommendations. He said that communities should try to take an adaptive management approach. Only by stepping outside of the process to take a broader look at changes within and outside the community will communities benefit from what has changed and be able to take advantage of new information when developing responses. He said

that the most important decision communities can make will be to forge partnerships as this issue can't be effectively dealt with on an individual basis.

Discussion

Following Jim's presentation, the workshop Facilitator opened up the discussion by asking for questions from workshop participants.

One participant asked how this process such as this can be kick-started in communities across the Yukon. Jim recommended that one-on-one community visits, such as those carried out by the NCE in the summer of 2000, be carried out to heighten awareness of the issue. He recommended that the NCE attend the Association of Yukon Communities Annual General Meeting to make a case for why initiating this process would be important. He said that a lot of communities are not familiar with who to talk to about climate change, and that some local governments may require assistance with knowing where to look for information. He suggested the NCE work to raise the profile the climate change issue, and improve access to information on what other communities are doing nationally and internationally. He agreed that a manual for local governments outlining a step-by-step process, that is relevant to northern communities, would be useful.

Another participant asked a question regarding how much responsibility should local governments take for reducing greenhouse gas emissions. Jim explained that the City of Dawson is facing similar issues with respect to sewage treatment - the City can't afford to do upgrades on their own despite a legislated mandate, and need assistance from senior governments. He said that local governments can require that climate change factors be considered when developing and designing new buildings, such as by passing bylaws requiring R2000 or C2000 codes be followed. He also said that individual responses are the toughest to make happen, but the responsibility for action lies more at individual level. Individual actions drive the decisions made by local and senior governments.

One participant noted that various levels of government need to be involved in the climate change issue, and provided an example from Ontario where the provincial government is not willing to make investment in public transportation, and local governments are begging for new roads instead of public transportation. The participant said that regardless of the price of gas, people are very reluctant to change their patterns of vehicle use. He emphasized that education of the general public and decision-makers is very important, and as an individual and a resident and citizen of Ontario, he feels helpless about

what is happening. Jim responded by saying that a feeling of helplessness may arise from uncertainty about what facts are and not knowing where to start to take action.

Session II: Emergency Response Planning in the Central Yukon

Presentation: Kevin Wallinger, Planning and Training Coordinator, Government of Yukon Department of Community and Transportation Services, Emergency Measures Branch

Kevin Wallinger of the Emergency Measures Branch began his presentation by stating that the only constant is change. In the case of emergencies, he said that the questions that need to be asked are what is an “emergency”, where will it happen, who will respond, when will it happen, what will the impact be, and what can be done. He emphasized that emergencies encompass immediate individual issues as well as community issues.

Kevin explained that there will always be emergencies, and it is impossible to prevent them from happening altogether. However, he did say that steps can be taken to minimize damage from impacts. Emergency responses come from a number of parties, a single agency or level of government can't handle an emergency situation alone. When an emergency does occur, there needs to be partnerships between the various agencies involved and partners must focus their efforts on the same goal and work towards the same result.

Kevin explained that the incident rate of weather-related disasters is increasing globally. At the same time, the cost to respond and recover is growing. Kevin attributes the global increase in the impact of natural disasters to an increase in population and infrastructure. He said that climate change may be responsible for the increase in the magnitude and frequency of disasters, but the effects of these events have not changed. In response to a question regarding the availability of data for the central Yukon on the rate of occurrence of natural disasters, he said that more forest fires and potentially more flooding has occurred over past 10-15 years, but he is not convinced that this is related to climate change.

He emphasized that if individuals and communities are prepared now for emergency events they will continue to be prepared if they happen more frequently in the future. He also said that with a greater frequency of emergencies, responses to these events will become more efficient. With more advance preparation to reduce or mitigate impacts from extreme weather events via preparedness and planning, response and recovery costs will be less.

Kevin outlined two types of emergencies: sudden or unexpected (i.e. a severe storm or forest fire), and gradual or predictable i.e. flooding and drought). He also outlined three levels of responses that are considered when prioritizing responses to an emergency situation. The first priority is to save lives and rescue injured, second is to protect property, and third is to protect the environment. Recovery is defined as assisting people with returning to their homes, re-establishing government and businesses, and reducing the chances of re-occurrence.

He explained the difference between an emergency and a disaster. Disasters endanger lives and can't be brought under control using regular resources, and emergencies are abnormal situations requiring prompt action beyond normal procedures. Emergencies can happen any time, can affect lives, property and the environment, can arrive suddenly or gradually, and they can be prepared for through awareness, training, education and planning.

Kevin explained the differences between awareness, training and education. Awareness of the importance of emergency response planning can be achieved through the media, displays, brochures, and presentations. Kevin explained that the more people are aware of the dangers associated with emergency situations, the more ownership they will take in preparing themselves. Training of individuals (fire escapes, grab and go), agencies (fire departments, ambulance), and multi-agencies (communications, equipment) is also important. Education can take place through school programs, public meetings, and events.

Emergency response planning involves identifying hazards, analyzing risks, setting priorities, establishing roles and responsibilities, and practice. Planning is key to establishing a legal framework, identify all potential hazards, evaluate the risk of occurrence of hazardous situations, understand what is most likely to happen, determine roles and responsibilities and communication protocols during an event in advance of the event taking place. He explained that sometimes it is appropriate to have one "all hazards approach" plan, plus a contingency plan for each hazard.

The Canadian Emergency Management System outlines roles and responsibilities of the various agencies involved in responding to an emergency.

The primary responsibility lies with the individual, then municipality, then territory, then federal. Responsibilities moves up a level when the resources required to respond to an emergency exceeds the capacity of that level to respond. Responsibilities are as follows:

- Individuals are responsible for protection of their own property. Examples include site selection, sump pumps, insurance, and a grab and go kit
- Communities are responsible for response preparedness planning, and by-laws that may prevent the magnitude of an impact. The Mayor and Council can declare an emergency, and can decide to assist other communities during emergency situations.
- The Yukon government has legislation in place requiring territory-wide planning, emergency management training, and responses for unincorporated communities. The territorial government can assist communities with resources, and has access to federal government assistance for recovery. The government provides recovery on critical infrastructure, and social and health services following an emergency.
- The federal government has legislation in place requiring national emergency response planning and training, and a fund for preparedness, response and recovery, and mitigation strategies.

Kevin concluded his presentation with a discussion on funding. In the Yukon, there is a joint emergency preparedness program between the federal and territorial government that is cost shared. Communities can apply for funding for emergency planning, training, and mitigation (i.e. dikes and equipment). Planning is highest priority for funding under this program. Arrangements for disaster financial assistance is a federal program, cost shared with territory, to provide assistance for loss recovery. This program requires that all other avenues for financial assistance must be exhausted before a funding application will be reviewed, including insurance claims, local assistance, and litigation.

Kevin recommended that individuals and communities take responsibility for being prepared for an emergency, regardless of whether or not climate change increases the magnitude and frequency of events. He emphasized that it is the responsibility of the community to have emergency response plans in place, not the Yukon government.

Discussion

Don Trudeau facilitated a discussion period following the presentation.

A question arose regarding what sort of planning or data recovery is underway in Yukon regarding climate change and emergencies. Kevin responded that there are no plans within the Yukon Government to collect information on the return intervals of certain events, or historical costs of response and recovery.

Another question arose regarding how much the Emergency Measures Branch is monitoring issues surrounding climate change and emergencies. The participant said that they got the impression from his presentation that this issue isn't raising any flags within the Government, therefore should communities take action to update their preparedness plans in response to climate change? Kevin responded that he doesn't believe climate change requires any additional consideration in emergency response planning. He clarified that it is the responsibility of municipal governments to carry out emergency response planning, and the Yukon Government does not see any need increase its awareness programs in response to climate change. He also stated that he thinks increase in extreme events is an assumption people are making and there is no data to prove that this is the case.

Another participant questioned if climate change affects how communities should plan for emergencies, and whether or not the resources that are available for communities to mitigate and respond to emergencies is sufficient. An example of forest fire hazard mitigation was given, and it was pointed out that additional resources for fuel reduction may be required than presently available, and the importance of this work may become more important with increasing summer drought and incidence of lightning strikes. Kevin emphasized that no additional planning or resources are required to prepare for emergencies in light of climate change.

Session III: Regional Planning and Climate Change

Presentation: Ron Cruikshank, Director, Yukon Land Use Planning Council

Ron Cruikshank, Director of the Yukon Land Use Planning Council (YLUPC) began his presentation by comparing the cost of gas to drive from Whitehorse to Mayo in a 36L truck (\$128), a 6L pick-up truck (\$50), a ford escort (\$23), and a gas-electric hybrid vehicle (\$11).

Ron explained that the YLUPC is a three party advisory council of the federal government, Yukon government, and Yukon First Nations. It is an independent

public council, initiate and guide regional land use planning processes and to assist Regional Planning Commissions (RPC's).

Regional planning examines the needs people have for the land and its resources and recommends ways by which conflicts between users can be avoided. Land uses include mining, oil and gas, forestry, water use, hunting, trapping, fishing, transportation and communication, sand and gravel, protected areas, tourism, housing, and waste disposal. Region planning considers the long term sustainability or health of a region's economy, culture and environment.

The mandate of the RPC is to produce a draft final regional land use plan for consideration by the parties – the Federal Government, Yukon Government and Yukon First Nations. The Commission does not produce the final plan. RPC's adhere the following goals when developing a land use plan:

1. Aims and goals for land use must be established
2. Knowledge about the land and forecasts about the future are used, and ad hoc decisions avoided
3. Different options for future land use are considered
4. Plans are a basis for decision-making
5. Plans require periodic review and flexibility

Eight potential planning regions have been recommended by the YLUPC – Kaska, Northern Tutchone, Peel River, North Yukon, Dawson, Kluane, Whitehorse, and Daak Ka Tlingit. The Northern Tutchone region includes Pelly Crossing, Carmacks and Mayo.

Regional Planning Commissions typically consist of 6 members – 2 First Nation, 2 Government and 2 based on the population within the region. Members are nominated, and because they are not representatives of a particular group, they act independently. Members of the Northern Tutchone Planning Commission have not yet been nominated.

The following milestones are associated with the development of a land use plan:

1. Land claims are settled
2. RPC is created
3. RPC creates precise terms of reference
4. RPC produces plan – issue and information gathering, plan options, draft plan, final draft
5. Plan is reviewed and approved by the parties to the plan – the Federal Government, Yukon Government and Yukon First Nations.

Public review and consultation is essential to the planning process. Consultation provides RPCs with issues, interests, information, forecasts for land use, and potential solutions to planning problems. The people who know problems associated with land use planning area also likely to know the solutions.

The final plan is guideline for regulators and resource managers. The power of the weight of plan decided by the parties to the plan, as implemented through their regulatory system. Regional Land Use Plans will be linked to Development Assessment Process (when implemented).

After land claims have been settled, the parties establish commission, and general terms of reference agreed upon. Approximately 2-3 years after a commission is created the plan is completed, however, this varies from region to region. The Federal Government agreed to allocate \$7.4 million for RPC's (roughly 1 million per plan), and the YLUPC annual budget is \$450k.

Ron also discussed the concept of a planning cycle. A planning cycle determines when plans will be reviewed, and the live expectancy of a plan. Typically, a planning period is 5 years in length. He noted that climate change occurs over a much longer time period than a planning cycle.

Ron identified four issues associated with climate change and regional land use planning.

1. Climate change mitigation and adaptation
2. Cumulative impacts
3. Yukon Protected Area Strategy
4. Forecasts and land use planning

Ron explained that it is likely that commissions will likely consider actions to mitigate climate change (i.e. reduce greenhouse gas emissions and protect natural carbon 'sinks') and actions to respond to the impacts of climate change (adaptation).

Regarding cumulative impacts, Ron explained that global climate change is a result of the total impact of human activity. Since land use plans should consider the cumulative impacts of land uses, he posed the question of how much of an obligation a RPC has to consider the need to prevent further global climate change.

Ron also questioned the role of climate change in designating areas under the Yukon Protected Area Strategy (YPAS). YPAS calls for a network of protected areas in Yukon with a protected area in each ecoregion. If ecoregions change

boundaries change as a result of climate change, will there be a need for some flexibility in YPAS?

Ron concluded by saying that planning requires accurate forecasts of future conditions, and climate change forecasting can assist planners with managing uses under changing land conditions.

Session IV: Forest, Fish and Wildlife Management

Presentation: Mark O'Donoghue, Regional Biologist, Government of Yukon

Mark O'Donoghue, Regional Biologist for the Yukon Government, cautioned against making predictions regarding wildlife and wildlife management. He explained that there is tremendous uncertainty, especially when it comes to interactions between wildlife, plants and climate, and making predictions can imply that we know more than we do.

Mark also doesn't recommend doomsaying on the topic of climate change, as it tends to turn off non-believers. However, he did indicate that there is certainty amongst the uncertainty. Climate is changing, and these changes will affect wildlife. It can be said with a great deal of certainty that the central Yukon will gain some species and lose some species, can make predictions about things that are most likely to change

Mark showed graphs and explained trends in calf survival rates of the Ethel Lake caribou herd. This herd, with a population of 300-400 animals, requires that 25-30% of caribou cows have calves in fall for the population to maintain itself. In 1998, snow lasted late into the spring and only 18% of the cows had calves. This trend continued in 1999 when no cows gave birth, and again in 2001 when only 5% of cows had calves. The Ethel Lake herd is not expected to do well if this trend of heavy snowfall and a persistent snowpack into the spring continues. Mark also gave the example of sheep at Talbot Arm, when in 1992 and 1999 late springs and more snow corresponded with a low lamb survival rate.

Mark also explained how warmer winter temperatures can increase human activity in areas of important winter range for caribou, especially in late winter. People tend to spend more time outside in late winter if the temperatures are milder, which can disturb animals. Mark explained that this can be especially

stressful for caribou if there are no cold snaps, and lots of human activity, throughout the winter.

Forested valley bottoms are very important winter ranges for caribou. Open areas have deeper snow than forested areas, and are more difficult for herds to travel through. Caribou spend more time digging through deeper snow looking for forage, and tend to spend more time in sheltered forest in winter months where it is easier to find food. If there is an increase in forest fires in lowlands it will make it difficult for caribou to find food in winter. In deep snow they need to spend more time pawing the snow to find food, which uses more energy and takes time away from eating. Mark gave the example of the Pelly Tatchun herd (population 300 animals) where much of the winter range has burned.

Mark explained research that has shown that caribou are harassed by mosquitoes and parasitic flies more during warmer summers. During warm weather the insects are more active and the caribou spend more time standing around and less time feeding. Caribou take refuge on snowpatches in summer months to get relief from insect harassment. In the southwest Yukon, permanent snowpatches are melting revealing evidence of use of these areas by caribou for thousands of years. Mark also mentioned some of the modeling that has been done on the Porcupine caribou herd that show a direct relationship between the degree of insect harassment and herd population size.

Mark also discussed the relationship between moose and climate change. Forest fires, which have increased in size and frequency in the central Yukon over the past few decades, improve moose habitat. In newly burned areas, willow tends to be prevalent, creating good forage for moose in the short term. Very hot burns will negatively affect moose habitat, however, Mark expects that moose will likely continue to benefit from improved forage if forest fires continue to increase in size and frequency. Ticks, which can cause significant adverse effects to moose populations because they can cause hair loss leading to death from exposure, are historically rare north of 60 degrees latitude and are now seen in the southeast Yukon. How these impacts of climate change will balance out and impact moose populations in the long term remains to be seen.

If climate change does result in an increase forest fires beavers will also likely benefit from improved habitat and forage, Mark explained. More beavers means more beaver ponds, which are in turn beneficial to some wildlife species (i.e. dabbling ducks and waterfowl), and detrimental to others (i.e. dams pose a barrier to the movement of chinook salmon and whitefish). Mark also noted that larger beaver population is also attributable to low fur prices and less trapping.

Mark also discussed some of the recent sightings of cougars in the Territory. He believes that cougars are following deer, and many folks think there are now more deer in the Yukon because of the warming trend. Mark said that the presence of cougars would now require that safety information to be made available to the public. Mark also said he is uncertain how climate change will affect deer populations, because similar to caribou, deer don't like deep snow that persists in the spring. If snow melts early in spring, he said that deer will likely benefit from warmer temperatures.

Mark also mentioned that new songbirds are appearing and at different seasons, and this winter he noticed some species arrived earlier in the year (i.e. waxwings). He raised the issue of spruce bark beetles. Very cold winter weather kills beetles and has prevented their northward expansion, and without the coldsnaps in the winter, bark beetles could become a problem in the future.

To conclude his presentation, Mark said that he expects species that are negatively affected by deeper snow will be negatively affected in upcoming years. He also expects those species which are positively affected by warmer temperatures will be positively affected in upcoming years. He encouraged workshop participants to be willing to adapt if and when changes take place, and gave the example of harvesting levels and how they will need to change to adapt to new conditions. Some intensive management techniques, which are often not very popular, may be required to conserve a particular species of interest in response to climate change (i.e. maintain live fish run by managing beaver, predator control when caribou numbers getting to low). He also recommended additional monitoring to keep track of changes that are taking place.

Presentation: Jill Johnstone, Graduate Student, University of Alaska

Jill began her presentation by displaying a map of the Arctic showing temperature change over the past three decades. The central Yukon lies within the area on the map that has seen the greatest warming.

Jill discussed the effects of climate on plant growth and ecosystem processes. Factors that limit plant growth -- sunlight/warmth, water, carbon dioxide, and nutrient availability - can all be influenced by climate change. Increased annual air temperatures result in a longer growing season, warmer soil temperatures, possible increased decomposition in the soil leading to increased soil nutrient availability. These factors combined suggest that a warmer climate will increase in plant growth. An increase in the amount of carbon dioxide concentrations in the atmosphere can also increase plant growth, providing other limiting factors

are in ample supply. Jill explained that increased decomposition may have a greater impact on increasing tree productivity than increasing atmospheric carbon dioxide concentrations, and noted that trees are genetically constrained in their ability to respond to changing conditions.

Warmer temperatures can affect plant growth positively or negatively depending on the availability of water, as moisture greatly influences plant response to climate change. If the climate is warm and dry, such that there is no available soil moisture, plants are unable to access water through their roots, and leaves wilt from evapotranspiration. If it is warm and moist, and there is an adequate supply of water in the soil, plants will grow and thrive.

With warmer temperatures, there is greater evaporation. Without an increase in precipitation alongside an increase in temperature, conditions will be drier. Increased snowmelt may provide some extra water for vegetation but if snow melts early in the spring, additional moisture may not be available in mid-summer. Melting of permafrost can also compound this effect as melting leads to better drainage and therefore, less water at surface that is available for plant growth.

The impact of climate change on plant growth can also depend on the physical location of the plant. Jill explained research that has documented improved plant growth at the bottom of slopes (where conditions are moister) and poorer growth at the top of slopes (where conditions are drier). This relationship also varies between species; aspen, white spruce and lodgepole pine have better growth in drier conditions, whereas black spruce prefers wetter conditions. She also explained that assessing growth by tree rings also relates to the physical location of trees. Annual variations in tree growth at the top of a slope are more of a reflection of moisture conditions, and annual growth of trees at the bottom of a slope reflects temperature conditions.

Jill also discussed how climate change might the type and frequency of forest disturbances (i.e. fire, insects, disease, windthrow). In a warmer climate, insects may become a more important factor in forest disturbance. Trees that are drought stressed are likely to be more vulnerable to infestations, and warmer temperatures may result in insects in areas that used to be too cold. Jill explained that warmer and drier weather in western Canada seems to be contributing to an increase in forest fires. The most significant fire years on record for the Yukon are 1989, 1994, 1995, and 1998 (the largest on record). Jill explained that most fires are small, less than 0.1 ha in size, and 98% of fires are 40 ha in size or smaller. Very few fires are large in size but these tend to burn more total area across the landscape than smaller fires.

Jill concluded her talk by explaining what these predictions mean for people and forest management. She said that it is becoming increasingly important to develop management plans for reacting to forest insect outbreaks. She also explained that it is unlikely that climate-driven changes in fire activity can be effectively dealt with by increased fire suppression. Planning can establish priority areas where suppression efforts should be concentrated, but it is often difficult to protect remote resources (i.e. camps), which Jill feels needs greater recognition by managers and the public. Where protection of resources is important, managers should consider alternatives to suppression such as prescribed burning and fuel management including fuel removal near communities, changing to less flammable fuel types (i.e. aspen-birch instead of spruce-pine), and creating fire breaks.

Forest harvest planning needs to taken into account changes in forest productivity and species distributions. As currently forests become more in disequilibrium with climate, it will become less likely that the same forest type will re-establish after human or natural disturbance.

Wrap Up Session - Where do we go from here?

Don Trudeau, Workshop Facilitator

Don Trudeau closed the workshop with a discussion on future steps. Don emphasized that a number of challenges lie ahead, and asked participants to discuss where actions should be taken locally to respond to these challenges. He asked workshop participants to consider the following questions, and to provide their thoughts in a roundtable discussion.

1. When do we make decisions regarding land use and planning in the community?
2. Which of these decisions are influenced by climate change?
3. How can results of day 1 (what do we know) be incorporated into local decision making?

A number of suggestions were offered:

- Document traditional and local knowledge on climate change.

- Create a local databank. The databank should be easily accessible, in electronic format, and be integrated with the NCE databases.
- Develop a community based monitoring program. Set up a pilot program for ground based monitoring of climate change indicators (for example, by trappers and others who spend time on the land), and formalize how this information will feed into management and planning. Mention was made of a NCE proposal to the Northern Ecosystem Initiative to host a workshop to develop indicators of climate change and bring together the various groups that are interested in doing this type of work across the North.
- Implement a school based monitoring program. The program should be integrated into school curriculum, and have support from parents. Mention was made of the NCE Climate Change Schools program, and the GLOBE program.
- Develop a forecast of what impacts will be at local level to make the issue more real to individual communities. The forecast should summarize climate change scenarios and predictions.
- Show Federal Government what seeing locally, life changing experience to take people around one of the best ways to drive issue home
- Get involved, don't depend totally on others, make a commitment
- Get individuals in each community to be the "local expert" to assist in disseminating information. It was noted that the NCE applied for funds to train a local representative from each community, but this work wasn't funded.
- Strategize on how to make southerners aware of the changes occurring in the north. The Porcupine Caribou Management Board had a successful campaign on oil and gas development on North Slope that could be used as a model
- Develop circumpolar partnerships to share information.
- Celebrate and build on successes, instead of focusing on bad news issues
- Frank mentioned the Sustainable Communities Initiative, which involves shaping an accord for central Yukon communities to work together, and expects workshops will be taking place on the initiative right away in which climate change will play an important role.
- Shannon said she intends to present the workshop summary report to Mayor and Council, then start the planning process. She explained that a decision needs to be made by Mayor and Council at a meeting to make climate change an agenda item at future council meetings. Shannon also mentioned an upcoming meeting of municipal governments in Watson Lake, the Association of Yukon Communities Annual General Meeting, and she hopes climate change will be an item on the agenda for this meeting.
- Jim said the next steps should be to move forwards from inventory and data gathering. He cautioned against inaction on the climate change issue because of gaps in the database and incomplete information. He recommended that

communities follow a defined process to deal with the climate change issue, and to follow that process step by step.

- One participant suggested that a lot of thought is needed to determine which local decisions have a climate change component, and suggested that it is not going to be easy to ascertain which decisions need to take climate change into account.
- Ron recommended we deal with the obvious issues surrounding climate change now, such as committing to reducing greenhouse gases. The degree of adaptation that will be required will depend on actions taken now to reduce emissions and he recommended moving forward cautiously in decision-making processes relating to adaptation.
- Kathy recommended monitoring for unforeseen hazards and opportunities, and to exploit opportunities when they arise.
- Chris discussed time and resources, which is what all actions on climate change will require, and how they are in short supply. Chris expressed concern that the emphasis on work done to date on the issue has been in the south and that the actions promoted to reduce greenhouse gas emissions have been voluntary.
- Mark discussed the issue of monitoring. In the 1970s and 1980s, monitoring used to be done by the federal government. Funding cutbacks resulted in fewer stations a substantial loss in coverage and quality of data since the early 1990s. The Yukon Government has not assumed this responsibility, leaving communities to enact their own monitoring systems. Communities need to attach a small amount of effort to an existing job description for monitoring, to ensure communities have access to a continuous long-term record. Mark said that if any community can do it, Mayo can do it and show rest of Canada how community-based monitoring can be done.
- Frank mentioned the need for a local education program will help to reduce gas emissions from landfills that affect atmosphere
- Brad expressed a need for prioritizing areas that require special attention and acting on these areas.
- Aynslie - suggested that communities foster a 'home-grown' local climate change expert that can be called in whenever a decision is being made that could have a climate change component
- John- explained that Yukon First Nations, including Nacho Nyak Dun First Nation, are working on establishing an environmental officer position. Part of this job would be monitoring and becoming an expert on local environmental management issues. He mentioned that if this position is established, which would happen in the next year, the officer will be shared among agencies in town.
- Kathy expressed a need for youth to get excited in studying the environment. This could happen through presentations in schools, and parental encouragement.

- Chris explained that interest in environmental professions has declined over past few years, and not as many people are entering the field. Computers and high-tech is more of a draw, and he noted that the environment can't be managed from a computer. He suggested a scholarship fund be established to provide incentive to youth to get started in this field.
- Frank mentioned that funds for youth programs are available through First Nation Youth and Elder programs, and encouraged interested parties to write a proposal to encourage Youth involvement in climate change.

**APPENDIX A
CENTRAL YUKON CLIMATE CHANGE WORKSHOP
AGENDA**

DAY 1 - WHAT DO WE KNOW?

8:30-9:15	Welcome	
8:30-8:40	Opening Prayer	(TBA)
	Welcome/Introductory Comments	Facilitator: Don Trudeau
	Introductory Comments	Aynslie Ogden
	Roundtable Introductions/Participant Expectations	Facilitator: Don Trudeau
9:15-10:30	Local and Regional Climate Change Observations and Concerns	
9:15-9:30	Municipal Perspective	Shannon Cooper
9:30-10:00	Observations and Concerns	Elder(s) (TBA)
10:00-10:45	Climate Change Science	Chris Burn
10:45-11:15	Break	
11:15-12:30	Session I - Climate Data	
10:45-11:30	Presentation of inventory data	Vicky McCoy
11:30-12:30	Discussion and local observations	Facilitator: Don Trudeau
12:30-1:30	Lunch (provided)	
1:30-2:45	Session II - Physical Trends	
1:30-1:45	Presentation of inventory data	Chris Burn
1:45-2:45	Discussion and local observations	Facilitator: Don Trudeau
2:45-3:00	Break	
3:00-4:15	Session III - Social Trends	
3:00-3:15	Presentation of inventory data	Vicky McCoy
3:15-4:15	Discussion and local observations	Facilitator: Don Trudeau
4:15-5:00	Wrap up session	Facilitator: Don Trudeau
	This session will conclude the day by summarizing the state of knowledge of climate change in the Central Yukon, drawing out the most relevant trends, and creating a "local" story or perspective on climate change based on available information.	

DAY 2 - WHERE DO WE GO FROM HERE?

8:30-9:00 Welcome

Review of Day 1

Facilitator: Don Trudeau

9:00-10:30 Session I - Climate Change and Local Infrastructure

9:00-9:15 Presentation

Jim Kincaid

9:15-10:30 Discussion and local observations

Facilitator: Don Trudeau

10:30-10:45 Break

**10:45-12:00 Session II Climate Change and
Emergency Response Planning in the Central Yukon**

10:45-11:00 Presentation

Kevin Wallinger

11:00-12:00 Discussion and local observations

Facilitator: Don Trudeau

12:00-1:00 Lunch (provided)

1:00-2:45 Session III

Climate Change and Forest, Fish and Wildlife Management

1:00-1:30 Presentation

O'Donoghue/Johnstone

1:30-2:45 Discussion and local observations

Facilitator: Don Trudeau

2:45-3:00 Break

**3:00-4:15 Session IV - Climate Change and Land Use Planning in Central
Yukon**

3:00-3:15 Presentation

Ron Cruikshank

3:15-4:15 Discussion and local observations

Facilitator: Don Trudeau

4:15-5:00 Wrap up session

Facilitator: Don Trudeau

This session will wrap-up the day by discussing the following questions: When do we make decisions regarding land use, planning in the community? Which of these decisions are influenced by climate change? How can results of day 1 be incorporated into local decision making? Where should we go from here?

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